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Hybrid Intelligence is a Highly Converged Model of Human-Computer Interaction

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Abstract

Introduction. The relevance of the study is explained by the fact that in the age of rapid development of science and technology related to the development and application of the concept of machine learning, operating with big data, artificial intelligence (AI) has achieved the ability to surpass people in each separate area. The development of hybrid intelligence faces cognitive differences, the digital gap between man and machine, and other challenges. Strengthening the interaction between cognition and perception can be the key to overcoming weaknesses. The purpose of the article is to conduct research on the development of a model of human-computer interaction, to study a new model of this process.

Materials and Methods. The work uses analysis and synthesis, a comparative method. The architecture of hybrid intelligence is built on the basis of a combination of the idea of human participation in the process and the confrontation between man and machine. The method of comparative and systematic analysis of similarities and differences between human intelligence, AI, and AI systems is also used.

Results. There are three main cognitive perspectives in current AI research: technological, human, and human-machine cooperation. Modern research mainly focuses on the theoretical elaboration and application of mixed intelligence and the construction of a hybrid intelligent architecture model. The confrontation between man and machine cannot be understood simply as competition between man and machine, and its ultimate goal is still to achieve a harmonious stable state of symbiosis between man and machine. It is emphasized that the interaction of man and computer involves the participation of man and machine, while the degree and status of this participation differ. "Interaction" reflects two-way information transmission and is machine-driven, while "cooperation" reflects human-dominated shared decision-making.

Discussion and Conclusion. Currently, a new round of scientific and technological revolution and industrial transformation is taking place. Big data applications and innovations in theoretical algorithms are driving intelligence. Technologies such as 5G and cloud intelligence take the development of distributed artificial intelligence to the next level allowing data to generate knowledge through cloud learning. Thus, thanks to the cooperation of machine intelligence and human mind, the merger of man and machine became the ultimate goal of the intelligence development. Human mind and machine intelligence adapt to each other and realize a common evolution and optimization of intelligence. Hybrid intelligence is a highly converged combination of rationality and sensitivity, intuition and logic, memory and data storage, as well as calculations, which is the future direction of the intelligent technologies' development.

Keywords: intelligence, hybrid intelligence, human-machine interaction, artificial intelligence, science, technology

Гибридный интеллект – высоконвергентная модель взаимодействия человека и компьютера

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Аннотация

Введение. Актуальность работы объясняется тем, что в век стремительного развития науки и технологий, связанных с разработкой и применением концепции машинного обучения, оперирующего с большими данными, искусственный интеллект (ИИ) достиг способности превосходить людей в каждой отдельной области. Развитие гибридного интеллекта сталкивается с когнитивными различиями, цифровым разрывом между человеком и машиной и другими проблемами. Укрепление взаимодействия между познанием и восприятием может стать ключом к преодолению узких мест. Цель статьи – провести исследование развития модели взаимодействия человека и компьютера, изучить новую модель этого процесса.

Материалы и методы. В работе применяются анализ и синтез, компаративистский метод. Архитектура гибридного интеллекта построена на основе сочетания идеи участия человека в процессе и противостояния человека и машины. Используется также метод сравнительного и систематического анализа сходств и различий между человеческим интеллектом, ИИ и ИИ-системами.

Результаты исследования. В текущих исследованиях искусственного интеллекта существуют три основные когнитивные точки зрения: технологическая, человеческая и сотрудничество человека и машины. Современные исследования в основном сосредоточены на теоретической проработке и применении смешанного интеллекта и построении модели гибридной интеллектуальной архитектуры. Противостояние человека и машины нельзя понимать просто как конкуренцию между человеком и машиной, и его конечной целью по-прежнему является достижение гармоничного устойчивого состояния симбиоза человека и машины. Подчеркнуто, что взаимодействие человека и компьютера предполагает участие человека и машины, при этом степень и статус этого участия различаются. «Взаимодействие» отражает двустороннюю передачу информации и управляется машиной, в то время как «сотрудничество» отражает совместное принятие решений, в котором доминирует человек.

Обсуждение и заключение. В настоящее время происходит новый виток научно-технической революции и промышленной трансформации. Применение больших данных и инновации в области теоретических алгоритмов способствуют развитию интеллекта. Такие технологии, как 5G и облачный интеллект, выводят развитие распределённого искусственного интеллекта на новый уровень, позволяя данным генерировать знания посредством обучения в облаке. Таким образом, благодаря сотрудничеству машинного интеллекта и человеческого разума слияние человека и машины стало конечной целью развития интеллекта. Человеческий разум и машинный интеллект адаптируются друг к другу и реализуют общую эволюцию и оптимизацию интеллекта. Гибридный интеллект представляет собой высоконвергентное сочетание рациональности и чувствительности, интуиции и логики, памяти и хранения данных, а также вычислений и расчётов, что является будущим направлением развития интеллектуальных технологий.

Ключевые слова: интеллект, гибридный интеллект, взаимодействие человека и машины, искусственный интеллект, наука, технология

Introduction. The relevance of the study is explained by the fact that in the age of rapid development of science and technology related to the development and application of the concept of machine learning, operating with big data, artificial intelligence (AI) has achieved the ability to surpass people in each separate area. At the same time, compared to human intelligence, AI is limited in the mode of entering and processing data, and also has disadvantages: AI is embodied in digital logic and complex calculations, but it does not work in a complex environment with emotions and purposefulness. Thus, the trend in the development of intellectual science is the mixed intelligence of man and machine, which we will call hybrid intelligence. The purpose of the article is to conduct a study of the development of a model of

human-computer interaction to comprehensively study a new model of this process. In this case scientific concepts related to hybrid intelligence and its architectural model are of interest.

Materials and Methods. The work attempted to clarify concepts related to hybrid intelligence through the method of analysis and synthesis, the comparativist method. The architecture of hybrid intelligence is built on the basis of a combination of the idea of human participation in the process and the confrontation between man and machine. The method of comparative analysis was used to identify similar AI concepts and systematically analyze similarities and differences between human intelligence, AI, and AI systems.

Results. Currently, the development of artificial intelligence (AI) is faced with many problems, such as cognitive differences, disunity, digital inequality between man and machine. There is no academic consensus on the definition of AI. Being an interdisciplinary field, it includes computer science, robotics, data science, neuroscience, philosophy and other disciplines. The report [1] comprehensively assessed the dynamics, problems, opportunities and prospects of modern AI: the future of AI is the merger of human and computer intelligence, namely hybrid intelligence (HI) of man and machine.

There are three main cognitive perspectives in current AI research: technological, human, and human-machine cooperation. The technology-oriented point of view claims that AI in the future will surpass people in all respects, that AI is theoretical and technical support for a human-machine intelligence system to achieve complex goals. This is mainly achieved through a combination of traditional robotics technologies and artificial intelligence technologies to increase the naturalness, safety and reliability of human-machine interaction and cooperation in terms of system modeling, interaction with perception, and joint control. In addition, technocentrism questions the fairness and effectiveness of human decision-making. For example, D. Kahneman [2] shows that the human decision-making process can be seriously distorted, since people tend to use heuristic approaches and can get biased results.

Anthropocentric experts have tried to make people's role more visible by focusing on a key topic: the impact of automated labor on people's sense of satisfaction and meaningfulness of life. Researchers [3, 4] do not deny the role of technology, but emphasize the importance of integrating intelligent technologies into a human-oriented system, since they foresee the possible negative consequences of using artificial intelligence technologies and do not consider it as a tool that will ultimately replace people.

Researchers who support the point of view of human-machine interaction [5–7] believe that AI is an advanced form of collective intelligence. Studying the development process of basic AI technologies, we came to the conclusion that AI has entered the stage of mixed intelligence consisting of many intelligent technologies. The so-called hybrid system is a system that spontaneously combines intelligent systems with complementary characteristics, mainly using intelligent technologies including expert systems, neural networks and fuzzy logic [8].

Modern research in mixed intelligence field focuses on theoretical elaboration and application of mixed intelligence and construction of a hybrid intelligent architecture model. As mentioned earlier, humans rely more on intuition and therefore have limited rationality, and machines do better at analysis, but they lack strong cognitive abilities and comprehension skills. AI will not be able to compete with human intelligence in perception, reasoning, induction and learning for a very long time. This requires introducing the role of humans into the artificial intelligence system. It should be noted that the confrontation between man and machine cannot be understood simply as competition between man and machine, and its ultimate goal is still to achieve a harmonious stable state of symbiosis between man and machine.

One of the most important difficulties is the difference in the perception of the world by people and computers when it is difficult to integrate human and machine intelligence. First, the perception and training of machines is limited in time and space and cannot be changed, while the perception of people is subjective and arbitrary. Second, machine perception of time and space is formal and specific, while people have subjective perceptions and expectations, and they adapt to the environment. Third, the basis of cognition is abstraction and representation. A person's high ability to abstract corresponds to the high ability of machines to represent knowledge. For machines, the ability to abstract information and extract knowledge determines the degree of difference between human and computer cognition.

Big data and artificial intelligence are inextricably linked: artificial intelligence relies on the existence and accumulation of big data and helps unlock the potential of data storage. However, big data not only contributes to the progress and development of artificial intelligence, but also limits the ideas of transforming artificial intelligence. The new "digital gap" caused by the monopoly on artificial intelligence technology has become an important problem in the development of intelligent technologies.

In a big data environment, human perception and knowledge of big data is especially important. Human intelligence must not only understand complex theories created by big machine thinking models based on big data, but also reveal the essence of things and solve complex problems based on large models. The problem of the "digital gap" between man and

computer arises when people cannot develop the ability to perceive and process complex information in conditions of huge amounts of data generated by machines.

The above dilemma reflects the high difficulty of reconciling the cognitive and behavioral levels of the brain and machine. At the moment, the merger of man and machine at the stage of application has a clear division of labor between man and machine. The process of human understanding of the world is essentially the process of using concepts, attributes, and connections to perceive the world.

In hybrid intelligent systems, both man and machine can develop together through enhanced cognition and achieve outstanding results at the system level [9, 10]. By expanding the possibilities of cognition, hybrid intelligence can flexibly coordinate various contradictions and paradoxes in human-machine intelligence. In human and machine data processing, the architecture for processing unstructured information (e. g., natural language) will have some structured gradient, and machine structured data, according to syntax, it will focus on unstructured cognition and interpretation. In such a situation, not only the use of reasoning based on justice but also combining it with non-public rational reasoning makes the entire process of cognitive conclusion more rigorous and justified in order to achieve the ultimate goal of improving cognitive abilities.

Another key to the success of hybrid intelligence is that people can understand how machines perceive the world and make effective decisions based on their thinking and self-expression. Thus, in the process of interaction, the key point is the transformation of the mode of thinking of man and machine. Fusion in thinking requires not only machines to perceive and understand human behavior but also humans to understand data-driven machine thinking. Only when perceptual interaction is achieved can intelligent integration be realized in the full sense of the word.

People are able to move from one area of knowledge to another, but machines are not. Therefore, the establishment of a two-way interaction between man and machine is a breakthrough towards the creation of real hybrid intelligence. On the one hand, the machine itself can use the mutual cooperation between machines and the feedback mechanism provided by the machine to "perceive" and strengthen machine intelligence through the game in order to realize the self-development of machine intelligence. On the other hand, as machine intelligence develops, people can also be inspired by machine feedback to enrich their own experience and knowledge, as well as improve their perception and cognitive abilities.

Based on the above problems and a key factor in the development of hybrid intelligence, a model of hybrid intelligence's architecture can be distinguished. The main part of the hybrid intelligent system includes both a man and a computer. The internal structure and operation of the system consists of the following levels: data source, data transfer, data processing, and application. In addition, the entire system also includes an external environment. Machine intelligence, represented by the computer, can achieve a rational, accurate and efficient state for transmitting and using objective data, and can also be trained on data from the environment. Some functions that people have not understood yet, but which they extract and compare, are that human-oriented human intelligence generates knowledge through the perception of the environment, relies on experience, and then transfers knowledge to the machine to help it better learn and perceive the environment. In the process of human-machine interaction and their collaboration, continuous interactive learning in the external environment allows the system to develop cognitive abilities and interact through perception, thereby achieving a more perfect result than when making decisions only by machines or people.

Against the backdrop of the era of big data, the combination of data and knowledge-based methods should be a way of continuous learning and the overall development of the man-machine system. At the data source level, people can provide high-quality data about swarm intelligence with characteristics of multimodality, rich content, space-time binding, human nature, etc., and form high-quality data sources by exchanging objective network data. At the level of data transmission in a swarm intelligence environment, the delay in transmitting perception data can be reduced due to interaction with a computer network.

At the data processing level, human cognitive abilities and experts' experience can help the machine to perform data association more efficiently and accurately, combining and understanding them. In particular, in cases where some tasks cannot be solved using existing machine intelligence technologies, joint human-machine calculations become the key to data processing. At the application level, based on the joint processing of data by man and machine, a machine can have developed abilities for perception and judgment, and its ultimate goal is to provide support in forecasting and decision-making, as well as cooperate with people to make the final decision. The accuracy of the final decision is largely determined by the ability of a man to comprehensively analyze, while a machine performs an indirect assessment of the result of the "interaction" obtained as a result of calculations. This unique decision-making process, combining intuition with "interaction", is an important feature of human-machine intellectual cooperation.

Thus, hybrid intelligence is the result of interaction and cooperation between man, machine and environment. This is a steady state resulting from the overlapping of the changing states of these three elements. Therefore, maintaining the

coordination and stability of these three elements is key. People in the system represent group intelligence. A machine includes not only equipment, but also methods of working with data, which is also associated with the natural and social, real and virtual environment.

Thus, artificial intelligence is an advanced form of intelligence that combines the advantages of machine and man. Unlike collective intelligence, which emphasizes the use of collective functions to enhance machine intelligence, AI pays more attention to solving complex problems simultaneously by both participants, which is more advanced interaction and cooperation. Although human-computer interaction involves human-machine involvement, the extent and status of this involvement varies. "Interaction" reflects two-way information transmission and is machine-driven, while "cooperation" reflects human-dominated shared decision-making. As a possible ultimate form of artificial intelligence, hybrid intelligence represents an ideal opportunity for human-machine symbiosis.

Discussion and Conclusion. Currently, a new round of scientific and technological revolution and industrial transformation is taking place. Big data applications and innovations in theoretical algorithms are driving intelligence. Technologies such as 5G and cloud intelligence take the development of distributed artificial intelligence to the next level allowing data to generate knowledge through cloud learning. Thanks to the cooperation of machine intelligence and human mind, the merger of man and machine has become the ultimate goal of the intelligence development. Human mind and machine intelligence adapt to each other, support each other, contribute to each other, and realize a common evolution and optimization of intelligence.

In a big data environment, the success of the big data model-based hybrid intelligence paradigm requires developing a new mindset. As the amount of data has increased, it has become obvious that human intelligence lags behind artificial intelligence in all areas. The human brain gradually has to adapt to big data and integrate with machine intelligence to create scale models to understand complex environments and solve complex problems.

As an organic system of human, machine and environmental integration, hybrid intelligence can absorb heterogeneous information from multiple sources faster and more efficiently. In the process of intelligent data processing, machine computing and human perception of information are combined to create a unique approach to understanding and adapting to external changes through cognitive amplification and interaction with perception.

Thus, hybrid intelligence is a highly converged combination of rationality and sensitivity, intuition and logic, memory and data storage, as well as calculations, which is the future direction of the intelligent technologies' development.

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