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BOOK REVIEW

Principles of Creative Problem Solving in AI Systems

Ana-Maria Olteţeanu: Cognition and Creative Machine: Cognitive AI for Creative Problem Solving. Freie Universität Berlin, Berlin, Germany, Springer, Cham, 2020 (Online ISBN: 978–3-030–30322-8), 282 pages, price: €117.69 (eBook), DOI: https://doi.org/10.1007/978–3-030–30322-8

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The utilization of Artificial Intelligence (AI) is springing up through all spheres of human activities due to the current global pandemic (COVID-19), which has limited human interactions in our societies and the corporate world. Undoubtedly, AI has innovatively transformed our ways of living and understanding how mechanical systems work on problem solving as or even beyond human beings. The core issues of this book include the following issues: (1) understanding the working mechanism of the human mind on problem solving, and (2) exploring what it means to be computationally creative and how it can be evaluated. By having an overview of the development of AI and Cognitive Science and rebranding the strands of creativity and problem solving, Dr. Ana-Maria Olteţeanu attempts to build cognitive systems, which propose a type of knowledge organization and a small set of processes aimed at solving a diverse number of creative problems. Furthermore, with the help of the defined framework, the relevant computational system is implemented and evaluated by investigating the classical and insight problem solving performance.

Part I of this book includes the previous four chapters, which introduces a series of theories such as creativity (p.11), insight (p.16), and visuospatial intelligence (p.20) to illustrate the necessary process and structure of creative problem solving. The author concludes from the relevant literature that the interplay between knowledge representations and organization processes would play an important role in searching for solutions. For better illustration and understanding, a selection of computational creativity systems is presented, such as AM, HR, Aaron, the Painting fool, Poetry systems, and BACON (p.34–37). Subsequently, from a methodological perspective, Dr. Olteţeanu introduces two different creativity evaluations for human beings and computational machines respectively. On the one hand, when measuring creativity of human, the thinking characteristics of the participants such as divergent thinking (the ability to diverge from subjectively familiar uses and think of other uses) and creative thinking are the primary objective for measurement in some

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of the most important empirical models. On the other hand, when assessing the creativity in the computational systems, various models of evaluating the behaviors or programs of creative systems are proposed mainly in terms of typicality, quality, and novelty.

In the second part, which comprises chapter 5th to 8th, the author develops a cognitive framework to explore how a diverse set of creative problem solving tasks can be solved computationally using a unified set of principles. To facilitate the understanding of insight and creative problem solving, Dr. Olteţeanu puts forward a metaphor, in which representations are seen as cogs in a creative machine and problem solving processes are regarded as clockwork, to view the relationship between creative processes and knowledge (p.69). Building on this idea, a theoretical framework (named as CreaCogs) is proposed based on encoding knowledge, which permits processes of fast and informed search and construction, for creative problem solving. These processes take place conceptually at three levels involving Feature Spaces, Concepts, and Problem Templates (p.91–94). Firstly, whenever an object encoded symbolically is observed, its sensors will be enrolled in the sub-symbolical level of feature maps and spaces. Then, in the following level, various known concepts are grounded in a distributed manner in organized feature spaces, and their names are encoded in a different name tag mapped for functionally constituting another feature. Lastly in the highest level, problem templates are structured representations, which are encoded over multiple concepts, their relations, and the affordance they provide. On the basis of the steps above, an integration of a wide set of principles in the framework would be accessible.

Part III, which forms chapter 9th to 12th, mainly focuses on applying the CreaCogs in a set of practical cognitive system cases, and developing a set of tools through which the performance of such systems could be evaluated. It is worth noticing that several evaluation tests of creativity are introduced to illustrate about how to apply implementation of the framework built above. In the preamble of this part, the CreaCogs mechanism of Remote Associates creativity Test (RAT) and Alternative Uses Test (AUT) are explored to develop the corresponding computational systems to solve these test tasks. Based on the practice of implementation and investigation, Dr. Olteţeanu analyzes how to evaluate the performance of the artificial cognitive prototype systems by solving different creativity tasks via inference mechanism or matching algorithm from CreaCogs. The book ends with an overview of the journey of exploring the creative problem solving and an outlook of the relevant experimental work.

Overall, the author provides a revolutionary academic framework to understand the theoretical and empirical cognitive processes involved in creative problem solving by computational systems. Various evaluation of creativity tests and tasks are drawn to illustrate how the cognitive framework works to find solutions of classical or even insight problems, which are stressed in the 2012 paper by Batchelder and Alexander (Insight problem solving: A critical examination of the possibility of formal theory, in *The Journal of Problem Solving*), as the alternative productive representations are necessary to overcome the failures of discovering solutions. Besides, it is deep insight when the author describes the cognitive models of creativity through using a variety of schematic diagrams and pictures in this book. That is rather helpful to illustrate how insight and creative problem solving can be viewed as processes of memory management, with both associationist and gestaltic (template pattern-filling) underpinnings, and with processes of recasting and restructuring using from the memory and the environment. From the theoretical matters to the variate practical domains, Dr. Olteţeanu constructs the cognitive systems on the basis of the CreaCogs and develops a set of tools through which the performance of such systems can be evaluated similarly to that of human participants. In short, the theoretical framework and

empirical computational exploration contribute to creating the imagination of the efficacy of AI in the area of creative problem solving.

However, the critical issue of the possibility of developing self-adaptive learning by the creative systems has not been further discussed yet. To quote the annotation in the fields of behavioral psychology and cognitive psychology, self-adaptive learning in AI refers to human's self-adapted learning methods and the habitual condition information processing systems, which forms a method that AI can solve theories and problems independently through discovering and summarizing in operations. Due to emphasizing to develop a framework for analyzing the creative problem solving, the author focuses on introducing the value, mechanism, application, and evaluation of the computational system based on the CreaCogs that is why the issue of self-adaptive learning has rarely been taken into account for now. In summary, this book enhances our understanding of the principles of problem solving in the epoch of AI and deserves to be widely read in this age of intelligent machines. The CreaCogs cognitive framework proposed here could be served as an applicable guide for graduate students and researchers in the sphere of Cognitive Science, AI, and Education.

Declarations

Conflict of interest There is no conflict of interest.