1678-765X

10.20396/rdbci.v24i00.8681711/en

Research Article

RDBCI

Revista Digital de Biblioteconomia e Ciência da Informação
Digital Journal of Library and Information Science

The frontiers of human and mechanized knowledge in the digital age (21st century): an analysis of machine learning projects applied in the field of Information Science

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ABSTRACT

Introduction: Human knowledge, based on information, faces the prospect of replacement by machine knowledge, also based on information which, through its processing, supported by advanced information technology resources, have become more sophisticated in our so-called digital age. Accordingly, the need to define these types of knowledge to correctly understand the knowledge we are acquiring in this digital age is deemed necessary. Objective: To establish a reference model drawing a dividing line between human knowledge and knowledge based on machine learning, enabling a more accurate boundary of each of these knowledge types and/or their convergence. Methodology: Bibliographic research, combined with field research, was represented by papers from projects focused on knowledge acquisition through machine learning in the field of information science. Results: The bibliographic research carried out so far denotes the urgent need for comprehensive interdisciplinarity between the fields of Information Science (IS) and Computer Science (CS), for correct appropriation, by IS, of the advances in the sub-area of machine learning, which integrates the area of artificial intelligence within the CS. Conclusion: Several theories within Information Science, analyzed in the ongoing bibliographic research, regarding machine-based learning, are mostly based on assumptions not supported by the technical foundations of machine learning in the field of CS, which ultimately distorts their proper use in the field of Information Science.

KEYWORDS

Knowledge. Information technologies. Machine learning. Algorithms.

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As fronteiras do conhecimento humano e o mecanizado no século digital (XXI): Uma análise de projetos de aprendizado baseado em máquina aplicados no campo da Ciência da Informação

RESUMO

Introdução: O conhecimento humano, calcado na informação, depara com a perspectiva de ser substituído por um conhecimento de máquina, baseado também na informação, mas mediante seu processamento, suportado por avançados recursos de tecnologia de informação, que se sofisticaram em nosso século, dito digital. Emerge então a necessidade de delimitação desses conhecimentos em prol da correta compreensão do conhecimento que ora adquirimos neste século digital. Objetivo: Estabelecer modelo de referência para traçar uma linha divisória entre o conhecimento humano e o conhecimento baseado em aprendizado via de máquina, que possibilite delinear de forma mais acurada os limites de cada um desses conhecimentos e/ou sua confluência. Metodologia: Pesquisa bibliográfica agregada a uma pesquisa de campo, representada pelos trabalhos acadêmicos de projetos voltados ao conhecimento a partir do aprendizado baseado em máquina no campo da ciência da informação. Resultados: A pesquisa bibliográfica até então realizada denota a urgente necessidade de uma interdisciplinaridade plena dos campos da Ciência da Informação (CI) e da Ciência da Computação (CC), para uma correta apropriação pelo campo da CI dos avanços da subárea do aprendizado baseado em máquina, que integra a área de inteligência artificial do campo da CC. Conclusão: Várias teorizações advindas do campo da CI, avaliadas na pesquisa bibliográfica em curso, acerca do aprendizado baseado em máquina, fundamentam-se, em sua maioria, em suposições que não encontram guarida nas bases técnicas do aprendizado baseado em máquina do campo CC, o que acaba por distorcer sua correta utilização pelo campo da CI.

PALAVRAS-CHAVE

Conhecimento. Tecnologias da informação. Aprendizado de máquina. Algoritmos.

CRediT

- Acknowledgements: Not applicable.
- Financing: Not applicable.
- Conflict of interest: The authors certify that they have no commercial or associative interests that represent a conflict of interest in relation to the manuscript.
- Approval: Not applicable.
- Data and material availability: Not applicable.
- Authors' contributions: Conceptualization, Research, Writing – original draft and Writing – revision & editing: CERQUEIRA, JNC; Writing – revision & editing: PALETTA, JC
- Declaration of AI tool use: The authors declare that no AI tools were used in writing the manuscript.
- Image: Extracted from the Lattes platform.
- Translation: Nakano Aulas e Traduções

JITA: AC. Relationship of LIS with other fields

SDG 4: Quality Education

Article submitted to the similarity matching system.

Submitted: 27/11/2025 – Accepted: 24/04/2026 – Published: 12/06/2026

Editor: Gildenir Carolino Santos

1 INTRODUCTION

Knowledge is one of the most relevant attributes human beings possess, as knowledge enables us to perceive all things around us in our environment, whether familial or social. Knowledge provides a range of physical and mental interactions with the environment, where information is the means by which knowledge is acquired, internalized, and processed. This statement corroborates Pinto's analysis (cited in Curras, 2005, p. 6):

> (...) Knowledge is an intelligent mental process for acquiring understanding, an intermediate step in the development of opinions. It would be among the largest proportion of useful information that impacts the brain and its subsequent mental process, which gives rise to various forms of thought.

The correlation between information and knowledge is clear, as they are in fact complementary, and they can hardly be dissociated as a human mental process. One of the definitions found by Semidão (2014, p. 128) underpins this statement:

> This definition establishes a link between “knowledge” and “information” from a perspective of nature identification, where “knowledge” is “information” (and also understanding) captured in the mind regarding some specific topic. In this way, as knowledge is a specific form of the same information, it would be possible to observe the presence in the notion of change of state (from "information" to "information" in the mind about some subject).

The generation of new knowledge follows a feedback loop, in which information generates new knowledge, characterizing a structured mental process: “once meaning has been created and knowledge constructed, the use of information has three aspects: decision-making, knowledge construction, and meaning creation” (Pinto, 2020, p. 11).

The acquired knowledge is quickly transformed back into information, which Wersig (cited in Kuhlen, 1990) denominates “Knowledge in action”. Following, the actions triggered by the three aforementioned aspects, which in turn also almost instantly result in knowledge, provide human beings with greater degrees of evolution and progress, both for themselves and for the community around them, which is evident, given the remarkable progress of humanity in social, political and technological terms in a historical context.

This is the context of how knowledge is disseminated today, which has always been linked to technologies of all kinds, constituting an object of study and observation by Information Science, such as the invention of the printing press. which led to the creation of Encyclopedias. According to Burke (2000, p. 19): “The Encyclopedia is a collection of information available in its time and a vivid illustration of both the politics and the economics of knowledge”.

Revisiting history, we find numerous other examples of technologies developed to facilitate information use and knowledge acquisition beyond the encyclopedia, such as the advent of the Univac computer in 1951, microfiche in 1961, and floppy disks in 1984 (Burke, 2012), to cite a few more examples. However, as Burke (2012) highlights, many of these technologies undergo a rapid obsolescence process, being replaced by others in a constant process of innovation.

Among these innovations, one that has been gaining prominence throughout history are the “thinking machines”, as Burke (2012, p. 329) asserts:

> However, the most significant development in the history of knowledge during this period was undoubtedly the advent of machines that – one might say – think, know, and learn, whether playing chess, aiming missiles, or taking photographs of distant planets.

The advent of the so-called thinking machines leads us to a possible “new” knowledge, resulting from the learning generated by them, governed by methodologies with the use of mathematical resources, the algorithm, mixed with statistical concepts, such as artificial neural networks, written in programming languages, which infer about databases arranged in the infrastructure of computational machines.

As an example of a methodology, we mention the *Knowledge Discovery Process* (KDD) (Fayyad, 1996), composed of nine stages, ranging from understanding the application domain, through algorithm selection, to the final phase focused on consolidating the discovered knowledge.

According to Regattieri (2018, p. 46), an algorithm can be defined as: “A computational algorithm is a finite set of instructions that, if followed, perform a specific task”.

These instructions are enhanced with statistical concepts, the most prominent of which today are neural networks, which seek to simulate the human learning process, such as the functioning of biological neurons found in the brain, as described by Silva (2020, p. 174):

> Specifically, reinforcement learning artificial neural networks have a training process analogous to human learning, via repetition and reinforcement, because the system's performance measure is based not on what is numerically expected from the network's output, but rather on whether the outputs are correct or not: that is, the parameter for verifying whether a neural network with reinforcement learning is successful is trial and error. This is equivalent to the idea that if a certain repeated action is satisfactory, it should be reinforced to be learned.

For a machine to “understand” this set of instructions, a translation is necessary, which is performed by a human being, in this case a programmer, via a machine-oriented program, which in turn is based on a previously defined programming language, such as Java, as Witten (2000, p. 265) demonstrates: “Java allows us to provide a uniform interface to many different learning algorithms.”

The program's execution is based on a database, also previously defined within the context of the chosen methodology, which requires rigorous processing to avoid potential “noise” at the end of the execution. The size of current databases is immense, requiring increasingly more machine resources for storage. This leads to the creation of neologisms, such as big data, whose meaning, according to Hartley (2019, p. 49), is: “The accumulation of larger collections of data than was technically feasible until the creation of vast data centers, which store them in what is now ironically denominated as ‘the cloud’”

The knowledge gained through machine learning is almost ubiquitous in early stages of the digital age, disseminated across various areas of human activity, such as business, academia, and government, expressed in the use of a myriad of algorithms, as Domingos (2017, p. 35) points out when referring to the Walmart company:

> Walmart sells millions of products and has billions of decisions to make every day; if its programmers tried to write a program to make all those decisions, they would never finish. Instead, these companies apply machine learning algorithms to the mountains of accumulated data and let them guess what customers want.

Despite an apparent natural evolution of knowledge, which becomes more “mechanized” to the possible detriment of human knowledge, which seems to be subjugated by the “mechanized”, some questions arise regarding this evolutionary path we have been rapidly following in our digital age: What kind of mechanized knowledge is this? What is it based on? What are the human inferences about it? Are we losing human faculties in the use of this knowledge? What are the limits of human and “mechanized” knowledge? Is there any prevalence or complementarity between these types of knowledge, or are we talking about symmetry?

To answer these questions, this study aims to conduct an in-depth analysis of projects focused on generating knowledge in a “mechanized” way. It proposes to go beyond a bibliographical review that meticulously examines the evolution of knowledge through time with technological support, culminating in the current context of the digital age.

The analysis of these projects will comprise from the design principles, through the choice of methodology, human resources and information technology, the expected results, and their assessment through a questionnaire directed at users who have benefited from the knowledge generated by machines, establishing a before-and-after comparison, with and without the “mechanization” of knowledge. The target projects to be analyzed will primarily be academic works focused on the use of machine learning within the scope of ANCIB’s Work Group-8 – Technology (National Association of Information Science in Brazil).

It is noteworthy that knowledge based on machine learning faces criticism and concerns regarding its everyday use, despite its success. Holzinger (2018, p. 2) states the following about machine learning: “This success is visible in many application domains in our daily lives, from healthcare to manufacturing”.

One of these criticisms stems from the deleterious effect that machine learning knowledge can have by being an agent of misinformation, an antithesis to knowledge generation, as Bucci (2024) states when discussing the digital age in relation to information and knowledge: “It stems from the opposite: the excess of misinformation”, and then asserts: “ignorance manufactured by cold algorithms and silicon tentacles”.

The absence of a dividing line between human knowledge and that based on machine learning gives rise to current discourses aimed at replacing humans with machines, since the machine's capacity to process the mass of information produced in the digital age and, therefore, generate knowledge, would far surpass the human capacity to perform such processing. According to one these discourses’ perspective, human beings would then be a mere consumer of knowledge obtained through machine learning, dispensed with the human action of thinking, which would correspond to the aforementioned machine processing.

Another cause for concern is the range of humans excluded from the digital age due to economic factors, including lack of access to technological devices such as computers, whose successful application of machine-based knowledge is still a long way off, as Canclini (2005, p. 236) states: “It is undeniable that the digital divide generates inequalities in productivity and labor income, occupational mobility options, access to markets, voice and vote in politics”.

Both criticisms and concerns deserve further attention in future studies, given their relevance to more concrete levels in the context of the evolution of human knowledge and that brought about by knowledge based on machine learning, in addition to other issues that deserve careful consideration, outlined below:

- Human beings are eminently beings lacking materiality, which does not correspond to the reality of knowledge based on machine learning, which is dependent on data based on electronic files.
- Currently, significant economic pressure is placed from the Big Tech companies, the largest American technology companies, such as Microsoft, to purchase AI (Artificial Intelligence) products, which has machine learning is a subfield, leading to discussions about the supplanting of human knowledge by machine knowledge.
- AI is proving to be a huge market, offering products, services, and training from a multitude of players, which creates insecurity for those seeking preparation to use AI products, such as information science professionals who lack the technical training for its use.
- AI is an area of Computer Science (CS). The term AI is used in many diverse ways and for many diverse purposes, which does not contribute to having an objective and clear definition of the term. This often leads to incorrect use, in light of CS,

> contributing to the emergence of multiple formulations and hindering a more assertive use by those who intend to enter this area of CS.

Given the absence of a clear dividing line between human and machine knowledge, it would be necessary to identify the foundations that would establish a reference model; and to draw such a line, enable a more in-depth definition of the boundaries between them or their convergence.

These foundations are constituted by the actions of human inference in obtaining knowledge through machine learning, as well as in the processing necessary for this acquisition, outlining the automatic actions of the machine and, subsequently, the human actions regarding the use of the knowledge generated by machine learning.

The identification would aim to thoroughly evaluate the knowledge produced by machine-based learning in comparison with human knowledge, establishing the differences between one and the other, guided by the results regarding the application of "mechanized" knowledge, obtained in machine-based learning projects by the beneficiaries of this knowledge.

2 OBJECTIVES

By determining the characteristics of human and "mechanized" knowledge, it would be possible to classify knowledge in light of the aforementioned comparison. Knowledge acquired by human beings has well-defined foundations throughout history, but the knowledge derived from machine learning imposes new foundations, which deserve to be examined in detail. In this sense, it would be appropriate to:

- To identify the input on which machine-based knowledge is based, with an in-depth assessment from a critical perspective of its use, seeking to establish its advantages and disadvantages in relation to human knowledge.
- To demonstrate the formats of human interaction in machine-based knowledge generation and acquisition, envisioning the human contribution in relation to the "mechanized" one.
- To estimate how humans utilize machine-based knowledge, in order to understand whether this knowledge is instantly applicable or subject to human bias.
- To define a possible vertical hierarchy between human and machine-based knowledge, in a form of subordination, or a horizontal laterality, which would entail interdependence.

In this sense, analyzing machine learning-based projects will be valuable, both for contributing to the achievement of the stated objectives and for providing a theoretical basis to obtain the necessary references to establish comparisons between human and "mechanized" knowledge.

3 LITERATURE REVIEW

Before the present discussion on machine learning, we have gone through an entire evolutionary process, with humanity using different technologies that serve as a basis for support and to meet the objectives sought here, first in relation to human knowledge, as Burke (2012, p. 12) points out:

> Technologization of knowledge continued at the same pace as the war, driven by Kondratiev's fourth wave, the "electronic age" with milestones such as the following: 1951 Univac computer; 1956 U-2 spy planes; 1957 Sputnik; 1958 photocopier; 1959 first meteorological satellite, Vanguard II; 1961 carousel slide projector; 1961 microfiche; 1969 Arpanet; 1970 satellites of the American Defense Support Program;

> 1971 microprocessor; 1977 Voyager 1 and 2; 1978 Seasat; 1981 personal computer; 1984 floppy disks; 1987 iris recognition technology; 1987 PowerPoint.

This series of technological events so far allows us to infer that technologies have always served as a support for knowledge generation, in an initial effort to classify this knowledge, which we can denominate the pre-information society, which later evolves via the "information economy", as termed by Burke (2012, p. 331):

> The emergence of the "information economy" and knowledge-driven companies such as Apple and Microsoft, where productivity depends on research, has in turn led to the emergence of the "post-industrial society", also known as the "information society" or "knowledge society", in which daily life is permeated by new forms of knowledge.

It would also be appropriate to add that a new form of knowledge, referred to by Burke, would be knowledge based on machine learning, the "machines that think". In this regard, Domingos (2017, p. 31) highlights the following:

> Some learners gain knowledge, and others acquire skills. "All humans are mortal" is knowledge. Riding a bicycle is a skill. In machine learning, knowledge often takes the form of statistical models because it is largely statistical: all humans are mortal, but only 4% are American. Skills often take the form of procedures: if the road turns left, turn the steering wheel in that direction; if a deer jumps in front of you, brake.

Knowledge generated through machine learning is dependent on technological inputs in the form of data, which are essential for this generation, according to Hartley (2017, p. 46): "In essence, machine learning is the training machines undergo to perform tasks autonomously; they receive enormous amounts of data and are programmed to analyze everything on their own".

The use of data faces certain criticisms alluding to phenomena such as datafication, which is defined by Abreu (2014, p. 204) as: "The idea is that there is a quantitative component in everything we do and that data is indispensable to society's learning". This quantitative component reflects a more deterministic statistical knowledge, which subverts spatial human knowledge, requiring reflection on the possible benefits and drawbacks, in a fair comparison between human knowledge and that generated by machine learning, as Baldi (2014, p. 83) leads us to consider:

> This ultimately leads to the marginalization of one of the most important assumptions of statistics, that is, the sociological requirements and criteria involved in framing and selecting information considered relevant for the constitution of a sample are no longer taken into account, and these requirements and criteria are replaced by the accumulation of a large quantity of data of different quality and status.

To conceive of human knowledge as separate from machine-based knowledge does not reflect the close relationship between them; after all, digital technology serves humanity and not the other way around, as the evolutionary process of human knowledge demonstrates, as we have discussed earlier.

In this sense, we rely on "n" interactions of this knowledge, such as the conception of algorithms, according to Cristian (2017, p. 16): "Thinking about algorithms in relation to the world, learning about the main structures of the problems we face and about the properties of their solutions can help us to see how good we really are and to better understand the mistakes we make".

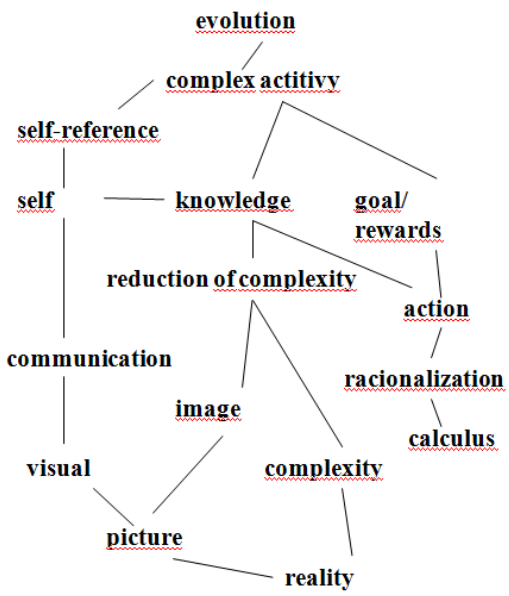
Demonstrating these interactions becomes useful for understanding machine-based knowledge, as well as illustrating how this knowledge is generated for human use, seemingly as an extension of human knowledge. We have a massive presence of machine-based knowledge, as Gillespie (2018, p. 97) states:

> Algorithms designed to calculate what is "trending," what is "popular," or what is "most discussed" offer us a superficial layer of the seemingly endless conversations that are available. Together, they not only help us find information, but provide us with the means to know what there is to know and how to do it; to participate in social and political discourses and to become familiar with the audiences we participate in.

It is worth considering whether this knowledge of what is "automatic" is absorbed, also "automatically", by its consumers, or whether there is any suspicion, especially as its origin becomes known, stemming from a "machine" based on data. In this perspective, Edmond (2018), in a lecture aimed at an audience of digital humanities, used a powerful phrase: "We cannot feel data. That is why everything we see printed on the screen is so sensitive. We are physical creatures. We need materiality".

In a framework for Information Science proposed by Wersig (1993), the presence of what has been conventionally denominated "calculus", symbolizing the spectrum of the most mathematical component, subordinated to rationalization, as one of the branches for knowledge generation. As shown in **Figure 1** below (Wersig, 1993, p. 238), entitled: "Example of a developing network", there is a reference to a hierarchical structure.

Figure 1: Example of a developing network



Source: Wersig, 1993.

Description: A black and white concept map connects Portuguese terms such as "evolution," "knowledge," and "communication" structured hierarchically and linked by simple black lines.

Transposing this hierarchy to the digital age, it is inferred that some of the hierarchy branches have been appropriated by machine-based knowledge, as observed in the consideration made by Weikum (2021, p. 9) regarding communication: "Both written and spoken languages are full of ambiguities. Knowledge is the key to mapping surface phrases to their proper meaning, so that machines interpret language as fluently as humans".

These appropriations require a detailed look at understanding these hierarchical relationships between machine-based knowledge and human knowledge, especially since, according to Cortina (2010, p. 34), Linguistics studies are quite complex: "[...] the limit they encounter is in the fact that a machine is not capable of inferring, deducing, concluding," alluding to the criticism from researchers in the field of artificial intelligence regarding the use of frames[1] in computer reading programs.

4 METHODOLOGICAL PROCEDURES

This research is a combination of bibliographic research and field research, represented by academic works from projects focused on knowledge through machine learning. A qualitative approach was chosen for this research project, aiming to establish a referential model of human knowledge versus "machine" knowledge.

The research project will be carried out by completing the following steps:

- Problem characterization: the objective is to contextualize the historical evolution of human knowledge up to the stage of knowledge obtained through machine learning in the digital age, drawing a dividing line between the two, in order to establish the limits of each of these types of knowledge.
- Literature review: In this second stage, bibliographic research will be carried out on the problem contextualized in the previous stage, in order to obtain a better understanding of the theme, including the point of view of various authors with a perspective to formulate a comparative basis that meets the general objectives.
- Field research: selection of a minimum of 10 academic papers focused on machine learning; definition of evaluation criteria for these papers through the development of a questionnaire for this purpose, aligned with the specific objectives already presented, developed on virtual environment, aligned with the practices of CONEP (National Ethics and Research Council), Brazil (2021). Throughout the process, answers will be sought to the questions raised in the introduction of this project, detailed below:
    - Identifying the user beneficiaries of machine-based knowledge projects.
    - Qualification of knowledge users obtained from the projects in focus: operational or decision-makers within their work in the field of Information Science.
    - Conducting interviews with these users, establishing the information base before and after the adoption of their projects.
    - Assessing the previous difficulties with information databases (source, generation, format, and transmission) and understanding the benefits subsequently gained from these projects in relation to users difficulties.
    - Determining a ranking in relation to the perceived improvement with the projects, such as none, little, medium, little and quite a lot, to establish a quantitative value for subsequent percentage evaluation.
    - Verification of whether users are still using the information base format prior to the projects, also fitting into the ranking.
    - The level of knowledge gained by users with the introduction of new projects, perceived and evaluated as low, medium, or high.

[1] We can conceptualize *frames*, as Muller (2013, p. 3) proposes: "We could also say that a *frame* is a knowledge structure that arises from the interactions reflected by language".

- Data tabulation: analysis of questionnaire responses administered to the target audience, in order to measure and qualify specific objectives based on the responses obtained, aimed at:
  - Evaluation of the information generated by the research, classifying information sources, generation, format, and transmission between human and mechanized knowledge, using a spreadsheet for comparison purposes.
  - Establishing a comparison between the rankings obtained from the research and respective level of knowledge, aiming at establishing percentages in relation to the number of analyzed projects, the number of users, and their categorization using Power BI tool, applied to the spreadsheet to eliminate redundancies in relation to the collected data.
  - Mapping the results to establish information inputs and uses for obtaining knowledge, both with and without machine learning, to establish the boundaries and limits of this knowledge.

5 DISCUSSION

Based on what can be inferred up to the present stage of this research regarding the literature review, machine learning is a subfield of Artificial Intelligence (AI), which belongs to the field of Computer Science (CS), and in turn the most representative, as described by Domingos (2017). Due to the large number of developments and applications arising from this subfield, it ends up being confused with the field of AI itself, and as if that were not enough, it is also disseminated as a technology, or tool, or even an autonomous entity, as materializing an AI portrayed by Wikipedia (2025) in the 1968 science fiction film, 2001: A Space Odyssey. In the movie, the computer HAL 9000 dominates all the functions of the Discovery One spaceship, on an exploratory mission towards Jupiter, engaging in a duel with the crew, such as Dr. David Bowman, in fluid and natural language.

The multiple formulations about AI mentioned here have already ingrained in people's imagination from the layman to the scientist, and do not seem to contribute to an adequate appropriation of machine learning by other fields as a resource for acquiring knowledge. In Information Science, theorists, referenced in this field, theorize with foundations about AI, in an apparent distancing from its original field, which is Computer Science, making inferences that may cause harm to the formulations they propose to make, in which it is pertinent to examine some authors and papers in this context.

Hui (2020), in his work Technodiversity, proposes a perspective of technology, more focused on the technical/mechanized issue, a topic of constant reflection by IS, as observed in Burke (2012), who traces an evolutionary roadmap of technology; Canclini (2005), who opposes the use of this technology as an instrument of inequality - authors referenced in the introduction section.

Hui's perspective, more Eastern than Western, when addressing what he calls the paradox of intelligence, draws a comparison between AI and human intelligence - the latter as limitless and little known, whose artificiality consists of schematized matter, while the former is subject to mutations. He theorizes about Bergson's geometricism, differentiating intelligence and instinct, and correlating intelligence with matter, adding a process of externalization of this matter via complementary organs, in which, according to the author, AI would gain advantages by enabling mutations.

The author warns that, in the long term, all quantifiable functions of human intelligence will be replaced by machine intelligence, and understanding the limits of AI does not mean gaining control over it, but rather bringing new ecological, political, and economic conceptions of machine intelligence.

The author reflects on the progression from weak AI to stronger AI, which would lead to superintelligence, drawing attention to the recursive nature of the algorithm that would enable computational efficiency, employing a non-linear causality unable to comprehend recursiveness between cognition and the world, as is the case, according to the author, with the Turing machine.

He infers that "with the increase in the amount of data and with more efficient mathematical models for development, machines can achieve higher levels of accuracy in terms of predictability", thus describing the power of AI, Hui (2020, p. 150): "The power of artificial intelligence is based on reducing the world to computational models".

The author addresses Bergson's view on mechanism and mysticism, which refuses to see mechanism as something repetitive, but rather as some greater soul capable of restoring life, and reflects on the need to consider other forms of knowledge not yet considered by engineers and scholars working with AI.

As observed, the author attributes the potential prevalence of cybernetics to a lack of technological knowledge. In this sense, without prejudice to the author's appropriate perceptions regarding AI, these could be more insightful, based on a greater understanding of AI, especially as the author is predisposed to understanding its limitations. First, it is important to establish that AI is not an autonomous entity, technology, or tool; it is an area of Computer Science, whose greatest expression is the subfield of machine learning, as, a graduate and active author in the field of Computer Science whose involvement in this field allows for a more accurate analysis of AI, Domingos (2015, p. 31), highlights that Machine Learning predominates over AI:

> Machine learning is sometimes confused with artificial intelligence (or AI, for short). Technically, it is a subfield of AI, but it has grown so much and become so successful that it has overshadowed its proud parent. The goal of AI is to teach computers to do what humans currently do best, and learning is undoubtedly the most important of these tasks; without it, no computer can match a human for very long; with it, everything else follows.

That said, the author could contextualize the view of externalization under Bergson's aegis, from the perspective of a human actor, whose knowledge proves relevant. Not present in this contextualization, but which is responsible for the possible mutations to which the author refers as belonging to AI, the programmer, which Domingos (2015, p. 27):

> A programmer – someone who creates algorithms and codes them – is a little god, creating universes whenever they want. We could even say that the God of the Bible is a programmer: language, not manipulation, is his tool of creation. Words become worlds. Nowadays you too can be a god, sitting on the couch with your laptop. Imagine a universe and make it real. The laws of physics are optional.

Despite the author's philosophical stance on technology, a recurring theme in various fields of knowledge, such as Information Science, a factor that could contribute to and serve as a basis for greater understanding of AI, beyond the fruitful contributions he offers, would be the advancement of interdisciplinarity within bordering disciplines of Information Science, advocated by Saracevic. Since the author discusses data as the basis of AI: library science, computer science, cognitive science (including artificial intelligence), and communication, could be carried out in such a way that we would have a more solid epistemological foundation, the result of this interdisciplinarity. This would allow us to infer about the important themes we have in relation to our digital age, which would add to the author's proposal, cited here, of understanding the limits of AI, potentially converging with the proposal of this research to envision the boundaries between human and mechanized knowledge. It is worth noting that Saracevic's proposal, regarding interdisciplinarity, explicitly mentions AI, Saracevic (1996; p. 50):

> One of the key areas of interest for both computer science and information science is artificial intelligence (AI). While AI can be discussed on its own, I prefer to discuss it from the perspective of cognitive science to illustrate the shared interests regarding the processes of the mind. Ultimately, the source and target of information science has been information from and to the mind.

Corroborating Saracevic's proposal, we perceive that the fields of knowledge, Information Science and Computer Science, seem to go hand in hand, as Cristian (2017, p. 161) describes, when citing an example of the association between the functioning of human memory and an analogous type of computer functioning also described as memory:

> In 1987, psychologist and computer scientist John Anderson of Carnegie Mellon was reading about information retrieval systems in university libraries. Anderson's goal—or so he thought—was to write about how the design of these systems could be informed by the study of human memory. Instead, the opposite occurred: he realized that information science could provide the missing piece in the study of the mind.

Han (2019), in his work Hyperculturality, discusses what he denominates the information regime. Information is processed by algorithms and AI, determining political, economic, and social processes. He warns, however, that docile bodies, converted into production machines, are not bearers of data and information, but rather bearers of energy.

In this context, Han, when mentioning information processing, investigates one of the most important objects of Information Science, which is the use of information, as referenced by authors cited in the introduction: Abreu (2025), who advocates a different way of dealing with information; Bucci (2024), in his critique of information that travels via algorithm; Pinto (2020), in the purposes of appropriating this use from a more human perspective; while Regattieri (2018) also considers the algorithm in a more technical/mechanized aspect.

The author also warns about the surveillance exercised in the information regime carried out through data, which is related to Beiguelm (2021), who also emphasizes this surveillance. citing a panoptic disciplinary regime, in which mobility would be restricted, with no possibility of escaping the control of that regime, but since this surveillance is not felt, one enjoys a sense of freedom, thus ensuring one's own domination.

People strive for visibility as if they were themselves, but ultimately, they serve as "pawns," offered restrictive positions so they cannot leave, through a pseudo-freedom, controlling our will through an unconscious plan.

He continues to advocate that we are participating in a *digital eucharist*, associating the media with a church, and the *"like"* (the word used to indicate that we like certain content) is equivalent to *"amen"*. He alludes to the digital environment as a totalitarian political system, in which the obedient masses submit to the leader, within a kind of globalized sports stadium. The masses are only able to watch the game, for which they did not participate in the organization, surrendering to the sovereign who controls the information on the network.

He refers to Luhmann to observe: “In an information society, we do not talk about rational behavior, but rather, at best, intelligent behavior”, and then highlights the influence of *bots* (known as robots, used to disseminate specific information on the internet) in modifying the climate of opinion, interfering in electoral decisions, for example.

What can be observed, then, is that Han denounces, among other issues addressed in his study, the harmful effects of information use, through the use of resources present in the digital age, in a categorical and assertive manner. However, like Hui, a deeper exploration of the AI context could have made a more robust analysis, as he refers to algorithms and AI as if they were different, when in fact they are part of the same context, as Regattieri (2018, p. 470) demonstrates.

> Artificial intelligence has been abandoned in favor of machine learning techniques. The transformation from a rule model based on algorithms to a set of machine learning techniques is due to the emergence of a technicality in the history of algorithms and the progress of machines capable of computing thousands of models at once.

The author further infers about information and data, whose categorization, present in many analyses in the field of Information Science, such as that by Simedão (2014), would be important, given the several existing interpretations regarding these two terms, which are sometimes confused. The correct understanding is crucial to underpin concepts derived from information and data, which in turn constitute a crucial resource for machine learning, reflected in the introduction by Hartley (2019).

Beiguelm (2021), in a line that seems to complement Hui and Han, turns to the aspect of technology over the human when examining technological resources, such as facial recognition, operated by machine learning. According to his view, from human characteristics obtained from the face, in Politics of the Image: Surveillance and Resistance in the Datasphere, also drawing a parallel regarding the use of photos through Creative Commons licenses, it serves to unlock copyright, but does not protect individual rights, which becomes evident with the use of AI, requiring ethical norms for this use.

The author reflects on how we arrived at data processing, machine learning, and IA programming techniques, understanding that it is necessary to consider the technical and political choices that led us to this point to construct a historical framework.

The text refers to Alan Turing (considered the father of computing) and indicates that Turing "spoke of learning machines and not machine learning", whose challenge would be an unlimited storage capacity using random programming, with an ephemeral validity for the rules altered in the learning process. He also cites Hui to emphasize that AI limitations stem from the fact that they are not technologies founded on recursive thinking.

Like Hui and Han, Beiguelm would have a better understanding of techniques related to the field of Computer Science, such as random programming, bringing it closer to this field, as random programming, from Turing in the 1950s, has been evolving to encompass randomness, represented by unknown events, through numerical classification in program development. Almeida (2025), who differs, in turn, from the recursive issue analyzed by Hui, in what languages geared towards AI-based applications, such as the large-language-model (LLM), seek to use, Bessa (2021), in which the limitations pointed out by the author are not eliminated, but they continue to be the subject of study by Computer Science, which tends to reduce these limitations over time.

Despite all this evolution in the field of computer programming, the central question remains: learning, something very difficult to define even for humans, let alone when applied to machines, according to Witten (2000, p. 6):

> This ties learning to performance rather than knowledge. You can test learning by observing the behavior and comparing it with past behavior. This is a much more objective kind of definition and appears to be far more satisfactory.
> But still there`s a problem. Learning is a rather slippery concept. Lots of things change their behavior in ways that make them perform better in the future, yet we wouldn`t want to say that they have actually learned.

Social scientists, particularly those in the category the authors belong, are not expected to have in-depth knowledge of issues arising from the field of CS, but a focused approach to reference sources in this field would help them build more solid inferences from these references, not limiting themselves to the field of origin, which would successfully implement the interdisciplinarity proposed by Saracevic (1996).

Despite this apparent limitation, even among social scientists, criticisms began to emerge regarding the use of AI, and Coldry (2014) can be mentioned, exposing certain of machine learning limitations, perceived through his own lens, even without reference to CS.

> "It's not intelligence, nor is it artificial, because it depends on human work to train it. It's merely probabilistic, not creative." And he goes further: he states that it's a misleading description that creates a misleading perception. "At the very least, it's a marketing exaggeration that serves the interests of some large technology corporations".

Coldry (2024) is even more emphatic when highlighting the potential risks of AI:

> If the 'existential risk' of AI lies in the social transformations that unfold around it, the role of the social sciences should not be **acceptance** but rather **critique** of AI.

It is noteworthy that a certain distance between Information Science and Computer Science continues to predominate, requiring a more accurate perspective on the boundaries represented by human and mechanized knowledge. This allows authors in Information Science to better situate themselves when constructing inferences from the field of Computer Science, even benefiting the development of both fields, as can be initially concluded in this ongoing research project.

6 CONCLUSIONS

As previously stated, the "so-called thinking machines" reflect an evolutionary character of technology in the digital age, indicating a new frontier for human knowledge in which Information Science is comprehensively involved. In this sense, Gómez (2004, p. 65) states when discussing knowledge production: "What appears as irreducible transversal elements in the cultural landscape would seem to be, from this century onwards, an inevitable scenario in the domain of science and technology".

Regarding this inevitability, it would then be appropriate to reflect on the boundaries that separate human knowledge from "mechanized" knowledge, to clarify the dividing lines and/or converging points. It is necessary to confront, with sound evidence, certain untimely discourses that claim the replacement of human knowledge by "mechanized" knowledge, which still seems to be a remote possibility.

This hypothetical possibility of substitution, which could be envisioned in our digital age, is felt in the realm of technological development, which has been gaining ground over the years, following a spiral trajectory, but which is understood to be more suited to assisting human beings in daily tasks , whether personal or professional, than to represent a mere replacement of human actions of thinking and doing.

This assistance to humankind, via technology, is evident in the use of technological devices, about which Gomez (2004, p. 60) refers as: "In the development of these devices, norms and infrastructures, multiple actors intervene, with different skills and interests, whose conceptions and procedures intersect different instances and dimensions of the possibilities of communication and information".

Machine-based learning, which produces the respective "mechanized" knowledge, could be categorized as an information device, as it acts within the action context of these devices, according to Gomez (2004, p. 56), as: "an organizing matrix of the concrete operations of information generation, transmission and use".

It would be appropriate to infer, therefore, that information, translated as knowledge, and consequently Information Science (IS) itself, are beneficiaries of the aforementioned development, which deserves a more accurate perception. This project aims to establish the boundaries mentioned in the previous paragraphs, attempting to set clearer limits between different types of knowledge, which is fundamental in the context of our digital age.

These boundaries would allow IS agents to navigate machine learning more smoothly, which, based on the current bibliographic research conducted so far, seems feasible and very welcome, as IS and CS (Computer Science) appear to go hand in hand.

Despite the possibilities of coexistence between IS and CS, some critics, such as Coldry (2024), do not envision a peaceful relationship between the social sciences, in which IS is included, and AI, which emerged from CS, but rather a relationship subservient to certain corporations, as inferred from the author's description of AI, even though he acknowledges AI evolution from computing, and is even more emphatic when he points to potential risks of AI.

Coldry's critique, far from invalidating the use of machine learning in IS, allows us to foresee, from an appropriate view of AI, as a probabilistic model, and if we compare it with Domingos' (2015) view, already referenced here, that the objective of AI is to teach computers to learn, and this involves the human training that Coldry refers to, we would only need to establish a minimum consensus on this machine learning, its appropriate terminology, something transmuted into the term AI.

Based on these minimum consensuses, it would be appropriate to analyze employability in IS through models, systems, and applications based on machine learning (AI), which are already proliferating with the various calls for papers in IS. This is revealed, for example, in the recent 33rd National Seminar of University Libraries (SNBU, 2025), whose papers, directed to axis 4 - Products, Services, Technology and Innovation, included five AI applications aimed at libraries. Finally, it would remain to qualify the knowledge produced in this employability, which this research project is undertaking, in order to translate the results in favor of IS.

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