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Bridging Minds: Linking the Constructs of Cognitive Psychology with Artificial Intelligence

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Abstract: ***Artificial intelligence (AI) and cognitive psychology are two unique but overlapping disciplines that have also impacted the other significantly. Cognitive psychology is the branch of psychology that deals with knowing human mental processes. Within psychology, the cognitive approach is centered on how mental processes, feelings, imagination, and problem - solving capacities interact with each other to impact how and why you think the way you think. Cognitive psychology contrasts various aspects of cognition, quantifies various forms of intelligence, and identifies how your mind is structured. The computer or software intelligence, as opposed to the living being's intelligence, primarily humans, is referred to as artificial intelligence (AI). It is a computer science field that deals with the development and study of intelligent machines. AIs may be a name used for the identification of these devices. AI, enables computers and other technologies to replicate human intelligence and capacity to solve problems. It is able to perform tasks that normally require human intelligence or intervention, by itself or in combination with other technologies (including sensors, geolocation, and robotics). AI is a part of computer science which encompasses artificial learning and deep learning as subsections and is most often considered along with them. In such fields, algorithms that simulate the process of decision - making by a human being using artificial intelligence are constructed with a facility to "learn" through available data and provide increasingly more accurate predictions and categorizations based on time. Blending human psychological mind and artificial intelligence, it is possible to mimic the perceptual cognition and rationality of the "brain" alongside the emotional communications that are the human - machine or human - machine sort. This paper discusses the interaction between cognitive psychology and AI, how ideas from this feild have shaped the development and application of AI systems, and how AI has also influenced our knowledge of human cognition. By a discussion of some major theories, methods, and applications, this essay seeks to clarify the mutual relationship between these fields and its consequences for future research and technology advancement.***

Keywords: Cognitive Psychology, Intelligence, Technology, Artificial intelligence, Emotion

1. Introduction

Cognitive psychology is a study of human mental processes. It is concerned with our internal mental processes, such as language, action planning, attention, perception, and memory. All of these factors contribute significantly to determining our identity and behavior. Cognitive psychology tries to compare lots of cognition's aspects, measure all types of intelligence, and determine how you organize your thoughts. The current form of cognitive psychology brings together an impressive list of new tools in the study of psychology. Although human cognition has been the subject of published studies since Aristotle's "De Memoria" (Hothersall, 1984), cognitive psychology began as a byproduct of cognitive methods of approaching psychological problems in the late 1800s and early 1900s, as reported in the work of Wundt, Cattell, and William James (Boring, 1950). With the advent of "behaviorism" in the early part of the 20th century, i. e., the science of rules relating appearing behavior to outside, measurable stimulus situations in terms of tangible, observable stimuli without recourse to inside mental events, cognitive psychology began to go down (Watson, 1913; Boring, 1950; Skinner, 1950). Behaviorism was stripped of this last requirement, which is fundamental to cognitive psychology. For example, an inability to make distinctions between performance and memory and to consider the role of sophisticated learning was due to a dearth of familiarity with internal processes of the mind (Tinklepaugh, 1928; Chomsky, 1959). These issues stimulated the "Cognitive Revolution" and the collapse of behaviorism as the ascendant subdiscipline of scientific psychology. The 1950s to the seventies was a time of increased popularity in cognitive psychology when scientists gained better understanding of how thought and behavior were connected. For psychologists, this time, which was later referred to as the "cognitive revolution, " was a paradigm shift in perception and field of study. The behaviorist tradition had held dominance over psychology until then. Behaviorists only focused on external conduct that could be measured. The basis for cognitive psychology is the assumption that the scientific method can theoretically uncover human cognition completely; that is, individual mental processes can be identified and understood; and psychological operations can be cast in terms of principles or algorithms applied with information processing models.

The basis of cognitive psychology is the assumption that the scientific approach can, in theory, completely disclose human cognition; that is, mental processes of individuals can be identified and understood; and psychological operations can be described in terms of principles or algorithms employed with information processing models. The phrase artificial intelligence (AI) refers to computers' ability to perform cognitive operations that are similar to those of human beings, such as learning, problem - solving, perception, decision - making, speaking, and language use. In its broadest definition, artificial intelligence (AI) refers to the intelligence exhibited by machines, particularly computer systems, in contrast to the inherent intelligence of living things. It researches and develops methods and programs that enable machines to understand their environment and take actions that maximize their opportunities for attaining preset goals, with a perspective of performing tasks traditionally associated with human intelligence. Computer science research in this direction is aimed at computerizing intelligent behavior using machine learning.

Artificial Intelligence is a useful tool in the realm of cognitive neuroscience research, as it has made it possible to gain a better understanding of the human mind. Artificial intelligence (AI) - based tools like text - to - speech, speech - to - text, natural language understanding, and personalized recommendations have made it possible to gain valuable insights into human recognition. The scientific community today relies on the majority of its work on brain cognition studies (Nadji - Tehrani and Eslami, 2020), which tries to imitate the real physiological processes of the human brain using computer software. Subjective psychological changes are hard to imitate realistically by imitating the physiological features of the human brain (Zador, 2019). In the case of memory, machine forgetting is a kinetic erasure that defies our psychological expectation, but human forgetting is passive and is remembered the harder we try to forget. One of the leading contributory theories of machine learning, psychology and the philosophy of mind, arises from playing an important part in the progression of AI, directly or indirectly.

Statement of the problem: To study the intersection and influence of Cognitive Psychology and Artificial Intelligence on each other.

Historical Context of Artificial Intelligence and Cognitive Psychology

After the start of the twentieth century, cognitive psychology received increased attention because of the cognitive revolution. Cognitive psychology became popular during the 1950s and during the 1970s. Behaviorism was the dominant psychological paradigm until then. Based on this perspective, we acquire all our habits through interactions with the environment. It neglects cognition and emotion and focuses entirely on behavior that can be observed. Later, the interest of researchers moved from the behavior itself to the psychological mechanisms that shape behavior.

In psychology, this shift is often referred to as the term "cognitive revolution. " Much research on topics such as memory, attention, and linguistic development began to emerge during this period. The term "cognitive psychology" was coined by psychologist Ulric Neisser in 1967. He defined it as the study of the mechanisms of perception, transformation, storage, and recovery of information. Cognitive psychology is a broad and diverse field. It encompasses a great variety of common issues. This research has a great variety of implications in the real world, such as helping individuals cope with memory difficulties, enhancing decision - making, recovery from brain damage, treating learning disorders, and constructing curriculum in schools to enhance learning.

The manner in which mental health professionals treat mental health illnesses, brain trauma, and degenerative brain diseases depends on the new evidence in cognitive psychology. Cognitive psychology has enriched our knowledge about the range of mental processes which impact our everyday existence and overall wellbeing, from cognitive abilities' variation with an infant's growth to how brain maps sensory input to perception. Artificial intelligence (AI) is a recently emerging discipline with just 60 years, is to simulate human intellectual abilities through a range of sciences, concepts, and methods (such as computer science, statistical reasoning, probability, and mathematical logic). Initiated during Second World War, its progress is directly associated with computing's and has enabled computers to do an increasing array of complex tasks that were formerly reserved for human performance.

Although they did not originate the term artificial intelligence (AI), John Von Neumann and Alan Turing were the pioneers of the science's technology having transitioned from computers to 19th - century decimal logic (which processed values between 0 and 9) as well as machines to binary logic (that depends on Boolean algebra and processes more or less important strings of 0 or 1). Hence, the two researchers formalised the structure of contemporary computers and demonstrated that they were universal machines with the ability to execute instructions. Turing's iconic paper "Computing Machinery and Intelligence" left open the query of whether the machine could first be intelligent at all. Turing also outlined a "game of imitation" in which a man ought to have the ability to distinguish in a dialogue over a teletype whether he is addressing a machine or a man. Although this work is problematic—most authorities do not appear to think that the "Turing test" meets the criteria—it is often given as the stimulus for the current discussion of the edge between humans and machines. Even as technology remained exciting and promising, its popularity waned during the early of the 1960s. Due to the computers having minimal memory, programming in a computer language was difficult.

Nevertheless, some of the building blocks had already been set and are used today, including problem - solving solution trees. The information processing language, or IPL, enabled the development of the Logic Theorist computer program in 1956, which was to demonstrate mathematical ideas. Deep learning seems to be the most viable machine learning technology for many applications, including picture or speech recognition. To make neural networks current to the times, Geoffrey Hinton (University of Toronto), Yoshua Bengio (University of Montreal), and Yann LeCun (University of New York) agreed to initiate a research program in 2003. With the aid of the Toronto laboratory in Hinton, experiments conducted simultaneously at Microsoft, Google, and IBM showed that this type of learning was effective in reducing the error rates of voice recognition by half. The team of image recognition headed by Hinton yielded similar results. With these undeniable benefits, a huge number of research groups acquired this technology overnight. Though groundbreaking improvements in text recognition have also been achieved through this type of learning, professionals like Yann LeCun opine that text understanding systems are very much still a long way from achieving this. Conversational agents get this point nicely across: although our smartphones can already transcribe instructions, they cannot fully contextualize or know our intent.

Cognitive Psychology and Its Influence on the Field of Artificial Intelligence

Cognitive Modelling:
Computer science's cognitive modeling discipline is aimed at developing computer models that effectively mimic human thinking processes and problem - solving methods. Such a model could improve human - computer interaction by mimicking or predicting individual behavior or success on tasks similar to those it simulates. Today, institutions in academia and industry, including MIT, IBM, and Sandia National Laboratories, are conducting research in cognitive modeling. The creation of thinking machines—machine intelligence systems which simulate some facet of human cognition—is a sophisticated application of cognitive modeling. Improving human - computer interaction so that it feels more like human - human interaction is one of Sandia's project goals. Though we had computing machines that were powerful enough to process huge amounts of data, there was limited software that could properly mimic human thought processes and reasoning. As Forsythe head psychologist at Sandia project explains, the problem was that the original designs did not account for factors that affect human thinking, such as fatigue, emotion, stress, and distraction, and they were based on rational steps people often fail to use. Some very complicated programs mimic specific thought processes. These sophisticated models are improved with the use of techniques like discrepancy detection. When an individual acts differently than expected of them according to the cognitive model, a discrepancy detection system will notify the user. The complexity of the model is then increased based on that information. Forsythe asserts its cognitive computers are able to store experience - based knowledge such as human memory, infer user intention, which is not always compatible with behavior, and call upon expert systems for advice when needed. Another class of cognitive models is neural networks. Even though this idea was originally proposed in the 1940s, it was just recently implemented because of advances in data processing and the collection of large amounts of data for algorithm training. As the human brain works, neural networks process training data through an enormous number of computing nodes, or artificial neurons, that share information with each other. Applications are able to predict future inputs by collecting data in this scattered manner. Reinforcement learning is increasingly used in cognitive modeling.

This process involves algorithms recasting a multi - step task a number of times, reinforcing behavior that eventually yields positive outcomes and penalizing ones that yield bad ones. It is the primary element of Google's DeepMind AI system applied to develop the AlphaGo software, which in 2016 beat the best human Go players. These models have evolved human - computer interaction in that they enable robots to converse with humans using simple conversations. They can as well be utilized in natural language processing and intelligent assistant application.

1) ACT - R (Adaptive Character of Thought – Rational): John R. Anderson developed a line of increasingly realistic models of human thinking, the last of which is ACT - R. Its roots can be traced back to the 1973 account of the initial Human Associative Memory (HAM) model of memory by Gordon Bower and John R. Anderson. Then the HAM paradigm was expanded in order to form the first version of the ACT model. The primary declarative memory system was integrated for the first time with procedural memory, resulting in a computational paradox that later turned out to exist in the human brain. The ACT model of human cognition was later established by generalizing the concept even further. From its inception, human memory has been modeled with the ACT - R declarative memory system. It has been utilized over the years to good effect to represent much known to be effects. These include serial recall, recency and primacy effects for list memory, and the fan effect of interference for related information. ACT - R has, in various cognitive paradigms, modeled the processes of attention and control. These are multitasking, task switching, the psychological refractory time, and the Stroop task. ACT - R has been employed by several researchers to model different aspects of natural language generation and processing. These include syntactic parsing, language comprehension, metaphor comprehension, and language acquisition models. ACT - R is now employed to capture human solution processes for algebraic equations and other difficult problems like the Tower of Hanoi. It has also been used to model human behavior in flying and driving. As a tool for modeling in the fields of human factors and human - computer interaction, ACT - R has become increasingly popular with the addition of perceptual - motor abilities. It has been applied in this field to model online browsing, menu choices and visual search in computer programs, and driving behavior under different conditions.
2) Soar (Cognitive Architecture): With the goal of creating a general computational system with cognitive abilities similar to those of a human, created by John Larid, Allen Newell and Paul Rosenbloom at Carnegie Mellon University. Soar is an overall cognitive architecture that has been developed for three decades. It incorporates knowledge - driven deduction, reactive response operation, hierarchical reasoning, planning, and learning through experience. By contrast, most AI systems are designed to address one type of problem, such as chess, web searches, or scheduling airplane flights. Soar is an idea of what computing architecture are needed to support human - level agents, and a software infrastructure for building agents. Both the theory and the computer system evolved over time. Important extensions to the current version of Soar are mental imagery, semantic memory, episodic memory, reinforcement learning, and integrated appraisal - based model of emotion. The relationship between procedural memory, or information regarding doing something, and working memory, or working memory's description of the current situation, enables the selection and use of operators and births Soar's basic processing cycle. Working memory retains information as a figurative graph structure dependent upon a state. If - then rules, or combinations of circumstances and activities, are how procedural memory holds information. These rules are continuously compared with the contents of working memory. A rule fires and acts when its conditions match working memory structures. Another term for this organization of working memory and rules is a production system. In other production systems, all the

matching rules fire together in Soar. Soar makes decisions through applying and choosing operators that are proposed, evaluated, and enacted by rules rather than depending on the selection of one rule. Rules that evaluate the current state, create a working memory representation of the operator, and give an acceptable preference—a sign that the operator should be considered for selection and use—suggest an operator. Additional rules support the proposed operator and give new preferences that evaluate and compare it with other proposed operators. A decision mechanism examines the preferences and selects the preferred operator, installing it as the active player in working memory. The current operator is balanced by rules that activate to use and alter working memory. Basic deductions, retrievals requested from Soar's long - term semantic or episodic memories, commands to the motor system to perform actions in the environment, communications between the Spatial Visual System (SVS), perception's interface with working memory, are some instances of the adjustments to working memory. Due to these adjustments to working memory, new operators are proposed, tested, and ultimately selected and utilized.

a) Reinforcement Learning: Soar supports reinforcement learning, which adapts the parameters of rules to allow numerical preferences for operator evaluation upon rewards. There is a mechanism in working memory where rewards are created to give the maximum amount of flexibility.
b) Impasses, substates, and chunking: An impasse arises when there are insufficient rules to control an operator or when the demands between the operators are insufficient to specify the choice for one operator. An impasse initiates the formation of a substate in working memory whose goal is to resolve the deadlock. The deadlock can subsequently be broken through additional procedural knowledge in making proposals and selecting drivers in the substate to learn further and either produce choices in the original setup or modify it. Substates provide on - demand use of declarative long - term memories, planning, and hierarchical breakdown of tasks in complex reasoning. All the structure in the substate is deleted upon the breakdown of the deadlock except for any outcomes. The processing of the substate is chunked with Soar's chunking technique, which converts the outcome into rules. By progressively converting hard thinking into automatic/reactive processing, the learned rules prevent any stalemate in the future by firing automatically under similar situations. In recent times, a goal - directed and automated knowledge base expansion system has been incorporated within the overall Universal Sub goaling process. This process facilitates the breaking of a deadlock by imaginatively and goal - orientedly recombining the knowledge which a Soar agent has.
c) R1 - Soar model: R1 - Soar, an enhanced reimplementation of the initial R1 (XCON) expert system John McDermott developed for DEC computer configuration, was the first large - scale application of Soar. Paul Rosenbloom created it. R1 - Soar demonstrated how to use hierarchical task decomposition and planning, scale to tasks of moderate size, and chunk planning and problem solution to support reactive execution.
d) NL - Soar system: The NL - Soar system was developed within Soar by Jill Fain Lehman, Rick Lewis, Nancy Green, Deryle Lonsdale, and Greg Nelson to translate natural language. It emphasized real - time time progressive parsing and generation and had natural language understanding, generation, and conversation facilities. NTD - Soar and an experimental TacAir - Soar both utilized NL - Soar.
e) Virtual Human Simulator: Soar is also a virtual human simulator that enables in - person discussions and collaboration in a virtual world developed at USC's Institute of Creative Technology. Virtual individuals have integrated senses, the capacity to understand natural language, feelings, control over their bodies, and the capability to act.

3) Learning and Memory: Soar's Semantic Memory (SMEM) aims to provide a vast long - term memory of fact - like structures. SMEM employs directed cyclic graphs to represent data. Structure - generating commands can store or retrieve a structure in a target area of working memory. Working memory receives new structures that were retrieved. SMEM structures use the base - level activation procedure originally specified for ACT - R, with the level of activation signifying how often or how recently each memory has been accessed. The setup in SMEM with the highest activation that can be matched with the query is retrieved during the process of retrieval. Soar also supports spreading activation, in which activation from the retrieved SMEM structures passes through working memory and the other long - term memories to which the structures are linked. Through some decline, these memories then went on to trigger the memories alongside them. Spreading activation is one method by which to allow current environments influence recoveries from semantic memory.

2. Challenges and Future Implications

The convergence of psychology and AI poses ethical issues regarding privacy, bias, and the ethical use of technology in mental health. Psychologists and AI engineers have to collaborate to resolve these issues. (Pratibha Kumari J., 2023). Numerous ethical questions are posed by the dynamic interconnection between artificial intelligence (AI) and cognitive psychology.

1) Privacy and Data Security: It is essential to protect privacy and data security when AI penetrates the private domain of human cognition and emotion. Psychologists must be firm supporters of robust ethical systems that guard individuals' privacy and prevent unauthorized access.
2) Fairness and Bias: The precision of AI systems relies on the quality of the training data. Prediction accuracy can be heavily affected by biases and inaccuracies in the data. Psychologists can be of tremendous assistance in the identification and removal of biases in AI systems, which will ensure justice and fair results.
3) Informed consent: Obtaining participants' informed consent remains important in applying AI to psychology

research or practice. Psychologists should endorse open discussion of the role of AI and its impact on individuals.

4) Human Sovereignty and Identity: Cognitive enhancements through AI raise questions on social justice, personal autonomy, and individual identity. Psychologists can make a significant contribution by examining critically the impact of AI interventions on these essential aspects of humanity.
5) Explainability and Transparency: As AI systems sometimes work as an "Unexplainable mystery" it may not be easy to understand how they come to conclusions. Psychologists can facilitate transparency and the development of AI models that have explanations for their output.
6) Responsibility and Accountability: It is important to decide on responsibility as well as accountability since AI is increasingly being incorporated into psychological therapy. By using AI responsibly, psychologists can assist in ensuring that benefits are greater than any potential detriment. The concern is not completely unknown. The UK Commission for Racial Equality branded a British medical school as having discriminated against candidates in 1988. It discovered that the computer program it was using to select candidates for interviews was biased against women and individuals with non - European names. Nevertheless, the software was programmed to match human admissions decisions ninety to ninety - five percent of the time accurately. In addition, in contrast to most of the rest of London's medical schools, the university accepted a higher proportion of non - European students. Human judgment cannot be removed with algorithms. But simply (going back to doing things manually by using humans to decide) would not be the answer either (James Manyika et. al, 2019). Algorithms can get biased in various means. Even after removing sensitive variables such as gender, color, or sexual orientation, AI systems are trained to draw conclusions based on training data, which can include biased human decisions or reflect historical or societal unfairness. Amazon ditched its hiring algorithm when it was revealed to favor applicants whose resumes included words like "executed" or "captured, " which appeared more commonly on men's applications. Incorrect sampling of data, where certain groups are represented inadequately or in excess in the training set data, is yet another source of bias (James Manyika et. al, 2019).

3. Conclusion

Computer science's area of cognitive modeling seeks to develop computer models that mirror human thought processes and problem - solving methods accurately, with the possibility of improving human- computer interaction. Institutions such as MIT, IBM, and Sandia National Laboratories are exploring cognitive modeling, such as the creation of cognitive machines that simulate human cognition. Also, John R. Anderson's ACT - R model has played a crucial role understanding human cognition, especially memory systems and cognitive processes. Soar, however, provides a broad cognitive architecture that integrates several aspects such as reinforcement learning, impasses, substates, and chunking to mimic human - like decision - making and problem - solving.

The convergence of psychology and AI sparks ethical issues on privacy, bias, and accountability in the application of technology to mental health interventions. Psychologists and AI builders need to engage in addressing those concerns, which include safeguarding privacy and protecting data security to ensure fairness and bias correction, gaining informed consent, taking into account human sovereignty and identity, fostering transparency and explainability, and imposing accountability and responsibility. Algorithms can be biased as a result of learning from training data that mirrors historical or social injustices, and these should be corrected in AI systems.

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