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John McCarthy: Pioneer and innovator of artificial intelligence

جون مكارثي : رائد الذكاء الاصطناعي

Marwa Merrouche[1], Djaouida Ghanem [2]

[1] Akli Mohand oulhadj University-Bouira - (Algeria), laboratory "interdisciplinary in human sciences, environment and society"
m.marrouche@univ-bouira.dz

[2] dj.ghanem@univ-bouira.dz

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Abstract:

The idea of an intelligent machine is not new, but it became clearer with the advent of the term "**Artificial Intelligence**", which can be dated with John McCarthy, one of the most prominent pioneers in this field. McCarthy has contributed significantly to the definition and development of artificial intelligence since its beginnings, providing many pioneering ideas that formed the theoretical and applied foundations of this science. At the Dartmouth Conference in 1956, McCarthy coined this term, and since then his achievements in Computer Science have been rolling out, including his invention of the programming language "LISP", which is considered an outstanding addition in the development of artificial intelligence.

So, this research paper aims to study the main concepts presented by John McCarthy in the field of artificial intelligence, and understand how they affect current research. It also seeks to discover the technical innovations introduced by McCarthy, to finally reach results that highlight how to take advantage of his legacy in the development of new technologies, enhancing innovation and creativity in this vital field.

Keywords: John McCarthy, artificial intelligence, Dartmouth Conference, lisp translation language, computer.

Marwa Merrouche

الملخص:

إن فكرة الآلة الذكية ليست جديدة، لكنها أصبحت أكثر وضوحًا مع ظهور مصطلح "الذكاء الاصطناعي"، الذي يمكن تأريخه مع جون مكارثي، أحد أبرز الرواد في هذا المجال. لقد أسهم مكارثي بشكل كبير في تعريف وتطوير الذكاء الاصطناعي منذ بداياته، حيث قدم العديد من الأفكار الرائدة التي شكلت الأسس النظرية والتطبيقية لهذا العلم. في مؤتمر دارتموث عام 1956، أطلق مكارثي هذا المصطلح، ومنذ ذلك الحين توالت إنجازاته في علم الحاسوب، بما في ذلك اختراعه للغة البرمجة "LISP"، والتي تعتبر إضافة بارزة في تطوير الذكاء الاصطناعي.

لذا، تهدف هذه الورقة البحثية إلى دراسة المفاهيم الرئيسية التي قدمها جون مكارثي في مجال الذكاء الاصطناعي، وفهم كيفية تأثيرها على الأبحاث الحالية. كما تسعى لاكتشاف الابتكارات التقنية التي قدمها مكارثي، لنصل في النهاية إلى نتائج تبرز كيفية الاستفادة من إرثه في تطوير تقنيات جديدة، مما يعزز الابتكار والإبداع في هذا المجال الحيوي.

الكلمات المفتاحية: جون مكارثي، الذكاء الاصطناعي، مؤتمر دارثموث، لغة الترجمة LISP، الكومبيوتر.

***Corresponding author**: Marwa Merrouche*

1. Introduction

It is now clear that artificial intelligence programs have a great capacity for self-reflection and learning. So, we can say : any program capable of performing human tasks is considered artificial intelligence, as it represents an imitation or simulation of the human mind. This is done by building and designing computer programs that enable a machine to perform tasks instead of a human, similar to its functions and mental abilities. Artificial intelligence is based on analyzing huge amounts of data, using it to track patterns and reach informed decisions.

John McCarthy is considered the most prominent pioneer in the field of artificial intelligence, as he played a pivotal role in the development of this field since its beginnings. He is credited with coining the term "artificial intelligence " during an article he published titled " What is artificial intelligence?", As well as his role in the famous Dartmouth Conference of

1956, which is considered the starting point of this science. McCarthy believed that machines could mimic human thinking, and he strove to realize this vision through his research and innovations.

McCarthy, however, was not limited not only to technical innovations , but also philosophical ideas about artificial intelligence. He had an ambitious vision about the future of intelligent machines, as he believed that artificial intelligence could be used to solve a wide range of problems, from medicine to engineering. However, his career was not without challenges.

The importance of the topic lies in the following: in knowing the historical foundations that show the outstanding background of the works and achievements of John McCarthy in the technical medium and promote the radical development of this term. It highlights the innovations developed by John McCarthy in artificial intelligence, which in turn contribute to the formation of the modern concept of artificial intelligence.

This research paper aims to highlight the most important contributions of John McCarthy in Computer Science, and his largest contributions are the formulation of the term artificial intelligence, and in providing a description of computer programs .In addition to trying to provide insights on how McCarthy's ideas can be used in the development of new technologies, foreseeing the future of artificial intelligence, and raising awareness about the importance of artificial intelligence and its impact on daily life, which helps to form a positive outlook towards future innovations.

The approach followed in this presentation is the descriptive analytical approach, the descriptive approach by providing a comprehensive description of the concepts and ideas presented by McCarthy, such as artificial intelligence and the "**LISP**" language, while clarifying their impact on research and applications. As for the analytical approach, it emerged in

analyzing the technical innovations launched by McCarthy and evaluating their role in the development of intelligent systems.

After John McCarthy established the theoretical and applied foundations of artificial intelligence, and made his legacy sustainable in modern research and applications researchers had to track these innovations according to a systematic presentation and on this basis we thought to pose the following main problem: How did John McCarthy's ideas influenced the development of the concept of artificial intelligence, and what challenges did he face in pursuit of The sub - questions are :

- What is the concept of artificial intelligence And how important is it And who is John McCarthy What is his most important achievement?
- What are the most important ideas and concepts presented by McCarthy that formed the basis for the development of artificial intelligence ?
- Can we take advantage of McCarthy's achievements in the current era?

2. An Overview of the Concept of Artificial Intelligence According to John McCarthy.

Artificial intelligence has undergone remarkable evolution, becoming an integral part of our daily lives and sparking a revolution across various fields. One of the key figures in the development and popularization of this groundbreaking technology is the renowned computer scientist John McCarthy.

2.1. The concept of artificial intelligence (Artificial Intelligence)

Since a long time ago, until the last century, there were many attempts in the field of artificial intelligence , this modern concept of making machines understand, learn, think and deduce, and not just perform calculations, it has been the great dream for decades due to the difficulty of combining theories in understanding the work of the human brain, and for this we find a difference between:

Artificial intelligence (**AI**) consists of two words: "intelligence" and artificial", and "intelligence" means the ability to understand new

circumstances or situations, through perception, understanding and learning, but the word "artificial "is related to the verb" make "or" make up " and refers to everything that arose through an activity or action through which things are made and formed in distinction from things that already exist and are born naturally without human intervention (Mahmoud, 2020, P. 182).

According to John Mccarthy, artificial intelligence is " the science of engineering and manufacturing intelligent machines that simulate the basic mental processes of intelligent human behaviours, and building artificial systems that enable a computer to perform actions that can only be achieved by human intelligence."

Research in the field of artificial intelligence began a long time ago, but its" official " beginning dates back to 1956, when John McCarthy and Marvin Minsky, two young mathematicians, persuaded clord Shannon, who was then famous as the inventor of Information Theory, and Nathaniel richeser, the designer of the first computer sold on the market from IBM, to join them to organize a summer program at Dartmouth University, the goal of which was as follows:

The program is based on the assumption that all learning answers or any feature of intelligence can, in theory, be accurately described so that machines can be made to simulate them, an attempt will be made to discover how to make machines speak language, formulate abstract ideas and concepts, solve a variety of intractable problems that are limited to research on humans, and develop from themselves, we think that significant progress can be made in one or more of these issues if a carefully selected team of scientists works on them during one summer (Russell, 2017, p. 16).

The concept of artificial intelligence refers to the ability of a computer program to solve a problem or make a decision in a particular situation. The program itself determines the appropriate way to solve the problem or reach a decision, by referring to a variety of heuristic processes involved in it. Artificial intelligence aims to understand the nature of human intelligence

and simulate its behaviours, through the development of computer programs capable of imitating intelligent human actions. (Al-lingawi, 2024, page 20).

Artificial intelligence is the behaviour and certain characteristics of computer programs that make them mimic human mental abilities and their working patterns .

One of the most important characteristics is the ability to learn, infer and perform a reaction to situations that an ordinary machine or an ordinary computer cannot act on because it was originally not programmed to do this (Al-dabaeen, 2020, P .46). then the concept of artificial intelligence expanded and specialists became carrying computer programs that simulate human mental abilities and modes of work, that is, the ability to learn, perceive, deduce, think logically and react to situations that were not programmed in the machine. This field is based on the assumption that the mother of the Queen of intelligence can be accurately described so that the machine can simulate her, and this is undoubtedly a special assumption both regarding the possibility of understanding intelligence and the possibility of simulating it (Sharif, 2017, p. 94).

And since artificial intelligence is computer systems that mimic humans in their actions , this does not mean that any piece of software that works through a certain algorithm and performs specific tasks is considered artificial intelligence.

In order to call this term a computer system, it must be able to learn, collect data, analyze it, and make decisions based on this analysis process, in a way that mimics the way humans think, which means the availability of three main qualities :

1-the ability to learn, that is, to acquire information and establish rules for the use of this information.

2- the possibility of collecting and analyzing these data and information and creating relationships between them, and this helps in the increasing spread

of giant data . 3-make decisions based on the analysis of information, and not just a certain verification algorithm (Khalifa, 2019, page 40).

3-make decisions based on the analysis of information, and not just an algorithm that achieves a certain goal (Khalifa, 2019, page 40).

Artificial intelligence can be defined as any method that aids in designing software, computers, and accounting systems that perform tasks typically carried out by humans with less time and effort, and in a more effective manner. It essentially simulates human intelligence.

2.2 The importance of artificial intelligence:

Artificial intelligence is extremely important in the life of humanity as the only tool or as a modern breakthrough that has caused an unparalleled revolution, which is why we are trying to highlight the importance of AI in these points:

- Due to artificial intelligence, humans will be able to use human language in dealing with machines instead of computer programming languages, which makes machines and their use accessible to all segments of society, even those with special needs, after dealing was the monopoly of specialists and experts

- Artificial intelligence will play an important role in many sensitive fields, such as helping diagnose diseases, prescribing medicines, legal and professional consulting, interactive education , security and military fields

- Intelligent machines will relieve man of many dangers and psychological stresses, and make him focus on more important and more humane things, and that is by employing these machines to do hard and dangerous work, explore unknown places and participate in rescue operations during natural disasters (al-Nour, 2005, p. 09)

- Artificial intelligence programs have a great ability to think and self-education, so we can say that any program that can perform human tasks is considered artificial intelligence, so the advantages of

artificial intelligence clearly show that it can reduce the occurrence of human errors, as it makes decisions at every step based on a set of algorithms and information collected in advance, so some may

- Due to the structure of coins that are resistant to the impact of natural hazards that an ordinary person cannot withstand, another advantage may appear in the use of artificial intelligence in dangerous work that may take human life . This is what artificial intelligence can do accurately and easily on behalf of humans (Al-Sibai, 2024, P. 126) . We can conclude that the importance of artificial intelligence is diverse and multifaceted, meeting the needs of individuals according to their specific requirements. While it is challenging to encompass all its benefits in a few points, here are some of the positive aspects that artificial intelligence offers, such as saving time and effort.

3. About the life and achievements of John McCarthy:

3.1. the life and beginnings of John McCarthy

John McCarthy (1927-2011), the godfather of artificial intelligence, was born on the Fourth of september1927 in Boston, Massachusetts, received a bachelor's degree in mathematics from the California Institute of technology in 1948, received a Ph. D. in mathematics from Princeton University in 1951 and after a brief period spent at Princeton as a research instructor (1953-1951) taught at Stanford University (1955-1953). In 1958 he moved to MIT as an assistant professor of Communication Sciences, was promoted to associate professor in 1961, McCarthy moved to Stanford University as a professor of Computer Science, in 1962 and in 1987 he became the Charles M. Pigott professor of engineering(Lifschitz, 1991, p. 02).

His father was named John Patrick McCarthy, he emigrated to the USA from Ireland, and his mother named Ilda Glatt McCarthy emigrated from Lithuania. When the Great Depression began in the USA at the beginning of 1930, his parents remained unemployed for some time, and after short periods spent in New York and Cleveland, they settled in Los Angeles, where John McCarthy's father worked as an organizer of workers ' clothing, and Ida

was active in the women's suffrage movement, both were active members of the Communist Party of America. Only John McCarthy was a child prodigy, and although he attended school late due to a childhood illness, he finished school early. While at school, he showed a deep interest in mathematics and applied to the California Institute of Technology, his goal was to become a professor of mathematics. (V.Rajaraman,2014, Page 200) . We can confidently say that John McCarthy is a pioneer of artificial intelligence, as he laid the foundations of this field. After all, he is the one who coined the term "artificial intelligence."

4. John McCarthy's contributions to artificial intelligence:

In November1990 , Professor McCarthy received the National Award this note was prepared and a copy was published for the first time in the notices of the American Mathematical Society, by President Bush at a ceremony held at the White House, and received the Medal of Science, the highest national medal in the field of Science, Professor McCarthy made fundamental contributions in the field of computer science, perhaps more than any other researcher since the most important researchers in this field .

4.1 Dartmouth Conference:

An important idea was reached in artificial intelligence, namely, it was John McCarthy who first coined the term "artificial intelligence", since this term was officially born at the Dartmouth Conference in 1956. Hence, we wonder: how was the beginning of artificial intelligence.

After this question, many ideas were put forward that try to determine its beginnings and origins, as most researchers attributed its launch to the

Dartmouth Conference, in which the step of developing digital computers was taken. Previous computer applications focused on complex decision-

making and management, which at that time were handled using operations research techniques. The 1956 Dartmouth summer conference was preceded by a preparatory document dated August 31, 1955, written by John

McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon. The aim of the meeting was to study the hypothesis that every aspect of

education or any other feature of artificial intelligence can be accurately described, giving the possibility of manufacturing machines to simulate it.Among the most prominent computer programming pioneers who attended the Dartmouth Conference, there were Allen Newell, Arthur Samuel, Oliver Selfridge, Herbert Simon. After Dartmouth, historical centers for artificial intelligence research were formed at Carnegie Mellon University with Newell and Simon, at MIT with Minsky, and at Stanford University with John McCarthy. Donald Michie in Edinburgh also took over the legacy of Alan Turing,
before AI research spread to other European countries and around the world (Cordeschi, 2007, p. 277).
While at Massachusetts Institute of technology , he and Marvin minsksy organized and managed the artificial intelligence project and under their leadership, the MIT (Massachusetts Institute of technology) Artificial Intelligence Laboratory became the site of an exceptional flourishing of important and pioneering works in a wide range of fields, from robotics to computational theory to Computer Music and research in human and computer perspectives, in 1963, Professor McCarthy organized the artificial intelligence laboratories at Stanford University and was its director until 1980, in addition to his intellectual leadership, Professor McCarthy computers, especially those from eastern Europe And the Soviet Union.(Lifschitz, 1991, p. 03).
Where the game of inferential programming at the Dartmouth Conference played an important role in taking complex continents and data management and these are among the reasons that made software simulations of human behavior prevail over distributed approaches, self-organization and neural splices, which necessitated viewing these methods quickly and widely as a more brain-like computational method, especially when artificial intelligence was proposed as a new science of the mind in and brain imitators, in his review of previous advances in inferential programming, menisky opposed systems " He claimed that he did not like this kind of programming, if it was

possible to "simulate really sophisticated behavior". moreover, it would not be surprising that the mechanisms of the nervous system not currently known for intelligent activities were identified, and the remaining heuristic theory would not differ much from the type concerned with formal or linguistic models. at the moment it may be useful, as Minsky concluded, to devote for inferential programming or whatmany call "artificial intelligence" .(Cordeschi, 2007, p. 278).

One of the most important events that took place at the Dartmouth Conference, a group of the attendees who were mentioned earlier, wrote programs that surprised most people, the computer solved problems in algebra, proved logical theorems and spoke English, and by the mid-sixties those researches became funded by the US Department of Defense and these researchers made the following predictions:

In 1965 Herbert Simon predicted that " within twenty years machines will be able to do any work that a human being can do."

- In 1967 Marvin Minsky predicted " that within one generation.. The problem of creating artificial intelligence will be greatly solved "

- In the early eighties, artificial intelligence research witnessed a new awakening through the commercial success of" expert systems", which is one of the artificial intelligence programs that simulates knowledge and analytical skills.by 1985, the profits of artificial intelligence research in the

market reached more than a billion dollars and governments started funding again. a few years later, the collapse of the Lisp Machine Market, one of the programming languages, and in 1987, artificial intelligence research experienced another setback, but longer. (Bassiouni, 2024, P. 175).

- In the nineties and early Twenty-First Century, artificial intelligence achieved greater successes, albeit to some extent behind the scenes, artificial intelligence is used in logistics, data mining, medical diagnostics and many other areas throughout the technology industry due to several factors, namely: the great power of computers today and the increased focus

on solving specific subproblems and creating new relationships between the field of artificial intelligence.

- In the Twenty-First Century, artificial intelligence research has become highly specialized and technical and has been divided into sub-fields that are so deeply Independent that they have become few to each other. sections of the field have grown up around certain institutions and researchers have worked to solve specific problems and differences of opinion that arose a long time ago about the way artificial intelligence should work and widely apply various tools (Bassiouni, 2024, P. 176).

The Dartmouth Conference served as the cornerstone from which the field of artificial intelligence emerged, focusing on and expanding the scope of AI. However, we cannot say that John McCarthy's contributions were limited to the Dartmouth Conference alone; his influence extends far beyond that pivotal event.

4.2 LISP programming language:

In 1958, McCarthy developed the programming language "LISP", which remained the basic language in artificial intelligence for more than 30 years. During the same period, McCarthy was also a leading member of the groups that developed the languages "ALGOL 58" and "ALGOL 60". The design of programming languages remained a major concern for Professor McCarthy . Starting in the early eighties, he began to think about high-level programming languages that derive their central features from aspects of the human use of natural languages in communication. His first effort in this direction was the language of joint business communication in 1982. More recently, he developed the language "Elephant 2000", which is based on ideas from the theory of speech acts. This work combines McCarthy's research interests in the theory of programming languages and the representation of common sense. (Lifschitz, 1991, p. 03)

LISP is primarily designed to process symbolic data used for symbolic calculations in calculus, circuit theory, mathematical logic, game playing,

and other areas of artificial intelligence. The manual describes LISP, which is a formal mathematical language and differs from most programming languages in three important ways, the first way is the naturalness of data in LISP, all data is in the form of symbolic expressions commonly referred to as "S" expressions, with an indefinite length, and has a kind of branched tree structure, so that important sub expressions can be easily isolated. In a LISP system, the bulk of the available memory is used to store "S" expressions in the form of list structures, the second distinction is that LISP is the source language itself that determines the Way "S" expressions will be processed and, accordingly, like a machine language, and, unlike most other higher-level languages, it can be used to create programs for other implementations (j.Edwars, 1985, p. 09).Nevertheless, the programming language created by McCarthy, known as LISP, remains a powerful tool for facilitating artificial intelligence research. It is an ideal instrument for symbolic manipulation and continues to be used to this day.

4.3 computer programs:

One of the things that McCarthy started and was hidden from view was the use of computers. McCarthy radically changed the way computers could be used. the capacity of large computers is rarely fully utilized. it serves only one program. at its simplest, the computer is in sleep mode while the user

puts the program and the data associated with it. the use of computers was a stressful job, as the user had sequential activity followed in a period of

relative disuse. with a piece of expensive hardware and a lot of demand, a more efficient model was needed. McCarthy implemented the first system to share time at the Massachusetts Institute of technology in 1959, where it allowed For several users to use the same device at the same time, with the computer itself tracking the location of each user in its own actions, indirectly, this meant that people could access the computer remotely via a terminal device, through direct machine interaction with offline programming using punched cards or tapes, whereas nowadays, many of us do not deal with large devices directly, but the time-sharing feature is still

with us to this day, in any multi-user system, such as a server connected to a network, or a penetrating cloud system, hence we need to use one of McCarthy's concepts (al-Rimawi, 2020, P.126). This interactive mode, a mode in which computers become partners of users enabling them to solve problems and this logically led to the idea of time-sharing of large computers by many users and the transformation of computing into an auxiliary tool much like a power tool, the main contributions for which he is best known are the coining of the term artificial intelligence to describe computer programs that apparently demonstrate intelligence (V.Rajaraman, 2014, p. 198).John McCarthy did not stop at developing the programming language; he also contributed to the advancement of computer programs, machine learning, and deep learning. These efforts have achieved unprecedented levels in the field of artificial intelligence.

4.4 **Mathematics and common sense**:

In 1962, Stanford University invited John McCarthy to return to the mathematics department, he agreed to come on the condition that he was offered a full professorship, which the Department did, a year later, a new Department of computer science was created at Stanford and he moved there, started artificial intelligence activity and thus created a whole laboratory of artificial intelligence. A world-famous School of artificial intelligence at Stanford began with activities in robotics, speech processing and knowledge representation, where more than thirty students received Ph. D. degrees by working with McCarthy, many of whom won the Turing Award. (V.Rajaraman, 2014, page 206).

As for common sense, deductive reasoning in Mathematical Logic had a property called monotonicity, and this property means that if one starts with some assumptions and comes to a conclusion and then later adds new assumptions, there may be some new conclusions due to the new assumptions, but the original conclusions do not change, but remain valid, that many situations that we face every day, do not necessarily have this, where he explained a formal formulation and rules involved for guessing Instead of inference rules, hence the guesses will be correct until more facts

are obtained that may force the system to withdraw, I call it "Selection" and this is one of John McCarthy's important contributions to artificial intelligence. (V.Rajaraman, 2014, Page 204).

5. The prospects of artificial intelligence after John McCarthy:

After the term artificial intelligence spread and large-reel digital computers expanded, many issues were raised that would affect future research areas and future controversies in the field of artificial intelligence, among them:

- How to use non-digital programming, that is, symbolic, in simulating human capabilities by machine .

- How to determine the different uses of computers on the one hand realistically simulate the behavior of an organism, and on the other hand in engineering and effective management applications?.

- How to determine the relationship between theory and model within non-digital computer simulations taking into account the experimental barrier group and theoretical hypotheses?.

- Determine how the brain works and how to justify the role of Neurophysiology, having identified various factors at the levels of investigations, behavioural processes and brain processes that are both considered the embodiment of knowledge.

- Identification of computers and the type of logic that can be useful especially in relation to real-life situations and how to relate the decision-making process (Cordeschi, 2007).

In the first decade or so after the Dartmouth program, artificial intelligence flourished and witnessed many significant successes, including Alan Robinson's algorithm for general logical thinking, Arthur Samuel's checkers program, which he developed himself until he beat its creator, but the first artificial intelligence bubble burst in the late sixties of the twentieth century, when early efforts in the fields of machine learning and machine translation failed to live up to expectations, and a report prepared by the British

government in 1973 concluded that " we cannot point out that a branch of this field we say that the discoveries made in it so far have achieved the enormous impact that was Expecting from her " or, in other words, the machines were not smart enough (Russell, 2017, Page 17).However, McCarthy's original vision of creating machines with significant human-like intelligence remains a distant goal and is one of the greatest challenges of our time. This realization prompted McCarthy to focus on the ethical aspects of developing artificial intelligence applications, giving them considerable importance. Today, transparency, fairness, and human values are crucial in shaping the future of artificial intelligence.

6. The ethical side of artificial intelligence according to John McCarthy:

Artificial intelligence designers need knowledge, awareness and Ethics in order to protect programs from doing unethical actions. McCarthy was supported by most philosophers in the idea that all animals, including humans are deterministic machines. some people are afraid of the idea that machines cannot have free will. according to McCarthy, free will involves considering different courses of action. He summed up his position on human free will in the example of his daughter Sarah, who at the age of four said: "I can, but I'm not going to do it." John McCarthy sees that some chess programs have this kind of free will. In two different memos, McCarthy argued that robots would also need free will.

With regard to consciousness, McCarthy was one of the authors of the opinion that" thinking about consciousness is intended in its design to provide a new approach to some of the problems of consciousness studied by philosophers", in particular, from the point of view of artificial intelligence, consciousness should be viewed as a set of interacting scientific processes and not as a unified object, for many philosophical speculations, but he also claimed that "robots should not be programmed to have feelings or behave in a way that emotions are attributed to them".(J.Nilsson, 2012, p. 10).Despite all the advancements McCarthy achieved in artificial intelligence, ethical considerations remain a cornerstone of his vision for intelligent research.

These principles serve as a guiding light that McCarthy sought to establish in the quest for human-like intelligence in machines.

7. Conclusion:

In the end, we conclude: John McCarthy is one of the pillars of artificial intelligence, as he left an indelible mark in this field through his pioneering ideas and technical innovations. Since his introduction of the term "artificial intelligence" at the Dartmouth Conference and until his development of the programming language "LISP", McCarthy has contributed to the formation of the foundations on which modern applications of artificial intelligence are built. Despite the challenges and criticism he faced, his ambitious vision about the possibilities of intelligent machines continues to inspire researchers and developers to this day.

Recommendations and suggestions:

- **Reviving philosophical ideas**: AI researchers should explore the philosophical ideas put forward by McCarthy, such as the nature of intelligence and consciousness, to guide discussions about ethics and future applications.

- **Encourage innovation**: innovations in the field of artificial intelligence should be supported through education and research, focusing on the development of new tools and technologies inspired by McCarthy's ideas.

- **Interdisciplinary cooperation**: it is advisable to promote cooperation between different disciplines, such as psychology, philosophy, engineering, to better understand the impact of artificial intelligence on society.

- **Ethics orientation**: current research in artificial intelligence should include clear ethical considerations, to ensure that the technology is used responsibly and safely.

- **Education development**: it is recommended to include the concepts of artificial intelligence and the history of its development in the school

curriculum, to enhance students ' understanding of the importance of this field and its impact on the future.

- **John McCarthy's** legacy in artificial intelligence remains proof of the importance of innovation and critical thinking in the development of technology. By adopting the mentioned recommendations, the academic and industrial community can continue to make remarkable progress in this vital area.

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