

The Information and Communications Technology is Driving Artificial Intelligence to Leverage Refined Knowledge for the World Sustainable Development

-Part1-

Prof.Eng.Ph.D. Victor GREU



Abstract

The paper presents an analysis of the complex challenges of artificial intelligence (AI) contribution in leveraging refining knowledge, in the dynamic context generated by information and communications technology (ICT) exponential evolution aiming the progress of the Information society (IS) toward Knowledge Based Society (KBS).

Based on Internet of Things (IoT) dissemination of intelligence everywhere on Earth, IoT and AI development will be strongly linked “learning from everything”. Using IoT sensors, AI could learn from everywhere and eventually turn data into information/knowledge, inducing the crucial role of IoT and AI in Industry 4.0 revolution.

For leveraging refining knowledge at World scale, AI is encompassing a large and diverse range of processes, referring to dynamic events and things, where eventually a huge amount of data will be generated. The AI role is there to process these data in order to extract information or even knowledge, as eventually to contribute to refining knowledge.

AI has to be seen and conceived not as “a replacement but rather as an enhancement of HI”, but this relation has to be mutually understood in order to increase precision, efficiency and sustainability of ICT development in IS/KBS, by refining knowledge. Eventually, refining knowledge could be obtained by combining the collected data and prior knowledge, but keeping the AI/HI combination alive.

In order to increase the confidence in the AI deep learning system, the old advice “divide et impera” could be used and applied as “different parts can be validated in different ways”. Therefore, a complex deep learning AI system could be better controlled from safety point of view if we can divide it in subsystems with higher safety parameters or easier to validate.

The paper also presents the importance of identifying and adding to the AI deep learning system “some rules and some human knowledge”, which, by our opinion, is just the most difficult, advanced but actual issue for supporting deep learning AI to really leverage knowledge refining, not only increase safety.

A prominent paper conclusion is that these rules include a structural approach of the collected data/information (known also as “knowledge engineering”), as “the better that information is structured, the more effective the program is”, but also data pre-filtering in order to obtain relevant knowledge along with usage of crowd intelligence in the process.

The final conclusion is that AI processes toward refined knowledge are more and more complex as we are heading to higher performance in the ICT/IS/KBS dynamic context and their further and timely deep analysis is necessary for a sustainable World development.

Keywords: Artificial Intelligence, Refining Knowledge, Machine Learning, Deep Learning, Human Intelligence, Internet of Things, Information Society, Knowledge Based Society, Knowledge Engineering, Sustainable World Development.

JEL Classification: L63; L86; M15; O31; O33

By three methods we may learn wisdom: First, by reflection, which is noblest; second, by imitation, which is easiest; and third by experience, which is the bitterest.

Confucius

1. The rise and rise of artificial intelligence in the exponential context of information and communications technology, by ‘learning from everything’

The old advice “learn from everything” is now more actual than ever, although, in a traditional approach, people would really have a challenge to simply learn from all complex and dynamic ecosystem they are living in, but a smarter approach should be to refine existing knowledge and adapt to the context by optimizing their actions and resources.

In fact, this smarter approach includes, among resources, the huge potential of the Information and Communications Technology (ICT), as the main driving factor of the Information Society (IS) toward Knowledge Based Society (KBS).

The ICT actual essential potential and context include prominent advances like Cloud, Big Data, Internet of Things (IoT). Among them, artificial intelligence (AI) is actually perhaps the most dynamic and important element [23][26][22].

Many authors consider this context as Industry 4.0 revolution, adding to above components robots, nanotechnology, quantum computing, biotechnology, 3D printing, autonomous platforms and so on [15][16][18].

We just consider that all are included or essentially leveraged by ICT and this way the driving role of ICT in IS/KBS is fulfilled.

More than this, it is important to observe that the new revolution will be made by the impact of ubiquitous communications and connectivity more than by technology, due to the power of digital disruption leveraged by digital connectivity [17].

On the same matter we have already presented our opinion that the future of ICT and consequently of IS/KBS progress will be most probably crucially influenced by learning from nature’s thousand years research, i.e. in bio-computing, biotechnology etc. [12][27].

The ways these advances are in fact cooperating give the force of ICT and IS/KBS, as they are integrating the progress of all activity fields and humankind life improvement processes (including economy, health care, science, education and creative potential).

First of all, a basic feature of these is the fact that IoT will provide a dissemination of intelligence everywhere on Earth, so IoT and AI development will be strongly linked.

This way we have just arrived to the above advice (“learn from everything”), as using IoT sensors AI could learn from everywhere and eventually turn data into information/knowledge.

Here we have to recall the amazing digital transformation that ICT induces and the crucial role of IoT and AI in Industry 4.0 revolution, by some examples.

Of course, the main impact that matters is on industry and generally on economical domains, but in a short view, our entire social *environment* will be dramatically influenced, as [4]:

“An athletic shirt that measures heart rate. A school backpack that relays a child’s location. Networked homes full of smart appliances and tools.

The Internet of Things (IoT) already makes it possible for intelligent products to simplify people’s daily lives. For companies, it’s revolutionizing the tracking and maintenance of physical objects, while its massive new streams of data improve decision making. Linking the physical and digital worlds could generate up to \$11.1 trillion a year in economic value by 2025, in settings including retail, healthcare, manufacturing, and technology.”

Above these, the authors notice that the whole World economy will be crossing dramatic (generally benefic) changes:

“The Internet of Things—sensors and actuators connected by networks to computing systems—has received enormous attention over the past five years...Our central finding is that the hype may actually understate the full potential—but that capturing it will require an understanding of where real value can be created and a successful effort to address a set of systems issues, including interoperability. To get a broader view of the IoT’s potential benefits and challenges across the global economy, we analyzed more than 150 use cases, ranging from people whose devices monitor health and wellness to manufacturers that utilize sensors to optimize the maintenance of equipment and protect the safety of workers. Our bottom-up analysis for the applications we size estimates that the IoT has a total potential economic impact of \$3.9 trillion to \$11.1 trillion a year by 2025. At the top end, that level of value—including the consumer surplus—would be equivalent to about 11 percent of the world economy...”

The intelligent products to simplify people’s daily lives are in fact very important, but we should observe that beyond the benefits we see everywhere, such huge development of IoT could generate a remarkable increase of World economy, as 11% in few years, which confirms and updates the role we already mentioned for ICT in IS/KBS.

We also consider that the AI potential is actually aiming higher levels of performance [5]:

“The availability of nearly unlimited, affordable data storage and processing has ushered in the Petabyte Age. Big Data is revolutionizing how we approach everything from science (e.g. genome sequencing, drug discovery), to business (e.g. retail analytics, collaborative filtering), to politics (e.g. the Obama campaign’s Narwahl). Incredible advances in Natural Language Processing (NLP) technologies have come about as a result of Big Data, enabling powerful search engines, automated language translation, and cloud-based speech recognition. These advances in NLP impact our everyday lives at home and at work, but they have yet to play a major role in how we make games, how we tell stories in games, and what stories can be told. ”

We think that it is important to foresee the next step, in “everything” of our IS/KBS environment, as „*what stories can be told*“.

With other words, a main purpose of AI high level applications should be innovation and optimization of our development and resources (including **humankind health** and evolution), in a sustainable manner, as the ICT exponential pace could also contribute to less desired implications [14][6][20][27].

We have already analysed such implications in the larger context of green ICT, pointing climate changes, Earth resources fading and humankind health/evolution, i.e. in a vision for a sustainable World progress [20][14].

This “vision” is fortunately more and more foreseen in our dynamic World and creates the premises for achieving such high and diverse hopes [8]:

*“The vision of artificial intelligence (AI) is often manifested through an autonomous software module (agent) in a complex and uncertain environment. The agent is capable of thinking ahead and acting for long periods of time in accordance with its goals/objectives. It is also capable of learning and refining its understanding of the world. **The agent may accomplish this based on its own experience, or from the feedback provided by humans.**”*

Here the AI impact on IS/KBS sustainable progress is clearly directed to a higher level of approach, as *learning from everything* and then contributing to **refining knowledge**. Eventually, this approach of AI performance main target could help to a better *understanding of the World* evolution challenges and optimization ways.

Another observation is that AI approach could not be separated from **humans**, as we also presented in the general context of using AI in collective intelligence [3].

Moreover, the optimization of the complex relation between AI and human intelligence (HI) is the way toward best AI performance and matching the goal of AI contribution to **refining knowledge**, step by step in real time, following or even anticipating, as close as possible, the fast changing of our environment/ecosystem.

Following our ecosystem is a huge goal, especially because it has to be done in a systemic approach, i.e. we have to first perceive the big picture and then the details, at World scale.

For example, whatever our philosophy, we have to consider first the business heart of the World, because there is located the engine of our IS/KBS, where AI and IoT will have a systemic impact [1]:

“There has never been a better time to achieve impact with (your) data. More and more data is available, computing power is ever increasing, and mathematical techniques and the so-called data science are getting more and more advanced. What’s more, “digital” and “data” have become the talk of the town. Yet while talking about data as the “new oil” or the “new gold” is fairly widespread these days, several technology- and business-related difficulties make understanding data’s importance and realizing its potential a persistent challenge.”

Beyond this opportunity picture, the authors also point the importance, the impact and the potential of IoT and *machine learning* AI emergence:

“Not only has the sheer volume of available data – mainly driven by the IoT – grown exponentially over the past five years and is expected to continue to do so ... but also have new tools been developed for turning this flood of raw data into insights and eventually into action. Machine learning, a term that encompasses a range of algorithmic approaches from statistical methods like regressions to neural networks, has rapidly advanced to the forefront of analytics.

Underpinning this progress in its entirety has been steady improvement in computational power from better processors and graphics processing units, increased

investment in massive computing clusters often accessed as cloud services, improvements in storage, and strong price decreases for all relevant parts...”

Consequently, it results just clear what crucial progress this *data science* could provide at World scale when applying its fundamentals methods and techniques, including *machine learning (that encompasses a range of algorithmic approaches from statistical methods like regressions to neural networks)* and *massive computing clusters often accessed as cloud services*.

On the other hand we have to notice that applying all these methods, techniques and technologies to the economical World is far from being simple and always efficient.

More than these, the complexity is much increased by all other activity domains and aspects exceeding World economy, but covering entire Earth ecosystem and humankind life.

That is why **the answers to all challenges could come only by sustainably developing AI/ICT for IS/KBS with wisdom, i.e. carefully refining knowledge step by step and adjusting the development pace the way it allows ... time for deep thinking!**

2. “When wisdom meets machine” or when AI is leveraging refined knowledge

Among many approaches [10][3][19], we consider that intelligence has a long way to become **wisdom** and due to this complex reality the subject must be time and time again, deeper and deeper analysed, especially when speaking about AI and human intelligence (HI) at Earth scale [7][25].

We also consider that, in our turn we could *learn* from *Confucius* thinking, as perhaps it is better to combine reflection, imitation and experience in order to obtain best results, but the real **wisdom** is just to choose the weights of the three ingredients on every step of the above mentioned ... **deep thinking**.

Anyway, we have to be sure to avoid the *bitter* method only, i.e. avoid the way the actual exponential pace could lead sometime: learning only from or long after ... experience.

This way we have just arrived to the paper main idea, to **use our imagination and deep thinking** in order to develop AI that could help us to get the maximal profit from the knowledge and even from refined knowledge the deep perception of all ecosystem processes could generate by data. That will be **a better understanding of the World and especially of its ... future**.

Following these high ideals we could just try to analyse some approaches and examples by which AI and HI should be implied in the actual/future AI/ICT development, pointing the challenges and issues that sometimes are either ignored or still not yet perceived with all their potential consequences.

Speaking about the potential, we think that a relevant and prolific opinion, exceeding *energy saving and production efficiency* (and even Industry 4.0), was given, although indirectly (by IoT), in [6]:

“In June 2013, the leader in the global industrial system field, General Electric (GE), held a leadership forum on the theme “when wisdom meets machine” in Beijing, which pointed out that the Industrial Internet of Things would set off the third industrial revolution and innovation, and will play a great role in energy saving and production efficiency ...”

We have considered this quote as relevant not only for developing this second section of the paper, but also for simply characterizing these complex and integrated processes of AI/IoT/ICT along with HI – as we could not speak about **wisdom** without HI.

In fact our subject includes this AI **challenging** “meeting” of *machine and wisdom*, which in turn exceeds even AI, as relating to a long and complex chain of waves, phases and processes where **humankind** innovation is rendering more and more ... challenges to its **wisdom**.

As we have mentioned above, the way of AI to leveraging, at World scale, refined knowledge, is long, challenging and encompassing a large and diverse range of processes, referring to dynamic events and things, where eventually a huge amount of data will be generated.

The AI role is there to process these data in order to extract information or even knowledge, as eventually to contribute to ... refining knowledge.

A systemic approach of optimizing this complicate and performant task of AI is to first *refine* the phase of extracting information, as it is also suggested by [2]:

“A deep-learning system’s ability to recognize patterns is a powerful tool, but because this pattern recognition occurs as part of algorithms running on neural networks, a major concern is that the system is a “black box.” Once the system is trained, data can be fed to it and a useful interpretation of those data will come out. But the actual decision-making process that goes on between the input and output stages is not necessarily something that a human can intuitively understand. This is why many companies working on vehicle autonomy are more comfortable with using traditional robotics approaches for decision making, and restrict deep learning to perception. They reason that if your system makes an incorrect decision, you’d want to be able to figure out exactly what happened and then make sure that the mistake won’t be repeated.”

Although this case is referring to *deep-learning* AI applications for autonomous driving, it points a general valuable and actual issue of AI performance evolution (based on *deep-learning*): the threshold between perception and decision making classes of AI applications, along with the natural preoccupation for safety and legal conformity.

We consider important and we also approached this aspect [14][25], as from safety and legal conformity this issue is easy to be extended to the general responsibility of sustainable development we have mentioned in the first section of the paper, implying as a necessity the HI control and ... imagination.

As a confirmation, the same author suggested the necessity of including human **knowledge** for safety reasons:

<<“This is a big problem,” Tandon acknowledges. “What we want to be able to do is to train deep-learning systems to help us with the perception and the decision making but also incorporate some rules and some human knowledge to make sure that it’s safe.” While a fully realized deep-learning system would use a massive black box to ingest raw sensor data and translate that into, say, a turn of the steering wheel or activation of the accelerator or brakes, Drive has intentionally avoided implementing a complete end-to-end system like that, Tandon says. “If you break it down into parts where you’re using deep learning, and you understand that different parts can be validated in different ways, then you can be a lot more confident in how the system will behave.”>>

More than these, here we notice a very concrete, but natural approach to increase the confidence in the *deep learning* system, by using the old advice “divide et impera”, applied as “*different parts can be validated in different ways*”.

With other words, a complex system could be better controlled from safety point of view if we can divide it in subsystems with higher safety parameters or easier to validate.

It is also important to notice the idea of identifying and adding to the *deep learning* system *some rules and some human knowledge*, which, by our opinion, is just the most difficult, advanced but actual issue for AI, so it could really leverage knowledge refining, not only increase safety.

A confirmation of this approach is given in the interesting and larger context of AI role in innovation [10]:

„However, we believe that despite the exceptional improvements in machine learning, human-to-human interaction will always be important.

AI opens up incredibly exciting possibilities in the world of innovation and it is about how these are integrated into organisations that is important. Avoid viewing AI as a replacement but rather as an enhancement. It is a process that organisations (and their humans) can leverage to improve on current processes, increase efficiency at an unparalleled rate and ultimately grow into something even better.”

Here we also agree that AI must be seen and conceived not *as a replacement but rather as an enhancement* of HI, but this relation has to be mutually understood in order to increase precision, efficiency and sustainability of ICT development in IS/KBS, by ... refining knowledge [3][17][22].

Eventually, **refining knowledge could be obtained by smartly combining the collected data/information and prior knowledge**, using both internal and external sources [11]:

“AI can use a combination of data available internally within an organisation along with the various digital footprints available across the web. Using this extensive mine of data and by acknowledging the various signals, artificial intelligence works by analysing countless correlations and trends. With this information in place, AI can provide organisations with solutions and opportunities that would likely have remained undiscovered otherwise.”

It is easy to observe that this approach could be logically extended and generalized from the organization context to any ecosystem context, making the appropriate adjustments, but keeping the AI/HI combination alive [3].

The implementation of such approach is confirmed and detailed in a relevant analysis made in [10]:

“AI encompasses a class of application that allows for easier interaction with computers and also allows computers to take on more of the types of problems that were typically in the realm of human cognition.

Every AI program interfaces with information, and the better that information is structured, the more effective the program is. A corpus of information contains the answers that the program is attempting to process and interpret. Structuring that information for retrieval is referred to as knowledge engineering and the structures are called knowledge representation.

AI can refine the process by using data to filter the most valuable intelligence from the crowd. It will be able to distinguish the relevant ideas that will be most effective in solving the problems posed. Rather than seeing AI as a means of taking over the process and rendering open innovation obsolete, it is more productive to view it as a means of streamlining the process to provide greater value."

The details we can reveal from here are in fact some useful methods of optimizing the AI system, pointing efficiency and precision, all implying also HI.

Considering the importance of such methods, it is worth to clearly express them, in the general context of refining knowledge with added AI means.

First is to notice that, on the above line of "divide et impera", we have to generally consider a structural approach of the collected data/information, as „*the better that information is structured, the more effective the program is*".

More than these, we find that such important processes tend to become a new activity field, called **knowledge engineering**.

Last but not least, "AI can refine the process by using data to filter the most valuable intelligence from the crowd", i.e. a twofold idea, pointing data pre-filtering in order to obtain relevant knowledge along with using crowd intelligence in the process, as we have already presented [3][25].

We may see that deep analysis of **AI processes toward refined knowledge is more and more complex as we are heading to higher performance in the ICT/IS/KBS dynamic context and its further and timely continuation is necessary for a sustainable World development**.

3. Conclusions

The paper approached the complex challenges of AI contribution to leveraging refined knowledge, in the dynamic context generated by ICT exponential evolution aiming the progress of IS toward KBS.

As IoT will provide a dissemination of intelligence everywhere on Earth, IoT and AI development will be strongly linked 'learning from everything'. Using IoT sensors AI could learn from everywhere and eventually turn data into information/knowledge, inducing the crucial role of IoT and AI in Industry 4.0 revolution.

The road of AI to leveraging, at World scale, refined knowledge, is long, challenging and encompassing a large and diverse range of processes, referring to dynamic events and things, where eventually a huge amount of data will be generated. The AI role is there to process these data in order to extract information or even knowledge, as eventually to contribute to refining knowledge.

AI must be seen and conceived not *as a replacement but rather as an enhancement* of HI, but this relation has to be mutually understood in order to increase precision, efficiency and sustainability of ICT development in IS/KBS, by refining knowledge. Eventually, refining knowledge could be obtained by combining the collected data and prior knowledge, but keeping the AI/HI combination alive.

A natural approach to increase the confidence in the AI *deep learning* system is by using the old advice "divide et impera", applied as "*different parts can be validated in*

different ways". That is, a complex *deep learning* AI system could be better controlled from safety point of view if we can divide it in subsystems with higher safety parameters or easier to validate.

It was also presented the importance of identifying and adding to the *deep learning* system *some rules and some human knowledge*, which, by our opinion, is just the most difficult, advanced but actual issue for AI, so it could really leverage knowledge refining, not only increase safety.

A prominent conclusion is that these rules include a structural approach of the collected data/information (known also as **knowledge engineering**), as "*the better that information is structured, the more effective the program is*", but also data pre-filtering in order to obtain relevant knowledge along with usage of crowd intelligence in the process.

AI processes toward refined knowledge are more and more complex as we are heading to higher performance in the ICT/IS/KBS dynamic context and their further and timely *deep analysis is necessary* for a sustainable World development.

REFERENCES

- [1]Niko Mohr, Holger Hürtgen, *Achieving business impact with data - A comprehensive perspective on the insights value chain*, Digital McKinsey 04.2018 Copyright © McKinsey & Company www.mckinsey.com,
- [2]Evan Ackerman, *How Drive.ai Is Mastering Autonomous Driving With Deep*, Posted 10 Mar 2017, IEEE Spectrum
- [3]Victor Greu, *Extending information and communications technologies's impact on knowledge based society through artificial and collective intelligence –(Part 3)*, Romanian Distribution Committee Magazine, Volume 9, Issue 3, Year 2018.
- [4]James Manyika, Michael Chui, Peter Bisson, Jonathan Woetzel, Richard Dobbs, Jacques Bughin and Dan Aharon, *Unlocking the potential of the Internet of Things*, Report -McKinsey Global Institute - June 2015, <https://www.mckinsey.com/>
- [5]Jeffrey David Orkin, *Collective Artificial Intelligence: Simulated Role-Playing from Crowdsourced Data*, Dissertation, MIT, Feb. 2013.
- [6]Jiandong Zhang, Xiaoyu Qu, Arun Kumar Sangaiah, *A Study of Green Development Mode and Total Factor Productivity of the Food Industry Based on the Industrial Internet of Things*, IEEE Communications Magazine, Volume: 56 Issue: 5, 2018
- [7]Victor Greu, *Developing information and communications technologies with more artificial intelligence, using artificial intelligence, when internet of things is "intelligence everywhere"-(Part 1)*, Romanian Distribution Committee Magazine, Volume 7, Issue 4, Year 2016.
- [8]Daniel S. Weld Mausam Christopher H. Lin Jonathan Bragg, *Artificial Intelligence and Collective Intelligence*, <https://homes.cs.washington.edu/~weld/papers/ci-chapter2014.pdf>
- [9]Victor Greu et al, *Human and artificial intelligence driven incentive-operation model and algorithms for a multi-purpose integrated crowdsensing-crowdsourcing scalable system* - paper submitted to International Conference Communications 2018 (Politehnica University of Bucharest, Romania Military Technical Academy, IEEE Romania), June 2018.
- [10]Seth Earley, *There Is No AI Without IA*, 2016, IEEE IT Professional (Volume: 18, Issue:3, May-June 2016)
- [11]Mike Sirius, *How artificial intelligence and innovation will interact*, June 5, 2017, Idea Drop Ltd, <http://ideadrop.co/artificial-intelligence-innovation/>
- [12]Victor GREU, *Information and Communications Technologies are Learning from Nature's "Research" to Push the Performance Limits*, Romanian Distribution Committee Magazine, Volume 5, Issue 1, Year 2014

- [13] Nelson Sizwe. Madonsela, Paulin. Mbecke, Charles Mbohwa, *Integrating Artificial Intelligence into Data Warehousing and Data Mining*, Proceedings of the World Congress on Engineering and Computer Science 2015 Vol II WCECS 2015, October 21-23, 2015, San Francisco, USA
- [14] Victor Greu, *Searching the right tracks of new technologies in the earth race for a balance between progress and survival*, Romanian Distribution Committee Magazine, Volume 3, Issue1, Year 2012.
- [15]*** *World Economic Forum White Paper Digital Transformation of Industries: In collaboration with Accenture*, Digital Enterprise January 2016, <http://reports.weforum.org/digital-transformation/wp-content/blogs.dir/94/mp/files/pages/files/digital-enterprise-narrative-final-january-2016.pdf>
- [16] Mike Shaw, *Digital disruption impacts every industry. Here's how to win in an era of constant change*, enterprise.next, 2016 Hewlett Packard Enterprise Development LP, <https://www.hpe.com/h20195/V2/GetPDF.aspx/4AA6-7153ENW.pdf>
- [17] Victor Greu, *Information and communications technologies drive digital disruption from business to life on earth -(Part 1)*, Romanian Distribution Committee Magazine, Volume 8, Issue 2, Year 2017.
- [18] Mark Knickrehm, Bruno Berthon, Paul Daugherty, *Digital disruption: The growth multiplier Optimizing digital investments to realize higher productivity*, Copyright © 2016 Accenture, https://www.accenture.com/_acnmedia/PDF-4/Accenture-Strategy-Digital-Disruption-Growth-Multiplier.pdf
- [19]*** , *Transforming data into knowledge*, Collective Learning group at the MIT Media Lab, 2017, <https://www.media.mit.edu/groups/collective-learning/overview/>.
- [20] Victor Greu, *Information and communications technologies go greener beyond IoT-behind is all the earth-Part1*, Romanian Distribution Committee Magazine, Volume 7, Issue 2, Year 2016
- [21] Anas Baig, *Artificial Intelligence Can Solve The Biggest Crowdsourcing Problem*, Aug 11, 2017, <https://crowdsourcingweek.com/blog/artificial-intelligence-can-solve-biggest-crowdsourcing-problem/>
- [22] Victor Greu, *Extending information and communications technologies's impact on knowledge based society through artificial and collective intelligence -(Part 2)*, Romanian Distribution Committee Magazine, Volume 9, Issue 2, Year 2018.
- [23] JP Kloppers, *Data mining for social intelligence – opinion data as a monetizable resource*, may 12, 2017, <http://dataconomy.com/2017/05/data-mining-opinion-data/>
- [24] Bhupinder Kour, *The Rise of Machine Learning and AI is Improving Lives in 2018*, <https://www.smartdatacollective.com/rise-of-machine-learning-ai-improving-lives/>
- [25] Victor Greu, *Tomorrow's paradox: refining knowledge by smarter information and communications technologies while humans tend to become a limited factor of performance*, Romanian Distribution Committee Magazine, Volume 7, Issue1, Year 2016.
- [26] Ioannis Karydis, Spyros Sioutas, Markos Avlonitis, Phivos Mylonas and Andreas Kanavos, *A Survey on Big Data and Collective Intelligence*, ALGO CLOUD 2016, Aarhus, Denmark, August 22, 2016, Revised Selected Papers
- [27] Victor GREU, *Evaluating the development steps based on life-inspired strategies for the information and communications technologies*, Romanian Distribution Committee Magazine, Volume 2, Issue 4, Year 2011