

The Information and Communications Technology is Driving Artificial Intelligence to Leverage Refined Knowledge for the World Sustainable Development - Part 2 -

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Abstract

The paper approaches the analysis of artificial intelligence (AI) development, in the context of Information and Communications Technologies (ICT) exponential evolution as main driving factor of the progress of the Information society (IS) toward Knowledge Based Society (KBS).

The actual context of the exponential pace of ICT development, which is still mainly generated by Moore's Law, is analysed by considering scientific, technical, economic and social implications, which led to the reasonable conclusion that any result are inherently partial and time sensitive, due to complexity and fast pace of these evolutions.

The base of the advances of technology, which support this pace and Moore's Law, is presented by some relevant actual examples. The 10nm technology is the highest peak this race reached, but the fight for the next 7nm target was dramatically uncertain until Extreme Ultraviolet (EUV) lithography became a practical reality last year, reason for which it is shortly detailed, along with main trends of implementations by GlobalFoundries, Taiwan Semiconductor Manufacturing Co. (TSMC) and Intel, i.e. the World leaders. The revolutionary technology of the carbon-nanotube field-effect transistors, which has the amazing target to "improve both the energy efficiency and speed of computers by a factor of 1,000" and the challenge of continuing Moore's Law), is also presented.

In the second section, the paper is focusing on some strategies and methods to approach the target, context, models or algorithms for developing AI, where the complex relationship between AI and HI is essential, as the huge diversity of ICT networks, equipments and software/applications could not be created and used without the AI-HI symbiosis, i.e. working in a mutual dependence.

One important conclusion is that the efficiency of AI-HI applications is strongly depending on the human expertise/education and responsibility, first by properly designing AI and then using AI to extract information/knowledge from data all over the World, aiming the humankind stable progress in every activity field and Earth ecosystem.

Because AI most prolific ways to leverage refined knowledge include machine and deep learning, in order to optimize the development and use of AI for providing sustainable progress everywhere, a more detailed picture of approaching its main techniques and processes is necessary. This way, the main features and differences of machine and deep learning are presented, including both supervised machine learning and unsupervised machine learning approaches. Along with these, the emergent cognitive AI is intended to extend human cognition, as the main process of refining knowledge, essential for IS toward KBS. As a main consequence, unlock more economic value and leveraging innovations are among the most important goals of ICT development for IS/KBS and became naturally priority fields for the potential of AI to analyse simple industrial or more complicated economical data flows in order to extract information and leverage refining knowledge.

The paper also analyzes one of the challenges for ICT/AI amazing targets/development, beyond the feasibility, as the sustainability, i.e. concluding that we have to carefully watch ICT/AI trends in order to foresee

and evaluate the negative consequences before it is not too late, because the chances to foresee all the consequences of the exponential ICT/AI development complex and complicate processes are lowering as their speed is increasing, as it is the actual case of digital age of IS/KBS.

An important conclusion of the paper is that, although we have deeply entered the AI development mechanisms, this is a never ending road with complex and interdependent obstacles, considering the “iceberg” of ICT and the elusive Morgan le Fay (Morgana mirage) evolution of the performance/applications targets, which are recalling sometimes the old issue of science fiction versus reality. This conclusion is also confirmed by a typical example: the fact that we see every day that, in spite of the crucial advances, in the last decades, of the ICT/AI power impact on weather forecast services applications, the recent aggressive evolutions of the weather, clearly induced by the climate changes, are more and more violent and more difficult to forecast. The final conclusion is that, in order to fully optimize the intelligent ICT development, including AI, we have to further analyse how wisdom could influence our power and why this development has to teach us to deeply think.

Keywords: artificial intelligence, machine learning, deep learning, cognitive artificial intelligence, extreme ultraviolet lithography, carbon-nanotube field-effect transistors, information society, knowledge based society

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

“I hope our wisdom will grow with our power and teach us that the less we use our power the greater it will be” - Thomas Jefferson

1. Using, developing and learning with ICT intelligent advances for a sustainable progress everywhere

Everywhere on Earth we can see the rapid and huge impact and consequences of the exponential development of Information and Communications Technology (ICT), which, by its overwhelming applications, services and products, became the main driving factor of the Information Society (IS) toward Knowledge Based Society (KBS).

Then it is essential to look for a smart approach of this ICT potential, in order to provide a **sustainable progress everywhere** its impact could produce benefice consequences, without neglecting the side effects of such complex processes at the Earth scale.

In this KBS context, the necessity of refined knowledge is obvious, as the ICT applications, services and products are generating unprecedented volumes of data (*data deluge*) ... everywhere.

On the other side, processing, storing and especially highly exploiting/valuing such huge and complex amounts of data could not be done without the most performant ICT advances like artificial intelligence (AI), Internet of Things (IoT), Big Data or Cloud.

Actually AI is sometimes foreseen as the most dynamic, promising and challenging domain of ICT and this is the reason this paper will continue our previous analyses [3][6], aiming to detail the prominent issues of developing AI in order to leverage refined knowledge for the World sustainable development.

We have to recall from the beginning that approaching such complex analyses is a complicate and multidisciplinary problem, considering all scientific, technical, economic and social implications, which could lead to the reasonable conclusion that any result are inherently partial and **time sensitive**, especially if we recall the **exponential pace** of ICT

development, which is still mainly generated by Moore's Law (which is generating very fast changes of IS/KBS and Earth environment/ecosystem).

Perhaps another mode to express this vision is that the advances of technology and humankind evolution in **the digital age** have no limits as human intelligence/imagination has not and then it's both positive and negative consequences have to be carefully and timely re-considered as ... *refined knowledge*.

Now it is clear why we have considered that the cautious accent of this approach could be well confirmed by our *motto*, inspired by **Thomas Jefferson**.

In a systemic approach, first we have to analyse *the power* of some actual intelligent ICT advances, which are mostly linked with AI and World sustainable development.

Although it appears not linked with AI, we think it is very important and it is worth to start with a realistic and clear picture of **the material base** of what we above mentioned as **the advances of technology**.

In fact, the **exponential pace** of ICT development is mainly generated by Moore's Law (doubling every two years the number of transistors on a chip), but we have already presented (including in one of our books in 1989) that the progress of CMOS technology could end once the channel length will go down to the physical limits of the semiconductor integrated circuit processes [12] [24].

As actually the 10nm technology is the highest peak this race reached, the fight for the next 7nm target was dramatically uncertain until Extreme Ultraviolet (EUV) lithography became a practical reality last year [1]:

"For more than a decade, the semiconductor-manufacturing industry has been alternately hoping EUV can save Moore's Law and despairing that the technology will never arrive. But it's finally here, and none too soon."

Samsung was the first to claim it will be ready to produce chips for customers using EUV tools, saying that will happen in the second half of 2018. But its competitors GlobalFoundries, Taiwan Semiconductor Manufacturing Co. (TSMC) and Intel are clearly on track to do the same within a quarter or two... Intel has purchased more EUV tools than any other company"

For having the concrete dimension and importance of EUV for ICT development, it is necessary to present more details of this excellent introduction of the whole context, made in [1]:

<<Gary Patton, GlobalFoundries' chief technology officer, describes the 7-nm process even without EUV as "an extreme sport."...Silicon wafers have to make many stops along the way in their transformation from smooth blanks to iridescent platters jam-packed with 13-billion-transistor microprocessors. And many of those stops take place inside a photolithography tool...Today's state-of-the-art process is called 193-nm immersion lithography...The problem is that light can't directly define features smaller than its own wavelength. And 193 nm is so much longer than the size of the features modern chips need. These days it takes a host of optical tricks and work-arounds to make up the difference. The most costly of these is the use of as many as three or four different photomasks to produce a single pattern on a chip. With today's most complex processors, that means a wafer could need some 80 trips through the lithography tool>>

Here the EUV comes and bring the long expected solution for unlocking the progress of highly integrated chips:

<<EUV lithography's reason for being is that it uses 13.5-nm light, which is much closer to the size of the final features to be printed. With it, manufacturers can turn three or four lithography steps into one. For its 7-nm EUV process, GlobalFoundries will replace 15 steps with just 5...While that will make the work at 7nm faster and cheaper, it's the nodes beyond where EUV will be absolutely crucial. "If you didn't use EUV for 5 nm, it'd be more than 100 [lithographic steps]," says Patton. "That'd be insane">>

If all the above could appear too much too much said for a single, but crucial, technological step, we should perhaps recall Neil Armstrong historical expression "That's one small step for a man, one giant leap for mankind."

In a similar way, our already presented perception of ICT huge impact on IS/KBS [8] [10], as **iceberg tip**, here as EUV, finds one more confirmation:

<<"A fab is like an iceberg" someone tells me. I can't tell who because we're all covered head to toe in clean-room garb. A tour of GlobalFoundries' Fab in Malta, N.Y., certainly reinforces that analogy: We've just come up from the "sub-fab," the 10 meters of vertical space under the floor, where pipes and wires snake down from each semiconductor-manufacturing tool above to a set of automated chemical handlers, water analyzers, power conditioners, and—in the case of the unit I've come to see—kilowatt-class lasers.

The laser system takes up 15 to 20 square meters out of perhaps 80 square meters of the floor space required for a single machine. About halfway through a six-week assembly process of mind-bending complexity, the equipment making up the tip of the iceberg is a house-size agglomeration of shiny metal tubes, opaque chambers, and wiring. A half dozen bunny-suited technicians are moving around the behemoth, probing and connecting things in a carefully choreographed procedure.">>

Before adding other comments, it is interesting to observe here that this (laser) behemoth reminds us the recent event which has putted **Romania among the World science and technology icebergs** by making functional the **most powerful laser on Earth**, at Magurele, near Bucharest.

If the question "Where is AI?" is still rising, we have to mention that mainly only with EUV technology the base of ICT/AI (and beyond these) highest advance could be foreseen, because, for example, the existing AI applications would soon become some kind of gadgets (like Apple SIRI, Google Home etc.), compared with the future AI target performances.

The reason of introducing in our analysis this dynamic **Morgan le Fay** (Morgana mirage) threshold of ICT/AI progress target is also largely (although a little sharply) analysed in [4]:

<<The concept of what constitutes AI has evolved as technology has evolved. A colleague of mine has said, "It's artificial intelligence until you know how it works." An interesting perspective indeed. I found support for this in material from an MIT AI course (see <http://bit.ly/IWTCUXK>): There's another part of AI [...] that's fundamentally about applications. Some of these applications you might not want to call "intelligent" [...] For instance, compilers used to be considered AI, because [...] statements [were in a] high-level language; and how could a computer possibly understand? [The] work to make a computer

understand [...] was taken to be AI. Now [...] we understand compilers, and there's a theory of how to build compilers [...] well, it's not AI anymore. [...] When they finally get something working, it gets co-opted by some other part of the field. So, by definition, no AI ever works; if it works, it's not AI>>

These examples are not isolated, as it will be further described, but in addition they open a larger perspective on ICT/AI development, recalling the old issue of science fiction versus reality, by the next continuation:

"Seemingly intractable problems have been solved by advances in processing power and capabilities. Not long ago, autonomous vehicles were considered technologically infeasible due to the volume of data that needed to be processed in real time. Speech recognition was unreliable and required extensive speaker-dependent training sessions...Most AI is quietly taken for granted today. The word processor I am using was once considered an advanced AI application!"

This issues show in fact another class of challenges for ICT/AI amazing progress, where we have to carefully watch not only the feasibility, but also if this progress is sustainable, i.e. we have to carefully watch ICT/AI trends in order to foresee and evaluate the negative consequences before it is not too late.

It is important to notice that the chances to foresee all the consequences of the exponential ICT/AI development complex and complicate processes are lowering as their speed is increasing, as it is the actual case of digital age of IS/KBS.

This way we came back to the ICT advances, as they are pointing, along with Moore Law, the increase of processing speed as main performance and then transmit this "wave" to all applications at Earth scale.

Other examples of prominent ICT advances could include carbon-nanotube field-effect transistors, quantum computing, bio computers, brain interfaces, new perovskite solar cell for green energy etc.

It is interesting to observe that most of these advance technologies are pointing either power consumption reduction or processing power (speed) increasing, which inherently recall the same essential "power" we have to carefully use, as **Thomas Jefferson** said.

Among the above technological advances, we consider that some details of carbon-nanotube field-effect transistors could bring here more direct relevance in the ICT/AI context [2]:

"You'd think computers spend most of their time and energy doing...well, computation. But that's not the case: About 90 percent of a computer's execution time and electrical energy is spent transferring data between processing and memory, says Subhasish Mitra, a computer scientist at Stanford University. Even if Moore's Law continued indefinitely, computers would still be limited by this memory bottleneck...Mitra and his collaborators at Stanford and MIT have come up with a new computer architecture that they say addresses this problem-and that Mitra believes will ultimately improve both the energy efficiency and speed of computers by a factor of 1,000. The new 3D-chip architecture is based on novel devices that haven't been integrated before: 2 million carbon-nanotube field-effect transistors and over 1 million resistive random-access memory (RRAM) cells, all built on top of a layer of silicon logic and connected by densely packed metal wiring between the layers"

Beyond the amazing target to “*improve both the energy efficiency and speed of computers by a factor of 1,000*” and the challenge of continuing Moore's Law, along with the main tremendous feature of space reduction, the new technology of carbon-nanotube field-effect transistors will bring impressing contributions to green ICT by using lower temperatures:

“Because of the temperatures needed to make silicon transistors-in excess of 1,000 °C-it's not possible to build conventional metal interconnects on top of a silicon layer and then add another level of silicon circuitry. Typically, the layers are made separately, then bonded together and connected with relatively large, sparsely distributed connectors called through-silicon vias, says Max Shulaker, a computer scientist at MIT...Carbon-nanotube transistors and resistive RAM can both be fabricated at about 200 °C. This means they can be built on top of each other and linked up with metal interconnects without researchers having to worry about accidentally vaporizing the metal. The resulting web of interconnects in their prototype was more than 1,000 times as dense as the through-silicon vias in conventional 3D chips”.

We have to observe, from all these examples and innovations, the hard struggle for seeming impossible targets and also the fact that ICT/AI bring for everyone, along with their products and services benefit of use, some remarkable learned lessons (exceeding education domains and leveraging refined knowledge generation everywhere) of how to efficiently progress by multiplying success models and innovations in the context of digital approaches and ubiquitous connectivity, as we have already presented [18][21].

After all these details about the technological power laying behind ICT/AI and practically contributing to the World sustainable development, we have to analyse some ingredients that perhaps are prominent challenges for the AI progress, generally but not exclusively toward human like intelligence, including strategies to approach the target, context, models or algorithms, which could value the most of the amazing potential of these technological advances.

2. Refining knowledge from complex processes of Earth ecosystem

It is more than obvious that the ICT/AI development must be optimized in many concerns, by a complex multi-dimensional approach, beyond the power of processing (speed), miniaturization and energy (which truly are crucial), one of them being undoubtedly the *leveraging of refined knowledge for all activity fields where it is needed*.

Considering especially the AI development above mentioned challenges, it is important to observe from the beginning that reducing the target as *the dream toward human like intelligence* is not precise and nor efficacious.

As a matter of fact we have to notice that one of the essential challenges of ICT/IS/KBS, thus including AI, is just the dynamic evolution of paradigms for most of structure levels, this being the main reason we have repeatedly presented as paramount the need for new (refined) knowledge in all activity fields of humankind and Earth ecosystem.

As it is well known that “*long is the explanation road by theory, short by examples*”, sometime we advise the communications students to remember that actually the purpose of communication devices and systems is no more reduced to the need of humans to

communicate one with other, but generally to transmit information “any-to-any” (human, robot, device, machine, application etc.).

Coming back, in the same way we have to observe that AI goal is not necessary only to do all that human intelligence (HI) could do, but ... **more!**

Here it is worth to recall that the complex relationship between AI and HI was already approached in our previous papers [10] [6], but here we have only to add some new issues, when involved in the AI processes of leveraging refined knowledge generation.

We have concluded and other sources confirmed that, in these processes, AI, HI and generally collective intelligence are generally complementary, acting to expand/compensate their limits [17][19][20][22].

For example, the huge diversity of ICT networks, equipments and software/applications could not be created and used without the AI-HI symbiosis, i.e. working in a mutual dependence. Therefore, we have to start from the essential point that *„the efficiency of AI-HI applications is strongly depending on **the human expertise/education and responsibility**, first by **properly designing AI** and then **using AI to extract information/knowledge from data all over the World, aiming the humankind stable progress in every activity field and ... beyond**”* [6].

So we have just arrived to the above mentioned “strategies to approach the target, context, models or algorithms” for developing AI, where HI is essential.

On the other hand, it is also largely agreed that HI is not just “everywhere”, i.e. it has to be found, identified and efficiently used and here is coming the AI part, i.e. the potential to leverage the creation of refined knowledge by extracting the needed information from the available data/information (including collective intelligence), or by enabling other mechanisms to create knowledge, as scientific research, education etc.

Still, in our days AI most prolific ways to leverage refined knowledge include *machine and deep learning*, as we have partially presented in [3][6], but in order to optimize the development and use of AI for providing **sustainable progress everywhere**, we have to start from a more detailed picture of approaching its main techniques and processes.

One of the simplest, but accurate (although mentioning a *game* for start example – we consider not priority) systemic image of the AI field and main techniques is given as [5]:

“For example, when Google DeepMind’s AlphaGo program defeated South Korean Master Lee Se-Dol in the board game Go earlier this year, the terms AI, machine learning, and deep learning were used in the media to describe how DeepMind won. And all three are part of the reason why AlphaGo trounced Lee Se-Dol. But they are not the same things. The easiest way to think of their relationship is to visualize them as concentric circles with AI — the idea that came first — the largest, then machine learning — which blossomed later, and finally deep learning — which is driving today’s AI explosion — fitting inside both”

A further and more comprehensive approach (versus concentric circles) is pointing AI main components and features [7]:

“One person says they’re using machine learning, while another calls it artificial intelligence. Still others may claim to be doing deep learning, while “cognitive” is the favoured phrase for some. What does it all mean? While many of these terms are related and can overlap in some ways, there are key differences that can be important, and that could be a barrier to fully understanding ...”

The involved key differences and specific features are then presented with details for each main technique:

<<Machine Learning

At its most basic level, machine learning refers to any type of computer program that can “learn” by itself without having to be explicitly programmed by a human. The phrase (and its underlying idea) has its origins decades ago – all the way to Alan Turing’s seminal 1950 paper “Computing Machinery and Intelligence,” which featured a section on his famous “Learning Machine” that could fool a human into believing that it’s real. Today, machine learning is a widely used term that encompasses many types of programs that you’ll run across in big data analytics and data mining...>>

Recalling that HI has a crucial role in developing AI, we find here that this role is mainly determining the actual two main approaches of AI (supervised machine learning - unsupervised machine learning) here presented as:

“In supervised learning, the user trains the program to generate an answer based on a known and labeled data set. Classification and regression algorithms, including random forests, decision trees, and support vector machines, are commonly used for supervised learning tasks. In unsupervised machine learning, the algorithms generate answers on unknown and unlabeled data. Data scientists commonly use unsupervised techniques for discovering patterns in new data sets”

As we have also presented above, deep learning has a “deeper” capacity or a higher level of understanding [7]:

<<Deep Learning Deep learning is a form of machine learning that can utilize either supervised or unsupervised algorithms, or both...deep learning has recently seen a surge in popularity as a way to accelerate the solution of certain types of difficult computer problems, most notably in the computer vision and natural language processing (NLP) fields... By extracting high-level, complex abstractions as data representations through a hierarchical learning process, deep learning models yield results more quickly than standard machine learning approaches. In plain English, a deep learning model will learn the features that are important by itself, instead of requiring the data scientist to manually select the pertinent features, such as the pointiness of ears found in cat pictures (because it somehow always comes back to cat pictures in the end). The “deep” in deep learning comes from the many layers that are built into the deep learning models, which are typically neural networks>>

The ubiquitous “iceberg” of ICT and **Morgan le Fay** (Morgana mirage) are also here, because although we have deeply entered the AI mechanisms, this is **a never ending road with complex and interdependent obstacles**.

Concretely, at the horizon is the next iceberg tip, as the “cognitive” AI, i.e. a natural trend to HI like performance [7]:

<<“cognitive systems are“ a category of technologies that uses natural language processing and machine learning to enable people and machines to interact more naturally to extend and magnify human expertise and cognition>>

We consider that “interact more naturally to extend and magnify human expertise and cognition” is confirming our highest expectations from future ICT/AI of **leveraging the creation of refined knowledge for sustainable progress everywhere**.

With simpler words, the *cognitive AI* is intended to extend human cognition, which is obviously the main process of refining knowledge, essential for IS toward KBS.

This does not mean that other challenges of AI development do not remain important, as refining knowledge is itself a dynamic concept in ICT/IS/KBS evolution.

After having some details about how ICT/AI could work for refining knowledge, a difficult question remains essential for humankind evolution and IS/KBS sustainable progress: which are the knowledge priorities?

We have repeatedly stressed that ICT development could contribute with huge benefits to all the human activity fields, starting naturally with the economy, but secondary effects include, on short or long term, climate changes (by ICT increasing carbon footprint), Earth resources fading and humankind behaviour and health [13][14][16].

With other words, we have to carefully watch and provide appropriate estimates of all these consequences, which is a very complex and difficult goal in the context of the amazing speed of ICT impact everywhere, as there is no necessary time and trusty data for such useful estimations [15][17].

This way we have just arrived where, by our opinion, AI could bring the most desired contributions to sustainable progress, by finding trusty data, information and finally easing the most valuable refined knowledge from the complicated processes where science does not have rules and computers still do not have the appropriate penetration power to give solutions for such sophisticated and dynamic problems.

One relevant example, where complexity and incertitude are among highest, but the expected benefit is also highly desired, is in the weather forecast and climate changes domains.

We have pointed these two domains aside just because in this case we have a relevant case of complex interdependence of dynamic complex processes which create the most complicated and unexpected evolutions.

In fact we see every day that in spite of the crucial advances, in the last decades, of the ICT power impact on weather forecast services applications, the recent aggressive evolutions of the weather, clearly induced by the climate changes, are more and more violent and ... more difficult to forecast [11][16].

We have already presented that for estimating the climate changes consequences, the most powerful computers of the World, including AI features, are heavily used [14][12].

On the other side, for short time weather forecast, AI is promising to provide better results in the above mentioned context, as it is presented in [9]:

“Technological trends driving advances in prediction and decision support several technological trends that are transforming all sectors of the economy are also fuelling advances in weather prediction and decision support. In particular, the Internet of Things, robotics, and miniaturization are driving advances in observations; decreased supercomputing costs and machine learning are enabling advances in modelling and forecasting; and, big data and analytics, cloud, mobile computing, and smart devices are fuelling innovations in service delivery. These advances offer the potential to unlock more economic value”

The above opinions not only show the beneficence expectations of AI applications, but reveal other essential challenges of ICT power to leverage refined knowledge in such priority fields.

We have to notice that, in fact, *unlock more economic value* and *fuelling innovations* are among the most important goals of ICT development for IS/KBS and became naturally priority fields for the potential of AI to analyse simple industrial or more complicated economic data flows in order to extract information and leverage refining knowledge [23].

A special attention has to be paid to *innovations*, which is a prominent key of progress for IS/KBS and beyond, for humankind life and personality.

Another relevant aspect is the mention of the ICT advances (power) involved in this potential: *Internet of Things, robotics, miniaturization, big data, analytics, cloud, mobile computing and smart devices*.

Last but not least, the *decreased (power) supercomputing costs* is mentioned as a potential to unlock more economic value, but we would add unlocking more resources for other priority fields, as the **huge potential of AI for the health domain and generally for refining knowledge on humankind survival in Earth ecosystem**[14].

Consequently we could notice, as a matter of fact, that, in order to fully optimize the intelligent ICT development, including AI, **we have to further analyse** how *wisdom* could influence *our power* and why this development has to *teach us* to understand, in this context, the *Thomas Jefferson*'s deep thinking.

3. Conclusions

The actual context of **exponential pace** of ICT development, which is still mainly generated by Moore's Law, is analysed in the paper, considering scientific, technical, economic and social implications, which led to the reasonable conclusion that any result are inherently partial and **time sensitive**, due to complexity and fast pace of these evolutions.

A realistic and clear picture of **the material base of the advances of technology**, which support this pace and Moore's Law, is presented by some relevant actual examples.

The 10nm technology is the highest peak this race reached, but the fight for the next 7nm target was dramatically uncertain until Extreme Ultraviolet (EUV) lithography became a practical reality last year, reason for which it is shortly detailed, along with main trends of implementations by GlobalFoundries, Taiwan Semiconductor Manufacturing Co. (TSMC) and Intel, i.e. the World leaders.

Another revolutionary technology, the carbon-nanotube field-effect transistors, which has the amazing target to "*improve both the energy efficiency and speed of computers by a factor of 1,000*" and the challenge of continuing Moore's Law), is also presented.

After analysing some strategies and methods to approach the target, context, models or algorithms for developing AI, the complex relationship between AI and HI proved to be essential, as the huge diversity of ICT networks, equipments and software/applications could not be created and used without the AI-HI symbiosis, i.e. working in a mutual dependence.

One important conclusion is that *the efficiency of AI-HI applications is strongly depending on the human expertise/education and responsibility*, first by properly designing

AI and then using AI to extract information/knowledge from data all over the World, aiming the humankind stable progress in every activity field and Earth ecosystem.

As AI most prolific ways to leverage refined knowledge include *machine and deep learning*, in order to optimize the development and use of AI for providing **sustainable progress everywhere**, a more detailed picture of approaching its main techniques and processes is necessary. This way, the main features and differences of machine and deep learning are presented, including both supervised machine learning and unsupervised machine learning approaches. More than these, the emergent *cognitive AI* is intended to extend human cognition, as the main process of refining knowledge, essential for IS toward KBS. As a main consequence, *unlock more economic value* and *leveraging innovations* are among the most important goals of ICT development for IS/KBS and became naturally priority fields for the potential of AI to analyse simple industrial or more complicated economical data flows in order to extract information and leverage refining knowledge.

One of the challenges for ICT/AI amazing targets/development, beyond the feasibility, is the sustainability, i.e. we have to carefully watch ICT/AI trends in order to foresee and evaluate the negative consequences before it is not too late, because the chances to foresee all the consequences of the exponential ICT/AI development complex and complicate processes are lowering as their speed is increasing, as it is the actual case of digital age of IS/KBS.

Another important conclusion is that, although we have deeply entered the AI development mechanisms, this is **a never ending road with complex and interdependent obstacles**, considering the “iceberg” of ICT and the elusive *Morgan le Fay (Morgana mirage)* evolution of the performance/applications targets, which are recalling sometimes the old issue of science fiction versus reality. This conclusion is also confirmed by a typical example: the fact that we see every day that, **in spite of the crucial advances**, in the last decades, of the ICT/AI power impact on weather forecast services applications, the recent **aggressive evolutions** of the weather, clearly induced by the climate changes, are more and more violent and ... **more difficult to forecast**.

The final conclusion is that, in order to fully optimize the intelligent ICT development, including AI, **we have to further analyse** how *wisdom* could influence *our power* and why this development has to **teach us** to understand, in this context, the *Thomas Jefferson*’s deep thinking.

REFERENCES

- [1]Samuel K. Moore, *EUV Lithography Finally Ready for Chip Manufacturing*, IEEE Spectrum, jan 2019
- [2]Katherine Bourzac, *Booze-sniffing electronic nose showcases 3D nanosystems*, IEEE Spectrum, sep 2017
- [3]Victor Greu, *The information and communications technology is driving artificial intelligence to leverage refined knowledge for the World sustainable development– (Part 1)*, Romanian Distribution Committee Magazine, Volume 9, Issue 4, Year 2018.
- [4]Seth Earley, *There Is No AI Without IA*, 2016, IEEE IT Professional (Volume: 18, Issue:3, May-June 2016)
- [5]Michael Copeland, *What’s the Difference Between Artificial Intelligence, Machine*

Learning, and Deep Learning?, <https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/>

- [6]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.
- [7] Hans-Dieter Wehle, *Machine Learning, Deep Learning and AI: What's the Difference ?* <https://www.researchgate.net/publication/318900216>, July, 2, 2017
- [8]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.
- [9]***, *National Weather Service Enterprise Analysis Report Findings on changes in the private weather industry*, June 8, 2017, https://www.weather.gov/media/about/Final_NWS%20Enterprise%20Analysis%20Report_June%202017.pdf
- [10]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.
- [11]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
- [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]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/>
- [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]Eliza Strickland, *Making Medical AI Trustworthy*, IEEE Spectrum, aug2018
- [16]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
- [17]Anas Baig, *Artificial Intelligence Can Solve The Biggest Crowdsourcing Problem*, Aug 11, 2017, <https://crowdsourcingweek.com/blog/artificial-intelligence-can-solve-biggest-crowdsourcing-problem/>
- [18]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.
- [19]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
- [20]Mike Sirius, *How artificial intelligence and innovation will interact*, June 5, 2017, Idea Drop Ltd, <http://ideadrop.co/artificial-intelligence-innovation/>
- [21]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.
- [22]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

- [23]****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>
- [24]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
- [25]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>