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COGNITIVE FEEDBACK LOOPS IN AI SYSTEMS

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Abstract:

In the field of psychology, cognitive structures can be defined as an information processing system that encompasses the acquisition of sensory information, its storage, retrieval, and use in making complex decisions in an individual's life. In psychological understanding, cognition or thinking involves mental activities such as comprehension, problem-solving, forward thinking, and decision-making. Cognition represents an individual's belief about something derived from the thinking process about a particular matter. Through cognitive processes, humans can acquire and manipulate knowledge by engaging in activities such as recalling, analysing, understanding, evaluating, and imagining a particular subject. The capacity and ability of cognition are generally defined as human intelligence. However, the presence of artificial intelligence (AI) systems in the field of psychology brings about a new transformation and new challenge. With continuous and unlimited two-way feedback interaction, humans can correct model errors, reduce bias, and inject domain expertise, while AI systems can support human thinking with real-time information and pattern recognition. Cognitive loops are heavily influenced by cognitive psychology principles, especially those related to perception, attention, memory, and learning. By modelling AI systems to reflect human cognitive processes, collaboration between humans and machines becomes more intuitive and effective. This paper explores the theoretical foundations, design strategies, and practical implications of cognitive feedback loops in AI systems. By fostering a symbiotic relationship between human cognition and machine intelligence, such systems hold the potential to create AI that is not only more accurate but also more aligned with human reasoning and values.

Keywords:

Cognitive Psychology, Human-In Loop, Feedback, Implementation, AI Feedback, Research Status AI.

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Introduction

The field of cognitive development in psychology focuses on how an individual's focuses on how the person or individual acquires, processes and stores information and mental skills evolve, influenced by their physiology, maturation, and life experiences, from childhood to adulthood. Most cognitive psychologists study the differences and similarities in the mental processes that occur in people at various stages of life. Prior to the 1950s the dominant school of thought has been behaviourism. For next twenty years, the concept of psychology world began to shift away from studying observables behaviours and moved towards studying internal mental processes which is focusing on topics such as attention, memory, problem solving, perception, intelligence, decision making and language processing. Significant changes in cognitive abilities are often linked to profound shifts in thinking, such as an increase in knowledge, maturity, and varying capabilities depending on one's developmental stage. Many cognitive psychologists agree that any changes in an individual are the result of their interaction with the environment and the situations they encounter throughout their lives. In the field of psychology, cognitive structures are regarded as essential systems through which individuals acquire, store, retrieve, and apply sensory information. This process enables them to make complex decisions about their lives. Cognitive functions, such as comprehension, problem-solving, forward and fast thinking, clearly decision making and critical thinking are central to human intelligence. Notwithstanding the current developmental issue, there are technically no limits to the possible applications of AI, which leads to ethical considerations, adept AI becomes at the crucial tasks of discriminating between different data sets to properly "self-learn. AI make us far away from distorted learning but if we're already being shaped by the AI. t's like looking into a mirror that reflects another mirror the feedback becomes circular. The AI thinks it's getting smarter, but it's actually learning from behaviour it helped create. That means its understanding of the world becomes more artificial and less grounded in reality. Dependency and Reliability. Over-reliance on AI could lead to a loss of critical thinking skills and judgment among individuals. The inability to discern between AI-generated and human-generated insights can be detrimental in situations requiring independent decision-making. Cognition allows humans to interpret and understand the world around them, manipulating knowledge through activities like recalling, analysing, evaluating, and imagining various subjects. While cognitive structures are fundamental to human intelligence, the introduction of Artificial Intelligence AI systems into this domain presents new challenges and possibilities for transforming human cognition. The rise of AI, especially systems that continuously interact and learn from human input, reshapes the way humans and machines collaborate. Through cognitive feedback loops, AI systems can complement human thinking and decision-making by offering real-time information, error correction, and pattern recognition.

This Paper Explores: The theoretical foundations, design strategies, and practical implications of cognitive feedback loops in AI systems, focusing on their potential to create a more efficient and symbiotic relationship between human cognition and machine intelligence.

Cognitive Structures and Human Intelligence

Research on artificial intelligence is still on development stage in term of stimulating human memory, attention, perception, knowledge emotions, intentions, desire or other dimension (Shi & Li,2018). According Yang,et al 2018, the perception of existing research and mythology and methodology artificial intelligence combine new theories and methods such as psychology, computer science and brain science to conduct artificial intelligence machine to simulation on peoples psychology and its reproduce people psychology with integrate and promote each other

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and jointly each other with balance , which is better and give great impact to human and computer interaction. Cognitive psychology describes the mental processes that allow individuals to comprehend, interpret, and respond to the world around them. These processes involve the acquisition of sensory information, its storage in memory, and its use for decision making and problem solving. Humans process information through perception, attention, and memory, utilizing these cognitive tools to navigate everyday challenges.

Cognitive is not just about recalling information, it involves the active engagement of the mind in critical thinking and decision-making. The implementation of AI in cognitive psychology aspect is providing new research an open new gate way to make the analyst do so through data mining, hidden pattern, new ideas, methodology and also probably lead to new hypotheses and results. Cognitive structures facilitate this process by organizing knowledge, allowing for efficient retrieval when needed (Baddeley, 2007). Human intelligence, a concept closely tied to cognition, refers to the ability to reason, solve problems, and adapt to new situations. In other hand, intelligence is often measured through various cognitive abilities such as memory capacity, problem-solving skills, and analytical thinking. In recent years, the concept of intelligence has expanded beyond human capability, with the emergence of AI systems that simulate cognitive processes and perform tasks traditionally requiring human thought. However, AI's involvement in cognition introduces new paradigms and potential challenges, particularly as machines begin to complement and collaborate with human thought processes (Russell & Norvig, 2020).

It the process of promoting the progress of artificial intelligence, psychology and its derived philosophy of mind of play an important role directly and indirectly, can build the strong fundamental supporting theories of Ai with human cognitive. Cognitive feedback refers to the process of providing information or responses to an individual or system based on their actions, decisions, or behaviours. The goal of this feedback is to help the receiver whether human or artificial system understand their performance, improve their thinking, and refine future actions or decisions. Cognitive development is seen through the information and internet breaking processing proposed by Piaget and Vygotsky. According to Sternberg (2003), any mental activity that involves observing, receiving, manipulating mentally, storing, combining, retrieving, or acting on the underlying information AI is a method and approach toward processing information accurately and effectively.

Literature Review

The Role of Artificial Intelligence in Cognitive Feedback Loops

The integration of AI into cognitive processes marks a new phase in the evolution of human cognition. Cognitive feedback loops in AI refer to continuous, bidirectional interactions between humans and AI systems. The purpose of feedback of loops to address these challenges, feedbacks looks have emerged as a pilot mechanism for aligning with AI output and feedback with real world need to ethical standards. The mainly aspect at cognitive loops it bridges the cognitive gap between human being intuition and machine pattern. These loops are designed to mimic the way human cognition works, where the system constantly learns from human input and adapts its performance accordingly. The key advantage of this dynamic relationship is that it allows for error correction and bias reduction, offering a more accurate and efficient decision making process (Jordan & Mitchell, 2015).

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Connecting the Dots in AI Theories Developed feedback loops appropriate for incorporation into our cognitive AI systems, which necessitate precise insights into cognitive psychology principles especially those dealing with perception, attention, memory, and learning. The AI Model Cognitive Feedback Loops are based on these ideas, but they take it one step further by allowing systems to interact with constant human input, which can correct errors and reduce bias, and ultimately learn continuously, rather than in epochs. This regular exchange from both sides creates a virtual channel which is essential to enhance AI's decision-making and maintain its alignment with human thinking (Barrett, 2018).

Psychological feedback loops are based on learning theories. Feedback loops, psychologically, wherein humans learn where and how they made mistakes and how future behaviours should be adjusted, keep this habit alive across generations. A similar idea is transferred to AI systems, where the AI model also receives feedback from human users, which can include corrections and expert knowledge of the domain. With each pass, the AI's decision making, pattern recognition, and general operations are improved (Varela et al., 2020).

Besides, most of AI system are called black boxes, which is would add to huge amount hardly already faced by research in transparency of cognitive psychology. Though AI algorithms may be good at to identifying correlation and making predictions and also to innate developing creative mind and make related recommendation to understand according human behaviour which is missing out of scope, beside that its comes as well with empathy and the huge ability of critical thinking.

Cognitive Feedback Loops in AI: Guidelines for Design

Implementing cognitive feedback loops in AI systems requires specific design strategies. The strategies emphasize designing the natural human-machine integration domain to maximize human cognition and machine intelligence cooperating effectively. Human-in-the-Loop (HITL) This is one of the key design principles you work with; make human feedback an integral part of the decision process. This method allows AI systems to improve constantly in real-world scenarios and with user interactions. By allowing these human paths HITL can allow for more personalized, responsive, adaptive systems that respond to person to person needs and preferences (Good fellow et al). Immediate and speedy feedback mechanism:

AI systems should be played in a way where they need to set up using rapid real-time feedback of users so that we can rectified it immediately. The functionalities help the system make corrections to adjust to new information or to an adapt to an environment that is changing outside of its knowledge (Bengio, 2020), ranging from specific changes not to make to these inputs that suggest more general behavioural adaptations. Adaptive learning Algorithms Another option is for data to be used in programming AI systems with adaptive learning algorithms. These algorithms allow the system to receive feedback in real time, using this information to continuously adjust its decision-making process. These algorithms mimic mental functions such as remembering, attention and even problem-solving; such systems enable artificial intelligence to "learn" from experience (Hinton et al. 2012). Pattern recognition and data interpretation beyond human input, IA systems can have feedback loops based on the accuracy of their human input. AI systems become more accurate as they increasingly analyse data and can find trends and patterns that are not immediately apparent or obvious, which increases the overall level of predictive accuracy (Silver, 2016).

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Cognitive feedback loops in AI systems: Below are a few useful implementations:

Healthcare Decision Support: Artificial Intelligence models can assist in diagnostics and decision-making increasingly more often within healthcare. Doctors and medical professionals appear to be able to correct AI predictions, inject expertise at key points in the prediction process, and adapt such systems to the idiosyncrasies presented by any particular patient, all in harnessing the power of cognitive feedback loops. These systems become increasingly more accurate in recommending treatment options and diagnoses (Rajpurkar et al., 2018).

Autonomous Vehicles: Cognitive Feedback loops are a must for autonomous systems, particularly self-driving cars. These systems use instant feedback and learnings from the ever changing environment, road surface quality and human behaviour. The infusion of human reasoning makes decision-making safer and more intuitive when such tasks demand to be adaptive and unpredictable (Bojarski et al., 2016).

Education and Personalization: AI-based educational tools use cognitive feedback loops to provide tailored learning experiences. Individual learning needs preferences are addressed with the feedback from students, AI will help student to develop the innate creative mind, communication skills, ability of critical thinking and learning proses, so that the system can change the content, teaching method, and difficulty per individual for enhancing the academic performance (Koller et al., 2013).

Cognitive Aspects of Human-Robot Interaction: Disciplines such as robotics leverage cognitive feedback loops to enhance the human-robot interface. By constantly learning from and understanding their human teammates, robots would be able to better adapt to human preferences and behaviour, allowing for more seamless cooperation in construction, caregiving, or even companionship (Breazeal, 2003). Ethical implications of cognitive feedback loops in AI systems. The addition of human input can guide AI systems to have ethical decisions accompanied with feedback loops to guide the AI to have human values and societal activity. Especially in high-stakes domains such as law enforcement, healthcare, and military applications, this is a more critical concern (Friedman et al., 2006).

Research Status (AI) and Cognitive Psychology

Research status between AI and Cognitive psychology is huge trending and give big metamorphosis among human nowadays but in the mid -1980s term of "Kansei Engineering" was introduced in Japanese science and technology community. According (Ali et al.,2020) the Japanese community interpret sensibility as human psychological characteristics student on human perceptual and ideas needs with engineering method, and then it could be conduct in-dept. research on people's perceptual information, and the term of their research on human brain and perceptual activities. Besides that, Professor Wang Zhiling of University of Science and Technology Beijing reviews that the concept of "artificial psychology on this basis. The artificial psychology theory is used in method of information science to realize the more comprehensive content of people's psychology activities. According the experts in "Kansei Engineering" this method can also be including low-level psychological activities and high-level presences of psychological activities. In this reflection of human brain on objective reality, which is makes artificial psychology have a new meaning of broader content.

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Minsky, one of the founders of artificial intelligence, proposed the theory of "society of mind" in his 1985 monograph "The Society of Mind" (Auxier, 2006), which attempts to combine the approaches of developmental psychology, dynamic psychology and cognitive psychology with the ideas of artificial intelligence and computational theory. Since then, the research on endowing the computer with emotional ability and enabling the computer to understand and express emotions has set off an upsurge in the computer field. In 1978, deep mind team put forward the theory of mind (Rabinowitz et al., 2018). In a broad sense, it refers to the ability of human beings to understand the psychological state of themselves and others, including expectations, beliefs and intentions, and to predict and explain other people's behaviours based on this. In 2017, in the case study of deep mind team, the research team selected "shape preference" as the entry point for detecting neural networks. It found that, like human beings, the network's perception of shape exceeded its preference for colour and material, which proved that neural networks also have "shape preference" (Ritter et al., 2017).

In 2018, the Deep mind team open sourced the simulation psychology laboratory Psych lab, which uses knowledge in cognitive psychology and other fields to study the behaviour of artificial agents in controlled environments, thereby simulating human behaviour (Leibo et al., 2018). In 2020, Taylor incorporated cognitive psychology into the emerging field of explainable artificial intelligence (XAI) with the aim of improving the interpretability, fairness, and transparency of machine learning. Figure 1 shows the evolution of AI in cognitive psychology (Taylor and Taylor, 2021).

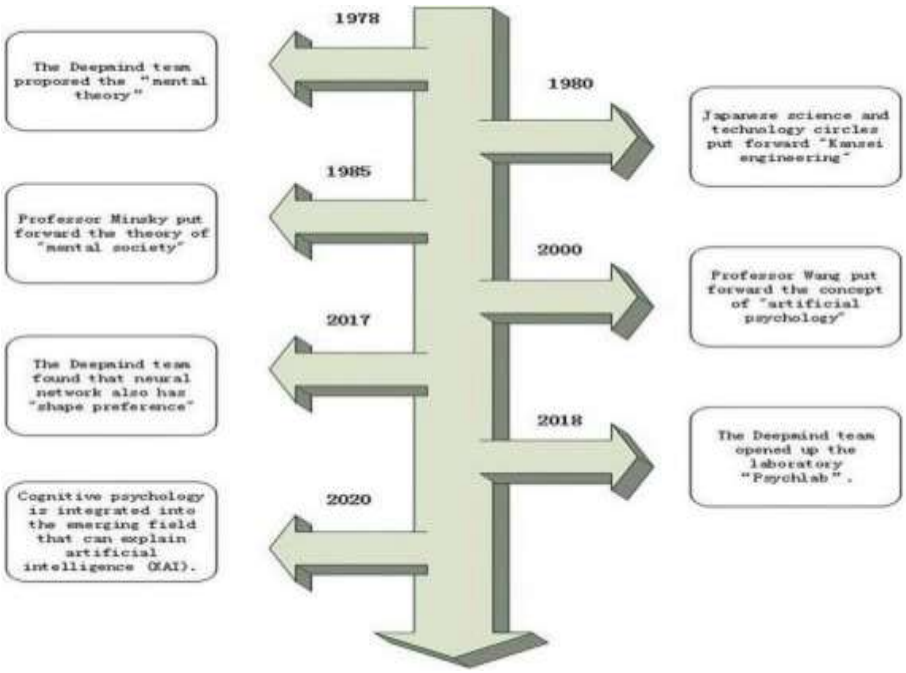

Figure 1
The Evolution of AI in Cognitive Psychology (Taylor and Taylor, 2021).

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Challenges and Future Directions

At Present, in the development of artificial intelligence AI nevertheless, the scientific there are a number of hurdles to clear in order to make the most of cognitive feedback loops as a powerful avenue for enhancing AI-human collaboration: Bias in Human Feedback. One of the most important subjects in the discourse on human feedback is the recycled bias of human feedback into AI systems. Feedback mechanisms for both the human and the algorithm need to be monitored and refined to avoid the entrenchment of stereotypes or biased decision-making (O'Neil, 2016) Privacy Concerns Real-time feedback mechanism based on personal data may create a privacy concern. To retain community trust in AI systems, it is essential that they respect ethical limits on their operations and user consent (Zeng, 2018). The scalability problem: The problem of scaling cognitive trusted feedback loops at large or in complex systems is still a problem. There is ongoing research as to how to keep feedback effective at scale without either saturating the AI system or degrading the quality of human feedback (Grosz & Sidner, 1990). Cognitive feedback loops will be developed in interdisciplinary collaboration, which is closely linked to both theories of cognitive psychology and models of behaviour learning with AI, and of course, ethics and human-computer interaction. Ongoing work, and conversations between these fields, will refine feedback loops and their incorporation into systems (Davenport & Kirby, 2016).

Conclusion

The use of cognitive feedback loops to create and increase the potential of adaptive, accurate and Human reason aligned AI. Through the use of human thinking and ongoing interaction, these systems can progress so as to enable immediate corrections, bias mitigation, and reliability improvement. With the increasing prevalence of AI across different sectors, everyone involved in AI and ML systems will need awareness of cognitive feedback loops and especially their potential consequences to design efficient, ethical and human-cantered systems. We also must reassert the importance of human researcher who have that empathy, communication skills, thinking skill, critical thinking to consider cognitions of development of human, AI also show great and huge promise as a tool in cognitive psychology however we must consider and tread cautiously to not fall into the hole of grip of technological tools all the time. With proper design and good implementation cognitive feedback loops can create a natural collaboration between humans and machines and make AI systems more effectively work as a global tool of human decision-making. The relationship between cognitive psychology and artificial intelligence is one of best correlation and give human mutual benefit. As cognitive psychology and AI continue unlocking the mysteries of the human mind which is creating more intelligent systems that truly comprehension and able to interact with us.

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