MACHINE LEARNING, INTELLIGENCE (AI AND HI) AND LEARNING ON DIGITAL NETWORKS

Jean Frayssinhes
Université Toulouse
jean.frayssinhes@yahoo.fr

Summary:

Artificial intelligence —understood as the set of technologies aimed at performing cognitive tasks traditionally performed by humans through computers— is today at the heart of debates on social transformations. AI has made spectacular progress in recent years and machine learning or deep learning make it possible to perform tasks that previously seemed inaccessible to machines, such as recognizing an image, satisfactorily translate a simple text or win at the game of Go. *But what about human learning?* Can artificial intelligence help the learner to be more successful in learning? We propose a research approach that can help us answer these questions. Especially online on digital networks.

Keywords:

Artificial Intelligence, Human Intelligence, Deep Learning, Machine Learning, Open and Distance Learning (ODL), Algoritms.

RESUME:

L'intelligence artificielle – entendue comme l'ensemble des technologies visant à réaliser par l'informatique des tâches cognitives traditionnellement effectuées par l'humain – est aujourd'hui au cœur des débats sur les transformations sociales. L'IA a fait des progrès spectaculaires depuis quelques années et l'apprentissage machine ou le deep learning, permettent de réaliser des tâches qui semblaient auparavant inaccessibles aux machines, comme reconnaître une image, traduire de façon satisfaisante un texte simple ou gagner

au jeu de Go. *Mais qu'en est-il pour l'apprentissage humain ? L'intelligence artificielle peut-elle aider l'apprenant à mieux réussir dans ses apprentissages? Notamment en ligne sur les réseaux numériques?* Nous proposons une démarche de recherche qui peut nous aider à répondre à ces questions.

Mots cles:

Intelligence artificielle, Intelligence humaine, Apprentissage profond, Apprentissage machine, Formation ouverte et à distance (FOAD), Algorithmes.

Resumen:

La inteligencia artificial -entendida como el conjunto de tecnologías destinadas a realizar tareas cognitivas tradicionalmente realizadas por los seres humanos a través de los ordenadores- se encuentra hoy en el centro de los debates sobre las transformaciones sociales. La IA ha hecho progresos espectaculares en los últimos años como el aprendizaje automático o el aprendizaje profundo. Puede realizar tareas que antes parecían inaccesibles a las máquinas, como reconocer una imagen, traducir satisfactoriamente un texto sencillo o ganar en el juego de Go. *¿Pero qué pasa con el aprendizaje humano? ¿Puede la inteligencia artificial ayudar al alumno a tener más éxito en el aprendizaje? ¿Especialmente en línea en redes digitales?* Proponemos un enfoque de investigación que puede ayudarnos a responder estas preguntas.

Palabras claves:

Inteligencia Artificial, Inteligencia Humana, Aprendizaje Profundo, Aprendizaje Mecánico, Aprendizaje Abierto y a Distancia (AAD), Algoritmos.

MACHINE LEARNING, INTELLIGENCE (AI AND HI) AND LEARNING ON DIGITAL NETWORKS

1/ Introduction

To predict the future has always been the wish shared by a certain part of humanity. If that were possible, some would think that we could then change it in order to make it more acceptable, even happier. Predictive analysis is now being developed and based on Machine Learning (ML), composed of statistics and computer algorithms that make it possible to automate the construction of a prediction function using a set of observations called "learning sets". The learning machine is supposed to make more effective predictions using Big Data technology. Our objective is to present what Machine Learning is, to compare human intelligence with artificial intelligence, and to explain how the machine learning could be used in predicting the success of adult learning (> 21 years), on digital networks (ODL, E-learning, MOOC, etc.).

2/ *What is Machine Learning?*

2.1/ General information

In the computer paradigm, Machine Learning (ML) is a subset of Artificial Intelligence (AI) that allows predictive models to be established from data corpuses. Once the corpus of data is sufficient, it is now possible to construct predictive mechanisms based on the reading and precise observation of these data, whatever they may be. However, while all Machine Learning is included in Artificial Intelligence, not all Artificial Intelligence is based on Machine Learning. Deep Learning (DL) is a subset of Machine Learning (ML). However, if all Deep Learning is included in Machine Learning, any

Machine Learning (ML) is not limited to Deep Learning (DL) as we indicate in the table below[1].

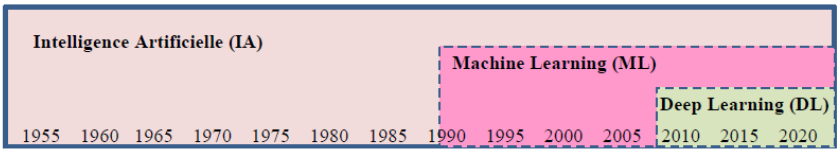

Table 1/ Evolution of Intelligence Artificielle

According to Lamberger, Batty, Morel & Raffaëlli, data scientist at Weave Business Technology, "Machine learning is a set of statistical or geometric tools and computer algorithms that automate the construction of a prediction function f from a set of observations called the learning set" (2015/16, p. 112). The rise of predictive analytics is due to the megadata now available (internet, connected objects, social networks, etc.), which require new approaches spearheaded by the learning machine. Fundamentally driven by megadata, the learning machine relies on statistical analysis, artificial intelligence, business intelligence (BI), and information technology (IT; Lamberger, Batty, Morel & Raffaëlli, 2015/16).

2.2/ *What is an algorithm?*

The word "algorithm" comes from the name of the Persian mathematician Al Khwarizmi (around the year 820), who introduced in the West the decimal number (brought back from India), and taught the elementary rules of the calculations related to it. The notion of algorithm is thus historically linked to digital manipulations, then it has gradually developed to focus on more and more complex objects: texts, images, logical formulas, physical objects, etc.. An algorithm is a method, a systematic way of proceeding to achieve something concrete, practical. By following a precise instruction manual, the algorithm allows you to: sort objects, locate cities on a map, multiply numbers, extract a square root, search the meaning of a word in the

1 Ludovic Louis : https://siecledigital.fr/2016/12/22/machine-learning-deep-learning-ca-marche/ (consulté le 26/12/2017)

dictionary, etc. As a method, it answers questions such as: *How can I do this?,get this result?*,find this information?, *calculate such number?* The algorithm translates the intuitive notion of systematic process, mechanically applicable, by simply following a precise instruction manual. To illustrate this, we can take the example of the kitchen. I find a pack of pasta and ask myself, "How do I cook pasta?". Here is a simple procedure to follow[2]:

- Fill a pot with water;
- Add a pinch of salt;
- Put it on the fire;
- Wait for the water to boil;
- Put the pasta in the pan;
- Cook for 8 to 10 minutes;
- Drain pasta.

Everything that has just been listed will then be programmed to create an algorithm, i.e. a way of processing the information, in order to automate it. Not only must information be manipulated, it must also be stored, and the way in which this information is stored could have very important consequences on its manipulation. In our example, the algorithm becomes a series of simple instructions (to cook the pasta), which will make it possible to obtain the finished product.

3/ What is intelligence?

3.1/ The brain: source of intelligence

A central element of neuroscience studies is the adult human brain. Weighing an average of 1.3 kg, is composed, according to Jean-Pierre Changeux[3], of about 10^{12} neurons, or 100 billion. Each

2 Inspired of Open Classroom. Retrieved from: https://openclassrooms.com/courses/algorithmique-pour-l-apprenti-programmeur/qu-est-ce-qu-un-algorithme (06/12/2017).

3 Professor at the Collège de France, directs the Molecular Neurobiology Laboratory at the Institut Pasteur.

of them connecting using synapses to about ten thousand others, we have a total of 10^{16} possible connections, which gives an idea of the complexity of brain functioning.

Thus, it is through synapses that nerve information is conveyed to neurons and serves as a support for the development of an individual's skills and learning capacity (OECD 2007)[4]. As new neurons appear at every stage of life (neurogenesis), our brain continues to shape itself well after birth and, in fact, constantly adapts to the stimuli of our environment. This is what we call plasticity, the ability of the brain to be modified by experience (Ibid.).

Forged in the 12th century, the word intelligence comes from the Latin *intelligentia* variant of *intellegentia* (faculty of understanding), derived from the Latin *intellegere* meaning to understand, and whose prefix *inter* (between), and the radical *legere* (to choose, to pick) or *ligare* (to bind) essentially suggest the ability to connect separate elements. Man has tried to define himself in the scale of beings, by situating himself in relation to his inferior, the animal, and in relation to his superior, the divinity[5]. The notion of intelligence developed in this context, conceived as a specific function of man. Intelligence has always been an attribute or a quality that each of us wishes to be adorned with in the greatest possible proportions. It is a virtue to possess a high one and a pride to display it, or a shame to have a mediocre or insufficient one, that is hidden because it is a source of inequality and contempt. For a long time, philosophers (Aristote, Plato etc.) and psychologists (Binet etc.) have known no other form of intelligence than the conceptual and logical intelligence of Man, exercised through language. Intelligence is a distinctive element that asserts its superiority over those who have little or no intelligence.

4 *In* Comprendre le cerveau : naissance d'une science de l'apprentissage – OCDE 2007

5 Retrieved from: https://www.universalis.fr/encyclopedie/intelligence/#i_84068 (21/02/2018)

3.2/ Defining human intelligence

How to define intelligence? In the common sense: “the ability to understand and discover relationships (causality, identity, etc.) between facts and things.” (Dictionnaire encyclopédique Hachette, 1992). If this lapidary definition allows us to understand roughly what it is, it does not explain in any way how intelligence works or how it is established. Indeed, it is very difficult to give a single, clear definition of intelligence that is accepted by everyone. The attempts proposed so far have provoked contradictory debates, so we will not claim to define it univocally, definitively and peremptorily. At most, we will list a few attempts at clarification over the centuries. Very schematically, we can oppose two major conceptions:

- An innate conception (Burt 1921), where intelligence is fixed from birth, chromosomally inherited from his parents,
- A constructivist conception (Kant 1787, Piaget 1968, Bruner 1996), where the child builds his intelligence through a set of interactions conducive to his development; in particular with his teachers and, more generally, with any person in charge of his instruction and education.

Many scientists from different specialties have tried over the centuries to forge intelligence, and the definition of intelligence has evolved, but it is still debated, both among specialists and the general public. We do not pretend to exhaustively circumscribe what intelligence is. We are simply giving some food for thought.

Socrates offers wonderful lessons in the pedagogy of intelligence. In Plato’s dialogues (2008), we see two men, Cratyle and Hermogenes, in profound disagreement about the origin of language. Socrates emerges and substitutes himself in turn to each of the antagonists whose point of view he adopts, so that he makes it accept

by the other. The purpose of Cratyle is to show that philosophical controversies are due to different modes of intelligence functioning. According to Plato, the intelligence we have of things must have a non-sensitive origin, without which any thought would necessarily be false. Knowledge cannot therefore be purely subjective. For Plato, knowing one thing is knowing its causality.

For Claparède[6], *in* Functional Education (1931) "intelligence is the ability to solve new problems". He showed that intelligence is an active function of adaptation to new situations because, faced with an unknown situation, the subject proceeds to trial and error which guides him in the search for hypotheses to be tested.

For the French philosopher Henri Bergson (1907, p.98) "Suffice it to say that intelligence is characterized by the indefinite power to decompose according to any law and to recompose into any syste".

At the dawn of the 20th century, the French state was worried about school failure. He called on Alfred Binet and Théodore Simon to develop a method to detect weak students at school. Thus the first intelligence test, Binet and Simon, was developed in 1905. This measures the metric scale of intelligence: it is an estimate of the child's intellectual development. Alfred Binet is wrongly credited with the IQ test. The name "Intellectual Quotient" was invented in 1912 by the German Wilhelm Stern. Although it was largely inspired by Alfred Binet's work, the IQ test can only be used by children and not adults.

The Adult Intelligence Test was created in 1939 by the American David Wechsler. To construct his eponymous test, David Wechsler uses the measure by rank[7] (this measure uses Gauss's normal law).

For psychologist Charles Spearman (1863-1945), this is a general

6 Édouard Claparède (1873-1940) was a Swiss neurologist and psychologist whose main interests were child psychology, teaching and the study of memory. This pioneer of pedagogy laid the foundations for what was to become the Faculty of Psychology and Educational Sciences in Geneva, thus paving the way for Jean Piaget.

7 The IQ by rank (or standard IQ) is the rank at which a person ranks relative to the population. The population is represented by a normal bell curve (also called Gauss curve).

factor that he calls "general intelligence". From the beginning of his academic career, he was interested in methods of measuring human intelligence by means of non-verbal tests. He wondered how to explain the differences in student performance on different tests, and concluded that these depend on a common source of variation called the *G factor* (general). This success factor reflects the fact that a student who performs well in one area will also tend to perform well in others, as there would be "general intelligence" involved in all tasks. Using experimentally the method of correlations developed by his predecessors in quantitative psychology (Thomson, Burt, Galton and Pearson, in particular), he finds the existence of positive correlations between several variables and exploits the significance of these correlations. In addition to *factor G*, there are various *specific factors* (S) that are necessary for the performance of particular tasks: the success of certain tasks depends both on the general *factor G* and on one or more *factors S*. The designation *factor G* is accepted by all.

For Anne Anastasi (1908-2001): "Intelligence is not an entity, a unitary capacity located in the organism, but rather a combination of several functions, characteristic of behaviour". Intelligent behaviour is essentially adaptive in the sense that it incorporates effective means to meet the changing demands of the environment. The term refers to the combination of skills required for survival and progress within a given culture. She was very inspired by Spearman's work and her research focused on understanding and measuring the factors underlying the development of individual differences in psychological traits (Anastasi, 1972, 1989). She argued against the strictly hereditarian position, emphasizing the role of experience and environmental influences on the results of intelligence and

psychological development tests. She emphasized that intelligence test results are not pure measures of innate ability.

Raymond B. Cattell (1905-1998) theorized the existence of two forms of intelligence at the basis of cognitive abilities, fluid intelligence (independent of knowledge) and crystallized intelligence (which corresponds to knowledge). His work first led him to enumerate sixteen measurable personality factors, and later, five structuring dimensions, called *Big Fives*: extraversion; pleasantness; consciousness (taken in the "conscientious" sense); emotional stability; and open-mindedness.

The concept of multiple intelligences was forged in 1983 by Howard Gardner, a cognitive psychologist and professor of neurology at Boston Medical School. It was in the early 1970s, while working in Norman Geshwind's neuropsychology unit at Harvard, that he sought to understand how brain faculties are organized. It was while working on damaged brains that he discovered the functioning and cognitive development that would give rise to multiple intelligences (MI). As he himself points out, it was during a voluntary lexical substitution, when he "stopped talking about gifts or abilities to talk about multiple intelligences" (Gardner, 2004, p. 8,9) as opposed to psychologists who favour logical and language skills, that his theory became widely known and disseminated. For this author, the forms of intelligence are multiple and are not confined to the simple value of an IQ, with which one "can at most predict one's academic success" (Gardner 1997, p. 15), because brief answers to brief questions would not be enough to reveal an individual's intelligence. He considers intelligence as a biopsychological potential where each member of the species has the potential to exercise the range of

intellectual faculties specific to the species (Gardner, 2004, p. 58). Howard Gardner distinguishes 8 main intelligences:

- Verbal and linguistic intelligence
- Musical and rhythmic intelligence
- Body and kinesthetic intelligence
- Visual and spatial intelligence
- Logical and mathematical intelligence
- Interpersonal intelligence
- Intrapersonal intelligence
- Naturalistic intelligence

As a species, we possess varying amounts of each of these eight intelligences and we "all enjoy what makes us cognitively human" (Gardner, 2004 p. 9).

Thus, the variability of what human intelligence represents is very important, but while there is no consensus on a univocal definition of human intelligence, we do know what it covers, that is, a combination of different functions, different elements. This is made possible by an unceasing dialogue with the outside, as well as with our inner world, our "self" in the psychoanalytic sense, which will always differentiate us from the machine. We will try to confront it with the concept of artificial intelligence, in order to know if the term "intelligence" is appropriate to describe it as such.

3.3/ *What is artificial intelligence?*

As early as 1942, a group of interdisciplinary scientists (mathematicians, logicians, anthropologists, psychologists, economists, neurophysiologists, psychoanalysts), under the influence of the mathematician Norbert Wierner, built a new transdisciplinary science of the functioning of the mind, called cybernetics. To study the mind, you have to assimilate it to brain activity, and compare the

brain to a machine. The subject disappears and becomes a program, syntax and information (ref: Turing Machine). The cognitive agent thus becomes a module operating with "inputs" and "outputs"; here we enter the computer field.

Thus, artificial intelligence can be defined as the search for means likely to equip computer systems with intellectual capacities comparable to those of human beings. The concept is based on the development of computer programs, capable of performing tasks hitherto performed by humans, which require learning, organization, memory, and reasoning. It is a form of reproduction, a "copy" of what human beings do and achieve that is envisaged with AI. But the human brain is so complex that one can wonder if *AI can really be compared to human intelligence (HI)? Isn't it an abuse of language to name the programmed operation of a machine "intelligence"?* Isn't comparing the human brain to the processor (brain) of a computer the source of a deep misunderstanding or a too fast shortcut?

AI tasks can sometimes be very simple for humans to perform, such as recognizing and locating objects on an image, planning a robot's movements to catch an object, or driving a car. Other times, they may require complex planning, for example to play chess or go. The most complicated tasks require knowledge in many fields, to translate a text, dialogue, or do facial recognition, but can we say that *AI is comparable to HI?*

If, as with human intelligence, artificial intelligence is able, through learning, to perform a task and improve its performance with experience, then one can answer "Yes". Moreover, if through learning, AI is able to learn to perform new tasks and thus acquire new skills, one can quite compare it with the concept of human brain plasticity, and also answer in the affirmative. However, it seems more complex. For Luc Steels, a researcher at ICREA in Spain, current

systems are “learned idiots”, and he tries to go further by making the world experiment with artificial intelligence.

Take the word “red” from the dictionary. Its definition is very different from the red experience. With this definition, the system cannot tell if an object is red. Because meaning is linked to the relationship between language and the world. To understand language, Wikipedia is not enough: we must anchor the intelligent agent in the real world, with a body, sensors, the ability to interact. (Newspaper “Le Monde” 12/10/2015)

Artificial intelligence has raised fears, questions and debates: will it replace the human? Is she even destroying humanity? The AlphaGo program that has been talked about so much, which beat the South Korean world champion at the go game, shows that the machine can sometimes overtake the human. Already, artificial intelligence has replaced humans in many sectors, such as agriculture and industry, and it is developing in services. It can also be put at the service of humans, as in the field of health, by offering, as is already the case, bionic arms or legs.

Bill Gates (creator of Microsoft), Stephen Hawking (theoretical physicist & cosmologist), or Elon Musk (creator of Tesla & SpaceX), believe that we are approaching the point of Singularity, that is, the moment when the machine will surpass human intelligence. The progress of AI is such that it can frighten some people: “Robots will be able to do everything better than we can”. And by “we”, I mean “all of us”, says Elon Musk, who is at the origin of advanced research on artificial intelligence[8], which also calls for the establishment of

8 Elon Musk co-founded OpenAI at the end of 2015, a research centre designed to make AI advances accessible to as many people as possible, and in March 2017 Neuralink, dedicated to increasing our brains through neural laces, the only ones capable in his eyes of saving us from machine intelligence.

an AI regulatory body among American governors (Online Review: Usbek & Rica 17/07/2017)

According to Gérard Sabah (CNRS Research Director, France), a specialist in AI and language, each individual develops a specific knowledge of the world, which is essential to understand the meaning of words.

The body of knowledge is such that we do not know how to represent them all in a program. They must be acquired little by little. A child takes years to acquire relevant representations of the world. Intelligent mechanisms can only be achieved through learning. […] (Newspaper "Le Monde" 19/09/2015)

In the field of language, what artificial intelligence is capable of today:

- Understand (roughly) what is being asked of them
- Express yourself correctly
- Answering simple questions
- What she can't do:
- Understand the meaning of language
- Adapting to the context
- The progress that remains to be made:
- Experience the world to understand the meaning of language
- Inventing one's own language" (ibid. Sabah)

3.4/ Intelligence *vs* Performance

According to Alan Turing, father of computer science: "The intelligence of the machine is a heretical idea"(Turing 1951). When we are in the non-human, should we not rather speak of "artificial performance" or "artificial results" than "artificial intelligence"?

Because that is what it is all about. Today, machines are capable of extraordinary "performances" or "results". By coupling hundreds, even thousands of computers together (data center), by constantly (re)programming them, by correcting errors, by exercising them thousands of times against oneself, one day one ends up creating an artificial "system" (ex: AlphaGo) that wins against a human being. *But does this make it an intelligent machine? a machine endowed with an intelligence superior to that of the human?* We do not believe it because the machine has no intentionality; it has no consciousness. A machine can imitate life, but it cannot create ideas, much less define or explain them.

The machine reacts to symbols to work, but does not understand them. Intelligence in its great complexity is linked to the human because, unlike the machine, it works on semantics; that is, the interpretation and meaning of what it does. Unlike the machine, a human is aware of who he is, and what he does (recursivity from the external to the internal). It was the humans at DeepMind (manufacturer of AlphaGo) who worked hard for months to program AlphaGo's performance first, then its latest version AlphaGo Zero. It is these humans who have accumulated their intelligence to build the machine that can only work on the syntax of reasoning processes (combinatorial rules). Moreover, for the comparison to be methodologically meaningful, for the confrontation to be fair and not biased and scientifically acceptable, it would have been necessary that the programming times of the machine: design, realization, tests, parameterizations, use, would have to be equal to the times of the "human" players. It would also have been necessary to have the same number of human players working on concerts, as computers connected together, which is surely unrealistic. Finally, these humans would have had to undergo the same training, in the same time frame as the AlphaGo machine which had to play against humans thousands of times to learn, then AlphaGo Zero which had

to play millions of games (Next Inpact 2017), against itself to learn from its mistakes, so that we could judge fairly the results obtained. If the term "intelligence" is inappropriate for us, the performance of some artificial machines is quite remarkable.

If we are still only at the beginning, AI is progressing every day, especially on neural networks, and in the laboratory, we have thus been able to develop programs that imitate human "basic" emotions: sadness, joy, fear, anger, surprise, disgust, but there are other emotions more complex to decipher for a program.

The concept of "strong" artificial intelligence is also a subject of study. It should produce intelligent behaviour, but also be able to experience consciousness or "feelings", which means having an understanding and reasoning (Site Francophone IA 2017) .

3.5/ Artificial intelligence and education

What role can artificial intelligence play in the world of education? some leads are already possible (Educavox 2014)

3.5.1 Automating evaluation

Different applications, such as *Socrative* and *eClicker*, allow you to create multiple choice questions that automatically correct themselves. In addition, learning platforms such as *Didacti*, *Moodle*, *Khan Academy* or *Netmaths* offer self-correcting questions or tools for creating them. In the near future, tools may correct short answers or essay questions. Less correction means more time to accompany students! (Ibid. Educavox).

3.5.2 Adapting to the student's needs

This technology already exists on the American *Khan Academy* platform. The student answers self-correcting questions related to the subject, and in case of difficulty, the system sends other questions or explanations to help him/her. This indicates that individualized learning could be simplified with tools of this type. (Ibid.).

3.5.3 Suggest improvements to the teacher

Imagine a learning tool that makes it possible to create courses and that also makes suggestions for improving this course, depending on the success or difficulties encountered by the students! This is already being proposed by the Coursera platform, one of the world's leading MOOCs. (Ibid.)

3.5.4 Be a virtual tutor for the student

If the presence of a tutor/mediator/facilitator is essential to successful online learning, the cost involved is also significant thanks to *conversational agents*, these sculpins become effective virtual tutors to accompany the student at a lower cost in the acquisition of basic concepts, and provide the student not only with the subtle direction he needs to learn more effectively, but at the same time provide him with an effective mediator free of all prejudices (Econocom 2017).

4/ Machine learning and human learning: questions

Can the concept of machine learning be used in the field of education and/or vocational training? Is it possible to create one or more algorithms to improve the quality of learning and promote the transmission of knowledge and skills? For example, can these

algorithms help teachers detect the different ways in which their students learn in order to adapt the way they teach? (Therer, 1998). Depending on the learner's dominant learning style (Ibid.), can learning on digital networks be improved: ODL, E-learning, MOOC etc.? (Frayssinhes 2011, 2012c, 2015).

4.1/ Machine learning: which process?

Based on an artificial intelligence technique, machine learning allows a machine to learn from examples already available (Mitchell, 1997). Today, the learning machine and neural network technology can handle the most routine human tasks (Susskind 2015) .

There are three modes of machine learning:

1. Supervised learning. Consists in learning a function from training data that are in the form of inputs/outputs.
2. Unsupervised learning. Consists in learning a function from input data only, the output not being specified.
3. Learning by reinforcement. Consists in finding, through a process of trial and error, the optimal action to perform for a situation perceived by an agent.

4.2/ Learning: the theoretical point

Learning, although natural as eating or drinking, is a slow and complex process whose definitions vary according to the authors and depend on the context and perspectives envisaged (Frayssinhes, 2011 p. 45). Thus, the educational scientist will have a different vision than the neuroscientist.

For the education sciences, we have adopted the definition given by Jean Therer for whom: "Learning is an extensive concept that cannot be reduced to learning outcomes alone. It is an adaptive change in behaviour as a result of the individual's interaction with his

or her environment" (Therer 1998, p.6, 10). This definition builds on the building blocks of successful adult learning on digital networks, namely: an evolving non-fixist concept, a strong capacity for adaptation and interaction with its environment: networks (Internet, Intranet, Extranet); the medium, computer, tablet or smartphone; the collaborative working group, peers; individualized coaching, tutor/mediator/facilitator (Frayssinhes 2011). Learning theories are numerous, and without excluding any, it is considered that cognitivism, which is based on information processing and cognitive and metacognitive strategies, as well as socio-constructivism, which emphasizes the relational dimension of learning, are the most relevant to be used to promote successful learning on digital networks. It is the combined use of these two complementary theories that will enable learners to persevere in their digital learning, thus limiting the high drop-out rate by offering the possibility of completing their training while limiting the risk of failure (Frayssinhes, 2011 p. 56).

For neuroscientists, the context and perspectives are different and thus, for Hideaki Koizumi (2005)[9], learning is "the process by which the brain reacts to stimuli by creating neural connections that serve as information processing circuits and allow information storage. Here, we are more in physiology and computer science, which allows us to understand the difficulty that it can have to communicate between researchers from "hard" sciences with those from "soft" sciences, because the vocabulary, epistemologies and theoretical references are not identical. Nevertheless, more and more multidisciplinary teams are being created in the world (Japan, USA, etc.), in order to work together in a transdisciplinary perspective in order to bring about the emergence of new sciences.

The appearance of artificial intelligence at the Dartmouth

9 Dr Hideaki Koizumi, adept of transdisciplinarity and mathetic theorist, scientific head of the Advanced Research Laboratory, Hitachi Ltd, Professor at Tokyo University, Director, Research Field "Brain Science and Education" Japan.

conference in 1956, allowed the emergence of a new generation of teaching in the 1970s, namely, Computer Assisted Intelligent Teaching (CAIT), or Intelligent Tutor System (ITS). These systems are characterized by their ability to provide individualized instruction based on the learner's level of knowledge, and to perform tasks not anticipated in advance, using artificial intelligence techniques to resemble a human tutor. However, these systems do not always take into account emotional factors, which have shown in various research studies that emotion plays an important role in human learning, particularly in decision-making, cognitive processes and performance (Damasio, 1994; Goleman, 1995; Isen, 2000).

5/ What predictive approach?

On a theoretical level, before predicting, we know that we must first understand the phenomenon observed using an explanatory model. To understand how adult learners have successfully completed their online learning, we therefore need to create a model that makes this possible.

Based on the statistical results of variables deemed valid during our work, we will be able to propose a research protocol to make predictions.

Within our cohorts of winners, we will select the variables whose Khi^2 test results were positive, then using machine learning techniques, we will try to create a predictive protocol.

Is this deterministic approach compatible with the analysis of the results of human behaviour? What is the likelihood that an individual will successfully complete online learning? In some situations, an explanatory model may have to be abandoned and simple correlations

made between past observations. If these correlations remain true in the future, then we can use them to make predictions.

5.1/ Which model?

We will have a function *F(x)* of the predictive variables: age, sex, CSP, etc. It is these variables that will allow us to make predictions. The *p* predictive variables associated with an observation will be noted as a vector x = $(x_1,.....,xp)$ with *p* components. A set of *N* observations will consist of *N* such vectors $\mathbf{x}^{(1)},...,\mathbf{x}^{(N)}$.

We will have a **target variable** (the learner) whose value we wish to predict for events not yet observed. This variable will be noted y with the same meanings for the indices as for **x**.

The objective of the learning machine is to obtain a good "approximation" of the function *F*. This approximation noted will be named "prediction function". The learning machine model must be able to construct a prediction function from a learning data set. The construction of constitutes the learning or training of the model. The prediction corresponds to the evaluation (x) of the prediction function on the predictive variables of an observation *x*.

6/ Conclusion

Machine Learning (ML) is a subset of Artificial Intelligence (AI) that allows predictive models to be established from sufficient data corpus. The information contained in the data is processed using an algorithm in order to automate it.

The human brain is the source and seat of our intelligence. The variability of what human intelligence represents is very important, and while there is no consensus on an univocal definition of human

intelligence, we do know what it covers, that is, a combination of different functions, different elements, and characteristics of adaptable behaviour, which are specific to the human environment. The complexity of the human brain is not comparable to that of a computer processor. By multiplying the number of processors, by making them work together, we can obtain phenomenal computing powers, and surprising results such as those of AlphaGo Zero who won against a human player.

Although artificial intelligence is capable, through automated learning, of performing a task and improving its performance with experience, as well as learning to perform new tasks to acquire new skills, it cannot be equated with human intelligence. To speak of artificial intelligence is for us an abuse of language, a semantic simplification, chosen to avoid further reflection. When we are in the non-human, we propose to speak of "artificial performance" or "artificial results" rather than "artificial intelligence". Because that is what it is all about. Today, machines are capable of extraordinary "performances" or "results".

Based on data from learners who have successfully completed their online training (Frayssinhes 2011, 2012b) it could be possible to propose a research protocol to make predictions. Within our cohorts of laureates already studied and statistically validated, we could choose the variables whose Khi2 test results have been significant; and by using machine learning techniques, we will work on the development of a predictive protocol with the creation of an algorithm, whose predictive veracity could be demonstrated, once it will be able to designate our laureates already studied.

Bibliography & Webography

Anastasi, A. (1972). Reminiscences of a differential psychologist. In T. S. Krawiec (Ed.), *The psychologists*, pp.3-37. London: Oxford University Press.

Anastasi, A. (1989). In G. Lindzey (Ed.), *History of psychology in autobiography: Vol. 7.* pp.1-37. Stanford: Stanford University Press.

Bergson, H. (1907). *L'évolution créatrice.* Paris : Les Presses Universitaires de France, réédition 1959, 86e édition, p. 372.

Bruner, J. (1996). L'éducation, entrée dans la culture. Les problèmes de l'école à la lumière de la psychologie culturelle. Paris : Retz

Burt, C. (1921). *Mental and Scholastic Tests*. London : King and Son : 4ème éd., 1962, Staples Press.

Claparède, E. (1931). *L'éducation fonctionnelle.* Neuchâtel et Paris : Delachaux et Niestlé

Damasio, A. (1994). *Descartes Error – Emotion, Reason and the Human Brain*. NY : Putnam Press

Econocom Review Online (2017) : https://blog.econocom.com/blog/education-avec-les-chabots-lintelligence-artificielle-a-aussi-fait-sa-rentree-scolaire/ (Consulté le 29/11/2018)

Educavox Online Review. 2014 : https://www.educavox.fr/innovation/pedagogie/5-roles-possibles-de-l-intelligence-artificielle-en-education (consulté le 03/01/2018)

Frayssinhes, J. (2011). *Les pratiques d'apprentissage des adultes en FOAD : effet des styles et de l'auto-apprentissage.* Thèse de doctorat en sciences de l'éducation. Université de Toulouse II le Mirail.

Frayssinhes, J. (2012b). *L'apprenant adulte à l'ère du numérique.* Paris : L'Harmattan

Frayssinhes, J. (2012c). *Réussir son apprentissage en FOAD: poids de l'intuition*. In Les journées du E-learning. Invité Colloque International LYON 28/29 Juin 2012 - Intervention :" E-learning: apprentissage intuitif ".

Frayssinhes, J. (2013). *Plaisir et apprentissage sur les réseaux numériques*– Revue en ligneImplicationsPhilosophiques.http://www.implications-philosophiques.org/actualite/une/plaisir-et-apprentissage-sur-les-reseaux-numeriques/ (consulté le 13 janvier 2018)

Frayssinhes, J. (2015). Conférence : Réussir son apprentissage en FOAD : poids de l'intuition.http://www.canalu.tv/video/universite_toulouse_ii_le_mirail/reussir_son_apprentissage_en_foad_poids_de_l_intuition_jean_frayssinhes.18001 (consulté le 13 janvier 2018)

Gardner, H. (1997). *Les Formes de l'Intelligence*. Paris : Edition Odile Jacob
Gardner, H. (2004). *Les Intelligences Multiples*. Paris: Edition Retz

Goleman, D. (1997). *L'intelligence émotionnelle*. Paris: Edition Robert Laffont

Intelligence Artificielle. (2017): Site francophone: http://www.intelligenceartificielle.fr (consulté le 04/01/2018)
Isen, A. (2000). *Positive Affect and Decision Making*. Handbook of Emotions

Kant, E. (1787). *Critique de la raison pure.* Paris : P.U.F 1975, 8ème édition

Lemberger. P, Batty M, Morel M, Raffaëlli J-L. (2015/2016). *Big Data et Machine Learning. Les concepts et les outils de la data science.* Malakoff : Dunod 2ème édition.

Mitchell, T. (1997). *Machine Learning*. New-York: McGraw-Hill.
Next Inpact Online Review (2017): https://www.nextinpact.com/news/105362-alphago-zero-derriere-dernier-coup-comm-deepmind-apprentissage-par-renforcement.htm (consulté le 29/12/2017)

OCDE, (2007). *Comprendre le cerveau : naissance d'une science de l'apprentissage*.
Piaget, J. (1968). *Le structuralisme.* Paris : P.U.F, Que sais-je ? Dixième édition

Platon, (2008). Cratyle : Platon, Œuvres complètes, Paris : Éditions Flammarion

Susskind, R & D. (2015). *The future of the professions*. Oxford University Press

Therer, J. (1998). *Styles d'enseignement, styles d'apprentissage et pédagogie différenciée en sciences*. Information Pédagogique N°40 – Mars 1998

Turing, A. (1951) Conference at the BBC: http://www.turingarchive.org/browse.php/B/4

Usbek & Rica (2017): https://usbeketrica.com/article/elon-musk-intelligence-artificielle-dangers

Wiener, N. (1948) : *Cybernétique et société*. Traduction française : Ed. Des deux rives 1952.