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## Foreword

Welcome to the Journal of Information Systems & Operations Management (ISSN 1843-4711; IDB indexation: ProQuest, REPEC, QBE, EBSCO, COPERNICUS). This journal is an open access journal published two times a year by the Romanian-American University.

The published articles focus on IT&C and belong to national and international researchers, professors who want to share their results of research, to share ideas, to speak about their expertise and Ph.D. students who want to improve their knowledge, to present their emerging doctoral research.

Being a challenging and a favorable medium for scientific discussions, all the issues of the journal contain articles dealing with current issues from *computer science, economics, management, IT&C*, etc. Furthermore, JISOM encourages the cross-disciplinary research of national and international researchers and welcomes the contributions which give a special “touch and flavor” to the mentioned fields. Each article undergoes a double-blind review from an internationally and nationally recognized pool of reviewers.

JISOM thanks all the authors who contributed to this journal by submitting their work to be published, and also thanks to all reviewers who helped and spared their valuable time in reviewing and evaluating the manuscripts.

Last but not least, JISOM aims at being one of the distinguished journals in the mentioned fields.

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# The Proceedings of Journal ISOM Vol. 14 No. 1

## CONTENTS

### Editorial

<i>Roxana Ștefania BÎRSANU</i>	<b>ANDRAGOGY AND FLT IN THE e-LEARNING CONTEXT</b>	7
<i>Mihai Alexandru BOTEZATU, Alexandra HOSSZU, Cezar BOTEZATU, Cornelia Paulina BOTEZATU</i>	<b>RESEARCH ON THE CORRELATION BETWEEN THE USE OF MODERN INFORMATION AND COMMUNICATION TECHNOLOGIES BY ORGANIZATIONS AND REGIONAL SUSTAINABLE DEVELOPMENT</b>	22
<i>Daniela Alexandra CRIȘAN Justina Lavinia STĂNICĂ Adam Nelu ALTAR-SAMUEL</i>	<b>COMPETITIVE PROGRAMMING. AN ANALYSIS OF THE PERFORMANCE IN ROMANIA</b>	43
<i>Ioana Monica DICHER Ana-Georgia ȚURCUȘ Eduard-Marius COJOCEA Patricia-Steliana PENARIU Ion BUCUR Marcel PRODAN Eduard STĂNILOIU</i>	<b>UNSUPERVISED MERGE OF OPTICAL CHARACTER RECOGNITION RESULTS</b>	60
<i>Ionel IACOB Mironela PIRNAU</i>	<b>SQL INJECTION ATTACKS AND VULNERABILITIES</b>	68
<i>Alexandru ILINU Cristian AVATAVULUI Giorgiana Violeta VLĂSCEANU Costin-Anton BOIANGIU</i>	<b>VOTING-BASED MOTION ESTIMATION</b>	82
<i>Ionela-Cătălina ZAMFIR Ana-Maria Mihaela IORDACHE</i>	<b>A REVIEW OF DATA MINING TECHNIQUES IN MEDICINE</b>	93
<i>Alexandra MĂRGINEAN</i>	<b>EMPIRICAL ASPECTS IN THE PSYCHOLOGY OF ONLINE TEACHING OF FOREIGN LANGUAGES</b>	107
<i>Alin-Florin MIHĂILĂ Patricia-Steliana PENARIU Giorgiana Violeta VLĂSCEANU Marcel PRODAN</i>	<b>ON IMAGE SEGMENTATION USING A COMBINATION OF FELZENSZWALB, SLIC AND WATERSHED METHODS</b>	121

<i>Jose MUJICA EE, Ramon A. MATA-TOLEDO</i>	<b><i>DIFFERENCING BETWEEN DECIBEL (DB) ADDITION IN ROOM ACOUSTIC DESIGN AND LINE ARRAY LOUDSPEAKERS DESIGN</i></b>	130
<i>Robert STANCA Eduard-Marius COJOCEA Cristian AVATAVULUI Costin-Anton BOIANGIU</i>	<b><i>ON HOW TO COMBINE SINGLE IMAGE SUPER-RESOLUTION ALGORITHMS</i></b>	140
<i>Radu STEFAN George CARUTASU</i>	<b><i>EXPLAINABLE MACHINE LEARNING FOR ETHICAL ARTIFICIAL INTELLIGENCE BASED DECISIONS</i></b>	151
<i>Alexandru TĂBUȘCĂ Gabriel-Eugen GARAIS</i>	<b><i>IOT AND THE FLYING ANSWER TO COVID-19</i></b>	162
<i>Marilena Roxana ZUCA Alice Emilia ȚÎNȚA</i>	<b><i>THE RELEVANCE OF ACCOUNTING INFORMATION IN MEASURING THE PERFORMANCE OF AN ENTITY</i></b>	174
<i>Janina Mirela GABROVEANU (VLĂDOI)</i>	<b><i>THE INTELLIGENT SPECIALIZATION MECHANISM PROPOSED BY ROMANIA FOR ECONOMIC GROWTH</i></b>	193

## ANDRAGOGY AND FLT IN THE e-LEARNING CONTEXT

Roxana Ștefania BÎRSANU<sup>1</sup>

**Abstract:** *The teaching-learning dyad has incurred significant changes of dynamics as a result of the emergence of the information sharing medium which is the online education environment. One of these changes reflects a revisitation of andragogic approaches, as increasing numbers of adult learners enrol in e-courses, mainly for convenience reasons – they allow for information dissemination in a manner which satisfies their concrete professional needs, at a pace and in a time frame that can be easily fitted into their busy schedules. Relying on the andragogic principles developed by Malcolm Knowles, this paper sets to analyse them in the framework of foreign language learning, as the study of foreign languages might be one of the most challenging instruction areas for adult learners. Thus, the article first reviews some of the most frequently used methodologies of language teaching such as the communicative approach, grammar-translation, task-based learning, the natural approach or suggestopedia. The aim of this appraisal is to detect which of them are most suited for adult students on the one hand and for virtual classrooms, on the other. Special emphasis is placed on the transformative learning theory advanced by Jack Mezirow, which is usually applied in adult education.*

**Keywords:** *language teaching, e-learning, adult learner, transformative learning*

### 1. Introduction

The digital age has led to a reorganisation of the complex structures of social, professional and economic layers. It has represented a genuine game-changer in education as well, that has entailed an adjustment of the instructional paradigm in respect of all the elements involved, from learner profiles to curriculum design and reconsideration of teaching methods. This paper draws on an interdisciplinary approach, as it tackles issues pertaining to foreign language teaching, e-learning and principles of andragogy. It focuses on three aspects of the broad educational framework: learner – in this particular case, the adult learner –, subject matter – foreign language acquisition –, and medium – online learning as opposed to traditional forms of instruction. The above-mentioned training triad can be addressed from various perspectives; however, in this particular instance, the focus

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will be on the learners, on their needs and expectations as to the result of their learning endeavours.

In the broader context of adult education, language learning is probably in the top three of all types of courses (together with computer literacy and management skills) in which adult persons enrol once they graduate some level of formal education. Most learners take up language classes as a result of a need that arises in their social and professional lives: “Some may need mainly speaking and listening skills, other may have to learn to read and write for particular purposes. Others may need informal language mainly for social interaction rather than the more formal language required for work purposes. Alternatively, they may be more interested in cultural aspects of language learning rather than the strictly functional ones” [1].

In the last decades, the advancement of the Internet and the continuous progress of information technologies have made it possible for people to engage in online learning as well, which is oftentimes preferred to traditional face-to-face education. The aim of this paper is to look into some methods of foreign language teaching such as the grammar-translation method, suggestopedia or the communicative method in an attempt to identify which would meet best the varied needs of adult language learning students.

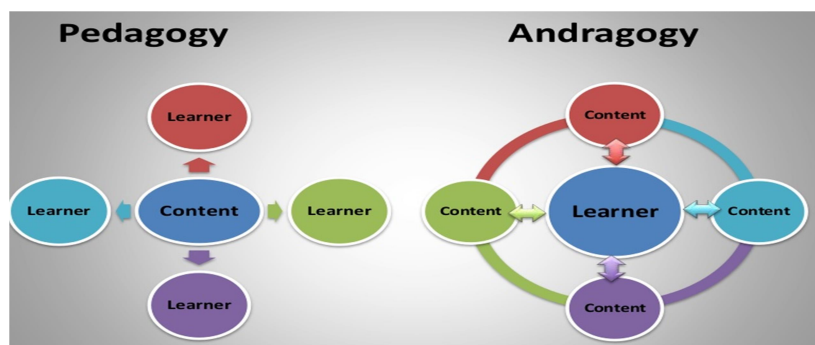
## **2. Notes on andragogic education**

In the context of continuous and fast pacing technological advances that constantly (re)shape the weave of professional interactions and expected outcomes, knowledge becomes a concept that needs constant readjustment. Such reconsideration does not necessarily refer to the content of knowledge itself, but to the actors and the general context involved in the transmission thereof. The age of students involved in ongoing learning processes has constantly increased, under the drive of new professional challenges they have to face. Likewise, the classical context of information imparting has ceased to be the norm, as both corporations and universities resort to online teaching as to a viable alternative to traditional courses. In other words, time has arrived for a reconsideration of learning in terms of how participants learn, what they learn, where and when they do it, as claimed in the 2019 UNESCO report on digital learning [2].

This paper focuses on the presumably optimal methods to be used in language teaching in a virtual classroom, when the students are adults. Before deciding on the most adequate teaching approach, tools, resources, assessment method etc, we will proceed to an analysis of the learner profile. Put differently, who are the learners, which is their motivation in engaging in this learning effort, previous experiences – both positive and negative and which are their expectations as to the outcome of the learning process.

The definition of the adult learner itself has made the object of debate, as researchers have taken into account different variables. Thus, some considered age as the main criterion of differentiating adult learners from children and adolescents, while others took into consideration social roles and even cognitive maturity. In this paper, we will adopt the definition that gives prominence to the criterion of age, and will concur with Myers et al. who adopt a definition “based on age (25 and over), but (which), when possible incorporates younger learners (20-24) who are still pursuing foundational learning such as a high school diploma or literacy and basic skills training as well as those who have assumed adult social roles such as having a child or working full-time as their primary activity” [3]. As can be inferred from this approach to adult learners, this is a category of students who are not only interested in the acquisition of knowledge for itself, but with a view to incorporating it in the real life and in the reality they are living and shaping.

The andragogic approach to learning dates back from the 19<sup>th</sup> century, when it was first formally claimed that there are differences between teaching children and teaching grown-ups [4]. However, the term andragogy became to be widely used in modern times due to the works of Malcolm Knowles, who made a clear separation between the principles of adult learning and those of instruction aimed at children in his book *The Modern Practice of Adult Education: Andragogy Versus Pedagogy*, which was published in 1970. The principles that form the basis of these two distinct learning paradigms were emphasised not only by Knowles, but also by other researchers in the field. The main idea is that in the case of pedagogy, the core of the learning process is the content, i.e. the process starts from the assumptions that students have an insufficient amount of knowledge; therefore, they need to be instructed and provided with the necessary information and thus come to rely heavily on the trainer. On the other hand, in andragogy the focus is on the learners – they have previous experience in the field, can contribute with their own beliefs and opinions and already know how to use the conveyed information in order to embed it efficiently and usefully in their professional life. The trainer is no longer the transmitter of information; s/he becomes more of a guide, a mentor who contributes to the further development of his/her students. This is the main difference between the two paradigms, which is best illustrated in the image below – that pedagogy is mainly content-centred, whereas andragogy is particularly learner-centred.



Another distinction between pedagogy and andragogy reflects the idea of the willingness to acquire information: while in children's case the need to be instructed is imposed from the exterior, in the case of adult learners, the need is intrinsic and is driven by their desire to fulfil their responsibilities better and more efficiently. Alternatively, because of their limited life experience, children can contribute little to the learning process and rely considerably on the resources made available by the trainer; adult learners, on the other hand, bring to the educational activity a wide range of already acquired skills and knowledge that can be successfully exploited by the trainer in the teaching process. Going further, in pedagogy the objectives are set by the teacher, are determined in advance and are inflexible; in andragogy, the objectives are flexible and are set together with the learners, depending on their needs and motivations.

The characteristics proposed by Knowles as describing adult learners are useful in sketching a profile of this category of students. The first he mentions is **self-concept**, i.e. the identity learners assume in the training process, which is not that of mere receivers of knowledge. They approach the learning process through the filter of the social status and roles they fulfil: "But something dramatic happens to their self-concepts when people define themselves as adults. They begin to see their normal role in life no longer as being full-time learners. (...) Their chief sources of self-fulfilment are now their performances as workers, spouses, parents and citizens. Adults acquire a new status, in their own eyes and in the eyes of others, from these noneducational responsibilities" [5]. The implications of self-concept for the practice of teaching have mainly to do with the learning climate, both physical and psychological, perhaps with greater emphasis on the latter. Learners should feel that in this learning environment they are accepted as they are and can express their ideas freely and without the fear of being ridiculed, bullied or punished.

Another feature of adult learners has to do with **experience**. Through the experiences that have shaped their lives, adults are themselves invaluable resources in the teaching/learning process. They already have a well-formed, complex identity. As Knowles claims, "Adults *are* what they have *done*" [6]. Among others, in the acquisition of new knowledge, this also means that it is easier for them to put a frame around and make sense of new information as they can connect it with previous experience. On the other hand, it also means that they already have some fixed patterns of thinking, which makes them less flexible. The implications for the teaching practice translate into the trainer's need to be fully aware of the huge importance of placing emphasis on the practical aspect of learning and on the application of teaching techniques that can exploit the learners' rich life experience. Such techniques may be case studies, role play, projects, simulation drills etc.

**Readiness to learn** reflects adult learners' interest in acquiring knowledge that has applicability for their particular situations, for the roles that they assume in real life. This feature is closely linked to the idea of motivation (of the learners) and

relevance (of the content). Again resorting to Knowles as reference, the implication for teaching is that care should be given to the structure of student groups, which should be established based on learners' interests, and to the relevance of the approached topics.

Finally, **orientation to learning** mirrors the fact that adult learners engage in the learning process as a result of the need to address specific and very concrete issues they are faced with. Therefore, as opposed to children – who are provided with information to be used at a later stage in life – adult learners need information that can be applied and implemented immediately; they are largely interested in knowledge that can assist them in solving problems and achieving performance. For trainers, this means that they have to be attuned to the concerns and interests of their learners, which would help them in properly designing the curriculum and in guiding the learning experience in the correct direction.

To sum up, one may claim that the adult learner profile suggests someone who has a very clear idea of who s/he is and why s/he engages in learning activities; someone who already possesses a certain life experience, that s/he is willing and even expecting to use as contribution to the learning experience; someone who has a very clear image of the relevance of the content s/he is expecting to be provided with and someone who, as a result of the learning process, hopes and demands to be able and use the newly acquired knowledge in everyday situations that represented in the first place the drive for enrolling in the respective instructional activity. Starting from here, the next step in our endeavour is to identify the particular case of adult learners in foreign language classroom, taking into account their main features and approaches to the learning process as indicated by Knowles.

### **3. Foreign language teaching and the adult learner**

As can be noticed from the consideration of the adult learner discussed above which takes into account age as the main defining factor, college students could be counted among adult learners. However, students pursuing academic training are not considered within the scope of this paper. Instead, it will focus on persons who have already graduated some form of formal training, who have already assumed a number of social roles and who are at the beginning of or already have a set career path. This category comprises for, instance, corporate workers, free lancers or simply persons who wish to improve their knowledge in a given field.

The area of knowledge under discussion in this paper is foreign language acquisition. Learners' motivation in pursuing language study is manifold. We could talk of extrinsic motivation, in the case of employees who are pressured by a multicultural work environment to handle a given foreign language better, this being a condition of improved performance; this form of motivation also reflects immigration intentions, when the learner is preparing for immersion into a

completely new culture and language. In these cases, we talk of integrative motivation, which “is identified with positive attitudes toward the target language group and the potential for integrating into that group, or at least an interest in meeting and interacting with members of the target language group” [7].

On the other hand – or sometimes adding to the extrinsic motivation – there are issues related to intrinsic motivation, in which case learners engage in language courses on their own accord. The underlying reasons for doing so may be trying not to lose face to younger peers at work who have a better command of the foreign language(s) most frequently used at the workplace; a drive for personal development that could be enhanced by accessing various resources which are mainly available in another language or simply because they feel the need to master a foreign language in order to be able and communicate better in an increasingly multicultural world. It is also true that many foreign language learners are drawn towards studying another language by previous and future expected travelling experiences, in which case they are also interested in acquiring skills that would assist them in mastering a certain level of intercultural competence.

As such, they enrol in language classes provided by language institutes and organisations, universities and colleges or continuous education institutions. In some situations, as is the case with large corporations, language courses are organised in-house, which allows for better structuring of classes and a customised curriculum which considers the particular needs of the employees in terms of language levels, desire to develop a particular skill (such as speaking or writing) and/or familiarisation with certain lexical fields, depending on the company profile. The success of the learning endeavour depends on a number of factors, among which the most relevant are “positive beliefs, motivation and self-confidence” [8]. To this, another significant one should be added, namely previous experience in learning in general and in language study in particular. Especially if the motivation is intrinsic, it is highly challenging for an adult learner to engage in language classes and not drop off in the early stages if his/her previous experience in the field was negative, with memories of failure and frustration.

We have seen above that in andragogy, the learner profile is more complex than in pedagogy, the implications for the trainers being that they have to adjust their teaching strategies and techniques to the particular needs, expectations, studying patterns and habits of this class of learners. In order to identify the optimal teaching strategies when dealing with adult foreign language learners, perhaps it would be opportune to take a look at some of the methods of foreign language teaching which are most frequently used.

The **grammar-translation method** relies heavily on the acquisition of grammar rules, which students put into practice through grammar exercises and translations from and into the target language. Although it places great emphasis on the structure of the language and enhances a quicker and better understanding of lexis,



this method does not hone the development of other skills such as speaking and listening; moreover, it does not help students think directly in L2 and does not account for untranslatable items and subtle meanings.

The **direct method** or the **natural method** of language teaching involves no use of the native language, which means that grammar rules are inferred from the resources used, vocabulary is taught through demonstration, realia and miming and there is a focus on question-answer drills. Since it stimulates learners to think mostly in the target language, places emphasis on speech, improves an increased language sense and encourages active student participation, it is particularly useful for learners who need to communicate efficiently in L2. However, it is not recommended for slow learners or those with no previous exposure to the language, it is difficult to apply in large classes and does not teach grammar in a systematic manner, if learners' focus is to improve grammatical proficiency.

**Suggestopodia** is a teaching method whose aim is to assist the command of conversational proficiency in a short span of time. According to Georgi Lozanov, the founder of this approach, learners' feelings are extremely important in the learning process and have to be "desuggested" of their psychological obstacles in order to focus fully on the process. "Suggestopodia sees learning as a process taking place through the interaction of two levels; the conscious linguistic level, which deals with language items, and a subconscious level which gives learners the impression that learning is easy and that they can carry out learning tasks" [9]. With this language teaching technique, the focus is on the content, some native language is used in order to explain vocabulary and grammar is presented without extensive explanations.

The **communicative approach** or **communicative language teaching (CLT)** has been largely used since the seventies, when it represented a breakaway from the then-classical audiolingual method of teaching languages. CLT has been greatly appraised for developing learners' linguistic competence in the context of real-life situations. With CLT, the syllabus focuses from the very beginning on the development of the four skills, which are worked on in an integrated-skills approach (which means enhancing more skills simultaneously). Learners study from authentic materials and the teacher is not a mere imparter of information, but a mentor, a guide, whose main role is to supervise student-student interaction, to stimulate learner motivation, to provide instructions and suggest activities and to offer constructive and effective feedback. Among the teaching activities preferred with this method are role-playing, open-ended debates and discussions, collaborative activities. The focus of CLT is assisting learners in communicating in authentic contexts, as ultimately "successfully learning a foreign language is assessed in terms of how well learners have developed their communicative competence, which can be loosely defined as their ability to apply knowledge of a language with adequate proficiency to communicate" [10]. The greatest advantage

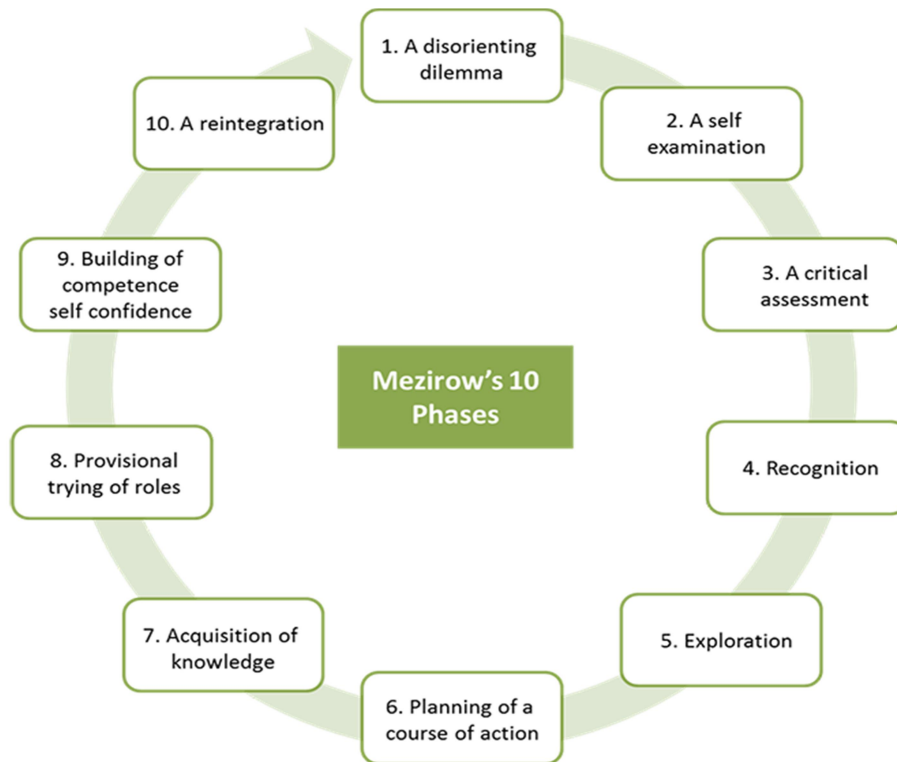
is that learners have the opportunity to bring to class their own life experience, turning it into a valuable resource for language learning.

Jack Mezirow developed the **transformative learning theory** in the late seventies. It was aimed specifically at adult learners who are encouraged to stimulate their thinking through disorienting dilemmas. Through critical thinking and questions, they are then expected to check whether their opinions and basic assumptions about the surrounding world are correct. With his theory, Mezirow's aim was to identify how people use self-reflecting to change their perspective on the world. He considered that they manage to achieve this by means of what he calls "disorienting dilemmas". When faced with such dilemmas, people are forced to use their critical thinking and reconsider their former perspective so as to frame the new experience into their general outlook.

In Mezirow's own words, transformative learning is "a process by which we transform our taken-for-granted frames of reference (...) to make them more inclusive, discriminating, open, emotionally capable of change, and reflective so that they may generate beliefs and opinions that will prove more true or justified to guide action" [11]. It is particularly effective in the context of adult learning, when recipients of new content are more aware of the need to constantly check and reconsider their view of reality and of using their experience as a frame for the acquisition of further information. Moreover, it is relevant in the context of learning as a general driver of change, as it places emphasis on "sociocultural awareness and understanding, with an objective of personal growth and positive changes in society as a whole" [12].

The concept of disorienting dilemmas is often used in learning environments, when trainers challenge learners to approach subjects and fields of study from new perspectives. Transformative learning can be easily and efficiently used in adult learner classrooms as it provides a good opportunity for practicing critical thinking – when dealing with new content, learners can debate upon it by engaging into discussions with their peers, confronting their own assumptions with those of their colleagues. It also offers the opportunity to relate to other learners who undergo similar transformative processes – learners exchange ideas and their own beliefs are altered and inspired by those of their peers. Finally, a transformative learning environment allows learners to act upon their newly acquired beliefs.

Mezirow claimed that transformational learning follows ten stages, which are illustrated below:



Source: [www.researchgate.com](http://www.researchgate.com)

The entire process starts with the occurrence of a disorienting dilemma, which leads to an analysis of the self under the form of a critical evaluation of one's own assumptions. The fourth stage is the recognition of the fact that there are other persons facing a similar dilemma, this triggering an exploration of potential options through discussions with those others. The next stage is designing a plan of action, with the logical sequence of acquiring the necessary skills and knowledge to put the plan into action. In the eighth stage, the person/learner is trying new roles, and s/he builds on skills and self-confidence necessary to fulfil these new roles. The final stage is the reintegration of the newly possessed perspective into the person/learner's life. These stages can be easily interpreted in the language learning context, but their implementation requires a significant amount of critical thinking and judgment; which is why this frame of learning is suited for adult learners, who have reached a certain level of maturity, are accustomed to juggling with frames of references in the process of knowledge acquisition and are willing to accept the idea that development entails at times necessary perspective shifts.

The language teaching methods briefly discussed above present both advantages and drawbacks in the context of adult learning. It is obvious that trainers could not

opt for a given approach based solely on learners' type. Things are more complex and more nuanced than that. Although students may all be included in the category of adult learners, there are other variables that determine the choice of a given teaching method or of a mixture of strategies. Such variables comprise the learners' level of language knowledge (in a mixed-level classroom, a blend of teaching approaches should probably best be put into practice), motivation (need of immediate application of language knowledge or simply improvement of one's language skills), different interests in content as far as lexis and grammar are concerned (some learners are more interested in consolidating grammar rules, while others are more preoccupied with acquiring new vocabulary) etc.

Therefore, the grammar-translation method may be useful for groups where the main emphasis is on the acquisition of language structures, with focus on writing and reading, as is the case with a business correspondence course, for instance. This approach would not be effective, however, with a large group of students or with learners who need to attain a level of speaking that may enable them to communicate efficiently in the studied language, in which case the direct method or the communicative one is best suited. Similarly, these methods are most frequently used in classes with advanced language level. On the other hand, they are unsuited for groups of beginners, as there is little to no use of the native language, or in the situation of learners with a negative previous experience of language learning, since such approaches might increase learners' frustration and sense of helplessness, probably leading to the undesirable outcome of drop off.

#### **4. e-Learning and the adult foreign language learner**

The adult learners whom we have mentioned above have to be functional in the current knowledge-based environment. This is their main stimulus for engaging in language learning courses after all. Actually, the challenge for them is double: on the one hand, to become familiar with new content, and on the other, to acquire the skills that could assist them in assimilating new knowledge as they need it. In other words, "as new technologies continue to quicken the pace of change in all parts of people's lives, learning to become a better learner is far more important than learning, for instance, the most recent finances or marketing tools" [13]. The focus is no longer necessarily on what you need to know, but on how to acquire the necessary strategies to help you learning the things that you still need to learn.

There is a wide range of institutions offering language courses for adult education – language institutes, universities or even high schools. In recent decades language courses, similar to other education forms that provide content for lifelong learning to adult learners, have largely moved to the virtual environment. E-learning is actually an extension of the distance learning that has been in used throughout the entire twentieth century and even before. Virtual instruction has become possible due to the development of a multitude of learning technologies which present a

number of valuable advantages to learners and training institutions alike. E-learning, as this form of education is mainly called, is increasingly preferred by learners to the detriment of face-to-face classes. However, there is a significant number of differences between the traditional form of instruction and virtual learning and for an optimal outcome of the learning experience, both trainers and organising institutions need to have “a sound understanding of the link between adult learners’ characteristics and the appropriateness of the online environments for their online experiences” [14].

The advent and evolution of information technologies have made education more accessible than ever to an ever-larger number of learners. Leaving aside the technological obstacles that may be significant, e-learning is increasingly favoured by adult learners for a variety of reasons. One of them refers to the feature known as “just-in-time and just-for-me learning” [15], which mirrors the advantage most valued by this category of learners, i.e. that it is convenient in terms of time availability – it can be available 24/7 – (when we do not talk of synchronous teaching) and it provides the opportunity of benefiting from customised forms of information sharing and content structuring.

Two other great advantages of e-learning are flexibility and accessibility. Regardless of whether they are university students or corporation workers, people from remote locations have the chance to attend courses and improve their training without having to travel, with the associated perk of saving costs. Moreover, in the case of adult learners, who have to fulfil their professional and personal roles at the same time, they value greatly the opportunity of self-paced instruction. Unless they are enrolled in synchronously held courses, they can study when their schedule allows them to and if they miss some classes, they can also resort to recorded lessons, webinars or collaborative instruction software.

One of the main arguments invoked by detractors of the e-learning system is the diminished social interaction among peers or between the trainer and the learners. Although this may be the case in some situations (but the existence of forums, chat rooms, eTandem - “interaction between language learners ...that allows users to learn a new language and teach their native languages by using a communication tool” [16] -, collaborative learning activities has significantly diminished this communication gap), this form of training is most convenient for people who prefer individual study and/or are not willing to interact with peers.

Despite the many advantages of e-learning for adult learners, an important issue that needs to be take into account refers to the barriers that still exist. Penina [17] mentions seven main e-learning obstacles: personal barriers, learning style barriers, instructional barriers, organisational barriers, situational barriers, content suitability barriers and technological barriers. To these, a number of other variables are added such as age, gender, ethnic belonging, marital status, education level, job position, computer literacy, venue of the study and any prior experience with e-learning

environments. This paper looks into an instance of education by taking into account three components: type of learners, studied content and form of content delivery, namely e-learning. This triad comes with a good number of challenges – if not downright barriers – which are generated by each of its component elements. When we mention barriers, we consider them from the perspective of the training outcome – in this case learners' attaining the desired language level following graduation of the course(s) – and we focus on their own view of the entire process.

In respect of the category of learners envisaged, the obstacles may have to do with their academic skills, their motivation, the time they are willing to dedicate to instruction, previous experience with language courses and the performance achieved at the time, availability to engage in tasks that may require a significant amount of time spent individually considering the social roles they have to assume as well in the family and at work, but also age.

Age is a significant factor when we consider the type of content envisaged in this paper, namely foreign languages. It is a well-known fact that people manifest some form of reluctance to engage in language classes especially if the class is of mixed age groups. Learners of a certain age may be embarrassed. This obstacle is further enhanced if the learner's previous experience in language learning was not successful and the approach is governed from the onset by feelings of frustration and lack of self-confidence. It may be daunting to embark in an activity that was previously marked by failure and the learner's mindset in this particular case may represent a genuine roadblock. The trainer's role in helping such students overcome this obstacle is essential, both through the approach meant to help them be active during classes and through the creation of a relaxed and collaborative atmosphere in the group.

Finally, the barrier that is most frequently invoked by adult learners refers to the use of technology. It may be the fact that some of them doubt their skills in using technology because they are aware that their level of computer proficiency is low, or ignorance of the plethora of resources – which include both materials and people willing to assist them in the language learning process - that may become available to them once they access the virtually unlimited universe of the Internet.

The ultimate goal of instruction is to satisfy the needs of learners, a target which can only be achieved with the adoption of the appropriate strategies and learning environment. The principle of active learning, promoted by D. Barnes [18] is of utmost relevance in adult learning. He suggested a number of principles that ensure the active participation of learners. Thus, active learning is assumed to display the features below. It should be:

- purposive: assignments and tasks should be considered by learners as relevant for their interests;
- reflective: learners are supposed to reflect and ponder on the conveyed content;

- negotiated: learners negotiate with their trainer the methods and objectives of learning;
- critical: learners evaluate various methods of content acquisition;
- complex: the tasks received by learners mirror the complexity of real-life situations;
- situation-driven: genuine situations are considered when establishing learning tasks;
- engaged: the activities used in learning follow real life tasks.

If the above-mentioned principles of active learning are complied with, then one may indeed assume that the conditions for efficient content communication are ensured and that the outcome of the learning process could successfully mirror learners' expectations.

Andragogy is an instruction model which places emphasis on the learners, with their own needs, expectations, learning styles and patterns, experiences and motivation. Online learning is also an education system that is learner-centred. Therefore, when engaged in an adult learning environment which also happens to be online, teachers should become aware of a necessary shift in their role in the teaching-learning duo. The teacher becomes a guide, a facilitator, a mentor, who has to abandon the former role of a supreme authority in his/her fields of knowledge. Although this adjustment may be a challenge in itself for teachers, the outcome of their efforts to adjust to the requirements of online learning interaction is worth the trouble. "Facilitating learning is empowering for both the learner and the teacher and frees the teacher from many of the burdens that having to be an 'expert' might entail" [19]. Indeed, when none of the parties involved in the process assumes or is attributed a position of power, there is more room for collaboration, learner initiative and active participation.

## **5. Conclusions**

Adult learning – in this paper we excluded college students from the definition of 'adult learners', and we focused rather on persons with defined social and professional roles and responsibilities – has a number of specific features with important implications for teaching and assessment methods, classroom environment, teacher role and student involvement. The learner has greater autonomy than in the case of pedagogy and participates actively in the decision-making process related to learning methods and activities. "A student who desires to be self-directed is one who will thrive in a learner-centred classroom where his or her ideas, experiences, learning styles and personal learning objectives are valued and included" [20]. Learners can use their life experiences, beliefs and knowledge as valuable resources to be used in the classroom.

These are all the more important in language learning, when content transmission envisages not only linguistic structures and lexis, but also cultural knowledge. In

adult learning, the efficiency of second language acquisition depends basically on several major factors: satisfaction of learners' expectations (which translates into the opportunity of using the language immediately in the various communication situations in which they have to be functional), learners' active participation and the use of their own experiences and beliefs, which emphasise the idea of contribution to the training process. "Adults studying a foreign language are usually learning it for a specific purpose: to be more effective professionally, to be able to survive in an anticipated foreign situation, or for other instrumental reasons. They are not willing to tolerate boring or irrelevant content or lessons that stress the learning of grammar rules out of context" [21]. Embedding new knowledge in the learners' reality is paramount for an efficient learning outcome.

Taking into account the main features of androgenic learning, but also those of online learning, one could draw the conclusion that this form of instruction best responds to the educational needs of adult learners: it is flexible enough to accommodate adult learners' busy schedules, it allows for self-paced training, it is more cost effective as compared to traditional forms of education and it can be customised so as to reflect the exact needs of the learner. In this paper the focus was on adult language learning in the online context. After looking into some of the methods most frequently used for language teaching, and in the context of androgenic instruction, we may conclude that the approach that best suits the needs of this learner category is the communicative method, implemented on the background of Mezirow's transformative learning theory. The activities most frequently used in CLT – information gathering, task completion, information transfer, opinion sharing – and the resources which represent mostly genuine, real-life materials, can ensure the expected outcome in terms of language acquisition.

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## **RESEARCH ON THE CORRELATION BETWEEN THE USE OF MODERN INFORMATION AND COMMUNICATION TECHNOLOGIES BY ORGANIZATIONS AND REGIONAL SUSTAINABLE DEVELOPMENT**

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**Abstract:** *Nowadays sustainable development concerns not only corporations, companies of all types and sizes, but also local or national communities and development regions at national or global level. The unprecedented development of information and communication technologies (ICT) lately, their use in all areas of economic, social, cultural life, etc. has determined the researchers to study and evaluate to what extent they influence the development of companies and local, regional or national communities. The paper analyzed, through statistical models, the correlation between the level of use of communication technologies by organizations and the territorial sustainable development of the local communities in which these organizations operate. Empirical findings showed that the use of new communication technologies led directly to the increase of activities from priority areas for the sustainable development of the local community, such as the health, the production and supply of energy and drinking water, and the waste processing. These results can encourage the managers of organizations to implement such technologies and the decision makers from local and central administration to promote and stimulate these ICT activities.*

**Keywords:** *sustainable development, sustainable regional development, information and communication technologies, regression model*

### **Introduction**

Within each economy, the economic growth is ensured, at the level of companies, by their competitiveness. The competitiveness of the companies is given by *their performance*, by the ability to ensure “a certain level of productivity and effectiveness, a sustainable presence on the markets” [1]. Until recently, the main task of the management of any company has been to ensure its competitiveness, for its development and adaptation to a growing competition, in an increasingly dynamic market.

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The industrial development over the last 50 years was highly supported by the development and dynamics of information and communication technologies in all fields, leading to a powerful, even aggressive, economic growth. But this industrial development came with an excessive consumption of natural resources, uncontrolled effects of increasingly voluminous and diversified waste resulting from the activity of companies, an increasingly aggressive environmental pollution caused by the lack or non-observance of strict rules regarding the protection of the environment. These influenced directly the life of local communities and the environment in which they lived. In the absence of responsibility rules and social cohesion, major gaps appeared between poverty and wealth, vulnerable groups, depletion of natural resources, etc.

Natural resources are limited in time and space, and their excessive consumption, together with the excessive pollution of water, air, soil resources endangers the very existence of life. If these inconveniences are added to the increased level of population, urban agglomerations and climate change, then the approach of economic development of companies will be achieved only through competitiveness which is unacceptable today. Sustainable development speaks of a world that needs a fundamental transformation, of its present needs and of future generations [2]. Thus, new development requirements, such as the application of measures of social responsibility, environmental protection, involvement in the life of the local community, are required in order to improve its living standard and working conditions, safety at work [3], to contribute to its education and health [8].

The present concerns of specialists, researchers and global, regional or national bodies, as well as of policy makers are related to the *sustainable development* of companies, regions, nations and all activities carried out, to their *social responsibility* and the obligation to ensure environmental protection and human rights. It is certain and compulsory, enforced by regulations established by specialists and political decision-makers, to approach the sustainable development of all entities in the world: companies of all types and sizes and local, regional communities. The latter take into account the local, regional or national specificities, in the analysis and decisions that are taken to stimulate and ensure sustainable regional development. Under such circumstances, as the competitiveness was studied by specialists also at the territorial level, so is the increasing need for the study, analysis and concrete solutions of sustainable development at local, regional or national level. The specialists defined, in this regard, the concept of *long-term competitiveness* [4], which satisfies, in addition to the requirements of development under conditions of maximum efficiency of any entity, the requirements of sustainable development as well.

In the first part the paper we presented the overview of the specialized literature on regional sustainable development outlining the rapid development of ICT and the latest implementation of communication technologies. In the second part of the paper we presented the research methodology, the data used, the working

hypotheses, the models and the results. We estimated the sustainable development of the local communities by the value of three indexes defined by the National Institute of Statistics of Romania: the turnover of the organizations in the following activities: *Electricity, gas, steam and air conditioning production and supply, Water supply; sewerage, waste management and decontamination activities and Human health and social work activities*. There are three areas of activity that are particularly important for the life of a territorial community, in which the production and distribution of energy and water influence directly both the health of the community and the quality of the environment, through the innovative processes of energy production, waste processing, water decontamination etc. In the final part of the paper we presented the conclusions of the research and how our study could influence decision makers.

## **1. Literature Review and Working Hypotheses**

### **1.1. Prior research on sustainable regional development and its relationship with the use of communication technologies within organizations**

Sustainable development has now become a global matter, a complex concept which concerns the development of all organizations, which is very difficult to evaluate objectively and scientifically [5]. Sustainable development has even become the existence requisite of the companies of all types and sizes on the current market, which is highly diversified, dynamic and demanding regarding the current requirements of consumers. Thus, a multitude of policies, debates, measures have been adopted at global, European, national or local level to define, regulate and force companies to comply with the requirements of sustainable development.

The main objective of all these major concerns of the decision makers all around the world is the welfare of people, individually and collectively, their material well-being, their culture and physical and mental health, conditioned not only by the economic development, but also by the environment and the community in which people work and live. All these required the identification of new forms of organization and management of activities within companies, new forms of interrelating them with the client, the environment, the market, the local community, with other companies or research centers, and some forms of new work organization, of communication with all these to ensure an efficient management. The competitive advantage of companies, given first of all their economic development in terms of efficiency, is no longer sufficient today. In order to maintain it, the competitive advantage should appear if there are possibilities of sustainable development for the company and the community in which it operates. To this end, it is necessary for all organizations to identify solutions that help them to become more flexible, efficient and more easily adaptable to change, in order to implement measures of social responsibility and environmental protection.

Sustainable development was first defined in the Brundtland Report as “the development that meets current needs, without compromising the ability of future generations to meet their own needs” [6]. The issue was then debated and regulated within the UN [7], measures for its implementation were taken [8], for the sustainable development of strategic activities, for the sustainable development of the global society, such as climate change, water, waste [9], transport [10,11], energy [12,13]. The European Union, through its institutions, responded to these demands by developing the Sustainable Development Strategy in Europe [14,15], the Sustainable Growth Financing Plan [16], a series of directives and regulations aimed at imposing and stimulating sustainable development for all member countries. Romania promptly met these requirements and developed its national strategy for sustainable development [17].

The importance of this issue caught the attention of researchers, economists, theorists and practitioners, who first defined the concept and requirements of sustainable development of companies. Analyzing companies that are closely related to the life and environment of the communities in which they operate, we outline the territorial, regional or national sustainable development. This was defined by specialists [18,19], who researched and identified a multitude of factors that determine it, grouped into three subsystems: economic, social and environmental.

Being concerned with finding a calculation algorithm and a model for evaluating territorial sustainable development, a number of specialists studied and proposed the calculation of one or more composite indexes and different models, which were controversial and much debated. Each model had a theoretical and/or practical justification, trying to make a more accurate evaluation of the territorial sustainable development considering some important factors: Italy [20], [21] Poland and China [22]. By means of the calculated index, comparisons can be made between regions, cities, development areas, between sectors of the economy and the important activities of the national economy, allowing decision makers to intervene through policies, laws and norms to stimulate them. A number of studies in China were conducted to analyze the sustainable development of urban agglomerations [23,24,25]. Other studies dealt with the analysis of important branches of the economy, with a special role in environmental protection and economic development, such as energy [9,26,27,28].

After 2011, the industrial revolution brought a new wave, that of the new information and communication technologies, which spread and developed, being more and more present in all the forms of manifestation of our life and society. The information society determined a major impact of the ICT sector on the economic, social and environmental subsystems of territorial sustainable development. Researchers and specialists in the economic field studied this impact to analyze the extent to which the new communications technologies influence directly the sustainable development at the organization or territorial level.

Analyzing the role of the ICT sector in the field of sustainable development, in the study [29] the author found a top-level approach: from a resource-based economy to a knowledge-based economy, an economy in which information became a major factor in production. The implementation of the new technologies had direct effects on the sustainable development of companies, at least through the following:

- a sustained technological development, innovative and automated production processes, aimed at ensuring increased labor productivity [30], greater efficiency of using all resources with less waste, less pollution of the environment, etc., implementation of new business models (online sales, online courses, contracting and online payments, etc.), new ways of structuring and monitoring work processes (virtual office, remote work, home work, etc.), as well as an adequate quality of the products or services (high quality standards, quality control and verification norms, etc.).

- an efficient management, namely an efficient management and coordination of processes within the company with the help of integrated software products.

The direct effects were the extensive and intensive development of the production of goods and services, the increase of the labor productivity, followed by the increase of employment rate and the improvement of life quality [29].

All these direct effects of ICT on the economic and social subsystem triggered a series of activities of the companies through which measures of social responsibility were implemented, both in relation to the protection of the environment and vital natural resources (water, air, soil), as well as for the community in which they carried out their activities. Thus, the development of companies' production and services led to an increase in the number of beneficial jobs for improving the standard of living, and the highly skilled and specialized workforce, which had access to information and education through ICT improved the economic performance of the companies. In addition, a human resource that worked in good conditions of health and safety at work [31] and learned constantly throughout life, will maximize the financial efficiency of the company.

In a nutshell, the economic development of a territorial community (region, country) cannot be achieved without healthy and well-prepared human resources, within the community or the environment in which they live.

The International Institute for Sustainable Development dealt with the impact of new communications technologies on the territorial sustainable development. The papers [32,33] talked about the digital economy or the internet economy, an economy in which the ICT sector was an important source of employment and "a contributor to the Gross Domestic Product", to productivity and territorial economic growth, to globalization of all activities, through the development of interactive relationships with suppliers and customers through the use of the Internet and new communication resources. ICT built new business models

(installation and maintenance of computers, provision of internet and cloud services, online sales, eLearning platforms, e-government, etc.) and created jobs for a large number of highly qualified people (software designers, programmers, analysts, network administrators, database administrators, etc.), contributing to the economic growth of companies and the territorial community, and to the improvement of working conditions, life, health and education. Furthermore, the study showed the influence of the technological development in the field of communications in increasing the volume of electronic waste, including the toxic waste. However, they allowed the widespread dissemination of information needed to adapt to climate change regarding weather, terrestrial and water resources, thus consistently helping to protect the environment and the territorial sustainability [34,35].

Other studies analyzed the future development of new communication technologies, which stimulated research and innovation [36,37], by using the Internet and enhancing the collaboration among the research, academic and production centers to solve specific problems in the economic, social or environmental field (robots, artificial intelligence, cloud computing services, etc.) [38]. The use of ICT in diagnostics and treatments in health [39,40,41] is the focus of the specialists in the field. In addition, the new technologies, robotics, artificial intelligence, virtual reality, cloud computing, allow for unprecedented technological development of the companies, contributing substantially to the automation of production, work, sales and marketing processes, education, culture, etc., as well as to the management of all these processes automatically and in an integrated manner. These are objectives of sustainable regional development, related not only to the economic subsystem, but also to the social and environmental one [37].

We can take into account that the diversity and complexity of business models in the economic and social field, their behavior, relationships and conditionalities between them, which are increasingly dynamic and unpredictable, are significant and require further studies, especially when using new information technologies.

## **1.2. Prior research on energy, water and health, as important factors of territorial sustainable development. Working hypotheses**

Nowadays sustainable regional development requires a comprehensive approach, within a reasonable timeframe, of sustainable development at all levels, for all organizations, in order to ensure economic development while improving the quality of people's life and social cohesion, and ensuring environmental and natural resources protection. International, regional or territorial bodies established sustainable development strategies, objectives, indicators for measuring the sustainable development of companies, the quality of life and environment, the human resources, the education, etc. As a result, a number of specialists in the field, researchers, and scientists tried to verify, analyze and evaluate the extent to

which various organizations act to develop or modernize various activities, in accordance with the latest standards in the field, for the sustainable development of the territorial community.

The specialists showed that the sustainable development objectives, which must be implemented at national, regional, continental or global level, are interdependent and mutually conditioned and must be treated as an integrated system, in which the exchange of expertise and knowledge is made between nations [42].

Sustainable urban development is considered by specialists an important challenge, especially if we talk about large urban agglomerations. Within it, urban public health is a very important issue for the life of the respective community. Cities are complex systems affected by a number of economic, social and environmental factors, which interact and influence one another. A number of studies analyzed the situation in several large cities in China and identified important indexes such as the number of hospital beds, health centers per 10,000 persons and the overall investment in the treatment of environmental pollution [23,43].

But the health of the population and the environment are largely dependent on the degree of pollution. Global pollution is strongly linked to the growing global demand for energy, largely obtained from fossil fuels (coal and agricultural wastes) which cause greenhouse gas emissions and a number of other air pollutants, such as carbon dioxide, nitrogen oxides and sulfur dioxide. Researchers analyzed this problem and offered solutions proposed by specialists in the field. Thus, the growing demand for energy worldwide, which is necessary for the production development and social development, can be solved by obtaining solar renewable electricity [44] which has undeniable beneficial effects, or by wind energy and biomass, which must be stimulated to be increasingly expanded through research and innovation activities [45].

However, the health of the population is conditioned by the quality of the water. Therefore, some researchers focused on the issue of management of river basins and urban waters, for which they tried to identify best practices in the field [46] or modern technical solutions for wastewater treatment with the purpose to promote them [47] in order to fill the gaps by the joint efforts of researchers and practitioners.

In a study on the sustainable development of large cities, the performance of their energy and environmental systems was analyzed and evaluated in an integrated approach for 12 cities in Southern Europe [9]. A special challenge today is to identify ways to improve the efficiency of all resources by integrating different life support systems: energy, heating, cooling, transport, water and wastewater, waste, industry, agriculture [48]. The identification of technical, practical and efficient solutions for the myriad of problems due to the increase of the population and of the demands of the global market for production and services could not be achieved without the use of ICT and Internet technologies. Thus,



specialists who have studied the effects of the large-scale expansion of new ICT technologies [49] have shown the benefit of their use at least in the next fields: mass robotization in the automotive industry, close interactive relationships with suppliers and customers through the use of telephony, Internet and other new communication resources in the supply chain, modernization of financial markets through electronic trading, major changes in the way businesses are run, increased volume of independent activities, development of online commerce and online payments, increased access to education, culture, health, recreation, social interactions, information in all fields, etc.

In Romania the issue of regional sustainable development is current and paramount as there are industrial pollution centers and accumulations of environmental degradation, a high share of deforestation, a generally aggressive attitude towards the environment, polluting enterprises, high energy consumers, and a large part of the population is still poorly informed and little interested in environmental issues etc. However, Romania has taken all the necessary measures to comply with European legislation and norms. That is why, in 2017, the Government of Romania established the Department for Sustainable Development [50], which coordinates at national level the implementation of the sustainable development objectives. Romania is committed to implementing these objectives both nationally and internationally.

Taking all of the above into account, we analyze to what extent the new communication technologies within the development regions of Romania influence the indexes of regional sustainable development for the field of energy and health.

In this study we considered the following working hypotheses:

*Hypothesis 1.* The turnover of all organizations in the activity *Electricity, gas, steam and air conditioning production and supply* is correlated with the *number of employees* in the *Information and communication activity*.

*Hypothesis 2.* The turnover of all organizations in the activity *Water supply activity; sewerage, waste management and decontamination activities* is correlated with the *number of employees* in the *Information and communication activity*.

*Hypothesis 3.* The turnover of all organizations in the activity *Human health and social work activities* is correlated with the *number of employees* in the *Information and communication activity*.

## **2. Data and Methodology**

### **2.1. Description of the data sample and the used variables**

The data sample used in the econometric models consisted of data between 2009 and 2016, taken from the Statistical Yearbook of Romania and a series of indexes considered relevant in characterizing the sustainable development of the regions. It is known that Romania has 8 development regions, recognized and measured by

indexes from the National Institute of Statistics of Romania, as follows: 1. North-West; 2. Center; 3. North-East; 4. South-East; 5. South-Muntenia; 6. Bucharest-Ilfov; 7. South-West Oltenia; 8. West.

Considering the latest exponential development of the information and communications technologies, we verified through the econometric methods of simple linear regression if the number of employees in this field is in correlation with the indexes specified in the three working hypotheses. For the models we used the variables in Table 1, which represent values corresponding to the local companies by size groups, according to the number of employees (0-9,10-49, 50-249, over 250), for the 8 development regions, between 2009 and 2016 [60]. Therefore, the data series had 256 values for each index (8 years \* 8 regions \* 4 types of companies, by size).

Table 1. Description of the used variables

Cr. no	Associated Variable	Variable definition	Variable Type
1.	X	Number of employees in the activity <i>Information and communication</i>	Independent
2.	Y1	Turnover of the organizations in the activity <i>Electricity, gas, steam and air conditioning production and supply</i>	Dependent
3.	Y2	Turnover of the organizations in the activity <i>Water supply; sewerage, waste management and decontamination activities</i>	Dependent
4.	Y3	Turnover of the organizations in the activity <i>Human health and social work activities</i>	Dependent

An analysis of the variables values used totally, calculated by years (between 2009 and 2016) is presented below. The graph (fig. 1) shows that an increase in the values of X is followed by an increase in the values of Y (an increasing trend for both variables).

Table 2. The values calculated for the total variables X and Y1 between 2009 and 2016

YEAR	X	Y1
2009	11859	50109
2010	12546	52747
2011	13237	59568
2012	14041	59764
2013	14274	56821
2014	14365	55488
2015	15874	58796
2016	20522	57936

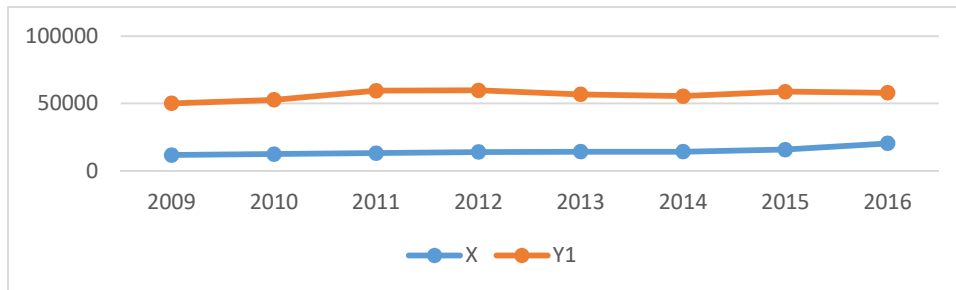


Figure 1. The graph of the Y1 variable values between 2009 and 2016

Table 3. The values calculated for the total variables X and Y2 between 2009 and 2016

YEAR	X	Y2
2009	11859	10094
2010	12546	14212
2011	13237	16206
2012	14041	16605
2013	14274	15190
2014	14365	14092
2015	15874	12627
2016	20522	12303

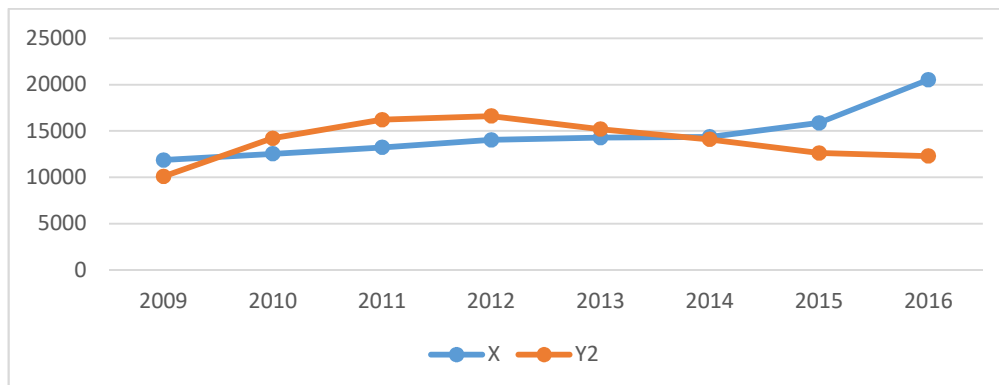


Figure 2. The graph of the Y2 variable values between 2009 and 2016

Table 4. The values calculated for the total variables X and Y3 between 2009 and 2016

YEAR	X	Y3
2009	11859	2826
2010	12546	3309
2011	13237	3911
2012	14041	4472
2013	14274	5097
2014	14365	5897
2015	15874	6774
2016	20522	7973

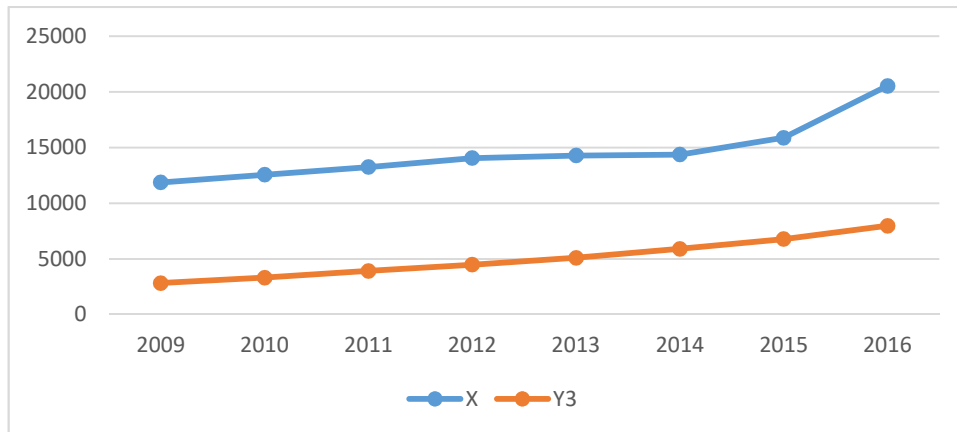


Figure 3. The graph of the Y3 variable values between 2009 and 2016

Analyzing these graphs we noticed they showed an existing dependence between variables. Therefore, we further verified, by simple linear regression models, if the correlations described in the formulated working hypotheses were maintained. Therefore, we checked whether a development of ICT activities complied with the following: hypothesis 1, determining the development and diversification of the production and distribution of clean energy, as described in the studies [43,44,45,47]; hypothesis 2, determining the development and identification of new solutions in the activities of water supply, sewage, waste management and decontamination, as described in the studies [46,47,48]; hypothesis 3, determining the development of activities of health and social assistance, as described in the studies [41,42].

## 2.2. Econometric Models. Results and Discussions

In order to verify the hypotheses, we constructed simple linear regression econometric models for each hypothesis.

**Model A** analyzed the extent to which the exponential development of information and communication technologies influenced the development of activities in the field of production and supply of electricity and gas, thus contributing to the growth of regional sustainable development.

The used variables were:

- Y1 as the *dependent* variable which represented the turnover of the organizations in the activity *Electricity, gas, steam and air conditioning production and supply* between 2009 and 2016, out of the 8 development regions, considering all companies and the 4 size groups.

- X as the *independent* variable which represented the number of employees in the *Information and communication activity*, considering the same type of data structure.

The regression model A verified, according to hypothesis 1, whether there was a correlation between the activity of companies in the field of production and supply of electricity and gas, measured by turnover (variable Y1) and the number of employees working in the *Information and communication activity* (variable X).

The proposed simple linear regression model was:

$$y = \beta_0 + \beta_1 x + \varepsilon \tag{1}$$

or, replacing:

$$Y1 = \beta_0 + \beta_1 * X + \varepsilon, \text{ where:}$$

- X, Y1 are the described variables;
- $\varepsilon$  – is the random error variable (residue);
- $\beta_0, \beta_1$  are the parameters of the regression model.

$$\text{The simple linear regression model was: } \hat{y} = b_0 + b_1 x \tag{2}$$

where:  $b_0$  estimated parameter  $\beta_0$  and  $b_1$  estimated parameter  $\beta_1$ . We estimated the parameter values for the simple linear regression model, using the smallest squares method, as shown in table 5. The model was tested and validated, and the result is presented in table 5.

$$b_0 = 191,80715 \quad b_1 = 0,335340$$

Thus,  $\hat{y} = 191,80715 + 0,335340 * x$  and the equation is:

$$Y1 = 191,8071516 + 0,335340 * X$$

Table 5. Estimated parameters of the simple linear regression model A by using the method of least squares

Variable	Coefficient	Std. Error	t-	Prob.
			Statistic	
C	191.8072	128.0563	1.497834	0.1354
X	0.335340	0.015379	21.80514	0.0000
R-squared	0.651799	Mean dependent var		1762.613
Adjusted R-squared	0.650428	S.D. dependent var		2865.058
S.E. of regression	1693.954	Akaike info criterion		17.71530
Sum squared resid	7.29E+08	Schwarz criterion		17.74300
Log likelihood	-2265.558	Hannan–Quinn criter		17.72644
F-statistic	475.4641	Durbin–Watson stat		0.503330
Prob(F-statistic)	0.000000			

Source: Authors' estimations. Notes: dependent variable: Y1. Method: least squares. Sample: 1 256. Included observations: 256.

**Conclusions for model A:** Testing the validity of the model, we found that at a significance level of 5%, *the model was valid*, and the variation of the values of the independent variable - *number of employees* in the *Information and communication activity* (X) justified by 65.18% the variation of the dependent variable - *turnover of the organizations in the Electricity, gas, steam and air conditioning production and supply activity* (Y1). The slope of the regression line  $b_1 = 0.335340$  showed that if the value of the independent variable (X) changed by 1000 people, then the

dependent variable Y1 changed on average by 335.34 million lei in the same direction. Hypothesis 1 was, therefore, confirmed. Hence the increase of the number of employees in the field of ICT, in other words the increase of their activities, definitely determined a significant growth of activities in the field of production and supply of energy and gas, using modern technologies and ICT support. This actually led to the development of companies in the field of clean energy production and distribution, a correct estimation of energy consumption using models of neural networks [51], algorithms for its optimization and storage of large volumes of data [52], identification of new sources of clean energy [53] and to a major impact on the quality of people’s life [27,35].

**Model B** analyzed, according to hypothesis 2, whether there was a correlation between the number of employees in the *Information and communication activity* (X-independent variable) and the other index - the turnover of the organizations in the *Water supply activity; sewerage, waste management and decontamination activities* (Y2-dependent variable). The model was built and tested in the same way as model A, and the result is shown in Table 6.

$$b_0 = 311,1721 \quad b_1 = 0,026409$$

$$\text{Thus, } \hat{y} = 311,1721 + 0,026409 * x$$

$$Y2 = 311,1721 + 0,026409 * X$$

Table 6. Estimated parameters of the simple linear regression model **B** by using the method of least squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	311.1721	21.96630 14.16589		0.0000
X	0.026409	0.002638 10.01092		0.0000
R-squared	0.282928	Mean dependent var		434.8789
Adjusted R-squared	0.280105	S.D. dependent var		342.4702
S.E. of regression	290.5744	Akaike info criterion		14.18938
Sum squared resid	21446101	Schwarz criterion		14.21707
Log likelihood	-1814.240	Hannan–Quinn criter		14.20052
F-statistic	100.2185	Durbin–Watson stat		0.319041
Prob(F-statistic)	0.000000			

Source: Authors’ estimations. Notes: dependent variable:Y2. Method: least squares. Sample: 1 256. Included observations: 256

**Conclusions for model B:** At a significance level of 5%, *the model was valid*, and the variation of the values of the independent variable - *number of employees* in the *Information and communication activity* (X) justified by 28.29% the variation of the dependent variable - turnover of the organizations in the *Water supply activity; sewerage, waste management and decontamination activities* (Y2). The slope of the regression line  $b_1 = 0.026409$  showed that if the value of the independent

variable (X) changed by 1000 persons, then the dependent variable Y2 changed on average by 26.41 million lei in the same direction. Hypothesis 2 was, also confirmed. Hence the increase of the number of employees in the field of information and communication technologies, in other words the increase of their activities, definitely determined a significant growth of activities in the field of water supply, sewage, waste management and decontamination, as described in the studies [46,47].

**Model C** analyzed, according to hypothesis 3, whether there was a correlation between the number of employees in the Information and communication activity (X-independent variable) and the index - turnover of the organizations in the Human health and social work activities (Y3-dependent variable). The model was built and tested in the same way as model A, and the result is shown in table 7.

$$b_0 = 23,83069 \quad b_1 = 0,028485$$

Thus,  $\hat{y} = 23,83069 + 0,028485 * x$  or

$$Y3 = 23,83069 + 0,028485 * X$$

Table 7. Estimated parameters of the simple linear regression model C by using the method of least squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	23.83069	7.957288	2.994826	0.0030
X	0.028485	0.000956	29.80774	0.0000
R-squared	0.777681	Mean dependent var		157.2617
Adjusted R-squared	0.776806	S.D. dependent var		222.8044
S.E. of regression	105.2605	Akaike info criterion		12.15854
Sum squared resid	2814264	Schwarz criterion		12.18623
Log likelihood	-1554.293	Hannan–Quinn criter		12.16968
F-statistic	888.5015	Durbin–Watson stat		0.770621
Prob(F-statistic)	0.000000			

Source: Authors' estimations. Notes: dependent variable: Y3. Method: least squares. Sample: 1 256. Included observations: 256.

**Conclusions for model C:** At a significance level of 5% *the model was valid*, and the variation of the values of the independent variable - *number of employees* in the *Information and communication activity* (X) justified by 77.76% the variation of the dependent variable - *turnover of organizations* for the activities in the field of *Human health and social work* (Y3).

The slope of the regression line  $b_1 = 0.028485$  showed that if the value of the independent variable X changed by 1000 persons, then the dependent variable Y3 changed on average by 28.49 million lei in the same direction. Hypothesis 3 was confirmed, too. Hence, the increase of the number of employees in the field of

information and communication technologies, basically the increase of their activities, definitely determined a significant growth of activities in the field of human health and social assistance, as described in the studies [39,40,54].

### **3. Conclusions and Future Research**

We believe this study has practical implications at managerial and political level. Thus, the models can be analyzed by specialists, economists, managers from all organizations, who, based on them, can enhance the use or implementation of new information and communication technologies as a safe solution for modern, scientific management, and efficient, competitive economic development of the organization, allowing the implementation of measures of social responsibility and environmental protection, thus leading to a sustainable development. This ensures the foundation of the flexibility requirement for modern management, which must be informed, adapt to the new demands of the global market, identify and use the opportunities, and deal with the arising risks, in order to ensure both competitive and sustainable development of the organization [4].

The analysis of the presented models showed that there was a correlation between the *number of employees* in the *Information and communication activity* and:

- the turnover of organizations in the activity of *Electricity, gas, steam and air conditioning production and supply* (A)
- the turnover of organizations in the activity of *Water supply; sewerage, waste management and decontamination* (B)
- the turnover of organizations in the activity of *Human health and social work activities* (C)

This means that the prevalence and development of activities in the field of information and communication technologies will lead to a significant growth of activities in the field of *Electricity, gas, steam and air conditioning production and supply and Water supply; sewerage, waste management and decontamination*;

Basically, the new information and communication technologies allow, within any organization, the introduction of high specialization technologies, robotization and automation of processes in their field of activity, but also a computerized management of the other processes within organizations, such as modern procedures for quality control of products, [55], staff training, improvement of health and safety conditions at work [3], environmental protection measures, etc. Therefore, we are certain that ICT implementation is a factor of multiplying the degree of development for other areas of activity within the local communities. A powerful company, developed with new production technologies and ICT technologies, will be able to support many activities in the areas of social and environmental responsibility and implicitly will enhance sustainable development at local (development region) or national level.



Political decision makers, at local or central administration level, can intervene in stimulating organizations to use and implement new communication and information technologies [56]. These have direct beneficial impact on each organization such as better management, more efficient work processes, and a healthier and safer work environment, as well as in the local community, which will have a lower unemployment rate, a highly specialized workforce with better paid jobs, better environmental and living standard. Moreover, in Romania the introduction of new computer and communication technologies was supported by the government increasing the number of specializations in the field of Information and communication for secondary and higher education, as well as by political measures to stimulate the specialists working in this field [57]. Basically the digital revolution has played a key role in the transformation of society, as it changed the shape and size of new business models, it changed completely the production process and the sale of products and services, work and education, culture and leisure, governance [58], the global economy on the whole. And thus, the new technologies, used on the planetary scale have become the tools of change related to sustainable development [42,59].

Our study is limited regarding the data selected from the Statistical Yearbook of Romania, for the number of employees in the ICT field, because many companies, especially the small ones, have employees who perform specific ICT tasks but are assigned to positions of economists or engineers. This means that the development of ICT activities is not rigorously represented by the *number of employees*, which in fact has a higher growth. We will conduct further research analyzing other priority factors of regional sustainable development, such as urban transport, education, research, innovation, waste processing and others.

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## **COMPETITIVE PROGRAMMING. AN ANALYSIS OF THE PERFORMANCE IN ROMANIA**

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**Abstract:** *Competitive programming is that branch of programming that challenges the programmer to exceed his own limits, to push his creativity to a new level. It is a mind sport, where the programmers are challenged not only to solve algorithmic problems, but to deliver the most performant solution, that will fulfill the very strict specifications of the problems. This requires the programmer to have a very good knowledge of algorithms, data-structures, a strong mathematical foundation, and, not eventually, high programming skills. The revenue is not at all negligible: the programmer is rewarded with significant visibility, becoming the target of important software companies, not mentioning the personal satisfaction and increase of confidence.*

*In this article, we try to focus on the main aspects of the competitive programming area, followed by a presentation of the most important competitive programming contests in the world. A distinct section is dedicated to fostering programming performance in Romania.*

**Keywords:** *competitive programming, algorithms, competitions*

### **1. Introduction**

In the literature, Competitive programming is regarded as a mind sport, where the competitors, the programmers, are challenged to solve several programming problems, according to specifications. The problems are of algorithmic nature and usually the main challenge of the programmer is not only to find a solution for the problem in order to get the right answer, but, moreover, is to imagine a solution that will fit within the specifications, namely the time and memory limits.

This requires from the programmer, besides the high programming skills, a very good knowledge of algorithms, data structures and a good grasp of mathematical

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instruments. And not forget about the knowledge of a bunch of tips and tricks very useful in contests. In competitive programming, solutions are “pushed” to their limits, when they are tested on large amount of data. In [5] it is specified that it is necessary to have not only programmers, "but also creative coders, who can dream up what it is that the programmers need to tell the computer to do. The hard part isn't the programming, but the mathematics underneath it."

Besides being a mind-sport, competitive programming is a launching pad for the professional career of the programmer: high scored competitors are very “visible” in the market, they are targeted by some of the top software companies in the world.

This is why, in the last years, an immense industry has raised around this domain, where organizations, associations, companies, educational institutions, and so many, invest in organizing and fostering this very modern and attractive segment of software development.

In this article, the authors tried to present the most important aspects of the competitive programming area. First, a presentation of the general aspects of such a contest is provided, then, in the second part of the paper, a list of competitions is brought into discussion. We start the presentation with some well-known international, multi-layered, contests: The International Collegiate Programming Contest (ICPC), The International Olympiad in Informatics (IOI) and The International Informatics Olympiad In Teams (IOIT). Then, we present some contest organised by companies, and we name here HackerRank’ CodeSprints, Topcoder and Code Chefs initiatives, and the famous Facebook Hacker Cup and Google Gem rounds.

The last section is dedicated to Romania. Romanian programmers are renewed in the entire world, being noted through their performance at all the international competitions. But more often their preparation starts in Romania, where they get a good preparation in schools, having the chance to meet very dedicated teachers and by testing their virtues on dedicated websites, or in national competitions and various contests.

## **2. General aspects regarding the Competitive Programming**

A programming competition is an organized competition that involves individual competitors, or teams of competitors, depending on the specific contest, who must solve a set of algorithmic problems in a specific amount of time.

**2.1. The contest.** The actual contest is held over the Internet or a local network, in online or onsite manners. The onsite contests are directed to specific competitors, such are students from a certain college, town, state. Online competitions are



usually more permissive in terms of the participants, usually they are held within the auspicious of an organization when the competitor must enroll.

Contests are generally organized in rounds. Points collected in rounds can be accumulated in the competitor's profile, especially in the case of web-sites competitions. Rankings in rounds can grant the qualification to the next round. There is no general rule, every competition has its own rules.

**2.2. The duration.** The duration of a contest differs from one competition to another, usually the duration is between 2 hours and 5 hours. For individual competitions the duration is usually 2 hours.

**2.3. The problems.** Competitors must solve a set of problems, in any order. Each problem has a score, in some competition all problems have the same score, in other competitions scores differ in concordance with their difficulty. The competitors must solve as many problems as they can in the limited time of the contest. They will be rewarded with scores depending on how their solutions passed the tests.

Moreover, problems in programming contests have a specific structure:

- The story: Problems begin with a story, meaning a translation of the problem statement in a narrative or tale which is more friendly presented. For instance, the statement of the problem is presented as "a country that has cities and roads ...", and not as "let's consider a graph...". Of course, behind the nicely presented story there is a mathematical model that will substantiate the further solution;
- The requirement: is explicitly stated;
- Input, output: complete and unequivocally specifications about the input and the output: type of the I/O (standard I/O or text file) and content;
- Restrictions and specifications: usually data description and/or constraints (size, limits, so);
- Examples and explanation: often the problems are accompanied with one or more examples accompanied by some explanations;
- Time and memory limits: are clearly specified as well. This means that the solution must fit within the time and memory limits in order to be scored. Time limit is expressed in milliseconds and more often it is under 2 seconds. The memory limit could be, for instance 64Kb.

**2.4. Programming languages and solutions:** Most common programming languages used in contests are C++, Java, and Python. The solutions are implemented in a single source file. Usually, the file must not exceed 20 KB, but this is not a restriction because competitive programming is much more about the

idea, the algorithm, the structures, while coding rests in the second place, so the sources are usually short, they doesn't exceed 200 lines of code.

Compiling the solution: the automated testing application includes or call an external compiler in order to compile the competitors' solutions. If the compilation is successfully done, the testing starts. Otherwise, a Compile Error (CE) will be generated.

**2.5. Testing and scoring.** The solutions are tested automatically, using Unit Testing type applications.

Testing a solution consists in 3 criteria testing:

- Correctness, meaning that, for a certain input, the output of the solution corresponds with the expected output;
- Time limit, meaning that the answer was obtained within the time limit allowed for the specific problem;
- Memory limit, meaning that the answer was obtained within the memory limits allowed for the specific problem.

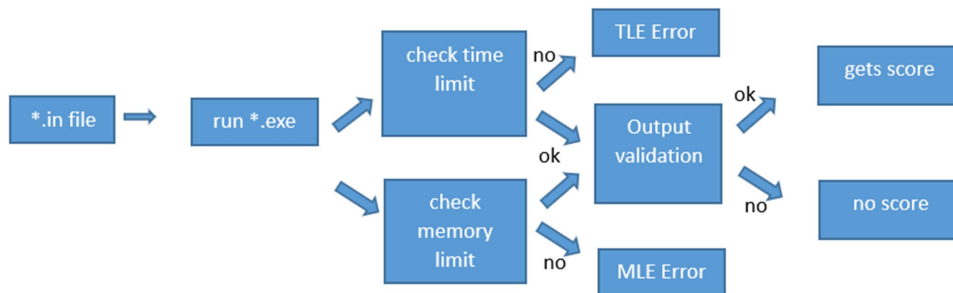


Figure 1. Single test flowchart

As the flowchart above shows, the solution complexity is very important in competitive programming, as well as in programming in general. It must fit within the time and memory limits, otherwise, even the output is correct, the test won't be scored. Unit testing applications records the status of the test, and if the solution didn't fulfill the requirements, an output will be given: TLE = Time Limit Exceeded or MLE = Memory Limit Exceeded or so.

Every solution is automatically tested against a certain number of tests. For instance, a problem can have 10 tests, every test consists in 2 kinds of files:

- \*.in file, where the input for that test is given;
- \*.ok file, where the expected output for that test is given.

So, there will be 10 \*.in files (X1.in, X2.in, ... , X10.in files, where X is the name or the id of the problem) and 10 \*.ok files (X1.ok, X2.ok, ... , X10.ok files).

The solution is run within the unit testing application, and for every test, its output, that could be an \*.out file, is compared against the corresponding \*.ok file. The degree of this correspondence can differ from one competition to another, in some competitions the expected file must be identical with the output file, in other competitions, partial scores are given for a partial correspondence. In order to get a correct evaluation, all tests are strictly formatted, and these formats are clearly specified in the statement of the problem, so the competitors can follow them. For instance, if an application asks for the minimum path in a graph, requiring its length and the lists of nodes, and the solution outputs correctly just the length, it can be partially scored, or not at all, depending on the rules of the competition.

In some competitions, tests are individual, meaning that a solution will score depending on how many tests it passes. In some other competitions, testes can be grouped, and a solution is scored only if it answered correctly to all tests in a group.

**Penalties.** Some competitions use a scoring system as a balance between the number of successfully tests and the productivity of the programmer: there is a penalty for how many incorrect attempts the competitor had during the contest. The penalty could also be related to the time of the submission of the successful solution.

Another form of inducing penalties consists in “hacking” other competitors’ solutions. Any competitor can ask for access to the solution of an opponent, then try to deliver a test where the targeted solution will not work correctly. If he or she succeed, then the author of the hacked solution will lose points but will still have the chance to repair it. If the hacking attempt fails, the initiator will face some penalties.

**2.6. Evaluation:** evaluation differs from one contest to another, in some cases can be done during the contest, after submitting the solution, otherwise, the evaluation is done after the contest has finished. Nevertheless, the contestant is informed with the status of the tests, if the solution passed the test and it was scored (Accepted), or if the solution got an error such as: CE (compilation Error), TLE (Time Limit Exceed), MLE (Memory Limit Exceed), Runtime Error, Wrong Answer, so.

**2.7. Some aspects regarding the performance (complexity) of a solution:** In competitive programming, the performance of a solution is very tricky. The performance is measured as the solution’s complexity, consisting in the execution time and the (extra)memory used. It is very well known that programming problems can accept more than one solution, but the choice of one or another strictly depends on the restrictions of the problem. In programming specific language, a brute-force solution is a solution that certainly solves the problem

(getting the right output), and sometimes it's easy to implement as well. But more often, the brute-solution doesn't fulfill the time and memory requirements, so a more sophisticated solution must be imagined.

**2.8. Code of behavior.** Most of programming competitions are online. This means that there is no control on who is the competitor and what he or she does during the competition. Therefore, competitors must conform to a code of conduct by which, during the contest, they cannot get help from outside, they cannot consult / use other people's sources and ask questions on forums or so.

**2.9. Some aspects regarding the 'Writing code for humans' principles:** In competitive programming, the sources are evaluated with automatic testing applications, so very often, competitors, especially the less experienced ones, don't give importance to the style of coding. But 'Writing code for humans', meaning respecting some code principles could be a good practice. It can help the competitor to organize better the flow of information through its code, which will prove an important asset in the maintenance and debug phase.

### **3. Competitive programming competitions**

#### **3.1. International competitions**

##### **3.1.1. The International Collegiate Programming Contest (ICPC)**

The International Collegiate Programming Contest (ICPC) is one of the oldest and most prestigious competitive programming competitions in the world. Its roots date back to the 70s. According to [6], "in 2018, ICPC participation included 52,709 students from 3,233 universities in 110 countries". Over several years, there had been a strong collaboration of ICPC with the Association for Computing Machinery (ACM), therefore sometimes the contest is referred to as ACM-ICPC.

The competition takes place every year among the universities of the world. ICPC is a team-based competition of 3+1 students (3 participants + 1 reserve) who are given 5 hours to solve between eight and fifteen programming problems.

ICPC is a multi-tiered competition, meaning that the contest consists in several rounds:

- ICPC - Regionals - are organized by the local universities. Sometimes they suppose multiple rounds in order to select the team that will represent the country at the World Finals. The onsite rounds are held the universities' premises, usually at the level of the university, followed by the sub-regional and then national level;

- World Finals – is the final competition that gathers the winners (one or more teams) from the Regional rounds.

The 2020 World Finals which were to take place in Moscow in June 2020, were postponed to May or June of 2021, due to the current pandemic situation [7].

The Top 5 ranking of teams at the ICPC World Finals in 2018 are presented in the table below:

<b>Rank</b>	<b>Institution</b>	<b>Country</b>
<b>1</b>	<b>Moscow State University</b>	<b>Russia</b>
<b>2</b>	<b>Moscow Institute of Physics and Technology</b>	<b>Russia</b>
<b>3</b>	<b>Peking University</b>	<b>China</b>
<b>4</b>	<b>The University of Tokyo</b>	<b>Japan</b>
<b>5</b>	<b>Seoul National University</b>	<b>South Korea</b>

Table 1. The Top 5 teams ranking at the ICPC World Finals 2018 (adapted from [8])

The Romanian Collegiate Programming Contest 2019 took place on 28 of September 2019.

The ICPC Southeastern Europe Regional Contest gathers 101 teams of students from 55 Universities, from 8 countries (Bosnia And Herzegovina, Bulgaria, Cyprus, Greece, Macedonia, Romania, Ukraine, Serbia and Turkey) [9].

In 2019 has been organized as a multi-site contest: it took place on 19<sup>th</sup> and 20<sup>th</sup> of October in the same time in two universities: Politehnica University of Bucharest, Romania and Vinnytsia National Technical University, Ukraine. The Top 4 ranking is shown below:

<b>Place</b>	<b>Team</b>	<b>Institution</b>	<b>Country</b>
1	Scrambled Eggs	University of Bucharest	Romania
2	KhNURE_NRG	Kharkiv National University of Radio Electronics	Ukraine
3	RAF Penguins	Faculty of Computer Science, Belgrade	Serbia
4	KhNU_DOROGA	V.N. Karazin Kharkiv National University	Ukraine

Table 2. The Top 4 ranking at the ICPC Southeastern Europe Regional Contest in 2019 (adapted from [9])

### **3.1.2. The International Olympiad in Informatics (IOI)**

The International Olympiad in Informatics (IOI) is a competitive programming competition for secondary school students. It is the most prestigious computer science competitions in the world. IOI takes place yearly under the auspices of United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Federation for Information Processing (IFIP).

IOI started in 1989 and in 2019 gathered 327 contestants from 87 countries [10]. The 2020 competition that was due to take place in Singapore, was postponed to an unspecified date.

The International Olympiad in Informatics is a multi-layered competition, it takes place at local level, regional, national and international levels. The national-level phases are organized through national organizations ending with the National Olympiad in Informatics. In Romania the national phases are: school level, town level (sector in Bucharest's case) and county. The Romanian national team counts about 20 high-school students, who compete in an extra competition in order to form the team for the international contest.

The national and international competitions are 2-days X 5 hours contests, where participants compete individually. For the IOI, there are at most four representatives of each country. The reward system is quite generous: 50% of the participants are granted with medals, the percentages are 1:2:3:6 for gold : silver : bronze : no medal.

The evaluation system has been changed in time: at first the sources were evaluated at the end of the competition, from 2010 there is a real-time evaluation but limited to the contestant (a participant can monitor his / her own results, not those of his or hers opponents). From 2012, a Contest Management System (CMS) is used for evaluation.

The 2019 Top 10 countries ranking at the International Olympiad in Informatics is presented below. Romania occupies an honorable position 6 cumulating over 100 medals, more than one third of them being gold medals.

<b>Rank</b>	<b>Nation</b>	<b>IOI Host</b>	<b>Gold</b>	<b>Silver</b>	<b>Bronze</b>	<b>Total</b>
1	China	2000	84	27	12	123
2	Russia	2016	62	38	12	112
3	United States	2003	52	35	16	103

<b>Rank</b>	<b>Nation</b>	<b>IOI Host</b>	<b>Gold</b>	<b>Silver</b>	<b>Bronze</b>	<b>Total</b>
4	South Korea	2002	41	39	27	107
5	Poland	2005	40	41	31	112
6	Romania	-	30	50	31	111
7	Bulgaria	1989, 2009	27	43	38	108
8	Iran	2017	24	57	23	104
9	Slovakia	-	24	40	33	97
10	Japan	2018	23	24	10	57
<b>Totals (10 nations)</b>			<b>407</b>	<b>394</b>	<b>233</b>	<b>1034</b>

Table 3. The 2019 Top 10 countries ranking at the International Olympiad in Informatics (adapted from [11])

Romania had the initiative of organizing a Central European Olympiad in Informatics (CEOI) and the first edition was held here in 1994, five years after the first IOI.

### 3.1.3. The International Informatics Olympiad In Teams (IOIT)

The International Informatics Olympiad In Teams (IOIT) is a 4+2 team competition. It was launched in 2017 at the initiative of the Aldini Valeriani Higher Education Institute from Bologna, Italy. The IOIT organization gathered several “Leader Schools” from different nations [12]. A Leader School is responsible with organizing the contests at national level. At national level, every school can participate.

In 2019 the organization had three members:

- Italy, represented by the Aldini Valeriani Higher Education Institute from Bologna
- Romania, represented by the National College of Informatics from Piatra Neamt;
- Russia, represented by the High School 1517 from Moscow

The Danderyds Gymnasium from Sweden is also in negotiations to join the IOIT community.

The competition includes 4 online national contests when all nations have the same problems in the same dates. The Leader School is responsible with the organization of these competition at national level. The teams consist in 4 students and up to 2 reserves from the same school.

### 3.2. Competitive programming challenges - support for business

#### 3.2.1. HackerRank's CodeSprints

HackerRank is a tech company that focuses on competitive programming challenges in almost 15 core computer science domains, such are: algorithms (almost 40% of the contests) and functional programming, artificial intelligence, machine learning, datastructure, so, all other domains not exceeding 10% of the contests each.

The company addresses to both consumers and businesses. From consumer point of view, competitors are challenged in contests, referred as CodeSprints, where they accumulate scores based on which they are ranked globally on the HackerRank leaderboard. There are no restrictions on who can participate, as in ICPC's case, everybody can sign up and participate.

Although this is not the purpose of this article, we should mention the business dimension of the HackerRank company, who has released products such as: HackerRank for Work, CodePair, DroidRank, SudoRank, DbRank, products which have been received very well in the IT&C market as powerful instruments for recruiting personnel or for upscaling production through better productivity in programming domain.

A 2019 HackerRank Top 20 educational institutions have been published, an extras is available below. Romania occupies a leading position, being among the Top 20 HackerRank institutions:

Rank	College	HackerRank Score	Country
1	ITMO University	407.39	Russia
2	Sun Yat-sen Memorial Secondary School	387.18	China
3	Ho Chi Minh City University of Science	321.99	Vietnam
4	UC Berkeley	299.48	United States
5	University of Waterloo	266.59	Canada
6	St. Petersburg State University	260.68	Russia
7	National Taras Shevchenko University of Kyiv	255.83	Ukraine
....			
19	Babeş-Bolyai University	153.72	Romania
20	Grigore Moisil Gymnasium Satu Mare	149.18	Romania

Table 4. A 2019 HackerRank ranking of educational institutions (extras, adapted from [13])



The HackerRank company offers on its blog a comprehensive analysis of programming market. Here we find out that the Top 20 HackerRank ranking of countries that have the best programmers are (extras):

<b>Rank</b>	<b>Country</b>	<b>Score Index</b>
1	China	100
2	Russia	99.9
3	Poland	98
4	Switzerland	97.9
5	Hungary	93.9
....		
20	Romania	81.9

Table 5. Top 20 HackerRank ranking of countries that have the best programmers, in 2019 (extras, adapted from [13])

### **3.2.2. Topcoder**

Topcoder is a tech company founded in 2001 in US that offers outsourcing technology services. From its foundation, it organizes important competitive programming contests. The Single Round Matches (SRMs) is a 1.5-hour online competition consisting in three phases:

- the Coding Phase – this is a 75 min phase where the competitor is faced to three tasks having three levels of complexity and, accordingly, three levels of points.
- the Challenge Phase - is a 15 min phase of “hacking” other competitors’ solutions.
- the System Testing Phase – consist in (re)evaluating the solutions targeted by a hacking attach: if the attach is successful, meaning that the targeted solution failed to a certain input, then all solutions will be retested with this new input. Scores will be reevaluated accordingly.

There is also a Topcoder Open Marathon Competition, a long term contest that consists in three online stages followed by the onsite Topcoder Open Finals that will take place in the US.

### **3.2.3. CodeChef**

CodeChef is a competitive programming website launched in 2009 as a non-profit educational initiative of Directi, an Indian software company. The website hosts several competitions with monthly frequencies [19]:

- the Long Challenge - a 10-days contest with several questions of different difficulties;
- the Lunchtime - a 3-hour contest that takes place once a month; it features 4 questions;
- the Cook-Off - a 3-hour contest that takes place once a month; it features 5 questions.

### **3.3. Competitive programming competitions organized by tech companies**

There are important technology companies that organize their own competitive programming competitions. Facebook organizes yearly, starting from 2011, the Facebook Hacker Cup, which is a worldwide programming competition.

Google hosts some of the most important competitive programming competitions that are organized directly by a company: CodeJam, Hash Code and Kick Start which take place every year in several rounds. Also, until 2018, the Distributed Code Jam took place.

Code Jam is a global coding competition for individuals. The competition has four online rounds and the onsite Code Jam World Finals, hosted at different international Google offices each year. Code Jam was launched in 2003 and, in the early years, has been hosted on the Topcoder platform. From 2008, Google uses its own platform for competitions.

A particularity of the Code Jam contest is that there are rounds when the competitors don't send their codes to Google to run them, but the competitors run their codes locally using the testing inputs sent by Google, and they have to answer with the correct output in a short limit of time. So, there is no code evaluation, but output evaluation. Only in the final rounds of Code Jam the participants have to upload their solutions to be evaluated by Google through a distributed environment.

Hash Code is another programming contest organized by Google. Hash Code is a team contest oriented towards students and professionals around the world and it covers the software engineering domain. It has two rounds: The Online Qualification Round and The Final Round, an onsite round hosted at a Google office.

Kick Start is a global online coding competition. The 3-hours rounds are online and are held throughout the year.

Regarding the rankings, at the Google Code Jam 2020, the last round took place in April 2020 (Round 1A), where there have been 1.193.000 participants, most of them from India (39%), United States (~10%) and China (7%). Three of the 75 programmers from Romania got the maximum score.

### **3.4. Competitive programming contests hosted by websites**

#### **Codeforces**

Codeforces is one of the most powerful websites that host competitive programming contests. It was launched in 2009 and in 2010 it hosted its first contest. It was created at the initiative of a group of competitive programmers from the Information Technologies, Mechanics and Optics (ITMO) University in Saint Petersburg. After 10 years of activity, Codeforces has over 60.000 active contestants and over 75.000 registered users; in the last year “an increase was obtained in all major metrics (from 15% to 45%)” [14].

The figure below shows the evolution of the Active contestants on Codeforces website in the 10 years of activity:

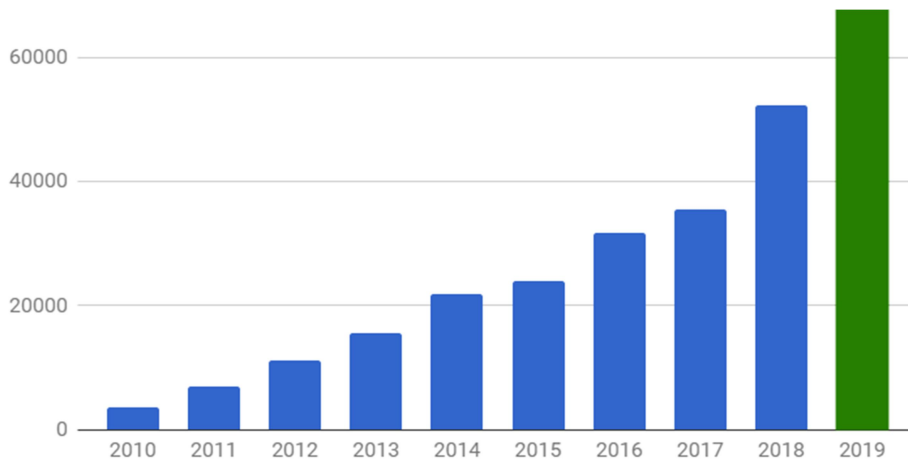


Figure 2. Evolution of the Active contestants on Codeforces website in the 10 years of activity (source [14])

Codeforces offers weekly short rounds of 2-hours, or longer Educational contests several times a month. Codeforces contests implement the hacking system: competitors can “hack” opponents’ solutions, thus getting ranking advantages.

Romania occupies a good position in the global rankings of Codeforces: there are over 1.000 Romanian competitors: 5 of them are GrandMasters, with rankings over 2.400, and 29 are classified as Masters or International Masters, having rankings between 2.099 - 2.399.

#### **4. Competitive programming in Romania**

In this section we try to make a characterization of the possibilities of performing competitive programming in Romania. It is not an exhaustive presentation, but a starting point in the knowledge of the domain.

##### **4.1. Infoarena website**

Infoarena is one of the most powerful Romanian websites that hosts competitive programming contests. The Website was launched in 2003, at the initiative of a small group of IOI Romanian gold winners [15]. The Infoarena.ro platform is a powerful tool for learning algorithms and computer programming and it hosts competitions like: Algoritmiada, Junior Challenge, Summer Challenge, FMI No Stress and so many others.

##### **4.2. Competitions organized by educational institutions**

In Romania, colleges and universities are strong players in organizing competitions addressed to both students and middle or high-school students. Among these contests, we notice:

“**EmpowerSoft**” is a school competition organized by “Mihai Viteazul” National College from the municipality of Ploiești. It is a yearly competition in its sixth edition, it was launched in 2015. It comprises several contests [16]:

- Programming;
- Educational software / utility software / mobile phone applications;
- Web-pages.

The programming competition is an online individual contest with different school-levels sections. The evaluation is performed using automated testing at the end of the contest. Scores are given for accuracy of the answers but uploading time could be an important asset in case of a tide break.

The National College of Informatics Piatra Neamt organizes the "**PROSOFT @ NT**" contest. In was launched in 2012, and now, at its ninth edition, it was attended by students from Bulgaria, Russia, Poland and from 11 Romanian

counties as well, with a total of 126 students who were enrolled in the individual test of the programming competition [17].

“Grigore Moisil” Theoretical High School of Informatics from Iași organizes two competitions:

- “**The Followers of Moisil**” contest for middle school grades 5-8 students;
- “**Moisil++**” contest for high school grades 9-12 students [18].

Important competitive programming contests are organized at university level as well.

The League of Students of the Faculty of Automation and Computers (LSAC) from the Technical University “Gheorghe Asachi” from Iasi organizes the “**IT Marathon**”, with five sections:

- Web development
- Desktop applications
- Mobile apps
- Design
- Junior Dev

The Junior Dev is an 8-hours competitive programming challenge dedicated to high school students consisting in solving a series of algorithmic problems of various difficulties, which require a broader vision of the field.

The Romanian-American University from Bucharest has its second edition of a competitive programming contest. The challenge entitled “**RAU-Devhack**” was launched in 2019 with a larger contest that included [20]:

- a Senior section consisting in a 24-hours hackathon for students;
- a Junior section, dedicated to high-school students, which was a 5+1 hours onsite contest.

The Junior section included two phases:

- Programming (5 hours) - consisted in solving 5 problems;
- What is the output? - (1 hour) consisted in a 100 multiple-choices questions set, where the student had to answer how many he or she could.

The 2020 second edition of the contest for high-school students was renamed “**RAUCoder**” and, at least this year, taking into consideration the pandemic situation, will be an online contest that will take place at the end of May.

#### **4. Conclusion**

Competitive Programming is one of the most exciting sport of mind nowadays. It attracts programmers, more often young programmers, keened to put themselves to constant challenge, to test and prove their skills in a domain with infinite resources. Results are spectacular, communities are incentives, everybody has a place and a purpose. It is a win-win situation for everyone. It's like a game: you play once, you play twice, you learn, get experience, then the reward will come, you are scored, you get image, you keep growing.

It is a worthwhile experience that such contests can offer. That's why, we consider this paper to be a good starting point in the knowledge of the competitive programming domain.

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## UNSUPERVISED MERGE OF OPTICAL CHARACTER RECOGNITION RESULTS

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**Abstract:** *This paper explores an innovative Optical Character Recognition (OCR) method that aggregates the results from different methods. Due to the fact that we have to our knowledge the typical characteristics of each OCR approach in any possible situation, a decisive operation can be issued between the outcomes. The proposed method aims to use a voting-based system, apply different preprocessing operations on the input image document, in order to enhance various text characteristics and expects to retrieve the “best text” in the image where it can be “read” more confidently by the OCR engine. The obtained results proved that the proposed approach delivered robust OCR reading in all kinds of processing scenarios, thus enabling the current method to be used, alongside other voting-based techniques in an unsupervised document image processing and information extraction pipeline.*

**Keywords:** *Optical Character Recognition, voting technologies, unsupervised machine reading, Tesseract OCR engine.*

### 1. Introduction

#### A. Previous work

Optical Character recognition is a Computer Vision technology that enables machines to retrieve humanly-readable text from regular images [1], the accuracy

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of the method being, in most cases, dependent on text preprocessing and segmentation algorithms [2]. One of the most popular, and widely employed OCR engines, mostly due to its open-source nature, is Tesseract, an engine developed between 84' and 94' by HP, starting from a Ph.D. research project in HP Labs [3]. At that time, commercial OCR engines were primitive and typically failed on anything except for best quality print, which is why HP Labs Bristol decided that this project may become a good product for their company [4]. After more improvements, the OCR engine was the subject of a contest in the 1995 annual test specially dedicated to accuracy in machine reading text [4] and obtained the best results, by far ahead of the performances acquired by the existing machines in that competition [4]. HP ultimately released in 2005 the Tesseract OCR engine as an open-source solution [6].

The Tesseract engine has a pipeline-based architecture in the following serial order: image thresholding [13][14], connected components retrieval from the Boolean thresholded image, blobs creation, basic character recognition, several text aggregation forms in order to build words, text lines [14], text regions or paragraphs and to detect the occurrence of small capitals [7] (Fig. 1.).

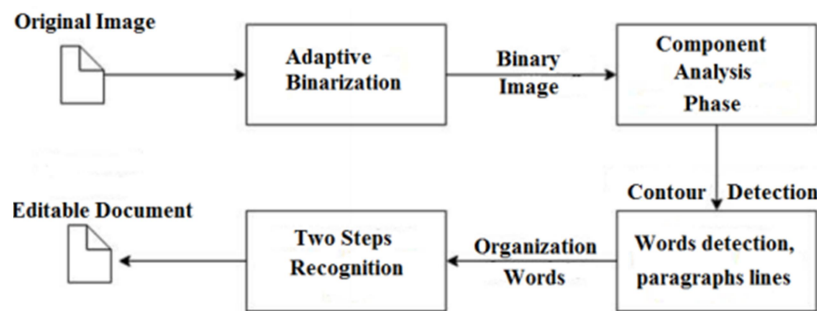


Fig. 1. The architecture of Tesseract OCR system; image taken from [7].

The first code version of Tesseract has improved over time, changes such as conversion to Unicode and retraining, contributing to the increase of its performance. R. Smith presents in [4], a comparison between the Tesseract 2.0 (2007) version and the original HP's version (1995). Table 1 presents a detailed performance comparison onto various types of document sets [4].

Version	Set	Errors		%Error rate		%Change	
		Character	Word	Character	Word	Character	Word
HP	Bus	5959	1293	1.86	4.27		
	Doe	36349	7042	2.48	5.13		
	Mag	15043	3379	2.26	5.01		
	News	6432	1502	1.31	3.06		
2.0.	Bus	6449	1295	2.02	4.28	8.22	0.15

Version	Set	Errors		%Error rate		%Change	
		Character	Word	Character	Word	Character	Word
	Doe	29921	6791	2.04	4.95	-17.68	-3.56
	Mag	14814	3133	2.22	4.64	-1.52	-7.28
	News	7935	1284	1.61	2.62	23.36	-14.51
	Total	59119	12503			-7.31	-5.39

Table 1. Results obtained with the 2007 version of Tesseract versus original 1995 Tesseract; table taken from [4].

### ***B. Problem motivation***

Voting-based systems are not something unfamiliar, these being found in different approaches such as [7], [8], [9], [10] and, the most recent, [11]. Similarly to [7], in this paper, the “voting-based” component refers to the following approach: distinct image filters are applied over the input data and partial results with the best confidence are aggregated by the voting process, to optimize the final result.

In general, it can be said that OCR engines are usually very powerful tools but they exhibit several weaknesses. They are very sensitive to the quality of the image presented at the input, especially when dealing with problems like uniform or non-uniform noise, variable illumination across the entire acquired image page, variable contrast determined by an inconsistency in the quality of the paper and/or ink. Physical support degradation over time, inconsistent lines with gaps and cracks and especially thinned characters.

Unfortunately, the aforementioned problems come with a huge cost: in terms of the retroconversion effort of library databases, the errors introduced in the textual information are the most difficult ones to correct, they need the most time and, subsequently, the more allocated resources (both people and money). Layout and hierarchy errors, for example, are much easier to correct, alongside with other common page defects like skew induced by the acquiring image mechanism.

### **2. Proposed method**

Our proposed solution in a voting-based one using various filters to trigger various image characteristics. By comparing the words confidence, the most suitable text version is selected as the final output result. Therefore, this method proposes as a solution to compare the confidence of each word and keep the highest value as the final result.

The diversity of the input data, using filters, determines variations in terms of contrast, sharpening, morphological operations like dilation and erosion performed with different kernels on the same image.

The first step is to apply filters on the input image, then send the image to the OCR engine. The outputted text is memorized with its detected confidence and tagged for later processing. We apply this step multiple times on the initial image in order to have more partial results. The final step assumes comparing and combining the partial results from the different OCR runs, as in the case in a proper voting mechanism.

Image binarization [13][14] is employed to increase the contrast between elements and to ensure unambiguous connected components retrieval.

Instead of a more commonly-used per-character OCR confidence, in order to increase the precision, but also have enough granularity for the voting process, word-based confidence (as an average of the individual letters' confidences) is generated and used in candidate selection.

After each run, a comparison based on each word's confidence is performed, and the best confidence word is promoted and selected in the output.

### 3. Performance measurements

Regarding the technologies used, the engine in the implementation is Tesseract 3.02 (Fig. 2) alongside EmguCV 3.0 library for various OpenCV-powered various image manipulations and processing tasks.

The combination of Tesseract and EmguCV is powerful enough to generate and compare a lot of image preprocessing that can be used in order to underline several text characteristics in several image areas.

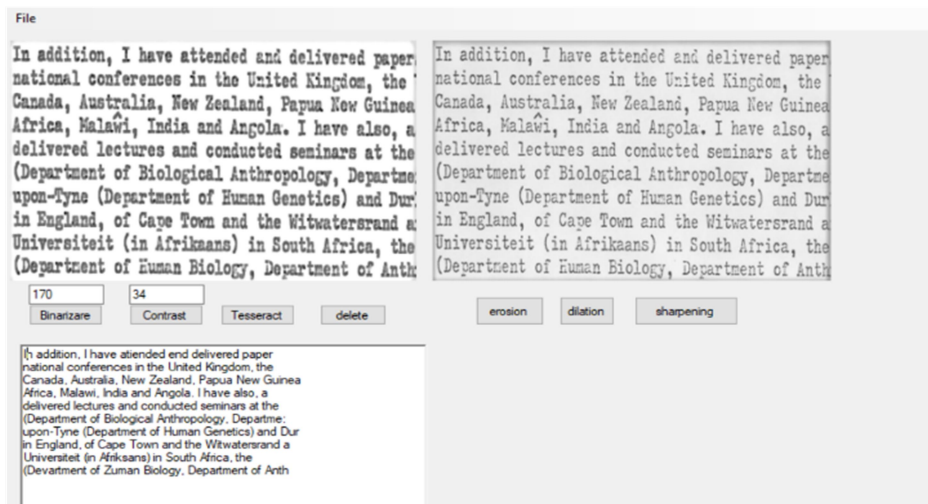


Fig. 2. Tesseract engine version 3.02.

Unfortunately, like any other OCR engine, Tesseract is disturbed by the presence of random noise, improper illumination, and variable contrast across the page, etc. In general, images are distorted locally, meaning that performing several

preprocessing might enable some areas to be confidently “read” by the OCR at the expense of worsening other areas. Capturing the best results from all the runs is the goal of the voting-based technology that was employed in this paper.

There was used a set of test scenarios in order to prove the validity of the voting system. In figure 3 it is illustrated the first scenario, where the low image quality requires applying filters in order to enhance it, and then to be ready for OCR processing.

In addition, I have attended and delivered paper national conferences in the United Kingdom, the Canada, Australia, New Zealand, Papua New Guinea Africa, Malawi, India and Angola. I have also, a delivered lectures and conducted seminars at the (Department of Biological Anthropology, Departme upon-Tyne (Department of Human Genetics) and Dur in England, of Cape Town and the Witwatersrand a

Fig. 3. Scenario 1, “Test 1” image.

All the below figures are generated using the Diffchecker [12], in order to visually present the word-level differences at every image preprocessing step and to illustrate the behavior of the proposed approach at every stage.

1	In addition, I have attended and delivered paper national conferences in the United Kingdom, the Canada, Australia, New Zealand, Papua New Guinea, Africa, Malawi, India and Angola. I have also, a delivered lectures and conducted seminars at the (Department of Biological Anthropology, Departm upon-Tyne (Department of Human Genetics) and Dur in England, of Cape Town and the
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Fig. 4. Comparison between image “Test 1” (first row) and the proposed voting-method result (second row)

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Fig. 5. Comparison between image “Test 1” (first row) and the image obtained by erosion and dilation (second row).

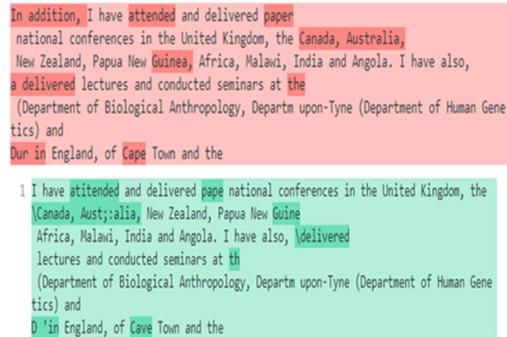


Fig. 6. Comparison between image “Test 1” (first row) and the image obtained by sharpening and erosion (second row)

The results obtained in figure Fig. 7, represents the last sequence applied to the image, namely image sharpening. There are 9 words that were not extracted correctly. In figure 8, 6 words were not extracted correctly by using Tesseract without any filter. The quality of the text was improved by using the partial results from the three sequences and, at the same time, the number of wrong words was reduced from 6 to 4.



Fig. 7. Comparison between image “Test 1” (first row) and the image obtained by sharpening (second row).

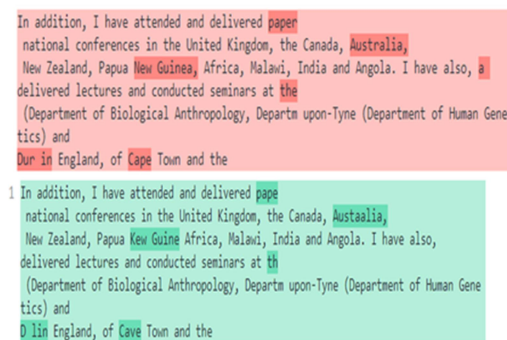


Fig. 8. Comparison between image “Test 1” (first row) and the image obtained by applying Tesseract (second row).

One can observe from the results that every small preprocessing step tends to enable the correct detection of some words, at the expense of the introduced erroneous detection of others, thus the multi-stage OCR process is a slow one but ultimately managing to reduce the number of wrong words.

#### **4. Conclusion**

The proposed OCR voting-based technology proved to increase the accuracy of text detection in basically any text retrieval scenario. It is robust but at the expense of the extra time needed to perform the various preprocessing tasks and the subsequent OCR runs. The combination of the obtained results into delivering the final solution is a fast operation though.

By employing a solution like this, the major problem of text correction in the large-scale mass-digitization projects is significantly dampened.

The main future development of the presented technology will be the integration in an ensemble of other voting-based methods [7-10] to increase the accuracy of a retroconversion system and to minimize the amount of supervision and correction work that often occurs in the case of image document analysis.

Ultimately it is expected that the current research to ensure a better OCR detection accuracy during the Lib2Life research project [16] aimed at obtaining good quality digital versions from the on-paper documents of several Romanian libraries.

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## SQL INJECTION ATTACKS AND VULNERABILITIES

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Mironela PIRNAU<sup>2</sup>*

**Abstract:** *SQL Injection represents a technique of code injection which exploits a series of problems regarding the vulnerability over the data base security from the computing structure of a certain application, with the main cause being the filtering or the incorrect usage of the processed data conducted by one user. These attacks include: queries to the operating system using the system queries; the usage of the external programs under the Shell orders and queries to the back-end databases by using a SQL code. By incorporating the malicious SQL commands in the content of the parameter, the attacker may trick the application to send a malicious interrogation to the database. The SQL Injection is considered to be an attacking technique over the security and the vulnerability with major impact risk (negative) and consequences of serious levels, both professional and personal. The severity of SQL Injection attacks is limited by the ability and the imagination of the attacker, and to a lesser extent, by the counter measures of defense in depth, such as the connections with reduced privileges to the database server, etc. From the point of view of the security against attacks of SQL Injection OWASP - Open Web Application Security Project type, the validation of all input and output data is recommended, the debugging of all errors generated by the application and the usage of roles and permissions in the database.*

*SQL Injection embodies the vulnerability when the attacker tries to introduce pieces of SQL code sequences in the input fields of the application, being sent afterwards towards the database server. A successful attack would allow the attacker the access both the database server and the files of the system. The SQL Injection attacks may be classified according to a series of criteria such as: the channel to obtain data from, the obtained responses from the server, the manner of response of the server, the impact point, etc.*

**Keywords:** *database, SQL Injection, vulnerability, attacks, scanners of vulnerability*

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## **1. Introduction**

Certain weaknesses of some attacks of one hardware or software system may allow the unauthorized users to obtain access. This implies the writing of a SQL query which may allow the display, the alteration and the deletion process from the database via Web forms or directly, by using URLs.

The attacks of SQL injection type allow the hackers to implement through a certain application of a malware code to another system. These kinds of attacks include SQL queries towards the operating system through system queries, through the usage of external programs, through shell commands as well as through back-end databases calls by using SQL queries.

When a Web application sends information form a HTTP query as part of an external interrogation, this must be prudently cleaned so that the possible breaches from the searching algorithm and from the retrieved unsecured information to be avoided.

Otherwise, a hacker or an attacker of a server or of a platform may use a series of incorrect modalities of (re)query a database, by injecting special (meta) characters or malicious commands or the implementation of command modifiers, and later the Web application would consider the interrogation and would return the queries towards the external system to be executed.

The attacks performed with the help of SQL interrogations represent a very outspread and dangerous form of “code injection” because it allows the unauthorized users to take over data and to process data from the tables of a database. In order to exploit a security breach by injecting a SQL code, the attacker must identify one parameter through which the Web application allows the display and the subsequent processing of certain confidential data from the database. By the process of SQL order integration which is malicious in its parameter contents settled as “target”, the attacker may define and implement a series of interrogations that may offer various advantages such as the unrestrained access to certain information, or the alteration of data of private pleasure which affects the control and the security processes of the database. These types of attacks are not difficult to perform because there are various and quite simple possibilities of “testing the vulnerabilities” of data, but also some instruments that may identify these defects. The consequences of this process are extremely damaging because one attacker may manipulate the existent data and may cause disclaimer problems, such as: the cancellation of transactions, to modify balances, to allow the complete disclosure of the entire system data, to destroy the data or to make the data unavailable and thus, to become the administrator of the database.

The SQL code injection is very frequent within the program’s structures of the applications developed in PHP and ASP, especially due to the prevalence of older functional interfaces.

The severity of SQL injection attacks is not only limited by the ability and the imagination of the attacker, but also, to a lesser degree, by the implemented security countermeasures, as well as by the connections holding low privileges of the database server, etc. Generally, SQL Injection may be considered one type of attack with great impact and very serious consequences.

## **2. SQL Language**

✓ The SQL history starts in the IBM laboratories in San Jose where the language was developed in the last years of the 8<sup>th</sup> decade. The initials stand for: Structured Query Language.

SQL represents a standard language for accessing the MS SQL Server, Oracle, MySQL, Sybase and Informix database servers. Most web applications must interact with a database and most programming languages for web applications such as ASP, C#, .NET, PHP or Java offer means to connect to a base and to interact with it. Each programming language implements its own means of definition, implementation and execution of SQL instructions, and the application developers often use combinations of the latter to achieve their aimed objectives. Without a deep understanding of the foundations of the database that are used within the working process, and without a clear awareness of the potential security problems resulted after the generated code, the programmer can develop uncertain, insecure and vulnerable applications towards the SQL Injection attacks.

### **✓ Definition and manipulation of data**

For the data manipulation the following commands are used: SELECT, UPDATE, INSERT, DELETE:

- ✓ SELECT – extracts data from a table;
- ✓ UPDATE – updates data of certain entries;
- ✓ INSERT – inserts new entries in a table;
- ✓ DELETE – clears entries from a table.

For defining data, the following commands are used, such as: CREATE, ALTER, DROP:

- ✓ CREATE – creates a new table;
- ✓ ALTER – modifies the existent table;
- ✓ DROP – deletes a table, an index or views.

## **3. SQL Injection Attacks**

SQL Injection represents one of the most devastating vulnerabilities whose major impact is reflected in the loss of confidentiality of the information stored in the database of the attacked application, such as: name and password of the user, addresses, phone numbers or security codes of the credit cards, etc.

SQL “Code Injection” represents a vulnerability which may manifest itself when there is the possibility of an attacker to influence the SQL queries that an application sends to a database. SQL Injection is not a vulnerability that exclusively affects the web applications, since any program that accepts entries to form SQL dynamic declarations may become vulnerable.

A SQL code structure will represent a possible attack to the security of the information stored in the structure of the database because there is a diversity of execution and implementation methods of the SQL standard and, implicitly, a variety of available methods regarding the specific coding options. The main manner of SQL Injection attack consists in the direct code insertion within the input and output parameters, which are subsequently chain-linked with SQL commands and then sent on a server to be executed. An attacker can modify a SQL declaration and that precise declaration will be executed with the same rights as the rights of the user by rights of the application.

When the SQL Server is used to execute commands that interact with the operating system, the process will run with the same permissions as the component element that executes the command.

SQL Injection can be used for:

- ✓ avoiding the authentication and access controls;
- ✓ determining the structure of the database;
- ✓ the enumeration of the database;
- ✓ the unauthorized access to the database (passwords, credit cards);
- ✓ unauthorized changes of the data including the deletion of the registries, of the tables, or the insertion of entries;
- ✓ performing commands of the operating system.

#### **Examples of successful SQL attacks:**

- ✓ In February, Jeremiah Jacks identified one vulnerability of the Guess.com website to the SQL Injection attacks, through which a hacker, by creating his own URL address was able to download the unauthorized information of over 200.000 clients of the application managed by that certain database, such as: names, passwords or the data on the personal credit cards (used for the online commerce);
- ✓ Subsequently, in June 2003, Jeremiah Jacks discovered that the same specific security problems SQL “code injections” were identified in the website of the e-commerce type PetCo.com. The consequences allowed the attackers to obtain the confidential information regarding over 500.000 credit cards;
- ✓ In turn, the TJK retailer in USA represented the target of the SQL Injection attacks in December 2006, being stealing from the database certain data of over 2.000.000 credit cards;

- ✓ In February 2009, a group of Romanian hackers managed to affect, from separate incidents, the security of the sites of some famous companies from the information security domain, such as: Kaspersky, F-Secure and Bitdefender;
- ✓ At the same time, the Department of Justice on USA accused Albert Gonzales in August 2009 for the theft of 130.000.000 of credit cards for the SQL Injection attacks. Among the affected companies were: Heartland Payment Systems the credit card processing companies, the 7-Eleven chain stores and the Hannaford Brothers supermarket chains;
- ✓ Also by the same “injection” method of unauthorized codes, in April 2011, the website of the Barracuda Networks company, one of the leaders in the “cloud” security of data applications domain, was successfully attacked and the database of the website (including the authentication credentials, “username” - “password” and the password hash) was entirely posted on the Internet;
- ✓ The well-known producer Sony was the target of some SQL Injection attacks in May 2011. Then, the LulzSec group succeeded to compromise some of the company’s websites and further displayed in the online environment the information taken over from the stolen database.

Starting with the year 2008 a significant increase of the “code injection” actions of some categories within different online applications and associated databases could be observed, thus worldwide had been recorded hundreds of thousands of attacks, some of the being successful, over the unsecure websites.

By generally using the same action method, the hackers used a type of programs that allowed them the identification of the vulnerable aspects from the implemented applications of codes and the successful exploitation obtained illegally (the display, the modification and even the deletion of certain confidential data or data of the highest importance).

Thus, a specific sequence of “exploit” type executes SQL instructions that locate each tablet from the database structure and implements, for each column of text type within the tablet, a malicious client-side script. Due to the fact that the majority of web applications uses data from the database to create a dynamic content. Consequently the created malicious script will be run in the browser of a certain user of the application or of the compromised website.

#### **4. Causes for an unsuccessful SQL injection attack**

##### **4.1. The incorrect manipulation of the escape characters**

The SQL databases interpret the character ' (single quotation mark) as a delimitation between the programmable code and the processed data. It is assumed that anything that follows the symbol ' represents a part of a code that must be run,

and anything that is framed by the symbol ‘ represents data. Therefore, a vulnerable website can be quickly identified by the simple push of the button of the single character ' in the URL address or in one field from the web page or web application. Below there is an example of code for an application that directly sends the data introduced by one user to a SQL declaration created dynamically:

***SQL = “SELECT \* FROM Table WHERE field = ‘\$\_GET[“input”] ‘;”;***

If one character ' is introduced as an entry into an application, an error message might occur. The result depends of a series of factors, such as the programming language, the used database and the used protection measures. The cause is represented by the symbol ' which was interpreted as a string delimiter. Syntactically, the executed SQL query is incorrect, and, therefore the database returns an error. The ' mark is used in SQL Injection attacks for the manipulation of the user’s query, thus the attacker can build personal queries that would be subsequently executed by the database server.

#### **4.2. The incorrect manipulation of different types of data**

The removal of the character ' through escape or the validation of input for the cancelation of the character ' is not enough. When numerical data is used, it is not necessary to be encapsulated data between characters ', because the numerical data would be considered as strings. In the below example is considered that the parameter will be a whole, and it would be written using single quotation mark.

***SQL = “SELECT \* FROM Table WHERE field = ‘\$\_GET[“user\_id”]”;***

MySQL implements the function LOAD\_FILE which can read a file and returns the content of the file as a string. The following declaration may allow one attacker to read the content of the file of “password” (passwd) type, one that contains the name of the users and the attributes for the users of the system.

***SELECT \* FROM Table WHERE user\_id=1 UNION ALL SELECT  
LOAD\_FILE (/etc/passwd)***

The introduced data is interpreted as SQL instructions, and the usage of the character ‘ is not mandatory.

#### **4.3. The incorrect assembly of the queries**

For certain complex applications, the web developer must allow some declarations to be created dynamically, based on the data for which the query was executed. The

following code sequence allows the transmission of introduced data by the user towards a SQL declaration which is created dynamically.

```
$$SQL="SELECT ".$_GET["col1"],".$_GET["col2"]." FROM ".$_GET["Tabel"];
```

In case one attacker can manipulate the HTTP query and the attacker can replace the values introduced by the user for the name of the table and its fields, the attacker can display the names of the users and their passwords from the database. A possible example of URL built by the application is the following:

```
http://www.Test.ro/user.php?Tabel=utilizatori&col1=user&col2=password
```

#### **4.4. Error exploitation**

The unsuitable exploitation of the errors may lead to a variety of security problems for a website. The most frequent problem occurs when detailed error messages that contain information about the database and error codes are displayed to the user and to the attacker. The messages that reveal implementation details may offer to one attacker important clues regarding the possible weaknesses from the application. The error detailed messages may be used to extract information from the database regarding the way SQL Injection declarations can be modified or built.

#### **5. The success of a SQL Injection attack**

The databases of the application are implemented for several predefined users. Microsoft SQL Server uses the account of the administrator "sa", whereas MySQL uses the accounts "root" and "anonymous", but Oracle creates the accounts "SYS" and "SYSTEM". All these codes are created implicitly whenever one database is created. For these codes, the default passwords are well known.

Some system administrators and some database administrators install database servers to run, from accounts of system administrators with high privileges, such as root, SYSTEM or Administrator. But the servers of services for the databases should run as an unprivileged user, if this is possible. All these may reduce the risk of deterioration of the operating system and of other processes, in case of a successful attack executed over the database. Each type of database server requires a certain model of control over the access through which different privileges are assigned to the users' accounts regarding the prohibition to the data access, regarding the execution of stored procedures or of other functions specific to the database. In a great measure, the developers of applications program codes for the connection to a database by using predefined accounts having default privileges,

instead of creating users accounts specific to the tasks of the applications, thus ignoring the fact that, when an attacker exploits one SQL Injection vulnerability within an application that connects to a database with a privileged account code can be executed in the database with the privileges of that certain account. For the increase of the security level of the database with separate privileges according with functional requirements of the obtained application.

For a hacker to succeed to implement a SQL Injection attack, this will be prior to the knowledge of the available resources, the typology of the data already installed, defined tables, as well as the list and the structure of the attributes or of the fields that may become vulnerable (or that represent the subject of the attack). When an attacker uses a SQL “code injection”, the attacker will try to access the metadata of the database for several times.

The metadata represents information about the data contained by a database, such as: the name of the database or of the tables, the fields or the attributes from the structure of each table, as well as the already existed relations among them. For the MySQL server (from ver.5.0), this data is stored in the virtual database INFORMATION\_SCHEMA and can be accessed through the commands SHOW DATABASES and SHOW TABLES. Each MySQL user has the right to access the tables from the databases but only the entries are visible, the ones that correspond to the objects for which the user has the corresponding access privileges.

The MySQL declaration for the enumeration of all the tables accessible to the current tables is:

```
SELECT table_schema, table_name FROM  
INFORMATION_SCHEMA.tables;
```

It is not possible for the access to the database to be hidden or canceled INFORMATION\_SCHEMA from a MySQL database.

In order to prevent the attacks of SQL Injection type, one of the most efficient method is implementing a series of complex techniques of validation of entry data, thus the existence of the possibility of inserting other data or inconsistent characters by the attacker does not exist. The methods through which the level of vulnerability of information can be limited, or found implemented at the level of databases and of the applications can be described as follows:

✓ **The usage of the well-defined variables and the definitions of the columns from the database**

The manipulation and the storage of numbers (the session IDs, codes, etc.) as whole numbers or types of proper numbers. The strings must have only alphanumeric characters and punctuation marks and the characters of SQL syntax must be rejected.

✓ **The result of the query is assigned to the well-defined variable**

If the application is searching for a numerical value, then the assignation represents the result of a whole number, so the attackers cannot extract information from the database.

For example, if a variable which was going to be displayed within a browser accepts only whole numbers, then the possibility of obtaining and of displaying the name of a column should not exist. Certain attacks are strictly restricted by this technique.

✓ **The length of data to be limited**

Many strings of characters are not limited to an adequate length for their purpose. For example, the name of one user should not be stored or manipulated by a variable of 256 characters long. The number of limited characters introduced in one field may restrain the success of SQL injections, thus reducing the length of strings of characters that one attacker can introduce.

✓ **Creating queries by the concatenation of the avoidable strings of characters**

For example, a view function is created, or another procedure that operated the variables from the application. From the concatenation of the strings of characters – the resulted query from the data taken over from the users is: "Select fields from table Where + conditions". This can be very vulnerable considering the SQL injections, but a procedure may generate an error if the introduced data is incorrect and this will not allow the manipulation of the query.

✓ **The separation of data and accessing databases on level roles**

Every application must use accounts with accessing privileges for certain tables which are needed to a function. These internal tables of the database, along with the management tables of the accounts and of the variables of the system must be accessible only to the accounts with access rights.

## **6. Vulnerability scanners for the databases**

The best way to evaluate the possible vulnerabilities of a certain application is a scanner of vulnerabilities; a tool that is used to test the security of a system or of a network. The best way to evaluate the possible vulnerabilities of one application is a scanner for vulnerabilities, a tool that is used for testing the security of a system or of a network. This returns information about the vulnerabilities of the system, the ones that can be later used by other applications or policies to provide protection.

The applications of evaluating vulnerabilities are divided into the following types:

- ✓ **Host** – An application for the evaluation of the vulnerabilities of the host can scan and report the vulnerabilities that are found only on the computer on which it installs and does not interact with other systems. The



advantage of using this application is that the scanner has complete access to all the resources of the system they can run on. The main disadvantage is that the scanner may use many of the resources of the device they run on.

- ✓ **Service** – There are applications that verify the vulnerability from a series of computers and services within the network. This type of applications varies, from scanners of ports, to scanners that detect the computers that are functioning and that are extracting data.
- ✓ **Application** – Most of the scanners of this type are dedicated to web applications. They may help to locate the pages that should not be normally accessible, but that may also execute complex operations such as the manipulation of the application to obtain information.
- ✓ **Active/passive** – The active scanners try to evaluate one type of network, a system or a service, by using attack strategies that might be used for a real attack. These scanners generally identify certain vulnerabilities caused by defective configurations or by system patches of missing systems. The advantage of these scanners is that the administrator retains the control over the scanning time. Among the disadvantages there can be mentioned that these scanners may lead to the discontinuance of the functionality of the systems, without being recommended over critical systems. The passive scanners do not affect particularly the resources of the system because they only monitor the data from one system and executes processing operations of the data on a separate device. These scanners behave similarly with the detection systems of the intrusion, meaning that they intercept the data about the system and evaluates them by using a set of rules. The main advantage of this type of scanner is that it can function continuously because it does not use the resources of the system. The disadvantage is simply represented by the fact that the passive scanners will only report the derived information which is easily available, and which will not be able to be executed thorough checks. Among the types of tests used by one passive scanner, the following can be mentioned: the determination of the version of one program or the checking of the presence of a certain program.
- ✓ **Examples of vulnerability scanners for databases**
- ✓ **Trustwave AppDetectivePro**<sup>3</sup> represents a database scanners and data stores that can immediately discover configuration errors, problems regarding the access and identification control and missing updates or any other unsuitable combination of settings that may lead to the escalation of privileges, to denial-of-service attacks, to information leakage or to unauthorized modification of the data.

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<sup>3</sup> <https://www.trustwave.com/Products/Database-Security/AppDetectivePRO/>

- ✓ **Integrigy AppSentry**<sup>4</sup> represents a new generation of security scanners and evaluation instruments of vulnerability. Unlike other security scanners, AppSentry uses audits and written security controls especially for the application that would be tested. The attackers and dissatisfied employees often exploit the security problems at different levels. Thus, only a complete and comprehensive validation would cover all the risks within one environment on various levels. The advantage of AppSentry is that it is no need for it to hold separate instruments for the operating system, for the web server, database or for the application. AppSentry represents one single instrument that may validate and audit the security of the entire technological stack of the application, from the operating system to the layer of the application. The module of validating the application searches within the entire configuration of the application and within the processing of the transactions to identify the security risks and possible frauds. By underlying the weaknesses from the audit procedure and by initiating alerts in case of suspicious actions, AppSentry can identify the missed risks resulting from the traditional testing of vulnerabilities.

The manner of testing vulnerability uses advanced penetration techniques to discover the security risks within the operating system, web servers, application servers, databases and applications. The tests for the already known exploits and for the configuration errors are externally executed towards the application with the attempt of penetrating it. The common and known ports, the web directories and the accounts of the database are tested for the identification process within the configurations.

The manner of cracking passwords (default passwords, dictionary or list attacks) by using brute force can be applied: to the operating system, the web server, the database and to the authentication process within the application.

- ✓ **Imperva Scuba** is a free instrument that scans the complex databases to discover security vulnerabilities and configuration errors. The reports provide information for measures that can be immediately considered to reduce the risk level and to update vulnerabilities. Scuba offers a number of almost 1200 of tests that can be run for different databases: Oracle, MS SQL Server, SAP Sybase, IBM DB2, Informix and MySQL. These tests can be run in real time, without the degradation of the performance of the database servers because Scuba does not exploit the vulnerabilities it identifies. Scuba offers rapidly an analysis of the security level and of the infrastructure of the database by displaying configuration defects such as weak passwords, known security risks or the lack of critical updating. All the identified risks represent a priority and are presented in reports very easy to be understood, along with the instructions regarding the way of

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<sup>4</sup> <http://www.integrigy.com/products/appsentry>

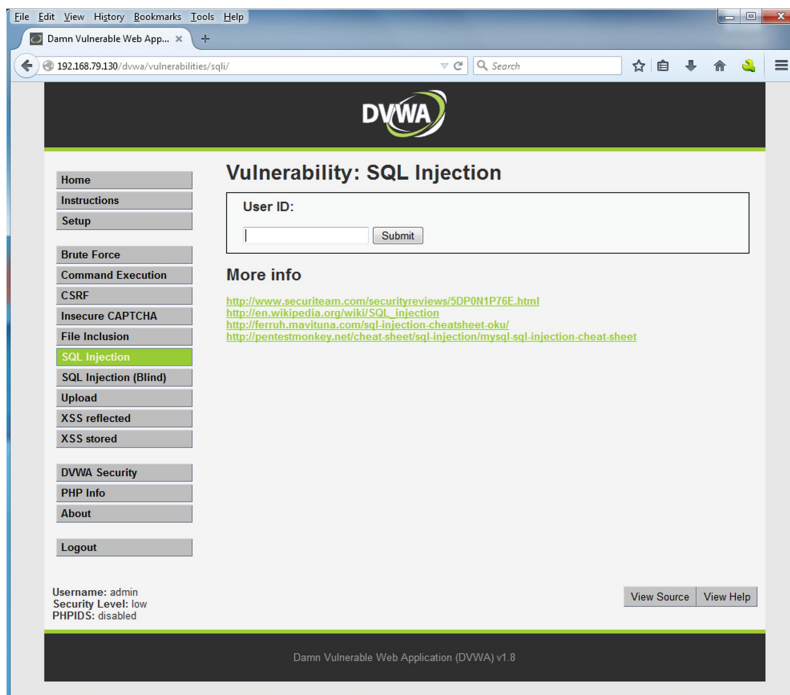
solving the problems regarding vulnerabilities. This helps to reduce the risks and to fulfill the requests conformance requirements without costs, labor force or the right type of expertise claimed by other applications. Regarding MySQL, the following journal files are useful for the debugging of the application or for improving performance.

- **Error Log.** It contains information about the errors that occur during the server's run (includes the server's switching on and off);
- **General Query Log.** Represents a general recording of the activities of the mysqld server. The server writes information in this file whenever clients connect or disconnect, and it also records each SQL instruction received from the clients. This general journal of queries can be useful when an error or malware activity is to be suspected.

## 7. Practical example of SQL injection

The used application is named: Damn Vulnerable Web Application. DVWA (<http://www.dvwa.co.uk/>) and it is a web application written in PHP/MySQL with major vulnerabilities. It is developed with the purpose of becoming a tool for testing the abilities and the instruments of specialists from the security domain within a legal environment.

It helps the web developers to understand better the security processes of web applications and to help the teachers/students to learn about the security of web applications within a supervised environment.



- Step 1.** To verify the functionality of the application
- Step 2.** To verify the vulnerability to SQL Injection
- Step 3.** To exploit the vulnerability level
- Step 4.** To identify the tables from the databases
- Step 5.** To verify the fields from the tables of the database
- Step 6.** To extract sensitive information from the database

### ✓ **Conclusions**

In the most serious cases, the SQL injection may allow for an anonymous attacker to read or to modify all the stored data within the database and even to detain the total control over the server on which databases run. The SQL types of attacks occur when malicious data is sent to one code interpreter as part of one command of one query. The malicious data may trick the interpreter to execute involuntary commands or to access data without an appropriate authorization. As the degree of awareness over the security of web applications has evolved, the SQL Injection vulnerabilities have gradually become even more difficult to be detected and exploited. Many modern applications avoid the SQL injection by using APIs which, if properly used, are inevitably secure against the SQL types of attacks. The SQL injection usually occurs in accidental cases whenever these defending mechanisms cannot be applied. The process of finding the SQL injection sometimes represents a difficult task, demanding perseverance to locate one or two instances from an application where ordinary controls were not applied.

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## VOTING-BASED MOTION ESTIMATION

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**Abstract:** *Motion estimation is an essential topic in computer vision, having a large number of applications, such as tracking and video compression, to name a few. This paper presents a voting-based motion estimation algorithm that combines two categories of methods, namely dense methods (optical flow) and sparse methods (block-matching). The obtained results proved that the proposed approach is fast, robust and reliable, thus being suitable for integration in unsupervised video processing systems.*

**Keywords:** *motion estimation, optical flow, block matching, motion vectors, voting system, voting methods*

### 1. Introduction

The main idea of motion estimation is (given a sequence of images, usually a video) to find the motion, namely what moved in the sequence and how or how much it moved (the direction and magnitude) as we step through the images in the sequence [1]. Usually, we want to find the motion between every two consecutive frames at the same point in the image space. We may be interested in finding the motion of some regions of the image, the motion in some specific sampling points, or the motion of all pixels of the image. Thus, the output of motion estimation algorithms is a 2D vector field. The vectors are defined at some points in the image space, or at every pixel, which represents an estimation of the motion at that particular point or in a neighborhood of that point). The vector field is calculated at each frame based on the difference with the previous frame.

#### 1.1. Previous work

In the past years, the domain of motion estimation had evolved considerably [1][2]. There are two major categories of methods for motion estimation mentioned in the literature: direct methods and indirect methods [3][4].

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In the first category, there are the methods presented in the scientific world:

- **Dense/direct methods** – estimate motion in every pixel based on the temporal and spatial variation of the intensity at that point ([15], [18], [19])
- **Block-matching methods** – divide the image space into blocks of equal size and estimate the motion for each block based on the correlation of the intensities of the pixels in that block and the ones in the other frame. They can further be generalized to so-called “region-matching” methods that use regions of arbitrary shapes instead of rectangular blocks [20][7][8].
- **Phase correlation** – compute an estimate of the global motion between two frames based on their Fourier transform. In some research papers are mentioned as frequency-domain methods [16].
- **Optical Flow** – compute a motion vector between two consecutive frames [12].

The second category is the indirect methods that have at the base the features (corner detection):

- **Feature-based methods** – these methods find feature points and track them across multiple images; they estimate the motion of only the feature points based on the locations they are found in the images [5].

## **1.2. Problem motivation**

Dense methods are based on a Taylor series approximation that only holds for small displacements of the same object point in the two frames. Thus, they are well suited for videos with a “small” amount of motion. On the other hand, block-matching methods can detect more significant motions depending on the size of the search region parameter; however, they are more computationally intensive.

We can obtain a sparse motion estimation method from a dense method by skipping pixels, or equivalently, by sampling the pixels regularly in the image space, at a given interval. Similarly, for a sparse method that computes the motion vector for a specific block, we can shift the block by any number of pixels and apply the same procedure to estimate the motion vector for any pixel in the image space (or decrease the block size up to a few pixels) – and obtain a dense method from a sparse one.

Thus, we can tune the “sparsity” of the methods and combine the advantages of the two methods into one voting-based algorithm.

## 2. Proposed Method

The method proposed here calculates the motion vector fields at the same “sparsity level” using the two methods described above, and then combines their results into a single output.

Firstly, the two methods will be described in detail, and then the final voting-based method will be presented.

For simplicity, the experiments consider only gray-scale image sequences.

### 2.1. Optical flow

This method [13][14] considers a sequence of images represented by a function  $I = I(x, y, t)$ , where  $x$  and  $y$  are the spatial coordinates (the locations of the pixels) and  $t$  represents time (or the frame number). The final goal is to estimate the motion vector  $[u, v]$  for every sampling point  $(x, y)$  in the image space and between every two consecutive frames ( $t$  and  $t + 1$ ).

It was considered a specific point (the blue point in Figure 1) at coordinates  $(x, y)$  in the frame  $t$ , moving along the motion vector  $[u, v]$ , so in the frame  $t + 1$ , the blue point will be at the location  $(x + u, y + v)$ . A reasonable assumption is that the point will appear in the same color (or the same intensity value) in the frame  $t + 1$  at the new location, so this gives the brightness constancy constraint (equation (1)).

$$I(x, y, t) = I(x + u, y + v, t + 1) \tag{1}$$

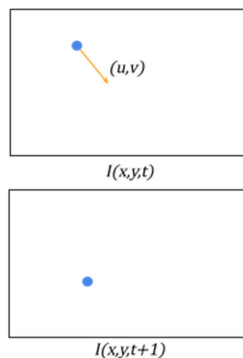


Figure 1 – Optical Flow Example

Now, if the motion vector  $[u, v]$  is sufficiently small, the following Taylor series expansion holds:



$$I(x + u, y + v, t + 1) \approx I(x, y, t) + \frac{\partial I}{\partial x} \cdot u + \frac{\partial I}{\partial y} \cdot v + \frac{\partial I}{\partial t} \quad (2)$$

From (1) and (2) it can be obtained:

$$I_x \cdot u + I_y \cdot v + I_t = 0 \quad (3)$$

In (2) and (3),  $\frac{\partial I}{\partial x}$ ,  $\frac{\partial I}{\partial y}$ ,  $\frac{\partial I}{\partial t}$  or,  $I_x$ ,  $I_y$ ,  $I_t$  represent, respectively, the estimates of the derivatives of the image function  $I$  (concerning  $x$ ,  $y$ , and  $t$ ).

The motion vector at  $(x, y)$  can be computed by solving equation (3) for  $u$  and  $v$ . The equation has two unknowns (underconstrained linear system of equations). A unique solution, in this case, is not available, and there are infinitely many. To overcome this, there are some approaches:

- Horn & Schunck [19] – impose a smoothness constraint on the motion vector field across the image; together with (II.3) this becomes a *minimization problem*: we need to find the motion vector field  $u(x, y), v(x, y)$  such that the following expression is minimized:

$$\iint (I_x u + I_y v + I_t)^2 + \lambda(u_x^2 + u_y^2 + v_x^2 + v_y^2) dx dy \quad (4)$$

where  $u_x, u_y, v_x, v_y$  represent the derivatives of the motion components and  $\lambda$  is a tunable parameter.

- Lucas & Kanade [14] – they assume a *local* smoothness of the motion vector field in the neighborhood of point  $(x, y)$ ; more precisely, the assumption is that the motion vector  $[u, v]$  is *the same* for every pixel in a small window around that point; the size of this window is a parameter that can be modified. This is the method that is used in the presented voting-based algorithm.

By writing (3) for every pixel  $i$  in the window, the result is an *overconstrained system* of  $N$  equations (the number of pixels in the window) with only 2 unknowns,  $u$  and  $v$ :

$$\underbrace{\begin{bmatrix} I_{x_1} & I_{y_1} \\ I_{x_2} & I_{y_2} \\ \vdots & \vdots \\ I_{x_N} & I_{y_N} \end{bmatrix}}_A \underbrace{\begin{bmatrix} u \\ v \end{bmatrix}}_b = - \underbrace{\begin{bmatrix} I_{t_1} \\ I_{t_2} \\ \vdots \\ I_{t_N} \end{bmatrix}}_b \quad (5)$$

where the subscript represents the pixel number. By making the above notations it results:

$$A \cdot \begin{bmatrix} u \\ v \end{bmatrix} = b \quad (6)$$

The above is an *overconstrained* system of  $N$  equations and 2 unknowns and in general, has no solution. However, it can find the “closest solution”, the one that minimizes the error:

$$E = \left\| A \begin{bmatrix} u \\ v \end{bmatrix} - b \right\|^2 \quad (7)$$

by solving the *normal equation*:

$$(A^T A) \begin{bmatrix} u \\ v \end{bmatrix} = A^T b \quad (8)$$

If  $A^T A$  is invertible, we have:

$$\begin{bmatrix} u \\ v \end{bmatrix} = (A^T A)^{-1} A^T b \quad (9)$$

which gives the following final expressions:

$$\begin{cases} u = \frac{\sum I_y I_t \cdot \sum I_x I_y - \sum I_x I_t \cdot \sum I_y^2}{\sum I_x^2 \cdot \sum I_y^2 - (\sum I_x I_y)^2} \\ v = \frac{\sum I_x I_t \cdot \sum I_x I_y - \sum I_y I_t \cdot \sum I_x^2}{\sum I_x^2 \cdot \sum I_y^2 - (\sum I_x I_y)^2} \end{cases} \quad (10)$$

where the summations are performed over the whole window around the point  $(x, y)$ .

If the point  $(x, y)$  corresponds to a *flat region*, then the motion vector cannot be computed, as the matrix

$$M = A^T A = \begin{bmatrix} I_x^2(x, y) & I_x(x, y)I_y(x, y) \\ I_x(x, y)I_y(x, y) & I_y^2(x, y) \end{bmatrix} \quad (11)$$

(which is the *second-moment matrix* of the *Harris corner detector*) is not invertible (or close to singular).

It can be seen from (10) that the complexity of calculating the value of one motion vector for 1 frame is  $O(W^2)$ , where  $W$  is the size of the window over which the summations are done.

To combine this technique with the following one, a consideration was made. A rectangular grid is considered over the image space and computes the motion vector at the center of each block/grid cell.

## 2.2. Block matching

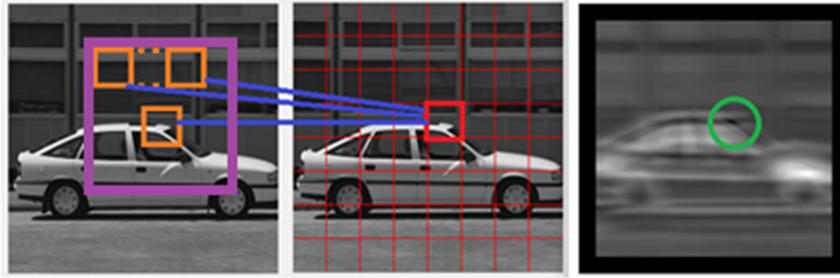


Figure 2 – From left to right: a. reference frame; b. current frame; c. (dis)similarity function. Where: red – current block, orange – sliding window, purple – search region, green – minimum of the dissimilarity function

The image is divided at time  $t$  (*current frame*) into a rectangular grid of blocks, as in Figure 2. Then, for every block, the aim is to find out the location in image space where that block was in the previous frame  $t - 1$  (*reference frame*) – that is, the location that best matches the current block [11]. To do so, it was considered a *sliding window* [10] (having the same size as the block) that swipes the reference frame and for each location in the reference frame, it was computed similar the region in the sliding window is to the current block. For that, it was used a (*dis*)similarity function such as the *mean squared error (MSE)*.

So, for a block at coordinates  $(x, y)$ , and a particular position of the sliding window, displaced by  $(d_x, d_y)$  from  $(x, y)$ , the *dissimilarity/cost function* of the two regions is:

$$\epsilon(d_x, d_y) = \sum_{i,j} \left( I_t(x + i, y + j) - I_{t-1}(x + d_x + i, y + d_y + j) \right)^2 \quad (12)$$

where the summation is performed on a block-sized region around point  $(x, y)$  show in Figure 2. As the difference between the intensities of the two regions at

corresponding locations is bigger, the cost function is bigger. So, the challenge is to find the displacement  $(d_x, d_y)$  that minimizes the cost function [9]. To do that, the motion vector  $(u, v)$  is chosen to be:

$$(u, v) = -\operatorname{argmin}_{(d_x, d_y)} \epsilon(d_x, d_y) \quad (13)$$

Alternatively, it can be used a *similarity* function such as cross-correlation and try to *maximize*:

$$\epsilon(d_x, d_y) = \sum_{i,j} I_t(x+i, y+j) I_{t-1}(x+d_x+i, y+d_y+j) \quad (14)$$

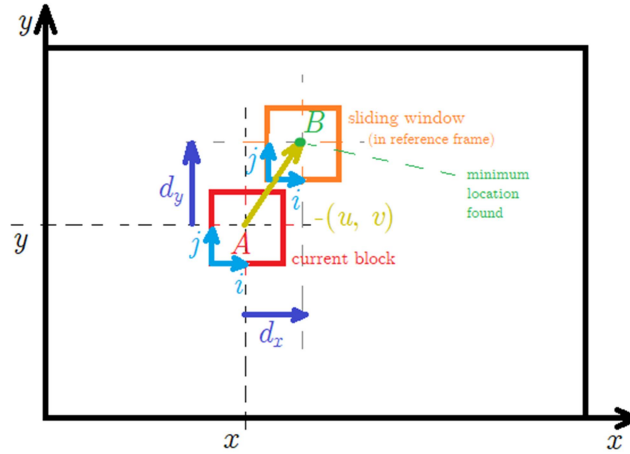


Figure 3 - The motion compensation vector  $\overrightarrow{AB}$

If it is denoted by  $A$  the center of the current block and  $B$  the location that gives the minimum cost, it can be seen that the point has moved from  $B$  to  $A$ , so the motion vector at point  $A$  is  $\overrightarrow{BA}$  (Figure 3):

$$\begin{bmatrix} u \\ v \end{bmatrix} = \overrightarrow{BA} = \begin{bmatrix} x_A - x_B \\ y_A - y_B \end{bmatrix} \quad (15)$$

If it is known that the motion is less than a specific value  $u_{max}$  pixels on  $x$  direction,  $d_x$  can be restricted to vary in the interval  $[-u_{max}, u_{max}]$  (similarly for  $y$  direction; thus, the restriction is the search for a block to a *search region* around  $(x, y)$  – see Figure 2).

The complexity of the method is  $O(S^2B^2)$  for 1 motion vector and for 1 single frame, where  $S$  is the size of the search region and  $B$  is the block size.

### 2.3. The Voting method

This section presents the output of the two previous methods with  $(u_1, v_1)$  and  $(u_2, v_2)$ . Then the voting method considers the output of the voting method as the arithmetic means of the two:

$$(u_{voting1}, v_{voting1}) = \left( \frac{u_1 + u_2}{2}, \frac{v_1 + v_2}{2} \right) \quad (16)$$

Another possibility is to take the mean of both magnitude and angle, such as in Figure 4.

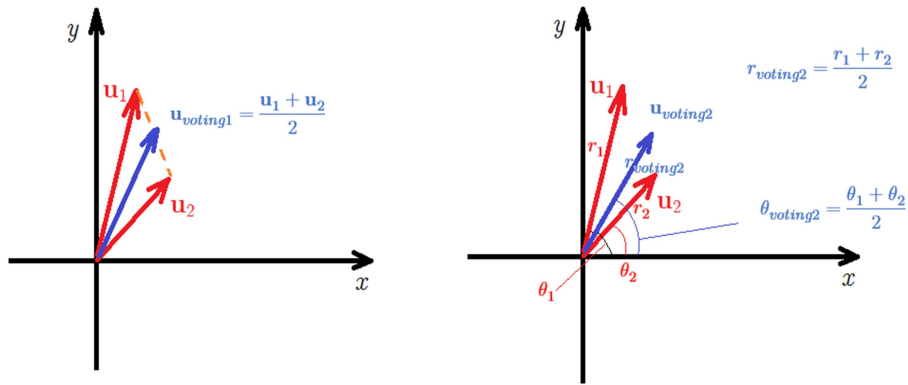


Figure 4 – The two cases for the voting method proposed

### 3. Implementation details

The motion estimation algorithms presented above were implemented in MATLAB.

The application opens a video and then loops through every frame, generates, and displays a motion field between the current and previous frame. In this case, this application was considered a rectangular grid over the image space and perform the motion estimation in the center of every grid cell.

For the first method - optical flow - the spatial derivatives of the image  $I_x, I_y$  were computed using a Sobel filter and  $I_t$  as the difference between the current and previous frame. The final motion vector components using was computed using equation (10).

As for the second method, for each location was looping through the search region, and compute the cost function using equation (12). The application keeps track of the position that gives the minimum value for the cost function and then calculates the motion vector by using equation (15).

#### 4. Results

The results of the voting approach are displayed in Figure 5.



Figure 5 – Proposed Voting Method. From left to right: a. original image, b. optical flow, c. block matching, d. voting approach 1 e. voting approach 2

The methods presented above are very computationally intensive and only worked for very small size input images. The optical flow method often gives highly inaccurate results, especially at the boundary of objects, where the assumption of constant motion field is violated. The optical flow method is unstable in flat regions (the denominator in (10) goes to zero since the matrix in equation (11) is singular). Moreover, this method is susceptible to noise and only works for tiny motions (up to a few pixels). The Block-matching method is more robust than the previous, but unfortunately, the complexity is higher. However, many optimizations can be added to improve the efficiency of the method, such as 2D logarithmic search, pixel subsampling, pixel projection etc. [4]

Some performance measurements are given below in Table 1 and Table 2.

	Optical flow	Block matching
Parameters:	window size = 2	Search region: 16
88 × 60 × 2 frames	9.46 s	9.62
352 × 240 × 2 frames	14.09	14.63

Table 1 – Performance measurements with Block size 8

Block matching		Optical flow	
Search region	Time	Window size	Time
32	16.65	2	14.15
16	14.63	3	13.47
8	13.78	1	13.38
2	15.06		

Table 2 – Performance measurements in time for block-matching and the optical flow

## 5. Conclusions

Although motion estimation is an essential topic in computer vision, most of the algorithms are very computationally intensive, and there is still room for improvement, especially for real-time applications. Every class of algorithms is suitable for a specific problem, and one needs to consider the requirements of the underlying application when choosing the appropriate method.

The presented motion detection approach will be used in the future in an unsupervised system containing various voting-based modules [21-23], with the explicit purpose of ensuring increased reliability and robustness, as well as better confidence in the obtained results.

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## **A REVIEW OF DATA MINING TECHNIQUES IN MEDICINE**

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**Abstract:** *Data mining techniques found applications in many areas since their development. New techniques or combination of techniques are created continuously. Techniques like supervised or unsupervised learning are used for prediction different diseases and have the aim to identify (diagnosis) the disease and predict the incidence or make predictions about treatment and survival rate. This paper presents the new trends in applying data mining in healthcare area, taking into account the most relevant papers in this respect. By analyzing both applied and review articles, using text mining on keywords and abstracts, it is revealing the most used methodologies (Support Vector Machines, Artificial Neural Networks, K-Means Algorithm, Decision Trees, Logistic Regression) as well as the areas of interest (prediction of different diseases, like: breast cancer, lung cancer, heart diseases, diabetes, thyroid or kidney diseases).*

**Keywords:** *data mining, predictions, literature review, disease, healthcare, medicine*

**JEL classification:** I15, C38

### **1. Introduction**

Data Mining techniques know a wide spread and applicability nowadays. Among the areas that use these techniques, the medical and economic fields have the most interesting applications. In economic area, the most studied issues are: the prediction of bankruptcy risk for companies, the prediction of fraud in insurance, fraud in financial statements, fraud in credit card transactions, or the customers' classification for targeted marketing campaign. In medical field, some of the most approached issues are: the identification of cancer (breast, lung, or other types), hearth diseases, diabetes, skin disease or the prediction of different diseases incidence.

Because "there are two primary goals for data mining prediction and description" (Sharma et.al., 2014), the pattern recognition techniques (both supervised and unsupervised) are the most used methods, as well as methods that extract essential knowledge from data, like dimension reduction techniques. The description goal

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suppose analyzing the raw data (huge amount of data) and extract important information that describe a specific case or model a group of facts with the same characteristics or rules. The prediction suppose analyzing a set of observations and variables that have similar features and describe the same phenomenon, classify observations into several classes of interest and extract a "rule" to fit other new observations into one of the classes.

This research is a review of the most relevant articles that describe the use of data mining techniques in medical field. The methodologies section describes briefly the analyzed papers, the results show the most important findings, while conclusions and further search summarize the research and show future directions.

## **2. Methodologies**

Data Mining represents a multitude of techniques and methods that helps extracting "hidden" information or patters from big amount of data. In medicine, starting from patient medical history, symptoms or new medical investigation, all is data. Using modern technology, this data is recording in large databases. The idea of using this huge amount of data to develop a decision support system that helps doctors to diagnose, treat and follow patients is not new, as well as the usage of data mining techniques to accomplish this goal.

The focus of this paper is to analyze new articles (starting 2010, until 2018), in order to identify data mining techniques that are used for medical purpose and its applications. There were selected 76 most relevant studies from 2010 to 2018, some of them are literature review (that analyze other papers or review the possible data mining techniques and applications), but most of them are applicative articles.

In the applicative articles, in general is used a database that is formed either of patients medical information and details ([62], [52]), either of images like chest x-rays for detecting lung cancer ([41]). In the most databases used, the patient's diagnosis is known, as well as their treatment and medical future. What data mining techniques usually try to "solve" is creating a model based on available data that is capable to support doctors for diagnose new patients. In order to test these new models, several techniques are used, like substitution or n-fold cross validation (where n is equal to 10 in many articles). An accuracy degree, sensitivity and specificity are calculated for each technique or group of techniques, in order to give more credibility and robustness. In general, the accuracy of predicting the disease is over 80% and it depends on variable selection, case modeled and technique used.

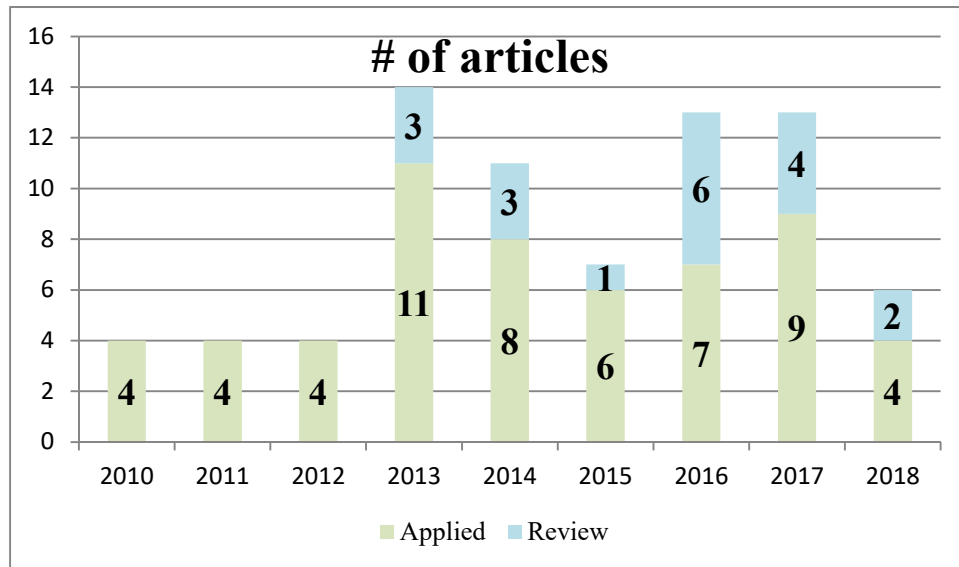


Figure 1. Articles database structure

The figure from above shows the distribution on years of the selected articles. There are 76 articles, 19 reviews (of literature or data mining techniques) and 57 applied papers from 2010 to 2018. Most of the articles (65%) are from the last 5 years.

Table 1. Papers description

Type of article	Subject	Examples
applied	cancer	breast cancer ([13], [20], [24], [25], [27], [29], [30], [35], [40], [62], [69], [70], [71], [74]), colon cancer ([36]), liver cancer ([63]), lung cancer ([41], [51], [57], [65], [68]), ovarian cancer ([33]), pancreatic cancer ([61], [75]), thyroid cancer ([76]), other type of cancer or multiple types ([17], [19], [37], [72])
	heart disease	studies like: [3], [5], [21], [34], [44], [47], [49], [52], [53], [56], [59], [67])
	diabetes	articles: [11], [14], [45], [64]
	multiple disease	studies like: [16], [42], [48], [54]
	specific disease	Parkinson's disease ([4]), thyroid disease ([12]), liver disease ([18]), kidney disease ([32], [43])
	other	studies like: [7], [8], [46]
review	cancer	lung cancer ([39])
	heart disease	studies like: [2], [6], [23], [31], [50], [55], [58], [60]
	multiple disease	[66]
	other	[1], [9], [10], [15], [22], [26], [28], [38], [73]

In the table from above is represented the main themes for selected articles. The subject that is approached often by researchers is the identification and prediction of cancer (that could be breast cancer, colon cancer, liver cancer, lung cancer, ovarian cancer, thyroid cancer or pancreatic cancer). Also, heart diseases, which are considered on top 5 most important causes of death on the entire world, represent an immense interest for researchers and doctors. The applied papers describe examples of data mining techniques, most of papers approaching several techniques that are compared from accuracy point of view (and training time), because each case have its own specificity and particularities, so one specific method or a combination of methods can be applied. The review papers discuss about literature review or techniques review in general, most of them without having a numerical example.

Also, there are some articles that have the main objective the proposal of a software application that is useful for disease prediction (web application that can predict a disease and have as input variables that represent the patient symptoms - [46]) or more specific for heart diseases and diabetes ([44]). On the other side, in articles like [68] and [76] it is presented models of survival prediction for patients with lung cancer and thyroid cancer. Authors used boosted Support Vector Machines, with an accuracy rate of 97% for lung cancer live expectancy prediction ([68]) and MLP and Logistic Regression with an average of over 80%-90% accuracy for thyroid cancer survival ([76]).

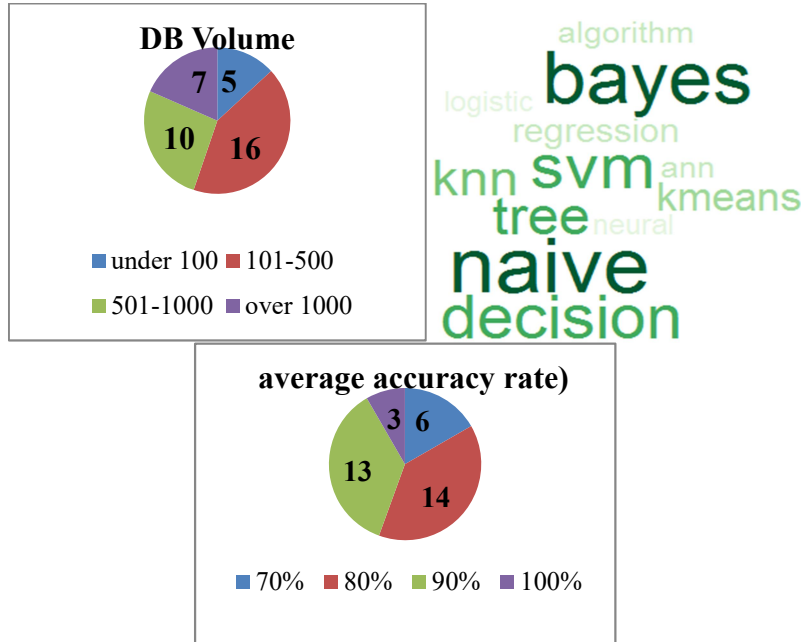


Figure 2. Databases volumes, methodologies used and accuracies rates (in average)



mining" and "techniques", words like "cancer", "heart", "breast", "medical", "patients" and "diagnosis" appear as the most approached issues.

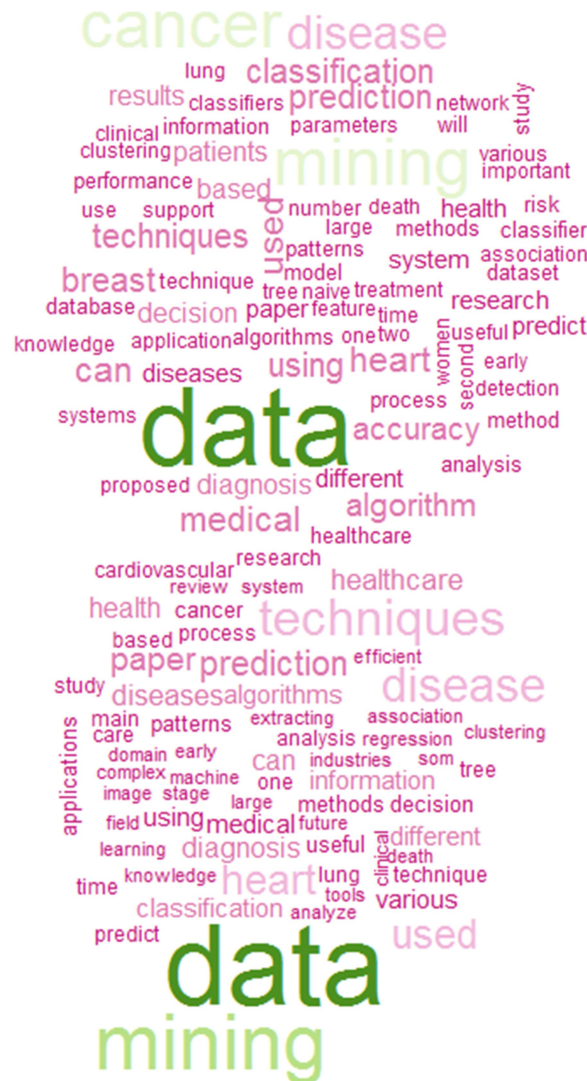


Figure 4. Applied papers abstracts (min freq=15) and review papers abstracts (min freq=5)

The figure from above show the difference between the most used words in applied papers abstracts (with a frequency higher than 15) and the most used words from review articles (minimum frequency is 5). Except "data mining" words, in review papers, words like "techniques", "heart", "prediction" and "disease" are relevant, that show the concern of researchers about prediction techniques in diseases in



In order to identify what are the new "trends" in applying data mining techniques for medical purpose, the articles from the past 5 years were selected from considered database of papers. The figure from above show the representation of most frequent words in abstracts (higher frequency than 10) and keywords (minimum appearances is 5) from 50 articles published between 2014 and 2018, both review and applied papers. It is interesting to notice that SVM and K-Means as methodologies does not appear in the keywords word cloud (right side of the figure). Also, issues like cancer and heart diseases remain the most researched areas.

#### **4. Conclusions and further research**

By analyzing 76 articles that contain description of data mining techniques and methods applied in healthcare area, as well as applications of these methods for predicting, identifying or follow different diseases cases, this research aim is to describe the latest concern about the use of methods that extract essential information from data. This article proposes a text mining technique to analyze the papers from an area of interest and see what words are common in most articles abstracts and keywords (with the highest frequency rate). This method could be used for many others areas of research, like emails spam detection, sentiment analysis or comments analysis, directions that represent further research.

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## **EMPIRICAL ASPECTS IN THE PSYCHOLOGY OF ONLINE TEACHING OF FOREIGN LANGUAGES**

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**Abstract:** *This paper starts by describing the wider context of the Covid-19 pandemic and the effects that it creates on the psyche – the paradox of combined passivity and a new type of dynamism and agency, the one reuniting a break in the pace of living mixed with a superior, extreme speed experienced in people’s lives, and, thirdly, that of creating presence in absence. We then link them with the narrower context of academia, online teaching and psychology of the new context, which we analyze from the double perspective of the teacher and the student. The method is to start empirically from some observations based on real time and real life contexts in the above-mentioned activity, to then work towards potential solutions for the encountered difficulties or problems. It is then a deductive approach, and we explain the rationale for it as matching the way things have occurred naturally in reality, given the anachronistic manner in which know-how had to suddenly have been a given, and was taken for granted, since there was no time (or next to no time) to follow the logical chronology of training and preparation before launching ourselves in the online activity. We call what we are looking at the psychology of the situation, in the wider acceptance of the term, as we deal with feelings, reactions and behavior. We point out the particularities of both the technical support of the online teaching (i.e. the Microsoft Teams platform and the specific way in which we used it) and the teaching of foreign languages. A great part of the study is dedicated to the matter of creating presence online, followed by a minimal query proving some related points, then an enumeration of other elements noticed throughout the online teaching activity. The conclusions sum up the observations made in the paper and draw again towards an interpretation of online teaching in the wider context of life in a time of general and marked crisis, converging back to the starting points of the discussion to come full circle.*

**Keywords:** *pandemic, paradoxes, online teaching, foreign language teaching, psychology, empirical data*

### **1. Introduction – The wider context**

When we were abruptly faced, because of the Covid-19 virus pandemic, during the difficult times that we are living now, with leading our lives, all of a sudden, from inside our homes, and only from there, but full throttle, as paradoxical as this may

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seem, a paralyzing sense of ambivalence overarched our lives. Let us explain why we live at full throttle, and why ambivalently.

We suddenly needed to be both contained, within very small boundaries, restricted, bound to our households, i.e. *here*, as well as *there*, able to perform the activities that earned our living as normally as possible (if possible), and the concept of one's *presence there*, in the action, has acquired new dimensions.

It is true that the measures of self-isolation, social distancing and absence from the public sphere were taken progressively, leaving some time for adaptation, but it is debatable how much time is enough (which depends as well on the historical, political and social context of each nation), and they still represent a trauma for people, especially a people that has stepped into democracy after a long period of communism which still sees some of its effects and mentality nowadays.

Spatial anchoring and concrete immovability came with a sense of rapid change created with the bombarding news (some of which fake news) on the developments of each day: presidential discourses, military ordinances, the sensation that a lot of changes occur in a short time span – such as the fluctuating numbers depicting new cases of infected people, deaths, successfully cured patients, and figures referring to other counts – pieces of equipment acquired or needed, amounts of money planned for various acquisitions, numbers related to what happens in various cities of the country (arrests and fines for breaking the law, interviewed people), not to mention all these statistics for other countries as well etc. These generate a dynamism which comes with a sense of imposition and urgency that creates stress rather than empowerment, because it describes something that occurs *to us* rather than something that we *cause* or *produce*. The impression these days has been that the world revolves somehow faster, and it does so without our input, as the way it spins and the outcome of things is no longer in our control, or a result of how far humanity has come because of the progress and breakthroughs that it has made. Speedy eventfulness no longer comes accompanied by a sense of accomplishment or fulfillment. Nor is it the consequence of intentionality. It is something experienced and not something imprinted by people's will and skill. Humanity has been forced to merely witness (to some extent), losing the agency that it has been used to hold, and learning to gain other types of agency as well.

What we may derive from the introduction above is a *contrast* that people feel, between being both more passive and somehow more active at the same time. The new type of agency required, in one of its aspects, stasis, which was a paradox we all have had to quickly understand. Passivity came with being still, restricted, limiting one's area of activity spatially, concretely, and dynamism came with learning to function, while in this situation, as close to normal as possible – continuing one's working activity in a way that adapted to the new context. In some aspects of life this is possible, and in others it is not. This dynamism is imprinted by both the speed with which events occur, and the fact that in order to



cope people need to make extra efforts, be better than they used to, do something more than they did, while at the same time paradoxically doing less. This kind of contrast creates psychological strain, disorientation and even confusion.

*Technology* has become a pillar in managing one's work activity and survival. We have become dependent on it in a way that is new. We are no longer referring, at any time, to the negative addiction which has been often discussed and highlighted, countlessly, as a cause for worry in various discourses, when paramount were its harmful effects when used in excess. All of that *criticism is forgotten*, as in these times technology is, uncontested, absolutely necessary for survival. Those previous worries have subsided, been backgrounded and made irrelevant by the immediate context.

For teachers, the *e-learning* that has made the topic of various conferences, workshops, preoccupations of academia has a new dimension. It is not only debated on and inquired about theoretically, and used every now and then, by choice; it has gained exclusivity and has become a condition for the unfolding of regular activities. It is no longer a preference or an option, it has become a must and a prerequisite, a *sine qua non* element. Academia have been dived, head-on, full speed, immersively and forcedly, inescapably even, as well, in online teaching as the sole type made (or, should we say, left) available by the times. And one of the potential problems raised by the situation is the need for a special skillset pertaining exclusively to online teaching, which we have needed to self-teach in our turn on the way, no questions asked, a skillset taken for granted as both an absolute, indisputable necessity, and one which we can and should gain more or less in the blink of an eye, and unquestionably.

Even though employers have tried, generally speaking, to provide for this want through *training*, *there has been anachronism in the endeavor*, as the need for the know-how to be taken in, already in place and operative was long due, before the initiative was in place, and this was a characteristic of the context, with no one to blame for the situation. The online teaching activity had to have happened before the know-how could be acquired. And the theoretical background that any teacher should and may have had, especially in the higher education environment, is definitely not the same as practice. Using technological tools was a component of regular face-to-face classes on a daily basis. But this is not the same as online teaching at all. Blended and flipped classes, as well as gamification may have resorted to technology as an element, but it did not amount to such a change as the one entailed by online teaching.

## **2. Defining the immediate context, method and objectives**

If we think about the students' motivations to get involved in the online academic activities, we have to take into account the context of crisis created by the pandemic, which has caused a lot of activities to halt and a lot of businesses to

collapse, which triggered a fear that this may happen in the case of workplaces and learning institutions where students unfold their activities as well, impacting their lives negatively, both professionally and educationally. This fear correlated with the obvious and natural desire of a student to graduate and fulfill the requirements of the ongoing academic year so as to pass into the next, for financial, developmental, time-investment or other considerations. In other words, both the academia and the students have had in common the desire to make things work, to ensure the continuation of the activity as normally and smoothly as possible and to finish the year in good conditions while also minding health, security and legislative issues. What we have just said helps us make the point of a sense of communion and community when it came to switching to the performance of the activity online, and a commonality of purpose which created a favorable collaborative environment. This helped a lot in what concerns the willingness and availability of doing things in this manner, from both sides. The concept of partnership, present among the key aspects of the Romanian-American University's mission, acquired a new dimension.

In this paper, I shall start from simple facts observed by experiment as delicate issues that needed to be handled in the context of online teaching, and use theory in the area to support the solutions that I have come up with empirically, *ad hoc*. The main object of the paper is mainly to document some aspects concerning behavior online in class, aspects that have more to do with psychology (given that we look at behavior, impressions, emotional responses etc.), in comparison with the one in face-to-face interactions.

The advantage is that I could compare patterns and reactions of the same people in the two situations mentioned, I have had the chance to notice how the same individuals conducted themselves in these contexts. The fact that I not only knew the students, but also had been working with them for at least a semester and a half (with some even more than a year and a half) at the time when the online teaching started, gave me the opportunity to actually bear witness to the fact that there indeed are changes that young adults – the learners – as well as myself, the teacher undergo in such circumstances.

It is a double perspective that we mean to consider here. It is not only students' reactions that we are looking at, but also the teacher's feelings and thoughts when faced with this context. Some of these appeared before the actual event of online teaching occurred, some others in the middle of the activity, while it was unfolding.

### **3. Empirical data – aspects involved in the online teaching of foreign languages**

The online classes were organized on Microsoft Teams. To the purpose of smoothing out the application to work better, students were instructed to keep the video off throughout the whole time of the interaction, and even their microphones

shut as well to avoid microphony and in order to increase overall sound quality. However, given the nature of the seminars – foreign language teaching and learning – the communicative method used, and the category and level of the students (higher education, intermediate-advanced), the students’ active participation and input was particularly important. In other words, more than in the case of the other subjects that they study, most of the times they had to speak more than the teacher, whose main role was to guide and foster the activity from the background, to be a facilitator rather than the main actor [1]. With the exception of moments in which some theoretical problems are reminded to the students or revised, practice rather than theory is paramount, and a deductive method, rather than an inductive one, is more often used, starting from examples in the language to rather help the learner remember or derive the rules or theory, and this only inasmuch as it helps performance in the target language, as fluency rather than accuracy is the main goal.

### **3.1. Creating presence**

Given what we have just said, that the teacher is rather a prop and does not take the center position (with the exception of certain moments), there is one problem or worry which may appear, particularly in the context mentioned above, and that is “*creating presence*” [2], i.e. “*telepresence*” or “being there” plus “*social presence*” or “being together with others” [3], while at the same time preserving a type of effacement, the kind of presence that is merely supportive and leaves the floor to, and the focus on the student. Also, it is important to understand that presence, which is the “dynamic interplay of thought, emotion, and behavior in the online environment” is different from “engagement” which is merely the formal participation in the online event [4]. We notice from these definitions of presence online that a great component of it, if we consider the notions that make up the definition of the concept, are part of or related with psychology – once we discuss ingredients such as emotion, thought, behavior, i.e. perception, the significant role of which has been discussed in literature dedicated to online teaching [5].

One of the main transformations taking place in the switch to online classes is that the *visual and the auditory reversed roles*, in terms of their relevance in the online classes. Generally speaking, most of the information that someone takes from the environment is through sight. In our case, this was no longer possible. What we had available included, in theory, the visual element through video, but practically we heavily relied on the audio, for the reasons mentioned above. Hence, a serious reversal in the means available for information intake occurred, one that we had to cope with, accommodate and adapt to instantly. Practically speaking, the foreign language seminar took place, for the most part, with the video off, and communication had to be done through the audio. The teacher needed to *sense if the students became at some point reluctant to intervene and participate – willingness* to do so being a component of the creation of social presence [6] – and

to distinguish between when such moments meant merely an inconsequential change of pace or a break caused by a need for clarifications. The teacher *could not rely on the non-verbal visual feedback* from students, which helped contrast which of these two cases (s)he was dealing with easily and instantaneously. Hence, what was needed was an ability to “Be aware of feelings and attitudes expressed” [7] and to both show and decode feelings based on words [8]. Another aspect is that all the teacher’s *explanations had to be worded more thoroughly and fully* than when the visual element was present. During an explanation that the teacher provides in face-to-face interactions, the visual feedback from the students helps the facilitator know and actually see from the others’ reactions if and how the message that (s)he delivers needs to be adapted: if the teacher needs to go slower or, on the contrary faster, if (s)he needs to make breaks and explain certain elements some more or get into details here and there, when the point is made and understood and the teacher can move forward, who has not understood from the students and, using previous knowledge of that/those students resort to some ways and manners of explaining that are more individual-oriented etc. The possibility to notice all these aspects disappears in online teaching and, when elucidations are due, the teacher needs to find some middle way in the manner of delivering them, taking into account an average of the group performance and personalities (if this is even possible), and hope for the best.

The perspective of the student in what regards the above-mentioned aspect was the same. In face-to-face interactions, the physical co-presence of the teacher favors her/his quality of fosterer for and guide of the activity, because the non-verbal components of discourse can be heavily resorted to and function as immediate feedback for the student. The teacher’s glances, eye contact, frown, smile, mimicry in general may give indications as to the correctness of the student’s input without actually interrupting it, and simultaneously with the communication occurrence, i.e. in real time, not after it. Online, this is difficult to do even if the teacher leaves the camera on, because there are or may be some technical issues that make this approach less relevant or successful: minor delays in image rendering, image quality etc., which postpone or even eliminate the intake by the student/interlocutor. Hence, if this exchange still works, it works in a modified, improper or maimed manner. This is even more of a problem if the teacher does not leave the camera on throughout the whole class, which, theoretically, was what we were advised to do ourselves. This non-verbal feedback was crucial for the type of interaction specific for foreign language learning and it was suddenly absent or problematic in the context of online teaching. Non-verbal feedback negatively impacted what has been called “immediacy” and theorized as a key component of creating (social) presence online [9]. Non-verbal feedback had to be supplanted by strictly auditory signaling and cues, if the teacher is unwilling to merely say “yes” or “no” (meaning “correct” or “incorrect”) and would like to suggest the answer leaving it to the student to find it on his/her own rather than point it to him/her directly. This has meant an increased emphasis on and deployment of *paralanguage cues*. Paralanguage includes grunts, voice volume and pitch, and

these are all things that I have used [10]. The teacher had to signal through sound everything that (s)he did visually. This presupposed increased attention to sound stimuli for the students. Since the human beings are used to receive seventy percent of the information they take from the environment via sight, it meant a switch in capabilities which we all had to do naturally, and, for most, unawares. Sorin Walter Gudea notices, relying on testimony from online teachers, that the richness of the non-verbal and feedback in general is affected negatively in this type of classes [11].

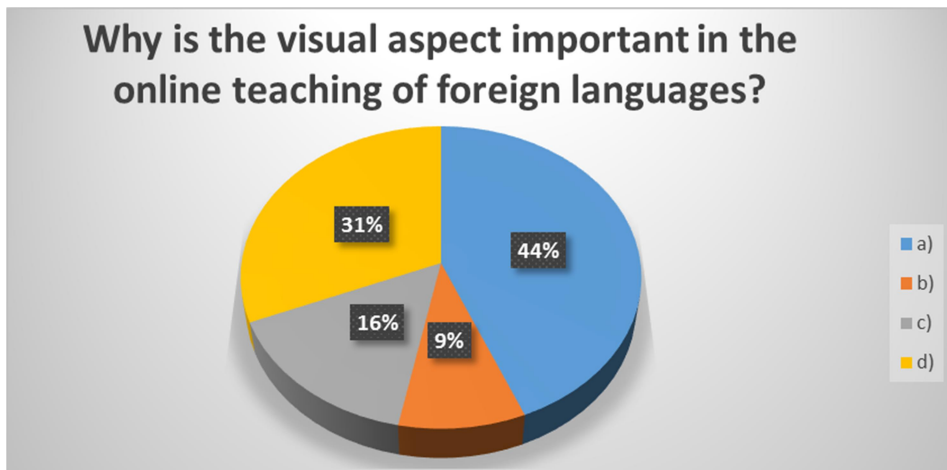
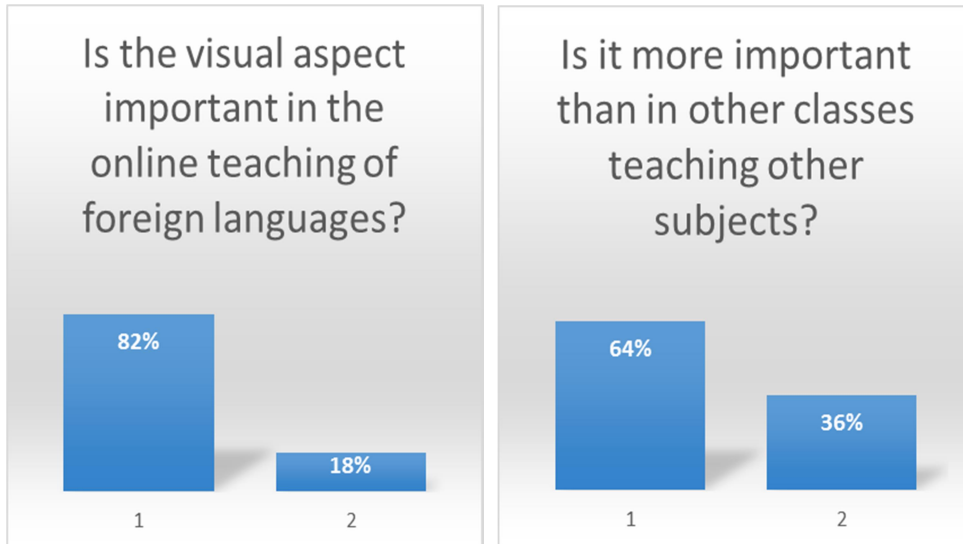
I checked the observations above by asking the students what seemed to them the most difficult aspect in this type of online interaction, under the conditions which we were advised to apply. I asked a number of 50 students to answer a query – in the form of a word document – two Yes/No questions at the end of the seminars that I held online, and one multiple choice question:

1. Is the visual aspect important in the online teaching of foreign languages? (Yes/No)
2. Is it more important than in other classes teaching other subjects? (Yes/No)
3. If you chose to answer Yes to the question above, why? Pick only one answer:
  - a) you see feedback from the teacher in real time while you give your input, and thus know if your discourse is alright as you deliver it
  - b) for the fun of the interaction
  - c) because not seeing the teacher makes you anxious and introvert
  - d) because you get non-verbal feedback from all your interlocutors/colleagues, i.e. you see their reactions

Out of the 50 students, 41 answered Yes to the first question and, out of these 41, 32 answered Yes to the second. Then, for the third question, 14 chose the first option, 3 the second, 5 the third and 10 the fourth. The results are summed up in the table and charts below:

Table 1. Students' answers to the questions related to the presence of the visual aspect in the online teaching of foreign languages

	Numbers of students saying Yes	Percentages of students saying Yes
Question 1	41	82%
Question 2	32	64%
Question 3		
a)	14	28%
b)	3	6%
c)	5	10%
d)	10	20%



The visual aspect is what created presence in face-to-face interactions, and when this is missing – something revealed by the query above – other means of creating presence have to be developed. The ones that I have come up with are using paralinguistics – in the context in which I still wanted to preserve a deductive approach – and more carefully worded explanations so as to create a sense of security and implicitly presence. This wording was designed so as not to be too developed or convoluted, in order to avoid obtaining the opposite effect, in which students lose focus because they already know what is being said, or because, on the contrary, they feel that it is too difficult to grasp. Gudea has referred to this as “clarity”, based on teachers’ testimonials, and it was defined as a must [12]. I need to confess that the fact that I knew the students from before helped calibrate these

explanations in the case of each group. Also, when I joined the class, so whenever I began, I did it with a video on, so as to announce my presence, to signal officially that the class has begun and be noticed, but also, very importantly, for the sake of creating reassurance, comfortableness through familiarity, continuity and grounding. Seeing their teacher, the one they have had in face-to-face classes and interacted with, provided all these things for the students. Also, I turned the video on at the end of the seminar, as I thanked them for participation and bid them farewell. I noticed better response and quicker mobilization at the beginning of the class with the groups with which I used the video, as, for the sake of having a term of comparison, I did not use it with all groups. With those where I did, the passage from the face-to-face to the online felt much smoother, the unfolding of the seminar much more alike to the one having happened under the conditions of physically shared presence.

### **3.2. Other aspects**

One of my first thoughts and worries (having never worked on an online platform, like Microsoft Teams, Zoom etc.) was whether I would have the ability to grant students turns to speak, which is advisable for the type of online class I was teaching [13] – foreign languages, a highly active and participatory one, one that could be hence classified as “synchronous” (as opposed to “asynchronous”) [14]. Also, the need to be able to do that was specific and extremely high, as I give grades to my students taking into account both the quantitative and qualitative assessment criteria for each seminar. Consequently, it was absolutely necessary to be able to know who spoke and how much, and more than in broad lines. Also, although I know the students, especially those who used to attend regularly the face-to-face classes, I worried, for instance, whether I would recognize their voices online, if the sound quality would allow it and in the case in which they sounded very differently from real life – which some of them actually did, but to a small proportion.

Microsoft Teams provides the possibility to show the list of participants and I could check and monitor who was available and wanted to answer, as the respective student’s name became highlighted and bolded once (s)he turned on the microphone, and I had established for them to use it on only at a time when they wanted to say something. In my class, I actually kept the list open on the right of my screen at all times.

One of the things that I have noticed happening in general between people is the way in which the impact of what someone says through messages in the virtual environment that we resort to is more powerful in these days than it used to be before the confinement started. The effect of what someone transmits to you through virtual means is stronger. A (sometimes simple) message has greater impact, meanings and reactions get amplified, everything is put under a magnifying glass, the importance of posts and information is exaggerated or given a heightened

dimension. The reduction of communication to one that is not face-to-face has inflated perception to what one has to make do, and has increased acuity and sensitivity. This may work in either a positive or negative way. Negatively, it triggers more radical attitudes towards, sometimes, relatively minor stimuli. Positively, and in the context of our discussion, it helps people involved in online communication to naturally adapt to the means of communication at hand and, to a certain extent, naturally develop some skills needed in this type of interaction.

To be concrete, during an online seminar, a student was very active and ready to give his input countless times throughout the class, monopolizing the conversation. Initially, I told him to give his colleagues the chance to engage too, promising him I would listen to what he has to say as well afterwards. He did not heed me and intervened again. To give him a hint that it was perhaps a good idea to retreat a bit, and in order to avoid nominating him directly again so as not to hurt his feelings, I reminded all of them to keep their mics switched off, for better sound quality, unless they want to intervene – something that I had already mentioned at the beginning – and as he was the only one keeping it on at all times. I repeated my request, saying that there is someone who does not comply. He did not take the hint and continued to try to dominate the discussion. Ultimately, I switched off his microphone myself, without pronouncing his name or mentioning anything else to the group. The result was that he immediately retreated, and, as I sensed, feeling offended, as he refused to share any ideas even when I said that anybody could answer, even though I had given him the opportunity to take in the idea and I had avoided putting him on the spot or in a face-losing situation. The simple act of switching off his microphone acquired bigger dimensions than what it should have, in the context in which he had had more occasions to comply without losing face before his colleagues. I knew the student's behavior in face-to-face classes and he usually listened to reason and did not become upset when I asked him to be balanced in the amount of input that he gave. Hence, *some reactions are disproportionate to the stimuli in the online environment.*

Another case of too much boldness in online interaction came from a student who deliberately kept his camera on after the group having been specifically instructed not to do so. It was one of my first online classes, when I kept my camera on longer, perhaps two thirds of the time allocated for the seminar. In order to determine him to switch it off, I did that with my own camera – at a time when I was actually explaining something and it made sense to keep it on – as a hint to him. The desired effect took place, and he closed his own, taking the allusion.

The cases illustrated above could not exactly be categorized as bullying or bad manners, or, perhaps, a mild form of the latter, although the intention to bother was not there from the students' part, and we should, instead, speak of a little too much enthusiasm and eagerness to stand out. Nevertheless, literature advises teachers to give feedback privately, such as in a mail [15], which sometimes does not work for



the situation if feedback is needed right then and there, so indirectly letting the student know that he needs to change something in his behavior was a strategy that I consider to reflect the advice given by specialists well enough, as, what is important in classroom management amounts to indirect mentions and saving the student's "face" while still getting the message across [16].

Another effect that I managed to observe in online class interactions was that, generally speaking, *shy students gained more boldness*. This phenomenon has been noticed by specialized literature as "Less anxiety thanks to anonymity" [17]. I assign the same explanation in the cases that I have noticed, based on my knowledge of the students in previous interactions. They were reluctant to speak in front of the others mainly because they felt that they were being watched and afraid of disapproval or mockery. Their poorer level of English had put them in the situation in which they had perceived the colleagues' feedback as critical and unkind, even when this feedback was indirect or even inexistent. In other words, knowing that their foreign language was worse, they implicitly felt judged and uncomfortable, either objectively or subjectively. For them, it was helpful to no longer feel scrutinized, and it imprinted them the courage to manifest more freely.

Conversely, I would have expected highly participative students to behave in the same way online, as they did not have any such problems, so what they did face-to-face should have stayed the same. To my surprise, not all of them behaved similarly. Although literature on this subject seems to agree that in the case of active students in face-to-face context the same input from them or even more may be expected online [18], an idea supported by the example of the student discussed above, what I have noticed first-hand is that for some of them the willingness to participate diminished. I naturally looked for an explanation for this discrepancy, and I found it in the students' differences in personalities. In the clear cases of bright and talkative students who were paradoxically silenced and taken aback by the online environment, the problem resided in the fact that they were highly empathetic and perceptive individuals, relying on non-verbal elements more than the others and in a natural, intuitive way. To them, who liked face-to-face communication for the richness of details that it brings on the interlocutor, the online functioned as an unpleasant filter. It was not that they could not compensate for, or overcome this filter, precisely due to their emotional intelligence and perceptiveness, it was merely that it provided for them a less authentic and rich experience, and that they were aware of it. Also, they responded better to improvisations, pace changes and unexpected turns (questions, for instance) being more creative and responsive in such cases because of their empathy, and the online classes provide less possibility and room for such approaches.

#### **4. Conclusions**

We have started in this paper from some general aspects characterizing the critical context of the virus pandemic of the times we are living, pinpointing it as a

particularly stressful period. Out of this, we have extracted the notion of paradox, and revealed some contrasting and poignant elements that came in contradiction and which overrode our lives. Then, we have connected these with others pertaining to the particular situation of teaching staff, such as the specifics of foreign language teaching which does not really go well with blind online one, the need to adopt a know-how that was missing in the real sense, the manifestation of a set of skills without theorizing about it, merely having theoretical knowledge and/or having used it sporadically not exclusively. We have analyzed the notion of creating presence by correlating it with concrete examples from the situations encountered in the online teaching, as well as other aspects that I have come across on the way. The novelty of this paper is perhaps not so much the empirical approach, but the interpretation of the foreign language online teaching activity in the context of an extremely critical situation worldwide and the correspondences made between the psychology of online teaching and that of the wider context overall.

Most specialized literature describes the online teaching situation as an exclusively online one throughout a whole module. In our case, the fact that we have had previous knowledge of the students and face-to-face classes with them would probably qualify the activity sum total as a hybrid teaching. Also, this previous experience added advantages to the online interaction and eased it. In this sense, some of the difficulty and weight of the switch to online mode has been lifted. This is something that we need to mention in order to be fair and give due justice to the context.

We have seen that, among the elements that are lost in online classes, the most striking is the richness of the non-verbal cues. This attracts losses in improvisation and human touch. For those of us who are more empathetic, it can represent both a hindrance and a helpful element, because the fact that it is missing creates, on the negative side, a significantly less rewarding and satisfying experience (which, in the context in which the psychology of the encounter is the focus, is regrettable and significant), but, on the positive side, it helps adaptation to the conditions of online teaching, i.e. empathetic people will be both more affected by the change and deal with it better. Empathy as an innate feature functions as a paradoxical plus and minus in online teaching.

Overall, the switch to online teaching has an important positive effect. It contributes to the feeling that, despite the passivity and static mode of behavior involved in the context of the pandemic scourge, it renders the teacher a feeling of fulfilment and progress. One feels that one has accomplished something, that one has developed professionally from inside one's home. To this, we may add social benefit for all participants, as this activity creates and amplifies a sense of belonging to the academic community, as well as one of collaboration, partnership and satisfies the natural tendency of the human being as a social animal. It also

counters the disempowerment imprinted by the times. Referring to what we have begun with in this paper, it helps us exercise the new type of agency, bringing us in synchronicity with being active and in control while passive and deprived of agency, being present while absent, and being together despite isolation.

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## **ON IMAGE SEGMENTATION USING A COMBINATION OF FELZENSZWALB, SLIC AND WATERSHED METHODS**

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**Abstract:** *Image segmentation is an essential problem in Computer Vision and it is foundational to the development of next-generation information extraction methods, issued in problems of great interest, such as driving autonomous machines, text analysis, object identification, extracting information from images. Knowing that there are no perfect algorithms for image segmentation, this paper aims to achieve a method that combines the results of different algorithms through various voting schemes in the hope of getting better results.*

**Keywords:** *Computer vision, image segmentation, image processing, voting algorithms, SLIC, Watershed, Felzenszwalb*

### **1. Introduction**

Image segmentation is a class of image processing algorithms that identify, and group pixels based on specific criteria. The segmentation process itself entails image processing algorithms that strategically isolate areas of interest within images: for example, image processing could use segmentation to direct self-driving machines in traffic. These algorithms generate certain limitations in terms of image quality. Their tendency to over- or under-segment makes it necessary to devise algorithmic combinations that can help maximize image segmentation results. A. Hoover et al. in [1] have outlined five categories of region classifications: correct detection, over-segmentation (many detections of a single surface, which can yield an incorrect topology), under-segmentation (not enough separation of multiple surfaces, results in a subset of the correct topology and a

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deformed geometry), missed (a segmenter fails to find a surface which appears in the image) and noise (the segmenter assumes the existence of a surface not in the image). Given that it is easier to merge segments to obtain bigger ones, as opposed to splitting large regions to yield the true segments, under-segmentation often gets more interest and attention dedicated to it than its counterpart, over-segmentation [2]. The figure below is a relevant example of highlighting the limitations of segmentation algorithms (Fig. 1).

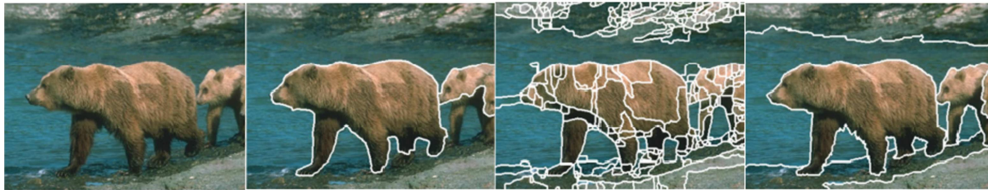


Fig. 1. Example of images over-segmented and under-segmented. From left to right: a) original image, b) under-segmentation, c) over-segmentation, d) ground truth image; image taken from [2]

This paper introduces a voting method that combines different algorithms in order to achieve a better performance in image segmentation than the results obtained with these methods taken separately. The selected approaches utilized for the proposed method are Felzenszwalb segmentation (based on graphs) [3], SLIC (Simple Linear Iterative Clustering) Superpixels [4][5] and Watershed [6][7], which will be described into the next section (Section 2A). These algorithms have been chosen to have partially different (over-segmented or under-segmented) results.

## **2. Proposed method**

### ***A. Segmentation algorithms***

The first algorithm mentioned here is Felzenszwalb graph-based segmentation [3]. In this category of segmentation, each pixel from the image matches a node in the graph. The connection between the nodes represents the specific pairs of pixels that are neighbors. For this scenario, each edge has a correlated weight based on the characteristics of the groups of pixels. The graph-based method proposed by Felzenszwalb et al. in [3] takes edges from a graph. For this method, the pixel represents a node in the graph. The undirected edges are in correlation with neighboring pixels. The weights for every edge represent the measure of the variation among the pixels. This technique tunes the criteria of segmentation concerning the variability of the neighboring areas. The weights for every edge represent the measure of the variation among the pixels. This technique stands out in a few ways: it customizes the criteria of segmentation according to the variations in nearby areas and it reveals that the process can be rapacious in its tenacity to attain segmentation that mirrors global characteristics. The pseudocode of

Felzenszwalb graph-based segmentation algorithm consists of four steps. Firstly, a graph  $Gph$  with  $n$  vertices and  $m$  edges is defined as an input,  $Gph = (Vert, Edg)$ . The output is a segmentation of  $Vert$  into  $Seg$  components,  $Seg = (C_1, \dots, C_z)$ . The first step is to sort  $Edg$  by non-decreasing edge weight into  $\zeta = (e_1, \dots, e_m)$ . The second step is to start with a segmentation  $Seg^0$ , where each vertex  $vert_i$  is in its own component. Then, construct  $Seg^p$ , given  $Seg^{p-1}$ , as follows: let  $vert_i$  and  $vert_j$  denote the vertices connected by the  $p$ -th edge in the ordering,  $e_p = (vert_i, vert_j)$ ; if  $vert_i$  and  $vert_j$  are in disjoint components of  $Seg^{p-1}$  and  $w(e_p)$  is small compared to the internal difference of both those components, then merge the two components otherwise do nothing (step three). The *internal difference* of a component  $C \subseteq Vert$  is defined as the largest weight in the minimum spanning tree of the component  $MinST(C, Edg)$  that is  $IntDiff(C)$ , shown into the following equation (eq. 1):

$$IntDiff(C) = \max_{e \in MinST(C, Edg)} w(e) \quad (1)$$

The *difference between* two components  $C_1, C_2 \subseteq Vert$  is defined as the minimum weight edge connecting the two components (eq. 2):

$$Diff(C_1, C_2) = \min_{vert_i \in C_1, vert_j \in C_2, (vert_i, vert_j) \in Edg} w((vert_i, vert_j)) \quad (2)$$

The *minimum internal difference*,  $MinIntDiff$ (eq. 3), is defined as:

$$MinIntDiff(C_1, C_2) = \min(IntDiff(C_1) + t(C_1), Int(C_2) + t(C_2)) \quad (3)$$

where  $t(C)$  is a threshold function (eq. 4) based on the size of the component,  $|C|$  denotes the size of  $C$  and  $k$  is some constant parameter:

$$t(C) = k/|C| \quad (4)$$

Step three is repeated for  $p=1, \dots, m$ . The algorithm ends with step four which involves returning  $S = Seg^m$ .

The second algorithm presented is SLIC Superpixels. Superpixels group similar pixels into atomic areas of pixels which can be used as entities in algorithms in order to reduce the number of primitives for some processing. This method addresses another way of looking at the classic pixel grid. Achanta et al. mention in [4] that this approach reduces the complexity, and the primitive used helps produce the needed features of the image. In terms of requirements, Stutz et al. summarize in [5] a list of general specifications agreed by [4][8][9][10] for the superpixel: partition (the possibility to determine a subdivision for the image), connectivity (describe an associated collection of pixels); boundary adherence; compactness, regularity, and smoothness (there are compact not in the presence of image borders), efficiency (the generating process must be the most efficient), controllable number of superpixels.

Achanta et al. [11] propose an algorithm that produces superpixels by clustering pixels. This operation creates the superpixels that start with areas of the same colors that are in proximity to the image level, in the combined five-dimensional color and image space. In this way, this method generates uniform and compact superpixels. This technique is an extension of the K-means algorithm. The K-means method groups the points in clusters based on a similarity function. The most used similarity function is the Euclidean distance. The algorithm presented by Achanta et al. differs from K-means by two characteristics. The first one is about the optimization step and, most accurately, about the number of distance calculations. By narrowing the search space to an approximate area of the superpixel, the number previously mentioned is decreased. The second one is about the weighted distance measure. In this step, proximity measurements are done (color and spatial) giving access to the dimension of superpixels. The SLIC Superpixels algorithm implies several stages: the first stage consists of initializing clusters centers by sampling pixels at regular grid steps  $S$ ,  $C_k = \{l_k, a_k, b_k, x_k, y_k\}^T$  while in the second stage the centers of the clusters are perturbed in an  $n \times n$  neighborhood, to the lowest gradient position. Then repeat until  $E \leq threshold$  the following: for each cluster center  $C_k$  assign the best matching pixels from  $2S \times 2S$  square neighborhood around the cluster center according to the distance measure  $D_s$  (eq. 5), then compute new cluster centers and residual error  $E$  {L1 distance between previous centers and recomputed centers}. The algorithm is completed by the last stage which consists of enforcing connectivity. Distance measure  $D_s$  is defined as follows:

$$\begin{aligned}
 d_{lab} &= \sqrt{(l_k - l_i)^2 + (a_k - a_i)^2 + (b_k - b_i)^2} \\
 d_{xy} &= \sqrt{(x_k - x_i)^2 + (y_k - y_i)^2} \\
 D_s &= d_{lab} + \frac{m}{S} d_{xy}
 \end{aligned} \tag{5}$$

where  $D_s$  is the sum of the lab distance and the  $xy$  plane distance normalized by the grid interval  $S$ . A variable  $m$  is introduced in  $D_s$  to control the compactness of a superpixel. The greater the value of  $m$ , the more spatial proximity is emphasized and the more compact the cluster. This value can be in the range [1; 20].

The third algorithm considered is Watershed. Watershed is a region-based segmentation method. The first approach is originally in mathematical morphology and was introduced by Digabel and Lantuejoul in 1978 [6]. In this method, the image is seen as a topographic scene [7] with ridges and valleys. The gray values of the pixels or their gradient magnitude define the rise values of the landscape. Preim et al. [12] call that the watershed technique decomposes an image into "catchment basins". Another view on the technique represents each valley as a relief [7], and this relief flood from its minima when two areas join. After joining, it creates a dam. All dams created represent this method. This representation



resembles the flooding process [13]. The main aim is to divide the image into regions of interest. The algorithm needs only the pixel intensity to obtain these regions. An example of the watershed algorithm can be seen in the figure below (Fig. 2).

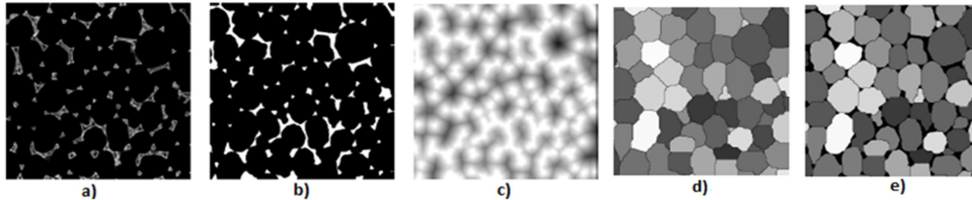


Fig. 2. Watershed segmentation - a) original scan, b) segmented and closed edge system, c) inverted distance map of the back-ground, d) watershed transformation of the distance map, e) reconstructed cells; image taken from [14]

### **B. Proposed voting algorithm**

There is a series of approaches for image segmentation. Each one has downsides or upsides corresponding to the input data. Methods such as model-based, central clustering, graph theoretical based, nonparametric density estimation based methods, empirical and hybrid approaches, and square-error clustering, present a view on some elements on the input data, by grouping or making clusters based on a set of properties [15]. In the current scenario, no single technique could manage all types of clusters. Studies in the last decade show that fusing classifiers helps to increase the accuracy and the diversity of input data [16]. The combining process of the methods' decisions is reviewed, and this technique is met in studies as the voting technique. The method proposed in this article involves two options for voting using the algorithms presented in Section 2.A. The first voting technique is the use of democratic voting, where each algorithm has an equal weight in the segmentation decision. This method has been proposed as a starting point in exploring voting techniques. Voting is represented as a linear function, and each algorithm has equal weight, as can be seen in the equation below (eq. 6).

$$V = \frac{1}{N} (Fz + SLIC + Watershed) \quad (6)$$

This algorithm was tested on several images and has been shown to have weaker results than the independent running of each algorithm separately. Another approach of this method is for each algorithm's vote to come with a weight (eq. 7). The weights are estimated from successive runs, and weights that provided performance were kept for the final vote.

$$V = w_{Fz} * Fz + w_S * SLIC + w_W * Watershed \quad (7)$$

### 3. Results

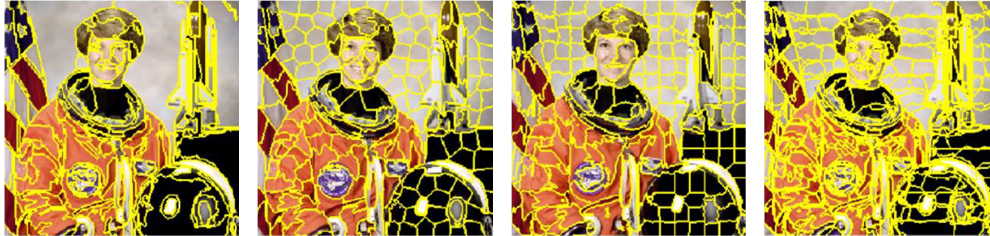


Fig. 3. Astronaut image. From the left to right: a) Felzenszwalb segmentation, b) SLIC segmentation, c) Compact watershed, d) Voting method.

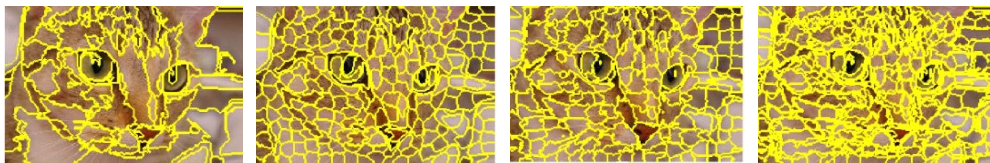


Fig. 4. Chelsea image. From left to right: a) Felzenszwalb segmentation, b) SLIC segmentation, c) Compact watershed, d) Voting method

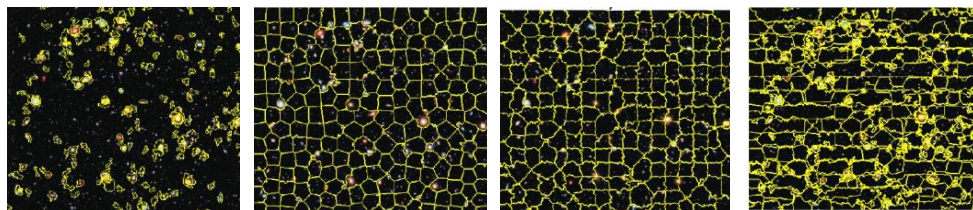


Fig. 5. Hubble deep field image. From left to right: a) Felzenszwalb segmentation, b) SLIC segmentation, c) Compact watershed, d) Voting method.

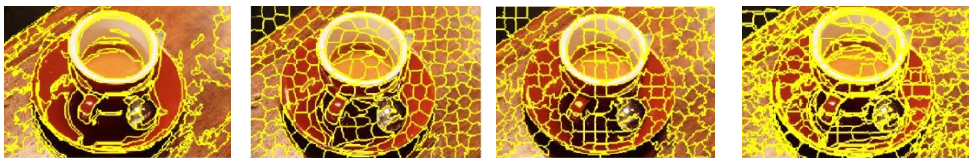


Fig. 6. Coffee image. From left to right: a) Felzenszwalb segmentation, b) SLIC segmentation, c) Compact watershed, d) Voting method.

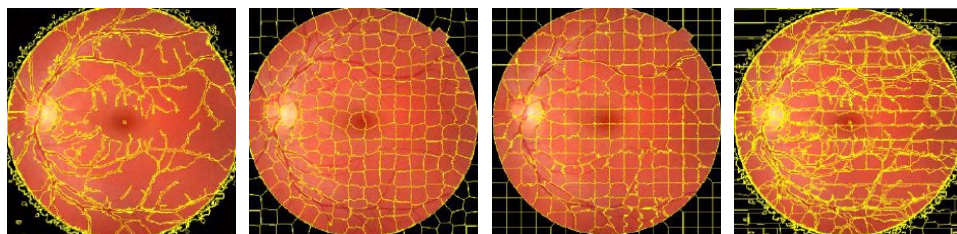


Fig. 7. Retina image - a) Felzenszwalb segmentation, b) SLIC segmentation, c) Compact watershed, d) Voting method

Image	Number of segments			
	<i>Felzenszwalb</i>	<i>SLIC Superpixels</i>	<i>Watershed</i>	<i>Voting method</i>
<b>Astronaut</b>	194	190	256	198
<b>Chelsea</b>	86	237	247	117
<b>Hubble deep field</b>	181	212	255	188
<b>Coffee</b>	109	223	260	134
<b>Retina</b>	295	226	256	283

**Table 1.** The number of segments for each of the images presented in Fig. 3 – Fig. 7. (Astronaut, Chelsea, Hubble deep field, Coffee and Retina) obtained with Felzenszwalb, SLIC Superpixels, Watershed algorithms and the proposed voting method.

In this section are highlighted the differences between the individual algorithms and the proposed weighted voting algorithm. The results obtained with Felzenszwalb, SLIC Superpixels, Watershed, and the proposed method, are shown in figures 3 to 7., representing different samples of images (Astronaut, Chelsea, Hubble deep field, Coffee and Retina) and their corresponding obtained segments (shown in Table 1) after applying these methods.

#### 4. Conclusion

In this article, different voting techniques have been explored using image segmentation algorithms, and from the obtained results, one can observe the influences of each algorithm on voting. For future work, Deep Learning algorithms can be applied to combine results similarly. Because the algorithms presented in this article are in the class of unsupervised algorithms, they cannot be combined with supervised algorithms, such as Deep Learning.

Integrating the proposed voting-based method with another similarly-designed systems [17-19] into an unsupervised document image processing system is the main goal of the future development of this research.

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## DIFFERENCING BETWEEN DECIBEL (DB) ADDITION IN ROOM ACOUSTIC DESIGN AND LINE ARRAY LOUDSPEAKERS DESIGN

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**Abstract:** *Historically, in the textbooks and based on the physical formula of the decibel, audio authors and practitioners have stated that “if we double the number of equal-sound sources we get an increase of sound output of + 3 Decibels.” However, since the line array loudspeakers (LAS) boom, we have seen correlated source systems where audio engineers stated that if these sources were also doubled, it was possible to obtain + 6 dB. This conclusion has been presented in many professional forum, conferences, and professional papers. When asked why this is so, in general, presenters justify this result as a direct consequence of the Sound Pressure Level Formula (dBspl). Although this justification is true for correlated sources, among the audio profession, the concept of dBspl has always been used undistinguishable with that of the Intensity of the Sound in dB. For this reason, in the acoustic design of a room, it is necessary to use a different value, namely, the Root Mean Square of the Sound Pressure Level. That in some system is possible to obtain one result but not in others has created confusion among practitioners. In this paper, the authors attempt to shed some light on the confusion on the use the concept of the dBspl as it relates to room acoustic and the loudspeakers design.*

### Introduction

It is generally assumed that in the design of an acoustic system, if the number of equal-sound sources is doubled, there is an increase in the audio output of + 3dB. With the advent of line array loudspeakers (LALs) in correlated source systems, according to some practitioners, the output should be + 6dB. The latter result is justified by using the Sound Pressure Level formula where its logarithmic factor is multiplied by 20 instead of 10, as it is done when calculating Sound Intensity. These two results have brought confusion in room-acoustic design among practitioners and technicians. In the opinion of the authors, this topic has been treated lightly; as a matter of fact, Eargle and Foreman [1], state that “...we can construct a new scale [table of values] in which a doubling of sound pressure corresponds to a 6 dB increase in sound pressure level (SPL).”

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The acoustic principles used in the installation of LAS are not new [2]. They have been known and used since first installed as column loudspeakers in big reverberation environments such as those encountered in traditional Christian churches. Here, engineers took column loudspeakers principles and combined them with the Neodymium magnets. The result of this new technology was a system of stackable small and light boxes with an amazing output power and accuracy between components as it was never experienced. In addition, as a consequence of this development, an old acoustical concept has reemerged, namely, that of correlated sources [3]. The application of this concept, under certain conditions, has made possible to get the equal sound pressure level at different positions from the same sound sources.

But again, you keep finding the mingling of the concepts of sound pressure level and sound intensity as can be seen in figure I which reproduces that of [4].

If the sound pressure level stated in dB this information can be use in calculations. For instance, a loudspeaker datasheet provides us with information for the Characteristic sound pressure level (1W/1m):95 dB. This means that at 1 watt of power,

The loudspeaker generates a sound pressure level of 95 dB at a distance of 1 meter. The

Following table indicates by how many decibels the sound pressure level of the Loudspeakers increases at a given power.

Power (w)	1	2	5	6	10	15	20	30	50	100
Increase in the sound pressure level	0	3	7	8	10	12	13	15	17	20

The table shows that at 6 watts you need to add 8 dB to the 95 dB. Consequently, at 6

Watts of power we obtain 103 dB SPL at a distance of 1 meter. There is also a Mathematical formula for this calculation that yields the same result.

$$P1 = pn + 10 \times \log (p)$$

P1: Sound Pressure level (dB) pn: Characteristic sound pressure level (dB) P: supplied Power (w)



**Each doubling of power gives us an additional of 3 dB spl**

Figure I. The Sound Pressure Level and the Power. TOA Page.

The confusion, previously mentioned, with regard to the difference in the number of **dB** that can be outputted from a sound system arises during the acoustical design of a room where the Root Mean Square of the Sound Pressure Level (in dBspl) should be used as oppose to traditionally used of the value of Level Pressure Sound at a point.

**1. Ratio between the sound intensity and the sound pressure level**

**1.1. Sound Intensity**

The sound intensity (Acoustic Power per unit of area) that goes through an imaginary spherical Surface around a punctual source (See Figure II), can be expressed as shown next [5]:

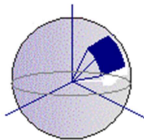


Figure II.  
Spherical Surface

The sound intensity can be calculated with a sound wave as follows:

$$I = \frac{W}{A} = \frac{W}{4\pi r^2} \quad (\text{W/m}^2)$$

$$I = \frac{W}{A} = \frac{p^2}{\rho c} \quad (\text{W/m}^2) \quad \text{(F1.1)}$$

where

I = Sound Intensity (W/m<sup>2</sup>)

W = power (Watts)

A = area (m<sup>2</sup>)

r = Spherical Surface radius (m)

p = Pressure Root mean Square (N/m<sup>2</sup>)

ρ = Density (kg/m<sup>3</sup>)

c = Sound velocity (m/s)

**Sound Intensity expressed in dB:**

According to [6] the Sound Intensity can be expressed as

$$L_i = 10 * \log \frac{I}{I_{ref}}$$

where



$$I_{ref} = \text{Reference Intensity} \left( \frac{W}{m^2} \right)$$

According to ISO 3740:2019 the Reference Level of the Sound Intensity is:

$$10^{-12} \frac{W}{m^2}$$

## 1.2. Sound Pressure Level.

Sound Pressure is the square root of the Sound Intensity. The Sound Pressure level is the root mean square pressure of a sound. From F1.1., given that

$$I = \frac{p^2}{\rho c}$$

Results

$$L_I = 10 * \log \left( \frac{\frac{p^2}{\rho c}}{\frac{p_{ref}^2}{\rho c}} \right)$$

Simplifying

$$L_I = 10 * \log \frac{\cancel{\rho} \epsilon p^2}{\cancel{\rho} \epsilon p_{ref}^2}$$

We get

$$L_{spl} = 10 * \log \left( \frac{p^2}{p_{ref}^2} \right)$$

Using a property of the exponents, we have

$$L_{spl} = 10 * \log \left( \frac{p}{p_{ref}} \right)^2$$

By the logarithm exponential law, we have that:

$$L_{spl} = 2 * 10 * \log \frac{p}{p_{ref}}$$

## **Sound Pressure Level expressed in dB**

According to ISO 3740:2019 we have that the Sound Pressure Level can be expressed as:

$$L_{spl} = 20 * \log \frac{p}{p_{ref}}$$

Where

P: is The Root Mean Square of the Pressure (N/m<sup>2</sup>)

The standard reference level  $p_{ref}$  is  $20 \times 10^{-6}$  N/m<sup>2</sup>.

## **2 Ratio between power and the sound pressure level**

### **2.1 The Decibel Power law**

If we double the power ratio of sound sources of the Sound Intensity, we will get an increasing of +3dB.

So, if we have

$$dB = 10 * \log \frac{P_1}{P_2}$$

Where  $P_1$  is the power and  $P_2$  the reference power.

Doubling the relation  $P_1/P_2$  we get

$$\begin{aligned} 10 * \log(2) &= 10 * 0.3 = +3dB \\ 10 * \log(4) &= 10 * 0.6 = +6dB \\ 10 * \log(8) &= 10 * 0.9 = +9dB \end{aligned}$$

But if we use the formula for Sound Pressure Level (spl) with a correlated source as we do with a line array, we would get the values shown below.

$$L_{spl} = 20 * \log \frac{p_1}{p_2}$$

Doubling the relation  $p_1/p_2$  we get

$$\begin{aligned} 20 * \log(2) &= 20 * 0.3 = +6dB \\ 20 * \log(4) &= 20 * 0.6 = +12dB \\ 20 * \log(8) &= 20 * 0.9 = +18dB \end{aligned}$$

The last relation shows that doubling the sound sources will increase the total Sound Pressure Level in +6dB. However, this is only true in correlated sources of sound.

## **2.2 Using the Root Mean Square into Room acoustic design**

When we work in acoustic design for rooms, we must use the Root Mean Square (rms) of the Sound Pressure level because the behavior of the sound waves may be affected by many factors such as reverberation, reflections, diffusion, standing waves, source position, etc. Also, the type of source can give us different responses according to the geometrical characteristic of the room.

If we work with software of Acoustic Prediction like EASE [7] or CATT [8] to design the acoustic of a room, we can observe the values we get when doubling the number of sources would be that of the corresponding Root Mean Squares.

### **2.2.1 Using JBL Software Simulator to get the Sound Pressure Level.**

The graphs shown in Figure III were obtained using the JBL Line Array Calculator II to compare the Sound Pressure Level when sources were doubled; the result we obtained was +3dB when compared two traditional loudspeakers.

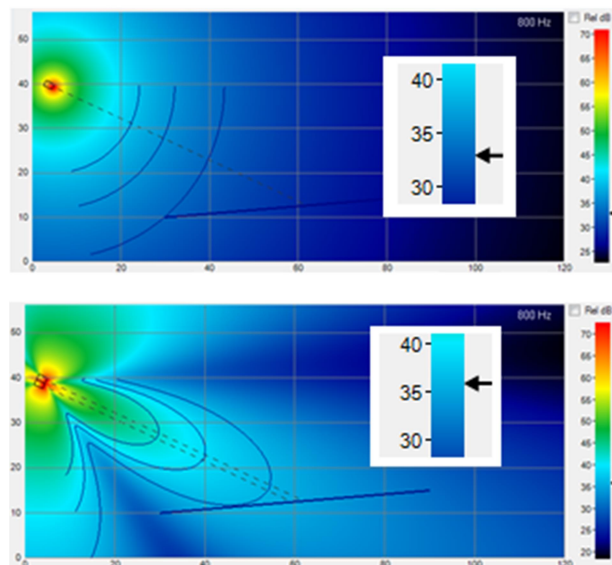


Figure III. Using the JBL Line Array Calculator II to double the number of sources. As can be seen, we got +3dB of increasing.

In the following example we use one Linea Array Loudspeaker (Figure IV)

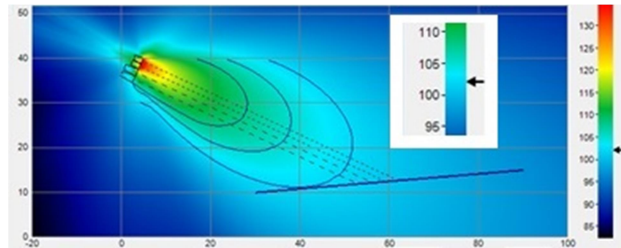


Figure IV. Four boxes

Then we doubled the number of speakers to get +6dB. But when we added two boxes of subwoofers to get the complete broadband, we got +4dB. This result tells us that, in fact, the Line Array technology achieves +1dB over the value we expected, but no the +6dB sales engineers are talking about. (Figure V).

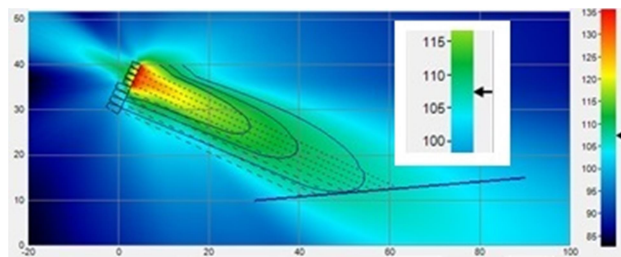


Figure V. Eight boxes.

### 2.2.2 Using the EASE Software simulator to get the Sound Pressure Level.

We then proceed placing one traditional loudspeaker into the acoustic simulator software EASE as shown in Figure VI, getting 76dB of Sound Pressure Level.

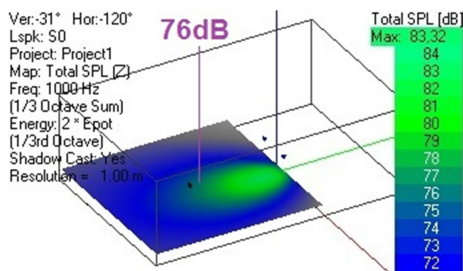


Figure VI. Placing one traditional loudspeaker we get 76dBspl.

Then we placed two traditional loudspeakers running the simulation again and got 79dB. We obtained an increment of +3dB as expected because the software uses the Root Mean Square and not a punctual sound pressure. Figure VII.

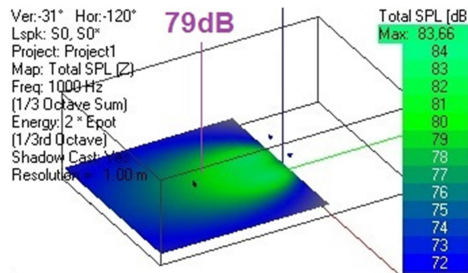


Figure VII. Placing two traditional loudspeakers we get 79dBspl.

### 2.3. Calculating the Sound Pressure Level using the rms. [10]

If we double a unity pressure under the rms formula, we will have

$$L_{spl} = 20 * \log \sqrt{\frac{(1^2 + 1^2)}{1}}$$

This can be expressed as

$$L_{spl} = 20 * \log \sqrt{2}$$

$$L_{spl} = 20 * \log(2)^{\frac{1}{2}}$$

Using logarithms

$$L_{spl} = \frac{1}{2} * 20 * \log(2)$$

$$L_{spl} = 10 * 0.3 = 3 \text{ dB}$$

Another way to express the rms is

$$L_{spl} = 20 * \log \frac{2}{\sqrt{2}}$$

$$L_{spl} = 20 * \log(2 * 0,707)$$

In any case we can show that

$$L_{spl} = 20 * 0.150 = 3dB$$

Therefore, we can then prove easily that

$$\begin{aligned} L_{spl} &= 20 \text{ Log } (2)^{1/2} &= 3 \\ L_{spl} &= 20 \text{ Log } (4)^{1/2} &= 6 \\ L_{spl} &= 20 \text{ Log } (8)^{1/2} &= 9 \end{aligned}$$

### **3. Conclusion**

You Can talk about that doubling the numbers of sound source will increase +6dB when you work with correlated sources. But when you are working in the Acoustics field you must work with Root Mean Square of the Pressure and in this case the increasing value will be +3dB.

Because the number of papers and speeches are most about Line Array loudspeakers, today, it must be desirable that sales engineers mention this difference to avoid confusing members of the audience not aware of this subtle difference.

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## ON HOW TO COMBINE SINGLE IMAGE SUPER-RESOLUTION ALGORITHMS

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**Abstract:** *In this paper, we present several models for super-resolution and how the performance can be increased on the DIV2K dataset using voting techniques. Combining various models and voting techniques we show that some state-of-the-art algorithms can be furtherly improved. At the same time, using voting or multiple experts' decision, we achieve more robust systems, which have stable performance, high subjective evaluation and also encouraging users' confidence. The results proved that the proposed method delivers accurately-enough results while ensuring strong reliability.*

**Keywords:** *super-resolution, voting systems, deep learning, convolutional neural networks, generative adversarial networks*

### 1. Introduction

In the last decade, the field of Computer Vision has grown exponentially both in popularity and in high-performance models, offering a new way of approaching problems involving image processing. Such a problem is super-resolution, which requires the transformation of the images from a lower resolution to a higher resolution. Super-resolution has significant applications in game development, multimedia content creation, advertising, medical imaging, security image analysis, autonomous vehicles and many others.

The super-resolution process involves transforming an image from a lower resolution to a higher resolution by supplementing it with information that must be approximated based on the lower quality image. Thus, Machine Learning algorithms are well fitted for this problem, making it possible to learn better approximations than the heuristic approaches. Deep learning techniques are a good choice since they can extract more complex and finer information in the learning

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process when compared to shallow networks, which usually are able to extract only coarse or superficial information from images. Convolutional Neural Networks (CNN) and Generative Adversarial Network (GAN) are the two main model classes that are used to obtain excellent details for a given image.

The main advantage of using Machine Learning for this task is the fact that such models do not require manually extracted features, CNNs and GANs being able to act as automatic feature extractors before they generate the results. This makes it possible for identifying filters and features that usually perform better than those extracted manually. Also, describing mathematically an object, an animal, a person, or how clear an image is to the human eye is very hard to do, which means that heuristic methods can only go so far, being dependent on the features extracted using human insights. But a CNN can extract such a description, which, if visualized by humans, might seem not related to the task. Despite this, CNNs can learn such descriptions during training. Sometimes, they even overcome human performance in some tasks.

Some of the most popular methods approaching the super-resolution problem are:

- ESRGAN: Enhanced Super-Resolution Generative Adversarial Networks [1]
- Residual Dense Network for Image Super-Resolution [2]
- Photo-Realistic Single Image Super-Resolution Using a Generative Adversarial Network [3]

In this article, we propose a voting system based on these three methods in order to obtain an improved and robust super-resolution technique.

## **2. Related work**

Initially, a heuristic solution for super-resolution was represented by bilinear interpolation algorithms [3], which allow the estimation of pixel values based on nearby pixels. Interpolation works using known data to estimate values at unknown points. In image interpolation, each pixel's intensity is estimated based on the values at the surrounding pixels. This operation is computationally intensive and the results are not the greatest. Also, bilinear interpolation introduces a blur effect that comes from the linear equations used for interpolation.

Dong. [4] presents one of the earliest solutions based on Deep Learning to solve super-resolution. The proposed architecture is called SRCNN and learns to map images from a lower resolution to a higher resolution using an end-to-end learning system where all essential features are automatically discovered, between stages data entry and output stage.

Later, a new series of approaches were presented using different architectures. The most significant are residual learning architectures [5], Laplacian pyramid structure [6], residual blocks [7], dense networks connected [8], and densely connected residual networks [9].

Generative adversarial network (GAN) architectures are also used in super-resolution. Unlike most networks, GANs use a pair of two networks to learn. This mechanism involves a generative network and a discriminative network, each having a crucial role in this architecture. The role of the generative network is to generate the best possible candidates to mislead the discriminative network into considering the candidate is real and not generated. The generative network is receiving feedback from the discriminative network. On the other hand, the discriminative network has the role of detecting candidates that were poorly generated, which aren't indistinguishable from real candidates. The two networks use learning similar to agent learning, where each component reacts to the feedback received from the other component.

GAN method can be successfully applied in the generation of photo-realistic images [10]. Also, in this sub-domain were introduced various mechanisms to improve the performance of GAN networks such as: using Wasserstein distances, regularizing the discriminative network through a technique called gradient clipping that limits the maximum value of the gradient.

### **2.1 Problem motivation**

The interest in super-resolution research has grown with the expansion of online services and the internet. Even though camera resolution has increased significantly in recent years, super-resolution is a technique that can benefit from reducing the size of transferred data by sending a downsampled image and reconstructing it with a certain degree of accuracy to the recipient.

Also, developing multimedia content for various resolutions is an expensive process and a possible solution is to develop at a minimum resolution and turn it into a higher resolution using deep learning techniques only when needed.

Other applications include interpreting data from surveillance video cameras, which provide lower resolution to make it easier to store this data for later use. The size of files saved by a surveillance camera is directly proportional to the quality at which they are recorded. Because the storage solutions are generally limited, they record video content in 720p or smaller format, which does not focus on the details in the frame.

Thus, the development of these types of solutions would bring a significant addition to the quality of the images generated at a lower resolution by using machine learning techniques.

### **3. Proposed methods**

In this paper, we will focus on combining the results obtained using well-known algorithms from the super-resolution domain to achieve better results compared to using these algorithms individually.

To combine the results obtained from the algorithms, we will use different voting techniques to determine the best result. The results of the voting algorithms will be

presented in the following sections, along with some insights and observations regarding the voting process.

In the following subsections, we will present the three Deep Neural Networks used in our experiments.

**Residual Dense Network - RDN**

This architecture brings significant improvements compared to the previous versions, by introducing new components named Dense Residual Blocks.

The architecture is presented in figure 1. It is composed of the following:

- shallow feature extraction net (SFENet)
- residual dense blocks (RDBs)
- dense feature fusion (DFF)
- up-sampling net (UPNet)

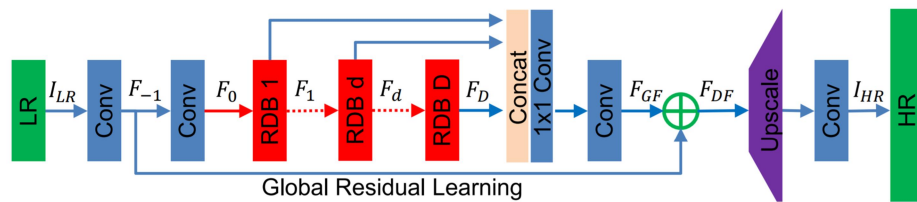


Figure 1. The proposed architecture of Residual Dense Network in [2]. Image taken from [2]

The first part (SFENet) is using convolution operations to extract shallow layer features ( $F_{-1}$ ,  $F_0$ ). These are afterward introduced in the residual dense blocks to generate another set of features.

These blocks are presented in figure 2. They are made of convolution operations and the ReLU (rectified linear units) activation function. The general convolution blocks differ from the ones used in this paper due to the usage of dense links. A final feature is generated by using dense links with all the features generated by the convolution operations. Moreover, this final feature is used along with the input feature to generate a global feature at the block level.

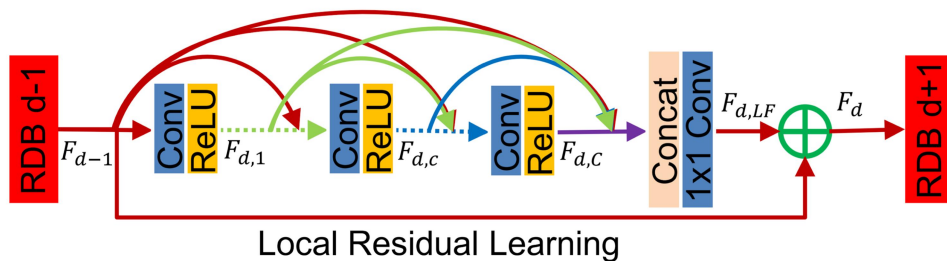


Figure 2. Residual Dense Block architecture. Image taken from [2]

Being composed of multiple residual dense blocks, each block generates a global feature, which is then used to generate a feature map.

This feature map is generated by concatenating all the global features generated until that moment. Also, the upscale network uses as input both the previously generated feature map and the shallow layer features generated at the beginning of the process.

In this paper, convolutions of size 3x3 are used to generate global and local features. Convolutions of size 1x1 are used to aggregate all the generated features.

### Super-Resolution Generative Adversarial Network - SRGAN

The paper proposes a loss function called perceptual loss. It is made of two-loss functions: adversarial loss and content loss. Adversarial loss is used to differentiate between photo-realistic images and images created by the generative network.

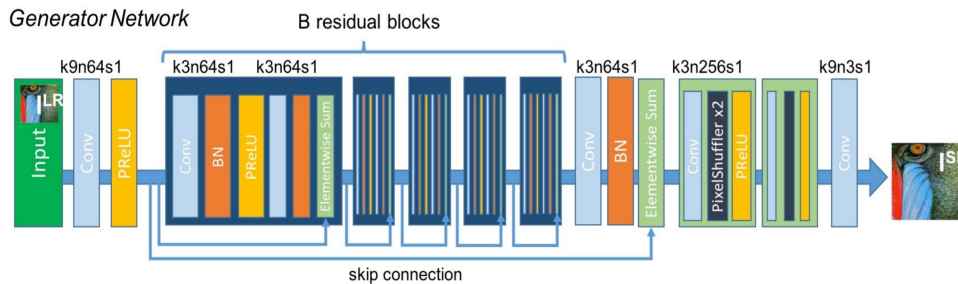


Figure 3. Generator Network. Image taken from [3]

Also, the authors note that perceptual loss is an improvement over pixel similarity, thus allowing the network to generate textures similar to photo-realistic ones.

The generator has a similar structure with the architecture presented in [2], both using residual blocks. The residual blocks described in this paper are more complex than the residual blocks from [2], and they are made of the following:

- Convolution operation
- Batch normalization
- Parametric ReLU
- Batch normalization
- ElementWiseSum

In contrast with the previous paper, the authors use two batch normalization operations, two convolutions, and an elementwise sum instead of concatenation to aggregate the features for each block.

The generative network receives as image input a lower resolution image. It tries, using the feedback received from the discriminator, to improve the upscale process.

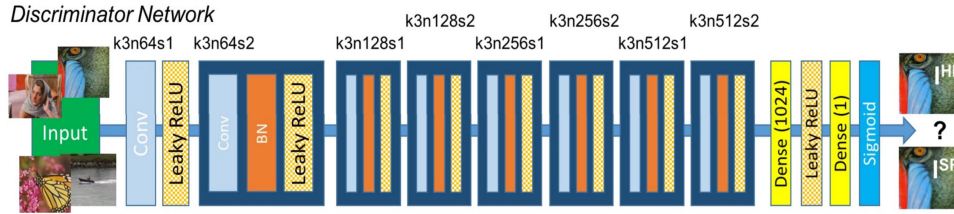


Figure 4. Discriminator Network. Image taken from [3]

However, the discriminator structure is a classic one composed of convolution operations, batch normalization, and the parametric ReLU activation function. This network tries to determine whether the input image is received as a high-resolution image or generated using super-resolution.

$$l^{SR} = l_X^{SR} + 10^{-3} l_{Gen}^{SR} \quad (1)$$

Where:  $l^{SR}$  is the perceptual loss,  $l_X^{SR}$  the content loss,  $10^{-3} l_{Gen}^{SR}$  the adversarial loss.

The main contributions of this paper in the super-resolution domain are the introduction of a loss that is able to generate textures that are similar to photo-realistic textures.

$$l_{MSE}^{SR} = \frac{1}{r^2WH} \sum_{x=1}^{rW} \sum_{y=1}^{rH} (I_{x,y}^{HR} - G_{\theta_G}(I^{LR})_{x,y})^2 \quad (2)$$

### Enhanced Super-Resolution Generative Adversarial Network - ESRGAN

The system presented in the [1] brings some significant improvements over SRGAN by using the concepts previously mentioned in the GAN framework.

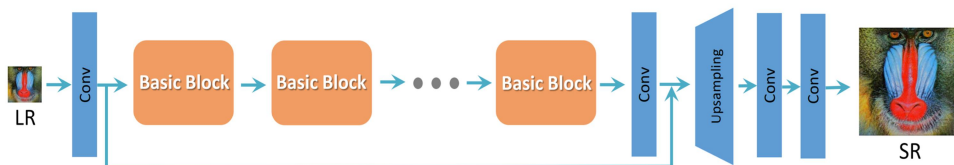


Figure 5. Basic architecture SRResNET. Image taken from [1]

The authors keep the general structure of the generator but replace the residual blocks with a new type of residual blocks called RRDB. They keep the convolution operations and replace parametric ReLU with Leaky ReLU but add block-level residues using a Beta factor to scale these residues.

Significant changes have also been in the structure of the discriminative network. So far, a discriminative determined the probability that an image was real and natural, and the authors introduce a new type of relativistic discriminative that brings improvements for specific tasks.

The relativistic discriminative is based on the following idea: instead of determining whether an image is natural or not, they decide whether an image is more natural than a fake one. This fake image is generated using the average of the values of the predicted fake images, thus introducing a comparative degree between real and fake images.

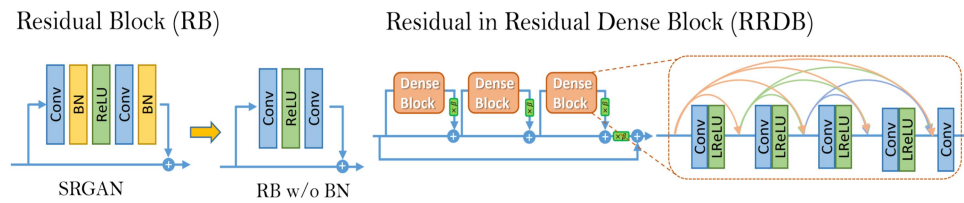


Figure 6. Residual Block and Residual in Residual Dense Block. Image taken from [1]

Another remark in the previous article is the order of use of the characteristics and activation. They argue that the brightness suffers when first using the activation followed by characteristic and propose the parameterization of the loss.

$$L_G = L_{percep} + \lambda L_G^{Ra} + \eta L_1 \quad (3)$$

### Voting algorithms

The previous algorithms are used to generate the most realistic images that we further use for the voting algorithm to determine the best representation.

The algorithms chose for voting are as follows:

- Average Voting (pixel-wise)
- Furthest away – the distances between the pixel values for each algorithm are calculated, and the one with the maximum distance is chosen
- Noise estimation – the image is transformed into BW, and it is estimated how much noise is in the image, the image with the least noise is chosen (patch-wise)

## 4. Experiments

### Dataset

DIV2K [11] is the most widely used data set to evaluate the performances of super-resolution algorithms. It contains 800 high-resolution images for the training stage, 100 high-resolution images for validation, and 100 high-resolution images for the test stage.

For each high-resolution image, it also offers a variant whose quality has been reduced using one of the following procedures:

- Bicubic interpolation
- Unknown operator – the procedures that generated the low-quality image are kept hidden in order to avoid finding a method that has results only for bicubic interpolation

In this dataset, there are also three scaling versions (x2, x3, x4) that determine the final size of the picture with reduced image quality.

For the experiments in the article, we used the x4 scaling and the unknown operations to measure the performance of the voting algorithm.

### Evaluation methods

To evaluate the quality of images, we use the most common metric in specialized publications, and we compare it with the results obtained by the individual running of the Deep Learning algorithms.

We can measure the success of a network by finding out how well it reduces the mean squared error (MSE) between the output pixels and the original version.

The best result is an MSE of 0, which means that the original high-resolution image and the high-resolution version generated by the network are identical.

$$MSE = \frac{1}{N} \sum_{i=1}^N (I_{(i)} - \widehat{I}_{(i)})^2 \quad (4)$$

$$PSNR = 10 * \log_{10} \left( \frac{L^2}{MSE} \right) \quad (5)$$

The purpose of the PSNR equation is to calculate the compensation between the MSE and the maximum value of the pixels. A higher PSNR represents high quality generated images. It is worth noting that PSNR is not a completely objective metric since PSNR-oriented approaches tend to output images overly smoothed, lacking

enough high-frequency details. Despite this, it is still a useful metric, which can measure how well an image is being upscaled.

### 5. Results

In Table 1 we present the PSNR values obtained for the three individual methods and then the values obtained by using the proposed voting strategies. We can observe that the average voting system performs worse than the individual methods. The same is true for the furthest away strategy. But the noise estimation strategy is performing better than RDN and SRGAN, although still is lacking in comparison to ESRGAN. Despite this, this strategy offered lower fluctuation in performance, making the system to be more robust. Thus, it is worthwhile taking into consideration a voting system when approaching super-resolution, which is harder to objectively describe than other Computer Vision problems.

Algorithm	PSNR
RDN	19.17
SRGAN	19.36
ESRGAN	19.85
Average Voting	18.98
Furthest away	19.09
Noise estimation	19.37

Table 1. The PSNR values obtained by using the three individual methods and the three proposed voting systems.

A snapshot of some visual results is presented in Figure 7.

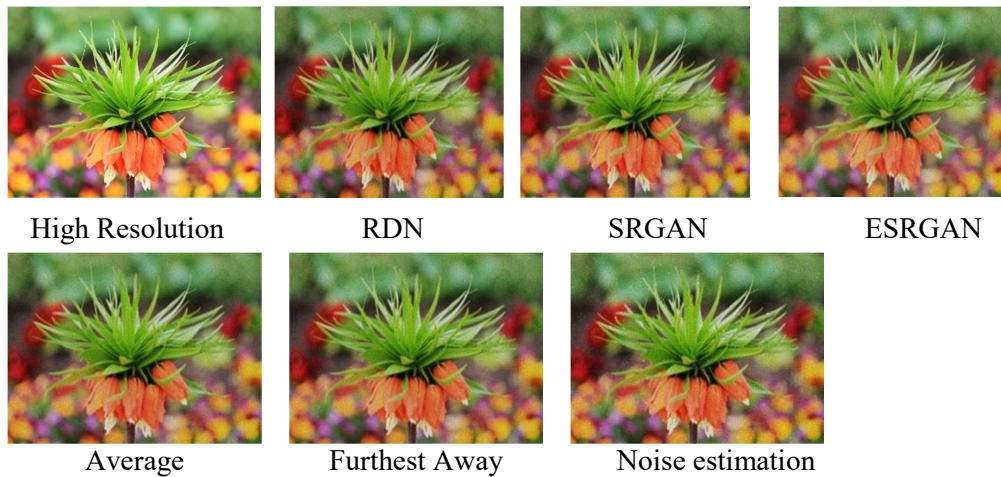


Figure 7. The original high-resolution image and the upscaled images obtained by using the three individual methods and the three proposed voting systems.



## **6. Conclusion**

In this article, we tested various deep learning models that solve the problem of super-resolution and we used voting algorithms to improve their performance. Since many models used for super-resolution achieve high PSNR, but they generated images still lacking for the human eye, we can conclude that this problem has a visual perception component, represented by the subjective evaluation of human observers. Since a perfect recreation of the downsampled image is unlikely, it is necessary to take into consideration the human perspective of the results, since for practical purposes, it is useless for an image to have high PSNR and low subjective quality (as determined by human observers). Thus, results should always be correlated with human observations.

In the near future, the current super-resolution approach will be integrated alongside other voting-based approaches [12-14] in a fully-unsupervised processing pipeline destined for analysis and processing of image documents.

## **Acknowledgement**

This work was supported by a grant of the Romanian Ministry of Research and Innovation, CCCDI - UEFISCDI, project number PN-III-P1-1.2-PCCDI-2017-0689 / „Lib2Life- Revitalizarea bibliotecilor și a patrimoniului cultural prin tehnologii avansate” / "Revitalizing Libraries and Cultural Heritage through Advanced Technologies", within PNCDI III

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## **EXPLAINABLE MACHINE LEARNING FOR ETHICAL ARTIFICIAL INTELLIGENCE BASED DECISIONS**

*Radu STEFAN<sup>1</sup>  
George CARUTASU<sup>2</sup>*

**Abstract:** *In the last century, many approaches and tools have been developed to implement systems that would achieve Artificial Intelligence (AI) and solve most difficult problems in computer science with that. The quest is to find the most suitable machine learning method for a given problem domain. Currently the approach that yields the best results in practice in most domains is based upon artificial neural networks, or the more advanced deep neural networks. Neural networks are highly efficient for most common scenarios, e.g. language understanding, image recognition and the like. Typically, models are trained for a specific task, and their performance is judged based on the binary outcome, e.g. in image recognition, whether the artefact was recognized or not. From an ethical decision-making point of view, the challenge remains to identify how the learning process influences the outcome and finally to rationally understand how a decision has been made. In this paper we present a framework for an enhanced machine learning model, that adds a layer of decision explanation to the outcome towards the user of the system. We suggest how the learning model needs to be expanded to an explainable model and the corresponding explainable interface that would allow presentation towards the user.*

### **1. Introduction**

There is a problem with artificial intelligence. It can be amazing at churning through gigantic amounts of data to solve challenges that humans struggle with. But understanding how it makes its decisions is often very difficult to do, if not impossible. That means when an AI model works it is not as easy as it should be to understand why they're doing what they're doing. In order to achieve ethical decision making, the prerequisite consist in the ethical dimensions framework we have detailed in an earlier publication called "*How to approach ethics in intelligent decision support systems*". For at least two of the ethical dimensions, that we would want to address here, it is crucial to have the ability to understand whether the system operates correctly and to understand how decisions are taken:

- Reliability & Safety, and
- Transparency

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## 2. The need for Reliability, Safety and Transparency of artificial intelligence based decisions.

Reliability, Safety and Transparency of artificial intelligence based system, typical address the understanding of how a system operates and whether it operates correctly up to the understanding of how decisions are taken.

### Problem with AI System TODAY

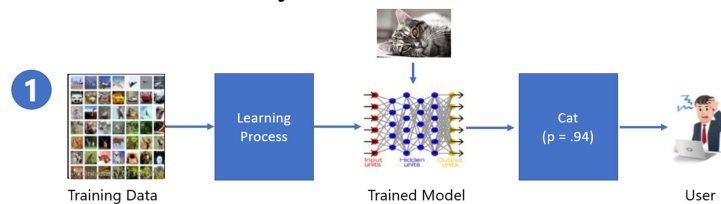


Figure 6 - User output: Cat ( $p = .94$ )

### 2.1. Reliability

By reliability we refer to a system that is consistent and accurate. On contrast unreliable systems are typically inconsistent and not accurate, thus mostly non-usable. For AI based systems the challenge in reliability, so in consistency and accuracy, lies in the very nature of probabilistic approaches. While for some domains an accuracy of 99% of producing the correct outcome may be considered accurate (e.g. placing ads based on user profile), some other domains (such as automotive) may require a 99.9997% accuracy.

Artificial intelligence systems, must operate at the domain specific accuracy, where accuracy is defined as the proximity of the outcome to the correct value. We intentionally assume accuracy as the key factor for reliability vs. precision that would be more relevant for the internal operation and not the outcome of the system for the end-user. The actual difference between *reliability* and *precision* is depicted in the image below.

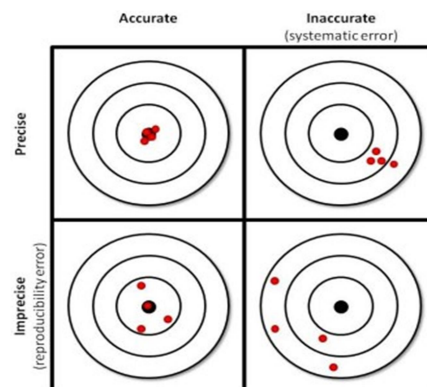


Figure 7 - Accuracy vs Precision

## 2.2. Safety

Safety, in contrast to reliability, refers to a system that operates in a manner which does not harm others, directly or indirectly. This is valid for a system action as well as for an in-action that would conduct to harm (especially harming humans).

Like the reliability, the safety of an AI based system needs to be defined in the context and the environment such a system operates. For example, AI based systems that operate a self-driving car, or such that are used in patient diagnosis are, amongst others, highly sensitive to safety of humans. This is also valid for most of embodied AI robots, as those systems have a physical degree of freedom, thus hypothetically capable of harming humans. On the other end of the spectrum would be AI systems that operate solely as a software system, e.g. recommender system for online shops or e-mail spam filtering. In general, those systems do not pose any risk to the safety of humans.

However, looking at a common example in artificial intelligence based systems, such as a credit scoring application used by financial institutions, the safety aspect would be harming humans that would be rejected a loan, although there is would not be an objective reason to do so. There are examples where credit scoring application are gender or race biased, even if the gender was eliminated as an input. For example, gender bias can be derived from written text as shown by [1].

A more general approach to classifying risks was formulated by Bostrom [2].

<b>Bostrom's Categorization of Risks</b>			
<i>Intensity of Risk</i>			
		<b>Moderate</b>	<b>Profound</b>
	<b>Global</b>	Ozone Thinning	<u><i>Existential Risks</i></u>
<i>Scope</i>	<b>Local</b>	Recession	Genocide
	<b>Personal</b>	Stolen Car	Death
		<b>Endurable</b>	<b>Terminal</b>

## 2.3. Transparency

Transparency of artificial intelligence systems, as the third aspect in this chapter, refers to the ability of the user to understand the outcome of the system. In this sense we look at the interpretability of the results. This relevant in the same manner for both levels of users: *novice* and *expert*. Typically AI based system are used in one of the two scenarios: *work* or *learn*. In the learn scenario we consider any user a novice, on contrast to the working (or usage) scenario.

(Domain) Experts using AI bases system, typically do have some types of knowledge, like: *terminological* and *strategic knowledge*, however they might miss the *justification* or *trace knowledge*. For novice users it is expected that they do lack any of the four types of knowledge, represented in the table below [3] :

Type of Knowledge	Description and Purpose	Illustration of question requesting explanations using such knowledge
Terminological knowledge Synonyms: definition knowledge	Knowledge of concepts and relationships of a domain that domain experts use to communicate with each other. In order for one to understand a domain, one must understand the terms used to describe the domain.	What is the definition of gross domestic product?
Justification knowledge Synonyms: Why, descriptive knowledge	“Textbook rudiments” which are required before one can solve problems. Justification knowledge provides abstract factual knowledge about a domain, typically represented declaratively.	Why is inflation dependent on the money supply?
Trace knowledge Synonyms: How, problem solving knowledge.	Knowledge about how tasks have, or are about to be accomplished.	How did you conclude that the patient has diabetes?
Strategic knowledge Synonyms: Control knowledge	Knowledge about the system’s control behaviour and problem solving strategy.	Why do you need to know if the patient has ever had mumps?

Table 2 - Types of Knowledge

### 3. Scope of Explainable Artificial Intelligence (XAI)

In order to address the shortcoming in Reliability, Safety and mostly in the transparency of AI based systems, an additional layer of *explainability* is required for every system. This layer shall be an integral part of the model and needs to be constructed along the way with the AI model itself.

The scope of the *Explainable Artificial Intelligence* lies at the intersection of three major areas:

- Artificial Intelligence
- Social Science, and
- Human-Computer Interaction

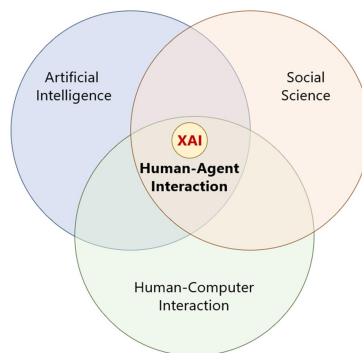


Figure 8 - Scope of Explainable Artificial Intelligence

Behind the *Artificial Intelligence* domain there is a specific machine learning model, that powers the system and produces an outcome based on the input. For systems developed in the last decades, most machine learning models produce results based on probabilistic models, therefore the outcome also has a probability attached. It is fairly known, that humans not trained in statistics are inclined to interpret probability wrongly, which goes both ways. A reasonable probability maybe mistrusted, or a poor probability might be accepted as a good outcome, depending on the understanding and the believe as defined in the social science.

The *Social Science* domain is concerned with human perception. Heider [4] defines social attribution as person perception. A detailed analysis would go beyond the scope of this paper, for the XAI model however it needs to be noted that human are in need of an explanation or a reason to believe, which is necessity to trust.

Lastly, the domain of *Human-Computer Interaction (HCI)* is crucial for generation a good explanation, as HCI defines how information is presented to the user and how the users can act upon the computer system. The form of interaction can significantly influence the perception of the user.

Overall an *Explainable Artificial Intelligence* system, might have several beneficial outcomes, that could address the needs presented in *chapter 2 The need for Reliability, Safety and Transparency of artificial intelligence based decisions*.

### **3.1. XAI to increase reliability and enhance learning**

In scenarios where artificial intelligence systems are used for learning and training, the explanatory part is necessary. The ability to learn is strongly connect with the ability to reason, thus systems used in learning scenarios should present explanations in at least all four types of knowledge as described in *Table 2 - Types of Knowledge*.

#### **3.1.1. Terminological Knowledge**

Every AI system should be accompanied by a terminological knowledge base that defines concepts and relationships of the particular domain. Based on keywords or other means of interrogation, users (or learners) should be able to interrogate specific terminology.

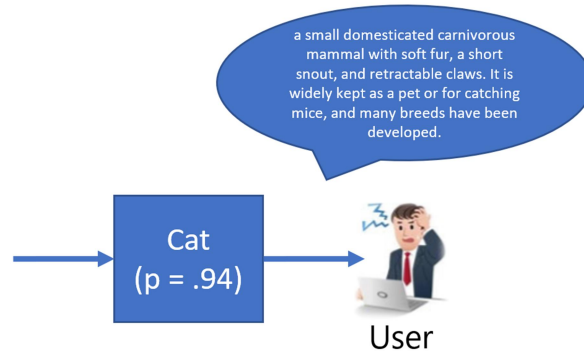


Figure 9 - Additional Terminological Knowledge

A superior functionality would be given, when the system automatically triggers explanations based on the given outcome and presents them to the user. The *Figure 9 - Additional Terminological Knowledge* shows a schematic example.

### 3.1.2. Justification Knowledge

A secondary addition to explanation is given by the *justification knowledge (or descriptive knowledge)*. A good example for justification knowledge especially in visual interpretations is given by Hendricks [5]:

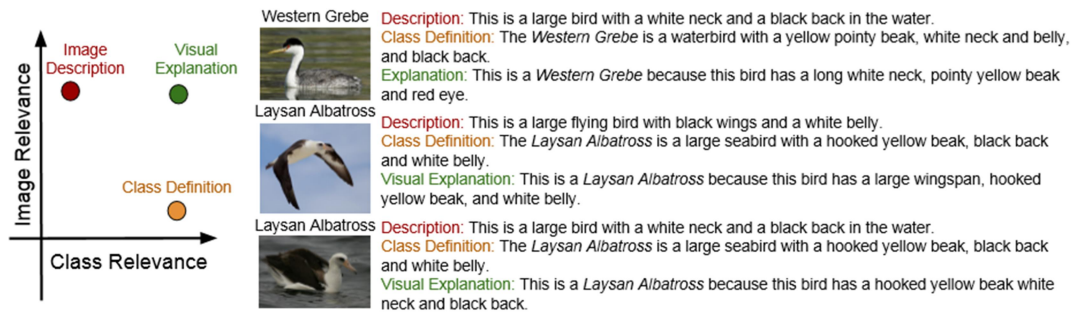


Figure 10 - Class vs Image Relevance

Using a *Description* and a *Class Definition* (from the terminological knowledge) an explanation can be generated.

### 3.1.3. Trace Knowledge

In image recognition a simple model to realize trace knowledge is by recognizing sub elements of a picture. This can be approached top-down or bottom-up. The first would be to recognize the image as a whole and classify it. In a second iteration to



lookup in the knowledge base for sub elements and lastly to rerun image recognizer to find the sub elements in the image. Using the cat example, it would mean:

- I. Image recognizer -> cat (p = .94)
  - II. Look up cat class for sub elements -> fur, claws, etc.
  - III. Rerun imaged recognizer to identify fur, claws, etc. -> if true -> traceable!
- Another approach would be to reverse the above order and to run the algorithm bottom-up. First recognize sub elements of the image, second search through knowledge what suits most all the sub elements, and lastly rerun image recognizer to ensure result from second step is confirmed.

Which of the two models is most appropriate, depends largely on the existing knowledge and the problem domain and on the model selected. Choosing the best model based on those dependency should be further researched in a separate paper.

#### **3.1.4. Strategic Knowledge**

4. The fourth knowledge type is mostly about the system and the operations that lead to the result present to the user. In this step a description (understandable by a novice and domain uneducated human) should be presented. A cumulation of the three methods described previously would suffice to increase the learning effect.

5. By designing implementing the above knowledge types into an AI system, not only the learning / usage experience would be enhanced, but implicitly the reliability of the system would be significantly increased. Especially the *justification* and the *trance knowledge* force the system into a higher reliability.

#### **5.1. XAI to increase safety by avoiding (more) mistakes**

An artificial intelligence system, that would incorporate all four of the knowledge types mentioned in the previous chapter, would be less prone to mistakes and errors. A terminology knowledge system would force designers and implementers to develop the system more accurately, but the real benefit is with the human user, that has the possibility to judge the result in the context of the terminology and feedback his or her perception back to the system or the model.

The justification knowledge ads the same benefits as the terminology knowledge, however it is surely more complex to embedded and from a financial point of costlier for the entire system.

The trace knowledge is the most significant contributor to reducing mistakes and it implements a secondary step of ensuring the answer is correct. It is obvious that the accuracy is highly improved, however it depends on the domain of usage to what

extend the trace knowledge is rather trivial to implement (as in the image recognition example) or highly complex.

The strategic knowledge also contributes to less errors, as it forces designers to precisely document and communicate the operations of the system.

## **5.2. XAI to increase transparency by enhancing trust**

Lastly increasing transparency and thus enhancing trust is the major scope of *explainable artificial intelligence*. Trust is something that needs to be looked at from an end-user perspective, no matter if a novice or an expert user.

On top of the technical implementations discussed above, the transparency and the trust, related mostly to the *human-computer interaction (HCI)* domain, as they are highly dependable on the user's perceptions.

Interfaces need to be designed appropriately for the domain intended. For example, an interface for medical staff using an artificial intelligence system for diagnosis will differ significantly from an interface a consumer is using to sort family pictures from the last year's vacation across Europe.

## **6. Extension of current approach**

By designing implementing the above knowledge types into an AI system, not only the learning / usage experience would be enhanced, but implicitly the reliability of the system would be significantly increased. Especially the *justification* and the *trace knowledge* force the system into a higher reliability.

As a general approach, all techniques described in this chapter could be incorporated in the user's screen. An example is depicted below for the same animal image recognizer.

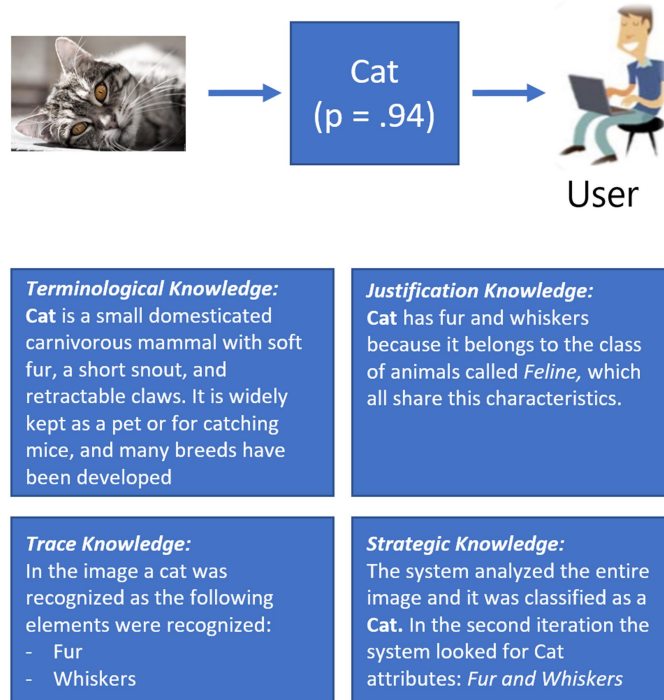


Figure 11 - Additional Knowledge to be presented

## 7. Explainable AI in practice

For explainable artificial intelligence to work in practice, it is necessary to construct the knowledge system along with the artificial intelligence model itself. We call the knowledge system the *explanation model*.

In a more general approach, all the above knowledges can be summarized as a justification narrative. In order to generate the narratives features of the data set need to be classified on importance and effect. Such a model is presented by Biran [6]:

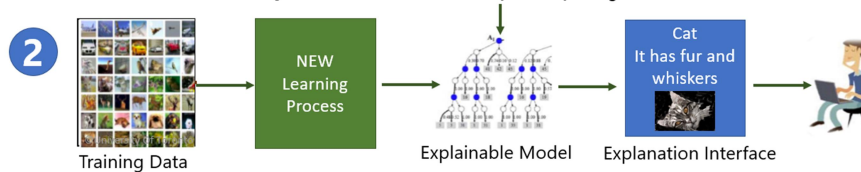
Effect \ Importance	High positive	Low	High negative
High positive	Normal evidence	Missing evidence	Contrarian counter-evidence
Low	Exceptional evidence	Negligible	Exceptional counter-evidence
High negative	Contrarian evidence	Missing counter-evidence	Normal counter-evidence

Table 3 Narratives Importance vs Effect

Extracting the evidence, as positive or negative effect during the learning/training phase of the model and having it available during operations, gives a framework that allows for every new observation, to construct narratives using positive and negative statements.

Converting features into human readable text is a separate research and work area that would go beyond the scope of this paper.

## Solution with Explainable AI (XAI) System TOMORROW



As a result, the learning process is extended to extract evidence and the outcome is embedded in the explainable model. This allows the user interface to be enriched with an explanation interface.

### 8. Conclusion

In conclusion we suggest an enhanced framework for explainable artificial intelligence based systems that includes ethical aspects of reliability, safe and most important transparency. Those aspects cover two major ethical dimensions as suggest by us in an earlier publication [7].

In future research, the approaches described in this paper need to be applied to specific domains and tested in practice. In some areas the applicability might be limited while in others many extensions might be possible.

The above implementations would contribute towards trustworthy AI, an initiative driven by the European Union. A final paper is expected to be published in May, 2020.

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## **IOT AND THE FLYING ANSWER TO COVID-19**

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**Abstract:** *IoT devices, especially drones on which we focus here, have demonstrated during the COVID-19 crisis that they have the real potential to actual be now, and not in an uncertain more or less distant future, of a real huge help. From basic surveillance of urban or outdoor areas to deliveries of medical supplies, from spaying different disinfectant materials to remotely checking body temperatures, the drones showed that they could be much more than flimsy toys or paparazzi tools. The usage scenarios and real-live deployments have shown that the drones have a potential that undoubtedly will be tapped in the future for solving more and more issues. In the same time, we must not overlook the arguable concerns related to the possibility of using these devices for spying, controlling and other malevolent approaches.*

**Keywords:** *iot, drone, covid-19, internet human rights, remote sensors*

### **1. Introduction**

During the current (still!) crisis emerged from the COVID-19 disease, that spread from China's mainland to encompass virtually the entire planet, the necessity to put all technology at the disposal of as many people as possible became a hugely important issue. Using high-tech gadgets and cutting-edge technology just to demonstrate different, possible, usages is not going to cut it anymore. The technology embracers must be able to show the there are also tangible usage, available here and now, able to really make a difference in the worst-case scenarios that humankind can endure. IoT devices had to show that they can do more than a hypothetic well-being increase by reminding us that we have an appointment at the massage parlour today, or that the coffee will be ready in ten minutes. Lives were at stake and automation has to show its full potential.

### **2. Context and implementations of drone usage during COVID-19**

Generally speaking, industrial automation processes or agricultural enhancing machinery have already showed their capacities well before the crisis. It was now the time of showing that some gadget-like machines and some "kids' toys" devices can do more than just being nice to play with. One of the shining examples of real help from the IoT world came from the small and somehow toy-like flying drone.

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Drones available off the shelf came into light and were used in many locations – on larger scale in China – as a more reliable, cheaper and safer solution to involving large numbers of personnel for different checking operations, announcements, trespassing in forbidden areas, light delivery duties etc.

Drones were used to very rapidly scan and later continuously supervise large areas, either urban or outdoor. In case that the drone's sensors and/or cameras detected human movement, they were able to broadcast audio messages, warning for example about the necessity to wear protective gear, remain inside or evacuate premises. All these activities were organized and controlled from remote locations, without any need for human personnel to directly go in those areas and increase the risk of their getting in contact with possible infected people or their direct contacts. There is also an already viral video on the internet, from the Chinese region of Inner Mongolia, with an old lady being talked to by a drone – figure 1.

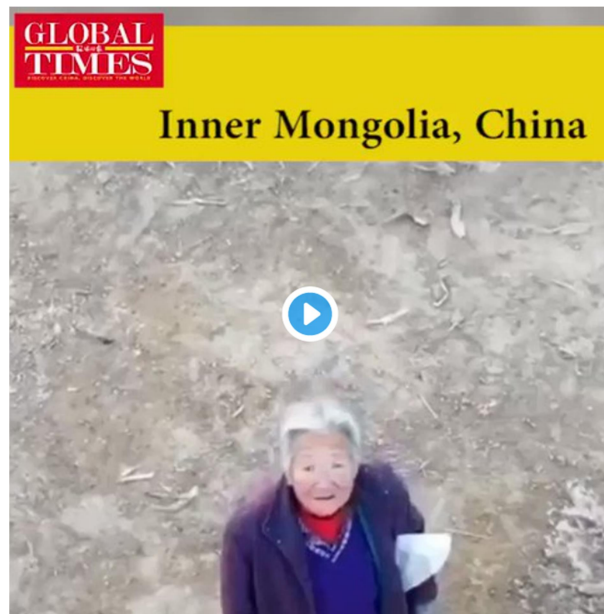


Figure 1. Capture from Global Times Twitter account<sup>3</sup>

In other cases, formerly agricultural field drones were used in urban areas to throw disinfectant materials over large areas and so preventing the spread of the virus. From a DJI<sup>4</sup> report, statistics show that drones are able to cover about 100000 square metres of area, in only one hour, with only one 16 litres disinfectant tank.

<sup>3</sup> <https://twitter.com/globaltimesnews>

<sup>4</sup> <https://www.dji.com/> - one of the best-known commercial drone manufacturers



Figure 2. Emergency unit from Spain, with two DJI AGRAS MG-1 used to disinfect<sup>5</sup>

Drones can also be equipped with infrared/thermic sensors and/or cameras. These devices can then be used in order to check the temperatures of people from afar, in cases where a normal handheld thermometer could put the handler into a higher risk zone.

But perhaps the best way to help, at least from a quantitative point of view, was to use drones for deliveries – especially medical supplies. Drone delivery is a concept that was already probed and even implemented a smaller, pilot-project, scale by different industry visionaries, such as the giant Amazon corporation. Nevertheless, in standard conditions, the normal drone deliveries raise quite enough issues and problems, related to both technical challenges as well as regulatory ones (different legislation and requirements in almost every country for example). Some cases of using drones in the medical field, to fight against another disease called Malaria, were already found in Tanzania or Zanzibar. Usually, the help of drones was normally needed in areas that were not developed enough and, as a consequence, more classical way of delivering goods or expertise were very feeble. During the COVID-19 crisis we found out that even giants like the US, EU, China, Brazil... and almost everybody else, are in need of such capabilities when we do not want people to get in contact to one another. Google's mother company, Alphabet, has in its panoply of tech-companies a drone based one: Wing. Wing has become, in 2019, the first company to receive official approval from the US authorities in order to deploy a pilot-project, together with the well-known FedEx courier company, for drone deliveries to ordinary customers.

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<sup>5</sup> <https://www.scmp.com/coronavirus>





Figure 3. Wing drone used for delivering goods<sup>6</sup>

One of the most important and debated issue – there are a lot more, but they are not to be tackled with inside this article – related to drone usage takes into account the privacy concerns as well as the property boundaries. Drone can be (and this is for sure) used for a lot of things on the border between legit and illegit, for things related to surveillance or taking pictures/recording videos inside private properties. Nevertheless, these real concerns should be addressed, and a way must be found in order for the modern society to take full advantage of their enormous potential for good. After researching this topic extensively, we consider that regulators (countries or common over-state entities) should have in mind, at least as a first step, an excellent idea that can be of a real help in this case:

- Create drone streets/highways, exactly above the present-day road infrastructure. This approach would ensure that the drones are not peeking on private properties and that their routes are clear and free of obstacle. Their speed and flight rules will make them cover the same distance way faster than a normal wheeled vehicle. On the downside, bot being able to choose the shortest, most straight forward route will impose a penalty on the drone's delivery trajectory.

In a more specialized implementation, a drone can be used to check the condition of people, from above, in relation to a certain cardio-pulmonary condition. An article published by a team of researchers from University of South Australia shows how a drone can actually be used to remotely extract the characteristics of a person's heart rate, just by analysing the picture/video capture. Even though the capability was first considered for war-zones, a COVID-19 crisis response team might also use such technology for best results [1].

<sup>6</sup> <https://techcrunch.com/2019/10/18/alphabets-wing-begins-making-first-commercial-drone-deliveries-in-the-u-s/> - Inaugural flight of Wing delivery-drone, in Christianburg, USA.

### **3. Concerns related to drone usage**

As already mentioned before, the drones are not bringing only joy and goodwill in their path. There are enough concerns and issues that still have to be addressed and solved, maybe even by the old trial-and-error approach, if needed. Instead of doing nothing and just finding the worst-case scenarios for using drones, the scientific community should focus on mitigating the legit concerns, as to make way for the numerous scenarios in which such devices could really make a difference for the best. Unfortunately, one of the main concerns related to drone usage – prying on private areas, illegit surveillance and the like – are indeed very real facts happening even now. China, a great supporter of drone usage and one of the leaders of development and deployment of these devices, has huge problems related to over-surveillance of its populations and generally to the use of high-tech to impose its state-policies without any regard for human rights. On the other hand, in countries with well-established and old democratic regimes, even the current pandemic was not considered enough reason for a possible breach of fundamental rights, related exactly to the using of drones by the police. French police was stopped by a court of law from non-discriminately using surveillance drones, until privacy concerns were properly and sufficiently addressed [2].

The possibility of drone usage becoming ubiquitous brings in the possibility that people become so accustomed to these devices as to not see or discern clearly their potential for enforcing non-democratic regulations. The drones that were used just some months ago for broadcasting messages to endangered people, for delivering medical supplies to the needy, for checking body temperatures before being allowed to enter a community, to disinfect public parks or to verify traffic status can also be used for apocalyptic-like approaches. The same drones can deploy a small weapon (and yes, not only the like of Predator drones can be deadly – an off-the-shelf DJI drone with a handgun can be as deadly as anything else) to kill the ones that do not obey the one-party rules, the same drones can transport almost undetectably small bombs into urban highly populated areas, the same drones can hover at the 20<sup>th</sup> floor of a building and take pictures of the people in their beds, the same drones can be programmed to follow somebody around and create a complete surveillance pattern, the same drones can take a photo from afar and expose the code someone is keying into his security system console etc.

Drones must be taken into account for their malicious potential from two different perspectives:

- The governing bodies, especially from pseudo-democratic countries, can deploy a huge armada of such devices to control their people to a degree never seen before.
- The cybercriminals can also use the drone for their own malevolent purposes, opening a whole new front for the law enforcement bodies to tackle.

The drones can also be constantly linked to the internet – or they can at least return to a certain space where they can recharge, connect to the internet and send their

data/receive new programming. All these facts converge to the fact that a set of regulations must be imposed at world-wide level, in order to promote and respect fundamental human rights, freedom and democratic principles [3]. We, humans, have to make sure that our rights are respected, as the technology improves and becomes more and more omni-present in our lives. At a certain point in future, the exhaustive use of very sophisticated IoT-like devices to control people might even bring disasters at planetary level. Without a concerted approach of this issue, starting with respecting our fundamental rights and accepted by all countries, the scenario of the Terminator's Judgement Day<sup>7</sup> might not be such a far science-fiction story.

#### **4. Case study for simple drone programming**

We consider that one of the first step into being able to tap the full potential of drone support for our society is to make them much more approachable. Their high-tech, cutting-edge technology aura should be debunked, and their inner workings exposed to more and more people, even starting with children.

Let us remember the case of the personal computers, just tens of years ago. Their environment was only for the "geeks" and super-technologically advanced people, for the enthusiasts or science lovers. Nowadays, children start exploring computers from kindergarten. The result? – a society which treats computers like basic tools, which is used to and employs in every aspect of life smartphones, laptops, desktops or other smart gadgets. We consider that by bringing the drone capacities close to the young ones we might not only make them get used to them, but we can also make use of their invaluable and unending capacity for innovation and finding new ways of using technology. Especially for such an approach, we will exemplify basic drone programming by the use of several wide-spread programming solutions – available to all ages, from children to adults alike.

Nowadays drones can be used in various scenarios like Landscaping, Gaming and basic or advanced Object Recognition. For each of these scenarios, the drones run advanced programming source code in order to handle basic flight operations like balancing and synchronizing the motor speed in order to keep it floating at the desired height and/or follow a specific path in the ways of:

- Horizontal direction
  - Backward
  - Forward
  - Left
  - Right
  - Rotate (also known as Yaw keeping): left / right

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<sup>7</sup> [https://en.wikipedia.org/wiki/Terminator\\_2:\\_Judgment\\_Day](https://en.wikipedia.org/wiki/Terminator_2:_Judgment_Day)

- Vertical
  - o Up
  - o Down

Some of the programming languages used for the presented drone case study include widely spread names like Java, Python, Swift or Scratch. The drone that was used for this case study case is a TELLO Ryze, which comes to the opportunity to use an educational platform - presented in figure 4. TELLO is a drone produced and commercialized by DJI company, one of the most prominent names in this industry.

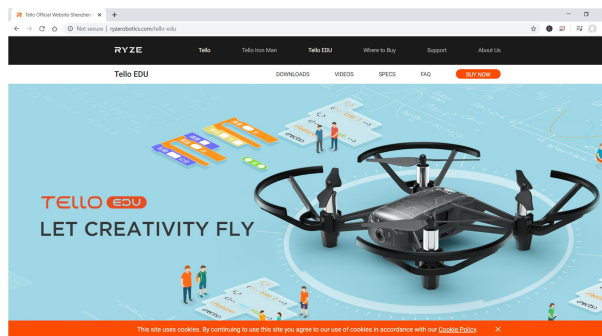


Figure 4 – Educational TELLO<sup>8</sup>

The case study will include three examples of how to actually create code that becomes a program the TELLO drone will understand and abide by.

One of the presented programming possibilities is based on the simple application that can be installed on any mobile phone or tablet and can be programmed (at basic levels) even starting with children’s age. The downloadable educational application is called DroneBlocks and is presented in figure 5.

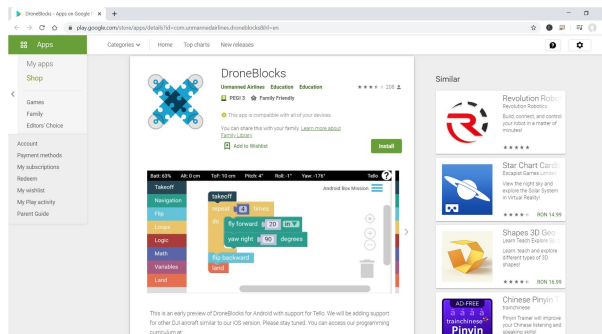


Figure 5 – DroneBlocks application from Google Play store

<sup>8</sup> <https://www.ryzerobotics.com/tello-edu>

The DroneBlocks application includes management for Altitude, Time of Flight, Pitch, Roll, and Yaw. The application has over 50.000 downloads and is currently at version 2.6, from January 7, 2020 (at the time of the drafting of this article).

The manufactures of TELLO, DJI, understood that their future success will be based on attracting the younger generation into exploring and using these flying devices. The best approach is to not bet all on a highly technical approach, but to create first a friendly and attractive environment that would be easy to understand, use and exploit for young children. A (semi-)programming environment, based on blocks and color-codes is a sure path, already tested and with proven results.

In figure 6 we present the flow of simple programming mode that will create a set of five actions, which include: take off, fly forward for 20 inches, flip backward, yaw right 90 degrees and land. The blocks have to be put together, linked through the contour indentation of one block matching the extrusion of another, and they are also color-coded for certain different actions: navy-blue for starting to fly, green for moving through the air or orange for finishing the aerial trip.

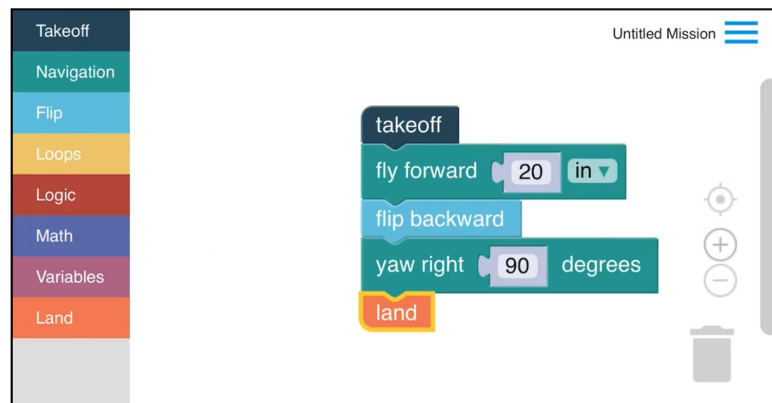


Figure 6 – DroneBlocks programming interface

The DroneBlocks programming is adapted for different environments and levels, including educational areas such as: science, technology, engineering and mathematics. DroneBlocks offers two main coding environments to choose from: Block (DroneBlocks) and JavaScript (DroneBlocks Code).

Regarding the flight terminology used above, the actual types of movement like pitch, roll and yaw are presented graphically in figure 7.



Figure 7 – Flight moves types of drones or quadcopters

If we think about the Scratch<sup>9</sup> programming language, which is free of charge and was developed by the Lifelong Kindergarten Group at the MIT Media Lab, we get a very wide spectrum of possibilities for creatively program drones to perform simple tasks during defined flight missions... even by tech-wise children that are the main target of Scratch. Inside figure 8 the interface of Scratch is presented with actual code for control of the TELLO drone.

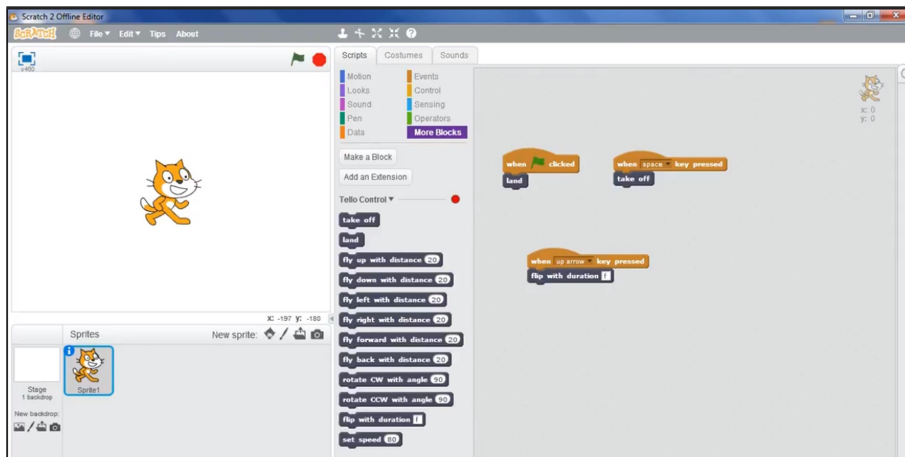


Figure 8 – Scratch interface with simple code for TELLO

<sup>9</sup> <https://scratch.mit.edu/>

And finally, we present the official Software Development Kit (SDK) from TELLO. The Tello SDK 2.0 connects to the drone using a Wi-Fi UDP port, to control the quadcopter with text commands. Python is needed to be downloaded and an example file from Tello’s website called *Tello3.py*. Inside the table below we have the most important Tello’s SDK control commands, with their basic descriptions.

<b>Tello Commands</b>		
<b>Control Commands</b>		
Command	Description	Possible Response
Command	Enter SDK mode.	ok / error
takeoff	Auto takeoff.	
land	Auto landing.	
streamon	Enable video stream.	
streamoff	Disable video stream.	
emergency	Stop motors immediately.	
up x	Ascend to "x" cm. x = 20-500	
down x	down "x" Descend to "x" cm. x = 20-500	
left x	Fly left for "x" cm. "x" = 20-500	
right x	Fly right for "x" cm. "x" = 20-500	
forward x	Fly forward for "x" cm. "x" = 20-500	
back x	Fly backward for "x" cm. "x" = 20-500	
cw x	Rotate "x" degrees clockwise. "x" = 1-360	
ccw x	Rotate "x" degrees counterclockwise. "x" = 1-360	
flip x	Flip in "x" direction. "l" = left "r" = right "f" = forward "b" = back	
go x y z speed	Fly to "x" "y" "z" at "speed" (cm/s). "x" = -500-500 "y" = -500-500 "z" = -500-500 "speed" = 10-100  Note: "x", "y", and "z" values can't be set between -20 – 20 simultaneously.	
<b>Read Commands</b>		
Command	Command	Possible Response
speed?	Obtain current speed (cm/s).	"x" = 10-100
battery?	Obtain current battery percentage.	"x" = 0-100
time?	Obtain current flight time.	"time"
wifi?	Obtain Wi-Fi SNR.	"snr"

Table 1. Tello command line instructions

Such control commands can be stored and later called by triggering at specific events like internal conditional functions or external manual controls from mobile applications or dedicated hardware controllers.

The actual TELLO application is downloadable from Google Play or Apple Store and has over 1.000.000 installations. This number shows the real interest of users, not only about playing with such small and (almost) inexpensive drones but also the desire to go beyond it and start producing lines of code that can customize the drone's behaviour. Inside figure 9 the you can see the Tello App (Google Play version).

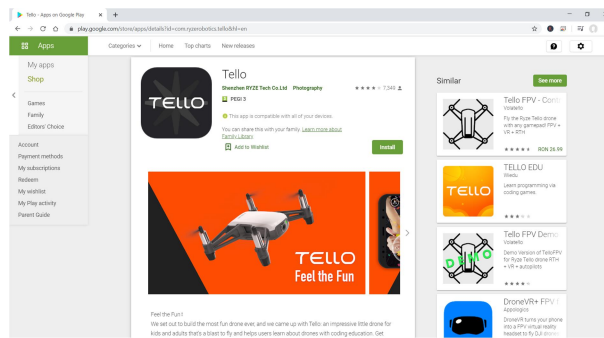


Figure 9 – Tello, Google Play App

The Tello case study presented in this article shows the possibility of starting to program drones in a more playful manner, one that includes actual hardware devices as small robots that can perform simple tasks. In this case, our drone can be made to perform flight applications called “missions” inside the dedicated APPs.

#### **4. Conclusion**

Our conclusion is that the age of drones has just started, accelerated by the COVID-19 crisis, which made society understand that we need to make use of all the tools available to us in order to overcome the risks that one situation might bring.

Not only drones but other IoT devices also have demonstrated during these months that a more fast-forward approach might bring much needed advances that can prove invaluable under certain conditions. Remote control or smart robots can access high-risk areas, mobile apps can keep track of infected people and develop a map of contacts to be checked for disease signs, UV enabled machines can disinfect hospitals and other dangerous zones before human personnel can get there, high-capacity or grid-computing can help decipher the disease's code and (eventually, when we will get there) automated factories will produce and distribute medical supplies and vaccines.



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## THE RELEVANCE OF ACCOUNTING INFORMATION IN MEASURING THE PERFORMANCE OF AN ENTITY

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**Abstract:** *In order to correctly appreciate the relevance of the accounting information, the users resort to the economic-financial analysis. The results of the analysis are important for managers in measuring the performance of the economic entities and in the decisions of exploitation, investment and financing. The study presented and developed at the level of an entity in the service sector, tries to put into practice the methods of calculating performance based on the information provided by the synthetic financial statements in order to constitute a relevant set of financial indicators that can be an information model, specifically a dashboard for managers. It is noticeable the presentation of the system of monitoring and reporting the performance of economic entities.*

**Keywords:** *accounting information, financial performance, financial position, relevance, financial statements, dashboard, monitoring system for performance.*

**JEL Classification:** *M41 - Accounting*

### 1. Introduction - The relevance of accounting information provided by financial accounting

**Financial accounting** provides a correlated and verified information system that does not leave room for subjectivism, instead promoting rigor and accuracy in reflecting economic-financial phenomena. **The supply**<sup>3</sup> of accounting information is directed to **external users**, for the needs of which various standardized forms of financial statements are used, and to **internal users** through confidential reports adapted and customized to the current needs of business management. According to the conceptual framework<sup>4</sup> for financial reporting, “**the purpose of financial reporting in general, is to provide financial information, regarding the reporting entity, that will be useful to existing and potential investors, borrowers and other**

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<sup>3</sup> Mica, I.G., Importanța raportărilor financiare în managementul firmei, „Contabilitatea, expertiza și auditul afacerilor” Magazine, no. 10/2009, pag. 40

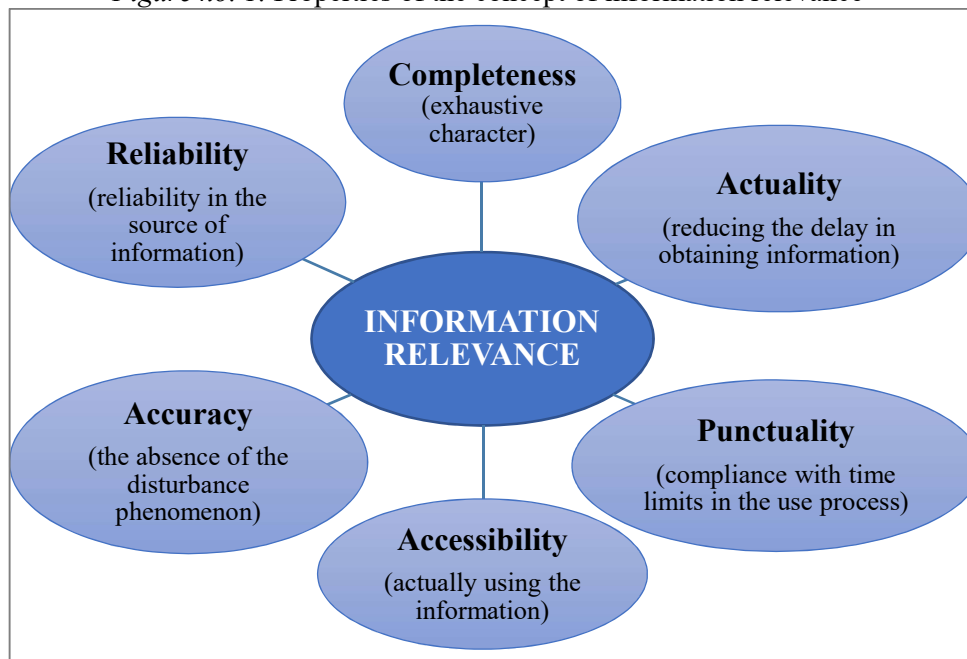
<sup>4</sup> International Financial Reporting Standards, part A, Publishing House CECCAR, Bucharest, 2018, pag. A27

creditors in their decisions in providing resources to the entity ..., to help evaluate the prospects for net cash inflows for an entity.” An essential aspect to be noted, regarding the supply of accounting information, is the fact that the information provided by the economic entities to the users to help them in making relevant decisions are not always produced by them, but may be the result of the activity of some **companies that provide accounting services**. It can be stated that the **accounting information is and should always be the product of the professional accountants**, whether they are the employees of the entity, or they are the employees of a specialized company of quotable services, or freely professionals.

## 2. Literature review

In the information processes carried out in an economic entity, an important problem concerns the need to provide properties to information capable of conferring a maximum value of use on it. These properties define the **concept of information relevance**<sup>5</sup> and are reflected in: the completeness, the accessibility, the actuality and the accuracy of the information ( **figure no.1.**)

Figure no. 1. Properties of the concept of information relevance



Source: Radu, I., 2007, Informatică și management, Publishing House Universitară, Bucharest

<sup>5</sup> Radu, I., et. all, 2007, Informatică și management, Publishing House Universitară, Bucharest, pag. 49

**Economic information**<sup>6</sup>, is a news/message, that contains new elements of knowledge of a state, situation, manifesting conditions of certain phenomena or economic processes. It is considered "raw material" at the disposal of a leader regarding the area in which it carries or the hierarchic level. With the help of economic information, one can promptly intervene in the organization and management of production, in its optimization and in the elaboration of decisions.

*The management structures within the economic entities are subject to an accelerated renewal rate of the economic information due to an increasingly complex environment characterized by a high degree of uncertainty..* In this context, the manager must be able to define the type of information he requests and needs, and the information system must be able to provide it. In practice, things are not exactly the same, the manager being obliged by circumstances to use the available information that comes from available sources.. Peter Druker stated<sup>7</sup>: *"the manager will never be able to take on all the facts he needs. Most decisions are based on incomplete knowledge - both because the information is not available and because it costs too much time or money. There is nothing more treacherous or painful, more common than the presumption of waiting for the precise substantiation of decisions, based on coarse and incomplete information.."*

For this study, particular importance is given to the **accounting information**<sup>8</sup> that can be defined as a specific *economic information resulting from processing methods, procedures and tools of the accounting data*. It must be real, precise, complete, being considered the support of the managerial process. It can be stated unequivocally that most decisions made in the management process are based on accounting information.

### 3. Research methodology

**The scientific research** is based on a correlative approach of the financial-accounting information aspects with those regarding the performance, financial decisions, managerial decisions and good governance.

The research methods used represent a combination of longitudinal and transversal methods, these being used to lay the foundations of a descriptive research, substantiating at a theoretical and conceptual level aspects of financial accounting by calculating performance indicators based on information supply, ways to capitalize on information and their usefulness in the decision-making process, to then move on to empirical research, studying the opinion of managers from economic entities on how useful and helpful is the information provided by

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<sup>6</sup> Surcel, Tr., 2004, Bazele informaticii economice, Publishing House ASE, Bucharest, pag 152

<sup>7</sup> Taking over Peter Druker, text found in Sorin Briciu, 2004, *Contabilitatea managerială - aspecte teoretice și practice*, Publishing House Economică, Bucharest, pag. 13

<sup>8</sup> Mihaiuc, C., 2008, Informația contabilă – suport pentru determinarea rentabilității întreprinderii, *Analele Universității "1 Decembrie 1918"*, Economic series

the accounting information system in making decisions that contribute to improving performance. Due to the transition from theory to practice, the study falls into the category of research that is based on a **deductive** approach in achieving the set objectives.

The information sources used to carry out this research include: literature both national and international; specialized articles published in renowned journals, recognized at national or international level; legislative acts; regulations of national and international professional bodies; studies and research conducted by various professional bodies.

#### **4. The objectives of financial accounting information supply**

- The activities carried out within the economic entities are too numerous and diverse to be reported individually to persons or institutions from outside so that at present it is considered impossible to represent all activities for each user, the solution being the preparation of official financial statements to meet external requirements<sup>9</sup>.

- Financial statements are a basic element of the accounting information system because they represent the channels of communication of information to users. According to the regulations in our country, the information in the financial statements is aiming at:

- *assets*, resources controlled by the firm as a result of past events and which are expected to generate future economic benefits for the enterprise;
- *debts*, current obligations of the company arising from past events, and the settlement of which is expected to result in an outflow of resources that incorporate economic benefits;
- *equity*, the residual interest of the owners in the assets of the enterprise, after deducting all its debts;
- *income and expenses, including gains and losses*;
- *cash flow*, represented by cash inflows and outflows and cash equivalents of the enterprise.

According to the international accounting standards, more precisely IAS 1 "Presentation of financial statements", the objective<sup>10</sup> of the financial statements is to provide information on the financial position, financial performance and cash flows of an entity, useful for a wide range of users in making economic decisions.

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<sup>9</sup> Balteș, N., Ciuhureanu, A.T., 2003, Obiectivele situațiilor financiare în contextul globalizării economice, published in the session volume "The Challenges of Science in the 21st Century", Management section, Publishing House Academiei Forțelor Terestre "Nicolae Bălcescu", Sibiu, pag. 201-206

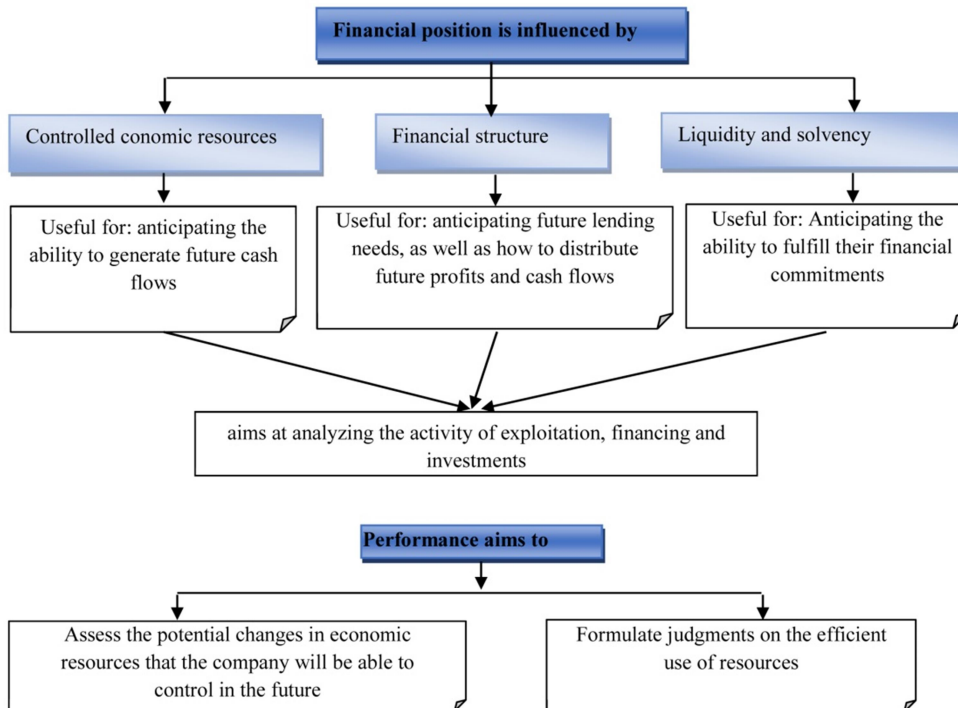
<sup>10</sup> \*\*\*, International Financial Reporting Standards issued on January 1, 2018, part A, Publishing House. CECCAR, Bucharest, 2018.

From this desideratum, the finality of the financial statements can be deduced, which must satisfy the needs of the users of financial-accounting information regarding the:

- **financial position** aims at anticipating the ability of the company to generate future cash flows, anticipating future credit needs and the possibility of obtaining these credits; how to distribute future profits and cash flows; anticipating the company's ability to meet its due financial commitments;
- **financial performance** aims to assess the potential changes in economic resources that the economic entity will be able to control in the future; formulating reasoning regarding the efficiency of using some resources;
- **change of financial position** aims at analyzing the exploitation, financing and investment activity.

The graphical illustration of the objectives of the financial statements is made in **figure no.2.**

**Figure no.2: Objectives of the financial statements**



Source: adaptation after Ciuhureanu, A.T., Balteş, N., Aspects regarding the accounting Information offer through the financial statements, Studia Universitatis „Vasile Goldiș din Arad”, no. 1/2009

In Romania, the republished Accounting Law no. 82/1991, makes a direct reference to this concept as follows: *"the official documents presenting the economic-financial situation (...) are the annual financial statements, which must give a true image of the financial position, financial performance and the other information regarding the activity carried out"*.

The general framework for the preparation and presentation of financial statements specifies that *"financial statements must accurately present the financial position, financial performance and cash flow of an entity. A fair presentation provides an accurate representation of the effects of transactions, other events and conditions, in accordance with the definitions and recognition criteria for assets, liabilities, income and expenses."*<sup>11</sup>

### **5. Practical highlighting of the relevance of financial - accounting information**

The main indicators extracted from the profit and loss account of the analyzed entity are presented in **table no. 1**.

*Table no.1* The main indicators in the profit and loss account

Indicators	Financial exercise		
	2017	2018	2019
Turnover	10,358,934	7,844,239	8,590,022
Operating income	11,092,865	8,156,207	8,756,658
Operating expenses	10,064,322	7,106,381	7,926,872
<b>Operating result</b>	<b>1,028,543</b>	<b>1,049,826</b>	<b>829,786</b>
<b>The financial result</b>	0	-32,069	-54,226
<b>The current result</b>	<b>1,055,880</b>	<b>1,017,757</b>	<b>775,560</b>
Total income	11,213,799	8,206,551	8,800,665
Total expenses	10,157,919	7,188,794	8,025,105
<b>The gross result</b>	<b>1,055,880</b>	<b>1,017,757</b>	<b>775,560</b>
<b>The net result</b>	<b>886,745</b>	<b>853,207</b>	<b>649,466</b>

Source: own processing of data from an entity's profit and loss account

Knowing only the absolute size of the indicators in the profit and loss account is not sufficient for the manager of the economic entity. He asks the accounting department to perform various analysis with the help of graphs that highlight the relevant information to support the managerial decision. Based on the information

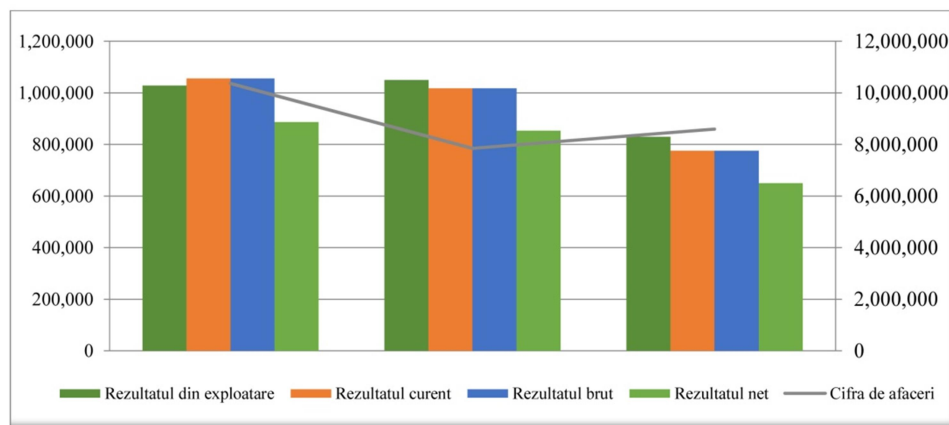
<sup>11</sup> \*\*\*, International Financial Reporting Standards issued on January 1, 2018, part A, Publishing House. CECCAR, Bucharest, 2018, p. A387

extracted from the profit and loss account, corresponding to the period 2017 - 2019, the accounting department performed the following analysis in dynamics highlighted in **chart no. 1**.

The main relevant information from the situations provided by the accounting department, which contributes to the achievement of an overview of the performance, are:

- **Turnover (cifra de afaceri)** in absolute terms registers comparable levels in all years under analysis. After 2017 it recorded a record value due to economic prosperity in 2013-2017, 2018 is marked by a reduction of 24% due to the difficulties of the current period characterized by economic stagnation and caution from customers. Starting with 2018, there is a resumption of growth (10%) until this year;
- **The operating result (rezultat din exploatare)**, independent of the financial, dividend and fiscal policies, is materialized in profit in each of the analyzed periods;
- **The current result (rezultat curent)** registers the same trend as the turnover, having a reduction tendency starting with 2018 as a result of the cumulation of the negative effects of the financial expenses from the same year;
- **The net result of the exercise (rezultat net)** is positive and follows the evolution of the **current result** indicator.

**Chart no.1 Dynamics of the main results**



(Source: own processing of data from an entity's profit and loss account)

The possibilities of interpretation being limited, this analysis does not provide information relevant to the management of the economic entity. Precisely for this reason, it is necessary to carry out detailed analysis that highlight the stages of formation of the result of the exercise. The economic presentation of the profit and



loss account is made through the **intermediate management balances**, representing indicators, in the form of margins, which highlight the stages of formation of the result of the year, in close connection with the structure of income and expenses related to the enterprise. Their necessity is imposed both by the economic-financial analysis of the enterprise and by the preparation of national accounts.

A schematic<sup>12</sup> illustration of the formation of intermediate management balances for entities operating in the fields of trade and production is made in **figure no. 3**.

**Figure no.3 SIG for trade and manufacturing activities**

Commercial enterprises		Manufacturing enterprises	
Sales of goods	Production sold	Production stored	Capitalized production
Cost of goods sold	Trade margin	Production	
	Trade margin	Added value	Intermediate consumption
	Added value		
	Taxes	Staff expenses	Operating subsidies
	The gross result of the exercise		
Income from provisions	Other operating expenses	Other operating income	
	Operating result		
Financial expenses	Financial income		
	Financial result		
	Current result		
	Taxable income		
	Tax profit		
	The result of the exercise		

Source:adaptation after Crecană, C., 2000, Ghidul afacerilor mici, Publishing House Economică, Bucharest

The calculation of the partial profitability indicators for the analyzed entity is performed in the **table no.2**.

<sup>12</sup> Crecană, C., 2000, Ghidul afacerilor mici, Publishing House Economică, Bucharest, pag. 158

**Table no.2 Calculation of SIG indicators**

No. Crt.	Intermediate Management Balances	Financial exercise		
		2017	2018	2019
1	Sales of goods	8.908.524	6.481.388	7.410.098
2	The cost of goods sold	7.522.851	5.237.232	6.099.222
3	<b>Trade margin (1-2)</b>	<b>1.385.673</b>	<b>1.244.156</b>	<b>1.310.876</b>
4	Production sold	1.450.410	1.362.851	1.179.924
5	Stored production - debit balance	0	0	0
6	Stored production - credit balance	0	0	0
7	Capitalized production	0	0	0
8	<b>Exercise production</b>	<b>1.450.410</b>	<b>1.362.851</b>	<b>1.179.924</b>
9	Raw materials and consumables	338.986	211.032	247.010
10	Other material expenses	95.189	139.810	76.768
11	Energy and water expenses	51.196	66.418	77.841
12	Expenditure on external services	489.428	418.017	479.471
13	<b>Added value</b>	<b>1.861.284</b>	<b>1.771.730</b>	<b>1.609.710</b>
14	Operating subsidies	0	0	0
15	Taxes, fees and assimilated payments	14.275	19.140	23.316
16	Staff expenses	518.615	543.327	581.851
17	<b>Gross operating surplus (GOS)</b>	<b>1.328.394</b>	<b>1.209.263</b>	<b>1.004.543</b>
18	Other operating income	733.931	311.968	166.636
19	Revenue from adjustments and provisions related to the operating activity	0	0	0
20	Other operating expenses	722.059	225.707	148.944
21	Operating expenses with depreciation, value adjustments	311.723	321.980	433.255
22	<b>Operating result</b>	<b>1.028.543</b>	<b>973.544</b>	<b>588.980</b>
23	Financial income	<b>120.934</b>	<b>50.344</b>	<b>44.007</b>
24	Financial expenses	<b>93.597</b>	<b>82.413</b>	<b>98.233</b>
25	<b>Current result</b>	<b>1.055.880</b>	<b>941.475</b>	<b>534.754</b>
26	Income tax expenses	169.135	164.550	126.094
27	<b>Net result for the year</b>	<b>886.745</b>	<b>776.925</b>	<b>408.660</b>

(Source: own processing of data from profit and loss account)

Based on the indicators obtained in the table of management balances, in order to increase the **relevance** of the information provided to managers and other users of accounting information, various rates can be calculated which express in a much clearer way the **performance** of the analyzed company. This information is highlighted in **table no. 3**.

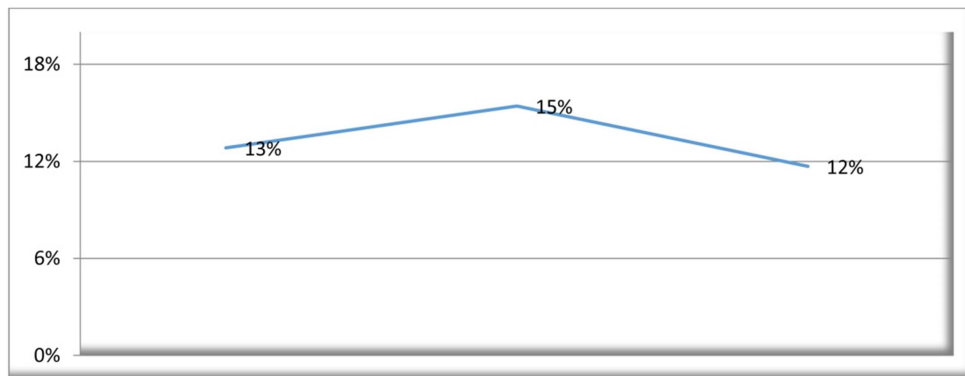
**Table no.3 Performance rates calculated on the basis of SIG**

No. crt.	Complementary calculations	2017	2018	2019
1	Turnover	10.358.934	7.844.239	8.590.022
2	Added value	1.861.284	1.771.730	1.609.710
3	Value added rate (%)	18%	23%	19%
<b>Different GOS rates, as effect</b>				
1	Gross operating margin rate (GOS /Turnover) %	13%	15%	12%
2	Development capacity rate (GOS/Added value) %	71%	68%	62%
3	The rate of wealth creation towards employees (GOS/salaries)	2,4	2,2	1,7

(Source: own processing of SIG data)

The manager of the analyzed entity can observe that the value-added rate has a downward evolution in 2018, a year characterized by a fall in the auto market. Also, the rate of development capacity has a downward evolution, starting with 2017, which is an alarm signal for the manager to change the commercial policy and to come up with new offers for the service side. Based on the absolute amount data, various graphs can be drawn to illustrate the evolution trend of some significant indicators from the profit and loss account. In the **chart no. 2** it is illustrated the evolution of the gross operating margin.

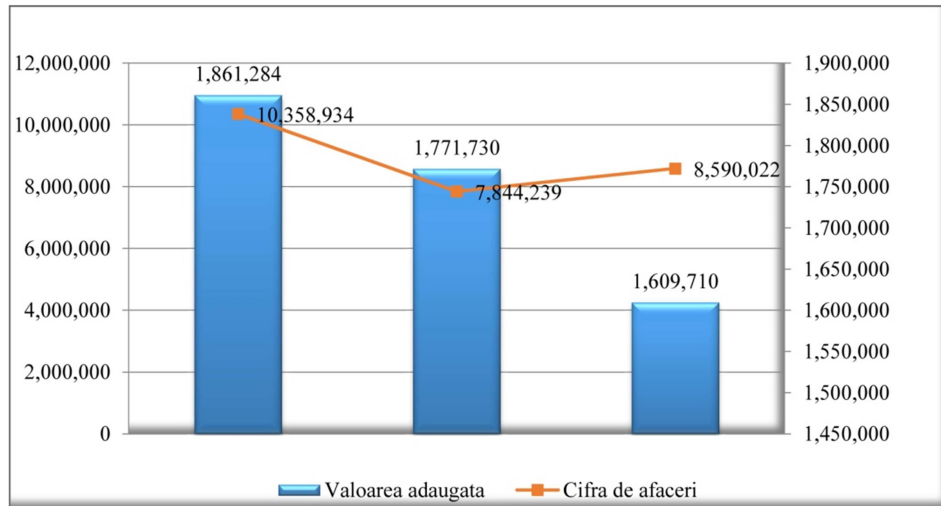
**Chart no.2 - The dynamics of the gross operating margin rate**



Source: Graphical processing of Turnover data

**Chart no. 3** illustrates the dynamics of added value and turnover for the analyzed company.

**Chart no.3 Comparative evolution of turnover and added value**



Source: author's data processing

As mentioned, the profit and loss account is the main source of information in analyzing the performance of the company. Due to the fact that the elements are classified in this report according to their nature, managers make all analysis by reference to the basic function of the entity: trade, services, production, not taking into account the general administrative expenses or sales expenses.

A situation that highlights the operating result calculated taking into account the functions of the entity (basic function, commercial function, administrative function) is illustrated in **table no.4.**

**Table no. 4. Presentation of the profit and loss account by functions**

Name of the indicator	Fiscal year						Variation 2018-2019
	2017	%	2018	%	2019	%	
Net turnover	10.358.934	100,00%	7.844.239	100,00%	8.590.022	100%	745.783
The cost of goods sold and services provided	8.838.560	85,32%	6.443.517	82,14%	7.275.140	84,6%	831.623
Basic activity expenses	8.838.560	85,32%	6.443.517	82,14%	7.275.140	84,6%	831.623
Expenditure on auxiliary activities	0	-	-	-	-	-	-
Indirect production costs	0	-	-	-	-	-	-

Name of the indicator	Fiscal year						Variation
	2017	%	2018	%	2019	%	2018-2019
Gross net income	1.520.374	14,68%	1.400.722	17,86%	1.314.882	15,3%	(85.,840)
Sales expenses	-	-	-	-	-	-	-
General administrative expenses	1.225.762	11,83%	662,864	8,45%	651,731	7,5%	(11.133)
Other operating revenues	733.931	7,09%	311,968	3,98%	166,636	1,9%	(145.,332)
Operating result	1.028.543	9,93%	1.049.826	13,38%	829,787	9,6%	(220.039)

Source: author's data processing

Regarding the period 2018 - 2019, it can be seen that although the turnover increased with 745.783, the operating result decreased by 3.72%. This decrease is generated by the decrease of the gross margin of 2.55% as a result of the increase of the expenses with the depreciation of the constructed building and the interest paid on the contracted credits.

The way of presenting the profit and loss account by functions responds better to the information needed by users and especially managers, because it directly provides useful information in the management of the company, but has the disadvantage that it can present a high degree of subjectivity; as expenses can be made on the basis of arbitrary criteria, which involve professional reasoning.

## 6. Tools for monitoring the performance of economic entities

There are few economic entities that have implemented **performance monitoring and reporting systems**. In most cases, these companies have outsourced the accounting service so that the only possibility to monitor performance is by directly consulting the data in the financial statements. At the same time, companies that have their own accounting service do not have applications that include performance monitoring modules. For the analyzed company, the accounting is kept using a commercial software that provides an option of Management Statements in which values can be obtained in the form of graphs for the following indicators: profit, income, expenses, receipts, payments.

In literature<sup>13</sup>, the verification of the achievement of the objectives defined by the management of the company is done through a system of performance monitoring and reporting that aims to solve the following problems:

- Establishing the organizational subdivisions that must receive information regarding the achieved performances;

<sup>13</sup> Caraiani C., Dumitrana M., (coord.), 2008, Contabilitatea de gestiune & Control de gestiune, the second publishing, Publishing House Universitară, Bucharest, pag. 391

- Specifying the decision centers and the ways of presenting the information regarding the activities lead;
- Coordination of the organizational subdivisions that receive information on the performances achieved in the operational subsystem.

Finding solutions to previously exposed problems, highlighting relevant information to enable the operational and decision-making system to achieve its objectives is facilitated by the existence of the following tools for monitoring and reporting performance: **Dashboard and Scorecard Balance**.

The **dashboard** consists of a set of indicators presented in a concise manner and with a correlated periodicity, which should allow the person in charge to react quickly in case of problems.

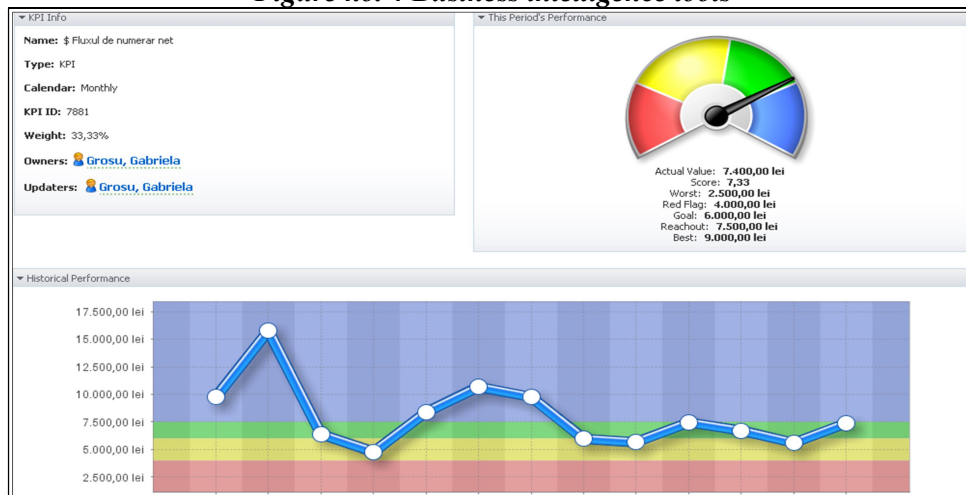
**Table no. 5 Conceptual aspects regarding performance monitoring and reporting**

Instrument	Comparative approaches			
	Goal	Information portfolio	Mode of expression	Orientation
<b>Dashboard</b>	The manager's quick reaction in case of a problem	Financial	Corporate piloting tool	Anticipation and action
<b>Balance Scorecard</b>	Assessment of corporate performance	Financial and non-financial	Performance tracking tool	Anticipation and action

Source: Caraiani C., 2010, *Contabilitate managerială. Tehnologii contabile integrate de raportare și decizie*, Publishing House ASE, Bucharest

The illustration by way of example of a dashboard provided by a specialized company that implements Business Intelligence projects is made in **figure no.4**:

**Figure no. 4 Business intelligence tools**

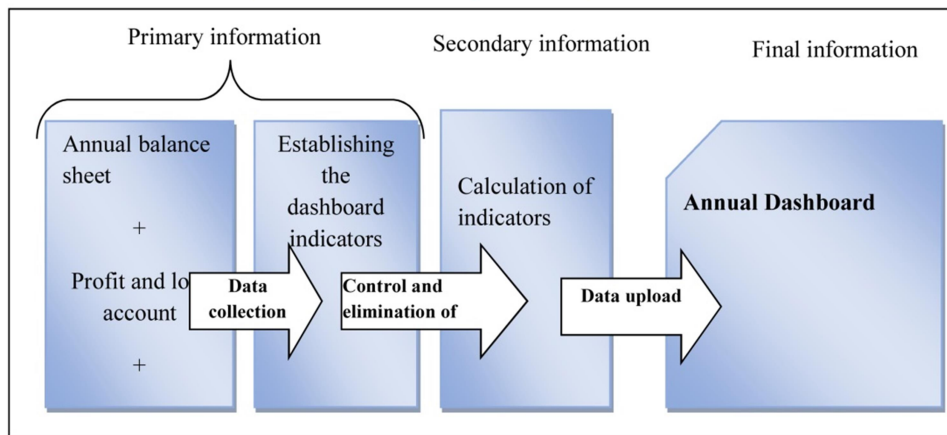


Source: <http://www.indicatori de performanta.ro/software-managementul-performantei>

For the analyzed entity the use of the Microsoft Excel table processor has been tried to build such a tool, until the management's decision to implement a performance monitoring and reporting system that will provide the manager with the necessary information in a timely manner. The product used is notable for its ease of use but has the disadvantage that it cannot provide the necessary information in a short time, because is not integrated within existing applications of the company

The process of constructing a dashboard starting from the primary information is illustrated in **figure no.5**.

**Figure no. 5 Stages of building a dashboard**



Source: author's own processing

The literature recommends that the number of key success indicators should not exceed the range of 10-20, given that in this way, the information can be efficiently exploited. A comparative situation<sup>14</sup> of the relevant indicators for entities from different sectors of activity can be seen in **table no. 6**.

For the analyzed company we selected the following relevant indicators that we highlighted in a dashboard: Turnover, Added value, Result of the year, Immediate Liquidity Indicator, Gross sales margin, Self-financing capacity, Taxes, Staff costs.

<sup>14</sup> Albu, N., Albu C., 2003, Instrumente de management al performanței, Vol. II, Control de gestiune, Publishing House Economică, pag. 129-130

*Table no. 6 - List of relevant indicators in various sectors of activity*

Key performance indicators	Commerce	Services	Manufacturing
Turnover	X	X	X
Quantity sold	X		
Gross margin	X	X	X
No. of complaints received	X		
Credit customers	X		
Average payment period	X		
Stock rotation	X		
Expenditures of the period (direct, indirect)		X	
Number of Employees		X	
Net result		X	
Rotation rates customers, suppliers		X	X
The planned / obtained production achievement index			X
Production costs (%Turnover)			X
Staff productivity			X
Productivity of machines			

The implementation of the dashboard with the help of the facilities provided by the information technology can be done with the help of spreadsheets that are intended to work with economic information..

A new approach to strategic management was developed in the early 1990s by Robert Kaplan and David Norton of Harvard University through the **Balance Scorecard**<sup>15</sup> method, which has evolved over time, being constantly improved, and has become a method practiced by many economic entities. Balance Scorecard can be translated as a **balanced dashboard** (BD).

The new system starts from the premise that the management approach practiced can have weaknesses and is not very well structured. With the help of DB, management can obtain a recipe through which the company can identify and measure strategic objectives in real time and through which they can put them into practice.

The Balance Scorecard concept supports strategic planning and implementation by coordinating the activities of all parts of the organization around common goals by creating a way to evaluate and improve strategy, it answers a series of questions

<sup>15</sup> Robert S. Kaplan et David P. Norton, 2001, Comment utiliser le tableau de bord prospectif, Éditions d'Organisations, Paris



about the economic future of the company and establishes coherent links between components of particular relevance in initiating their vision, strategies and tools for implementation.

This concept of strategic management built on a balanced system of financial and non-financial indicators is useful for the internal information needs of managers by providing in a synoptic table all relevant information in business management.

Essentially two seemingly simple ideas form the basis of this method:

- For organizations to be successful in the long run, the expectations of three must be met. In 1992, authors Kaplan and Norton defined the balanced dashboard as: “*a set of measures that give top managers a quick but complete view of the business.*”.

The experience of the first companies that used the balanced scorecard demonstrated that it satisfies some important managerial needs:

- **the balanced dashboard** brings together, in a single report, many seemingly different elements of an organization's competitive plan: customer orientation, reduced response time, teamwork promotion, reduced launch times for new products, commitment to long term development, etc.;
- **the balanced dashboard protects against under-optimization** by forcing top managers to consider all important operational measures simultaneously, BD allows them to observe whether improvements in one area have not taken place to the detriment of other areas.

The balanced scorecard allows managers to look at the business under four important issues, providing answers to four fundamental questions:

- How do consumers see us? (*customers' perspective*)
- In what must we excel? (*internal perspective*)
- Can we improve and add value? (*the perspective of innovation and learning*)
- How much are we worth for shareholders? (*financial perspective*)

Although it provides managers with information from four different perspectives, the balanced Scoreboard at the same time minimizes the degree of information loading, limiting the number of performance measures used. The balanced scorecard forces managers to focus on a set of measures that prove to be ethical.

Within the economic entities, the balanced scorecard is not a common practice, it is used only by the companies characterized by a high degree of innovation and have a quality management that is willing to invest time and money for the permanent construction and updating of such an instrument.

For the envisaged enterprise, a balanced dashboard was further developed by completing all perspectives with relevant indicators, starting from the dashboard.

In table no. 7 a balanced scoreboard is presented for the analyzed service company.

Table no. 7 Balanced scoreboard applied to the entity under analysis

<b>Financial</b>				
<b>Objective</b>	<b>Indicator</b>	<b>Target</b>	<b>Current state</b>	<b>Initiative</b>
<b>Turnover</b>	CA ( mii lei)	180000	150.863	Diversifying the product package
<b>Increase addition</b>	Addition	70%	60%	
<b>Increase profit</b>	lei	168,690	180000	
<b>Increasing market share</b>	Number of clients	Over 200 new clients /year	150 new clients/year	Adapting the supply to the individual needs of the clients
<b>Client</b>				
<b>Objective</b>	<b>Indicator</b>	<b>Target</b>	<b>Current state</b>	<b>Initiative</b>
<b>Increasing customer satisfaction</b>	Grades obtained in the satisfaction questionnaires	8	7	Transposition of the conclusions of the analysis of the questionnaire into actions
<b>Competitive prices</b>	lei	Discounts with 10%	Discounts with 5%	Initiating new attractive promotions
<b>Efficient delivery</b>	Minutes/order	30 min	45-60 min	
<b>Internal processes</b>				
<b>Objective</b>	<b>Indicator</b>	<b>Target</b>	<b>Current state</b>	<b>Initiative</b>
<b>Faster development of new products</b>	No. of new products / quarter	over 3/quarter	2/quarter	Product promotion through various events
<b>Improving the quality of services</b>	Availability for processing complaints	12/24 (7 days)	8/24 (7 days)	Mailbox for complaints
<b>Order receipt and processing time</b>	minutes	6-7 minutes	Over 10 minutes	Improving the layout of the software for receiving orders
<b>Growth and improvement</b>				
<b>Objective</b>	<b>Indicator</b>	<b>Target</b>	<b>Current state</b>	<b>Initiative</b>
<b>Supporting and encouraging skills</b>	No. of trainings	More than 3/year	2/year/employee	Change of position with the acquisition of skills

<b>Employee motivation</b>	% salary bonuses depending on the performance achieved	20% salary increase	10% salary increase	Awarding cash prizes for holidays
<b>Improving customer relationships</b>	No. of complaints/year	Under 8/year	9-10 complaints/year	

Source: author's own processing

## 7. Conclusions

The production of financial accounting information aims to inform users about the **performance** of the entity. The analysis and interpretation of **performance indicators** is an essential part of business success and must be accessible to any party interested in achieving them. The quality of the analysis results must be judged by management according to its clarity, even if the phenomena are seemingly complex and complicated, impossible to decipher, they must be presented in a simplistic way without losing accuracy, avoiding overloading with numbers that make it difficult to read the text.

The success of **performance** analysis and evaluation will never be real if the results are not followed by immediate decisions on the implementation of the results. The results obtained from the interpretation of the **performance evaluation indicators** must be brought to the attention of those involved in this process, in due time, which will allow their subsequent use, and the permanent completion of the dashboard with performance indicators will create the premises for unsuspected possibilities in updating decisions.

**Monitoring the performance** of economic entities takes various forms: direct consultation of information on the result for the year, gross operating result, turnover, various rates of return, until their inclusion, and other non-financial indicators, in sophisticated instruments such as the **dashboard** which aim to provide management with an overview of the relevant aspects of the business. The dashboard concept supports strategic planning and its implementation by coordinating the activities of the economic entity around common objectives, by creating a way to evaluate and improve the strategy, answering a series of questions about the economic future of the entity and establishing coherent links between the components with special relevance in initiating the vision. The dashboard tool was used for the selected entity to analyze and **monitor the performance** of the five basic elements that make up performance: revenue, turnover, quality, customers and employees.

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## **THE INTELLIGENT SPECIALIZATION MECHANISM PROPOSED BY ROMANIA FOR ECONOMIC GROWTH**

*Janina Mirela GABROVEANU (VLĂDOI)<sup>1</sup>*

**Abstract:** *The concept of smart specialization aims to provide the necessary context for substantiating investments in research, development and innovation through EU cohesion policy.*

*Smart specialization requires a strategic and integrated approach, which aims to capitalize on the potential for smart growth and the knowledge-based economy in all regions.*

*EU states are committed to developing a smart national specialization strategy as part of the Europe 2020 Agenda for Growth.*

*In this regard, one of the essential conditions for the use of funds allocated through cohesion policy 2021-2027 was the development of a clear and well-designed mechanism in the field of research and innovation, to guide how investment funds can be used in the next 7 years. and to ensure that clear objectives are achieved.*

**Key words:** *smart specialization, smart growth, economic growth, research, development and innovation*

### **1. Introduction**

Considering the current context related to the new trends regarding the transition to a new stage of digitalization, in Romania have been identified the priority areas in which it is necessary to intervene to facilitate interventions. [2]

In this sense, at the Romanian level, the national investment priorities necessary to be financed from the European Funds post-2020 but also from the national funds were identified, which should be the basis of the Integrated Intelligent Specialization Mechanism proposed by Romania for economic growth in the period 2021-2027.

Thus, in relation to the national priorities identified for funding, priority intervention objectives have been set. At the level of each priority objective, general objectives, specific objectives and measures for their fulfillment were established.

For the period 2021-2027, Romania has set itself the following five priority objectives:

1. A smarter Romania;

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2. A more connected Romania;
3. A more social Romania;
4. A greener Romania;
5. A Romania closer to its citizens. [3]

Thus, in order to fulfill the priority objective 1. A smarter Romania, several general and specific objectives have been proposed as well as the necessary measures to be implemented in order to facilitate the transition to a Romania based more and more on a smart specialization, respectively:

**General and specific objectives:**

***OG 1. DIGITALIZATION***

OS: Harnessing the benefits of digitalisation for the benefit of citizens, companies and governments

***OG 2. COMPETITIVENESS***

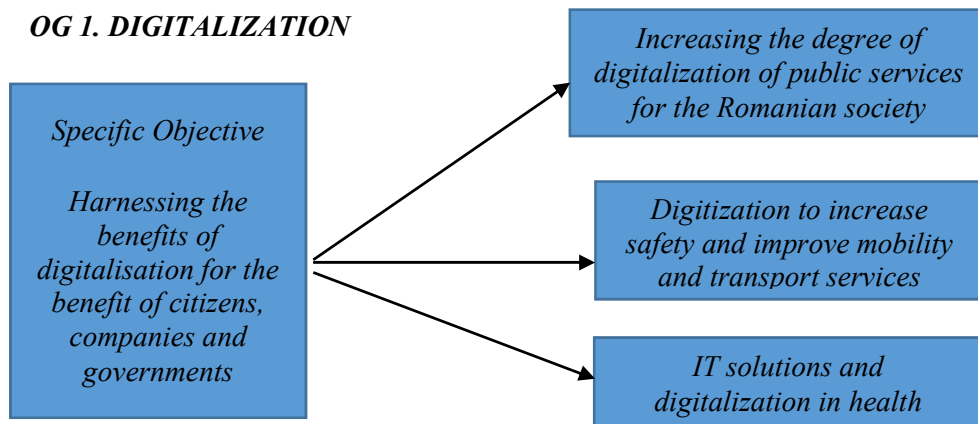
OS: Research and Innovation - Boosting the growth and competitiveness of SMEs

***OG 3. RESEARCH AND INNOVATION***

OS: Development of research and innovation capacities and adoption of advanced technologies

***OG 4. INTELLIGENT SPECIALIZATION, INDUSTRIAL TRANSITION AND ENTREPRENEURSHIP***

OS: Development of skills for smart specialization, industrial transition and entrepreneurship



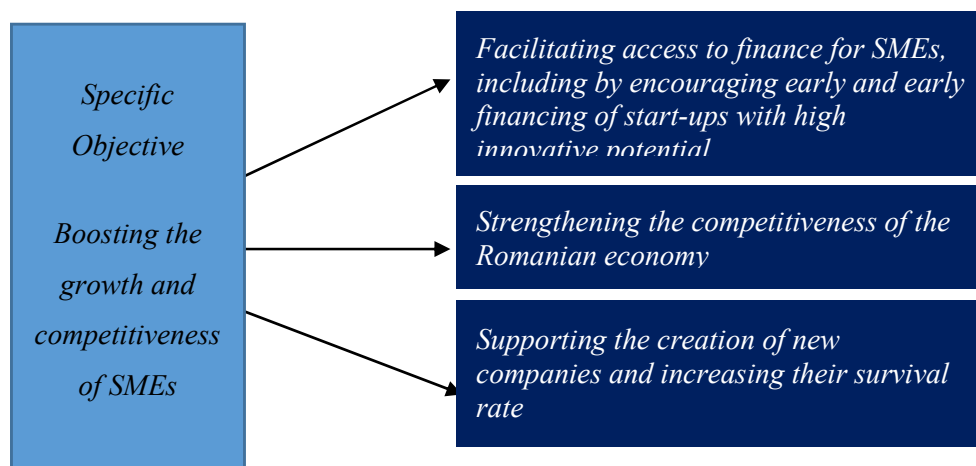
In this sense, for the fulfillment of the general and specific objectives, concrete measures and sub-measures were proposed, each of them being financially supported with the help of local, regional or national interventions but also European ones, respectively:

- For the measure: *Increasing the degree of digitalization of public services for the Romanian society*, the following sub-measures were established:
  - Implementation of measures for the development of e-government services (life events) - national interventions
  - Digitization and advanced digital skills in public administration - national interventions
  - Digitization of public services at local level - regional interventions

For the measure: *Digitization to increase safety and improve mobility and transport services*, the following sub-measures have been established:

- Development of digitization tools to improve safety and security for all modes of transport - national interventions
- 6.2 Financing of digitization tools, including implementation of ERTMS / ETCS, RIS / VTMS systems for all modes of transport - national interventions
- For the measure: *IT solutions and digitization in health*, the following sub-measures were established:
  - Restoration and modernization of the information system (CNAS) - national interventions
  - National Observatory for Health Data - (Construction, equipment acquisition / development of information systems) - national interventions
  - Soluții digitale în infrastructură din sănătate (digitizare internă și externă a instituțiilor medicale) – intervenții naționale,
  - Standardization of information flows (up-grade software, development of information systems / equipment acquisition - national interventions.

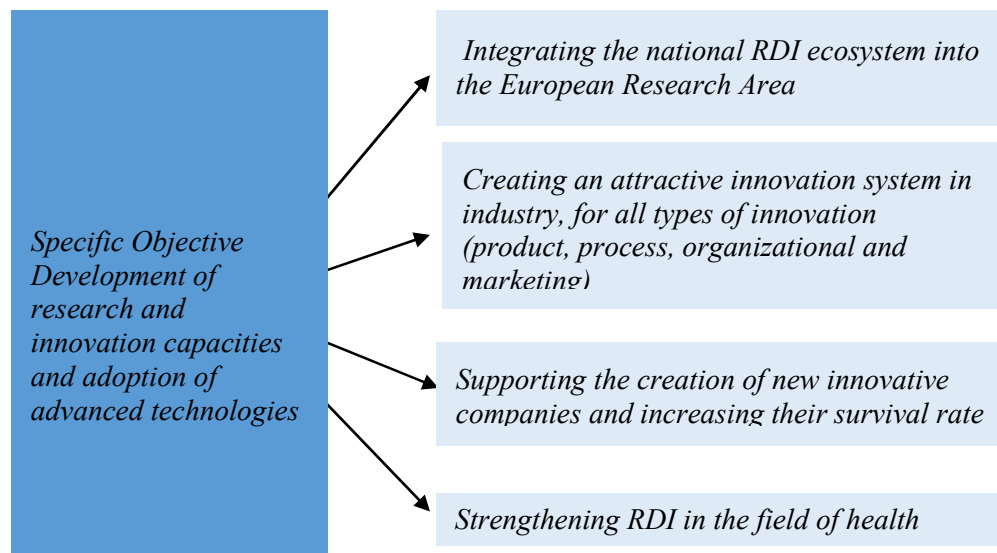
## **OG 2. COMPETITIVENESS**



To achieve the general objective 2. **COMPETITIVENESS** and the specific one: Promoting the growth and competitiveness of SMEs, the following measures and sub-measures have been proposed:

- Regarding the measure: *Facilitating access to finance for SMEs, including by encouraging the initial and early financing of start-ups with high innovative potential* was established as a sub-measure:
  - Provision of Financial Instruments for SMEs - national interventions
- Regarding the measure: *Consolidation of the competitiveness of the Romanian economy* were established as sub-measures:
  - Facilitating investments in new technologies - regional interventions
  - Support for internationalization - regional interventions
  - Supporting the adoption of IT&C technologies by SMEs - regional interventions
  - Supporting clusters for their integration into European value chains - regional interventions
  - Supporting the implementation of the mechanisms of the circular economy within the Romanian enterprises - regional interventions
- Regarding the measure: *Supporting the creation of new companies and increasing their survival rate* was established as a sub-measure:
  - Support for the creation of new enterprises (start-ups, scale-ups) - regional interventions

### **OG 3. RESEARCH AND INNOVATION**

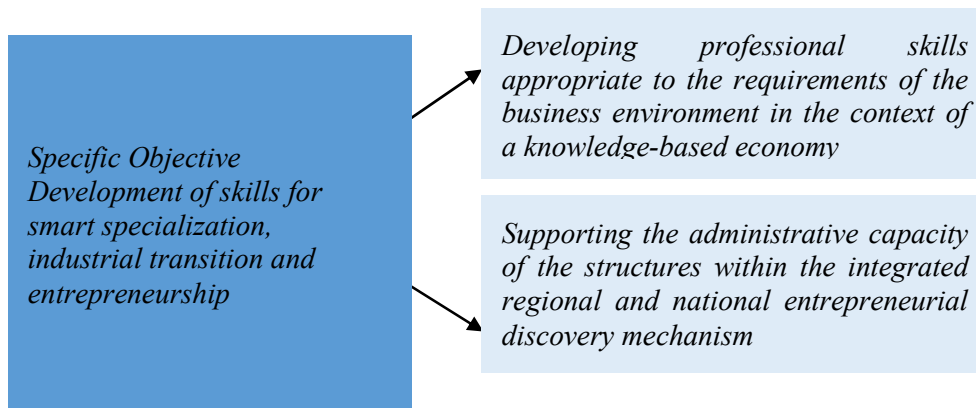




In order to meet the general objective in the field of research and innovation and the specific objective on: Development of research and innovation capacities and adoption of advanced technologies, the following measures and sub-measures have been proposed:

- Regarding the measure: Integration of the national RDI ecosystem in the European Research Area (European Research Area) were established as sub-measures:
  - Integration of Romanian RDI organizations in cross-border and international collaboration programs (Horizon Europe Synergies, Single Market, Interreg, etc.) - national / regional interventions
  - Development and use of RDI infrastructure - national / regional interventions
- Regarding the measure: Creating an attractive system of innovation in industry, for all types of innovation (product, process, organizational and marketing) were established as sub-measures:
  - Strengthening the RDI capacity of enterprises and promoting collaboration between RDI organizations and the business environment - national / regional interventions;
  - Supporting technology transfer processes to increase the degree of innovation of enterprises - national interventions;
- Regarding the measure: Supporting the creation of new innovative companies and increasing their survival rate were established as sub-measures:
  - Development of an entrepreneurial ecosystem that favors the emergence and maturation of innovative start-ups / spin-offs - regional interventions;
  - Development of services related to business support infrastructures (incubators, accelerators, etc.) - regional interventions;
- Regarding the measure: Strengthening RDI in the field of health was established as a sub-measure:
  - Development of research / innovation capacity and adoption of SMART systems in health - national interventions.

#### ***OG 4. SMART SPECIALIZATION, INDUSTRIAL TRANSITION AND ENTREPRENEURSHIP***

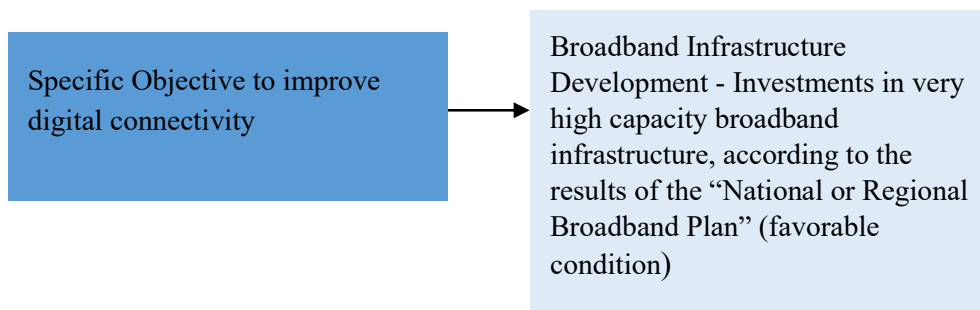


In order to achieve the general objective of smart specialization, industrial transition and entrepreneurship, it was established as a specific objective: Development of skills for smart specialization, industrial transition and entrepreneurship being proposed to implement the following measures and sub-measures to achieve the objectives:

- Regarding the measure: The development of professional skills appropriate to the requirements of the business environment in the context of a knowledge-based economy were established as sub-measures:
  - Development of competencies at the level of RDI enterprises / organizations / entities (regional interventions) through:
    - involvement in the Entrepreneurial Discovery Mechanism for intelligent specialization, industrial transition and entrepreneurship, including internships;
    - endowment of high schools for the application of digital learning methods
    - Training for the implementation of the standard: Innovation Management system in companies
  
- Regarding the measure: Supporting the administrative capacity of the structures within the integrated regional and national entrepreneurial discovery mechanism were established as sub-measures:
  - Developing the administrative capacity of the actors involved in the implementation, monitoring, review of smart specialization strategies and the Entrepreneurial Discovery Mechanism (MDA) (national and regional interventions) by:
    - administrative capacity of the actors involved in MDA (as it results from the Methodology for carrying out the entrepreneurial discovery process;
    - administrative capacity of ADRs;
    - ADR capacity to support beneficiaries.

**For priority objective 2 A more connected Romania was proposed:**

***OP 2. BROADBAND***



**For priority objective 3 A more social Romania were proposed:**

***In the field of EDUCATION***

- Improving the quality, effectiveness and relevance of the education and training system for the labor market, to support the acquisition of key skills, including digital skills, by implementing the following measures:
  - Adapting education and training programs to market requirements, in key and digital skills
  - Increasing the quality, effectiveness and relevance of education provision and services (at all levels)
  - Correlation between the needs of pupils and students, counseling services, support, accompaniment
  - Improving teacher training to increase the quality and effectiveness of the educational process

***In the field of SOCIAL INCLUSION***

- Promoting the socio-economic integration of third-country nationals and marginalized communities, such as the Roma
- Improving equal and timely access to quality, sustainable and accessible services; modernizing social protection systems, including promoting access to social protection; improving the accessibility, effectiveness and resilience of healthcare systems and long-term care services

***In the field of HEALTH***

- Improving equal and timely access to quality, sustainable and accessible services; modernizing social protection systems, including promoting access to social protection; improving the accessibility, effectiveness and resilience of healthcare systems and long-term care services

***In the field of EMPLOYMENT***

- Improving access to the labor market for all jobseekers, especially young people, the long-term unemployed and disadvantaged groups in the labor market, inactive people, by promoting self-employment and the social economy by:
- Development of the mechanism for multidisciplinary integration of employment, education, social assistance and health policies by harmonizing the legal framework between the services offered to the labor force by the four sectors
- New approaches to providing integrated employment services, adapted to the needs of disadvantaged groups on the labor market (inactive people, with disabilities, long-term unemployed, returnees, migrants, etc.), through personalized and tailored service packages
- Promoting entrepreneurship, supporting entrepreneurial initiatives

**For priority objective 4 A greener Romania, the following interventions have been proposed:**

***In the field of Energy:***

- Promoting energy efficiency and reducing greenhouse gas emissions,
- Promoting energy from renewable sources,
- Development of intelligent energy systems, networks and storage outside TEN-E.

***In the field of Climate change, risks, water:***

- Promoting adaptation to climate change, risk prevention and disaster resilience,
- Promoting sustainable water management,

***In the field of Circular Economy:***

- Promoting the transition to a circular economy  
In domeniul Biodiversitate, Aer și Situri contaminate:
- Improving the protection of nature and biodiversity, green infrastructure, especially in urban areas, and reducing pollution,

**For priority objective 5 The following interventions have been proposed for a Romania closer to its citizens:**

***In the field of Urban Mobility***

- Sustainable, smart and intermodal climate, resilient, sustainable and intermodal national, regional and local mobility, including improved access to TEN-T and cross-border mobility

## **2. Literature Review**

It is already scientifically proven that digital technologies are changing the way society works.

The changes are obvious no matter how fast we accept them. Romania is in competition with other countries in the world to occupy an important strategic place among those who impose life changes on Earth.

Digitization has penetrated strongly into the structures of public and private institutions of the great planetary economic powers (USA, Japan, China, Germany, France, UK, and Singapore).

There are trained people, education and local private companies in Romania that can place Romania among the great winners of the new industrial revolution 4.0, of digitalization. [1]

***The evolution of the paradigm of the production process - the industrial revolutions 1-4***

Since the first industrial revolution (mechanical warfare with water and steam as energy) the trend has been to release the human element from the production cycle to increase productivity, quality and uniformity of products.

The second industrial revolution (assembly line and electricity) further mechanizes the realization of complex products composed of several components made separately and is a significant step in efficiency, uniformity and productivity (Ford model T product example).

The third industrial revolution, generated by the introduction of the programmable automaton (PLC), brings cybernetics and electronics to the production line.

The fourth industrial revolution aims to integrate physical and cybernetic systems into a unitary, digitized whole.

Each industrial revolution represents a leap in productivity based on previous developments, but also by introducing a new paradigm of industrial activity.

***What's behind the "buzzwords" of I4.0 and IoT?*** [4]

Current technologies under the I4.0 umbrella (IoT, Industrial Ethernet, Cloud, Big Data, Edge Computing, Fogetc.) Are not just marketing “packaging”, but represent the technological answer to concrete needs in digitizing the industrial production environment to increase performance, operational and agility to adapt to change. Industry 4.0, Smart Factory, Industrial Internet, The Connected Machine-terms that cover the same concept. IoT key component.

Behind the generic names are technologies and services that ensure superior competitiveness through the digital integration of processes, equipment, materials and products. From smart materials to smart products through a chain of logistics, production, maintenance, digitally integrated.

***What does I4.0 mean?*** [5]

- Integration of cybernetic and physical systems in a single digital universe for control and interconnection of production processes. Interconnection of the service chain through IT platforms.
- It means a mix of technologies, processes, services whose role is to create a unique digital space for industry.
- It means the unification of digital technologies with those of production and the integration of management platforms.
- Brings efficiency (use of materials, energy), agility (market adaptation, technologies, new products), cost reduction, quality, productivity.

### **3. Proposed measures to be implemented:**

By implementing at national level an integrated mechanism of intelligent specialization to facilitate the transition to the new standards imposed by the European Union, Romania should propose and implement concrete measures such as:

- Starting a research program applied on RI 4.0 as a national strategy,
- Building a system of relations through which Romania can influence the development of RI 4.0 in other countries for a mutual benefit,
- Rapid development of pilot solutions in education, health and administration,
- Reopening of high schools, industrial colleges for the training of specialists, operators in RI 4.0 and robotics.

#### **4. Conclusion**

We have been witnessing for several years, in the world, the phenomenon of Industry 4.0, the fourth industrial revolution, which involves changing the current industrial paradigm: the transition from computerization and automation to the involvement of Cyber-Physical-System (CPS), Internet of Things and Internet of Things in processes technological and decision-making.

Industry 4.0 or the "Fourth Industrial Revolution" is a transformation characterized by the computerization of industrial processes, which leads to the creation of a fusion between the physical and digital world. Industry 4.0 involves a partial transfer of decision-making autonomy and cyber coats of arms.

The initial objectives of Industry 4.0 were to automate and optimize production. Currently, following the achievement of the first set objectives, Industry 4.0 focuses its efforts on innovation and the creation of new business models.

Every company constantly needs up-to-date information in order to be able to carry out its activity successfully and to be able to respond to customer needs.

Industry 4.0 brings with it a number of innovations, which is why it is necessary for these companies to keep up with all the transformations that occur.

In this sense, we can propose 5 directions of intervention that companies could use as strategic directions that they can use as a strategic basis for digitization, respectively:

- Cost efficiency
- Development of digital platforms,
- Digitized distribution channels - by using digitization to create new digital distribution channels to customers and provide the opportunity to track the distribution process
- Product customization - by using digitization to create products tailored to customer requirements and needs,
- Development of digitized products and services - by creating new products that incorporate digital features.

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