Cognitive Computation (2024) 16:3316–3318
https://doi.org/10.1007/s12559-024-10352-7

Guest Editorial: Cognitive Analysis for Humans and AI

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Published online: 22 October 2024

Introduction

The primary goal of studying artificial intelligence (AI) is to develop systems capable of simulating human intelligence, allowing machines to perform tasks that involve learning, reasoning, perception, and decision-making. While the advancement of deep neural networks has enabled AI to achieve human-like accuracy across a wide range of tasks, this accuracy does not equate to human-level intelligence [1]. Current AI systems, particularly those based on deep neural networks, rely on learning from large datasets to identify distribution patterns for task processing [2]. In contrast, human intelligence manifests not only accurate task performance but also complex cognitive processes, such as memorizing, learning, reasoning, and mental organization, that allow individuals to learn from limited data, adapt to new situations, and make ethical judgments. Thus, understanding human cognitive patterns is essential for advancing AI systems that achieve truly human-like intelligence [3]. The intersection of cognitive science and AI presents a valuable opportunity to explore the bidirectional influence between human cognitive mechanisms and AI models.

Over the past years, a wide range of cognitive analysis models has been developed for various applications, e.g., sentiment analysis [4], emotion detection [5], user profiling [6], and concept mapping parsing [7]. These models have frequently demonstrated significant improvements in accuracy when tested on benchmark datasets, reflecting the progress in the respective research domains. Despite their success in controlled experimental settings, it is still uncertain how effectively these models can be employed for practical tasks that involve complex, context-dependent human cognition.

On the other hand, recent advancements in generative AI, such as ChatGPT [8] and Stable Diffusion [9], have showcased the remarkable potential of AI to generate coherent, contextually relevant, and creative outputs in natural language processing and image generation. These models have achieved unprecedented levels of performance in mimicking human language and creativity [10], which opens a new field for exploring the cognitive processes involved in AI systems. Given these developments, it would be highly valuable to leverage state-of-the-art computational methods to analyze and compare the cognitive patterns exhibited by both humans and AI systems. Such research could provide deeper insights into the similarities and differences between human cognition and AI, offering insights for enhancing AI models to better align with human cognitive processes in real-world applications.

Inspired by the latest cognitive analysis studies using natural language processing techniques [11–15], this Special Issue, *Cognitive Analysis for Humans and AI*, aims to compile pioneering research that explores the cognitive processes of both humans and AI systems. The goal is to foster interdisciplinary discussion and promote innovative approaches that improve the modeling, analysis, and mining of cognitive patterns in human and AI contexts. This Special Issue was conducted in two phases. In the first phase, 46 submissions were received, and following extensive reviews and revisions, 13 papers were selected for publication, as presented in the subsequent section. The papers accepted during the second phase will be included in an online special collection.

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Contents of the Special Issue

Only the first article, titled “From Pixels to Prepositions: Linking Visual Perception with Spatial Prepositions Far and Near,” explores how individuals perceive and classify distances using spatial prepositions such as “far” and “near.” Utilizing neural networks, they analyze a dataset of synthetic images to assess depth perception based on monocular cues. The network is trained to classify objects in both grounded (contextualized) and ungrounded (non-contextualized) scenarios, investigating the role of spatial constraints in depth estimation.

In the work titled “A Consensus Model with Non-Cooperative Behavior Adaptive Management Based on Cognitive Psychological State Computation in Large-Scale Group Decision,” the authors employ an adaptive feedback mechanism grounded in cognitive dissonance to manage non-cooperative participants. This process involves constructing decision matrices, calculating trust and influence weights among decision-makers, and iterating the consensus process until a satisfactory group consensus is achieved. Simulation experiments are conducted to assess the model’s effectiveness in fostering consensus and addressing non-cooperative behaviors.

In “Diagnostic Potential of Eye Movements in Alzheimer’s Disease via a Multiclass Machine Learning Model,” the authors recruited 258 participants, including 111 Alzheimer’s disease patients, 81 individuals with mild cognitive impairment, and 66 with normal cognition. They recorded eye movements during four visual tasks: fixation, smooth pursuit, prosaccade, and anti-saccade. The study evaluated several machine learning models and found that eye movement parameters, particularly from the prosaccade and anti-saccade tasks, demonstrated significant diagnostic value for identifying Alzheimer’s disease.

Next, “Cognitive Tracing Data Trails: Auditing Data Provenance in Discriminative Language Models Using Accumulated Discrepancy Score” investigates data provenance in discriminative language models to assess whether personal textual data has been utilized for data augmentation and model training without user consent. They introduce the accumulated discrepancy score as a method for auditing data membership within these models.

In the work “Disentangling User Cognitive Intent with Causal Reasoning for Knowledge-Enhanced Recommendation,” the authors attempt to improve recommendation systems by accurately capturing user cognitive intents and mitigating challenges such as popularity bias in user-item interactions. They introduce the Knowledge-Enhanced User Cognitive Intent Network, which utilizes knowledge graphs and causal reasoning to investigate user intents across various item categories.

The work titled “Barrier Function to Skin Elasticity in Talking Head” studies the task of predicting facial expressions from audio inputs, particularly for generating realistic talking head animations. They propose a spatiotemporal model that incorporates facial landmarks and a barrier function to simulate skin elasticity, demonstrating a significant improvement over baseline models.

Following, “Prompt Learning for Multimodal Intent Recognition with Modal Alignment Perception” introduces a token-level prompt learning approach that incorporates modality alignment perception. This method improves text representation and uncovers latent intent information via the use of intent generation templates. Refining the text modality bridges the gap between pre-training tasks and intent recognition, enabling the adaptive fusion of text and non-text features.

In “PrimeNet: A Framework for Commonsense Knowledge Representation and Reasoning Based on Conceptual Primitives,” the authors introduce a framework developed for representing and reasoning about commonsense knowledge. This framework involves the development of a new knowledge base, PrimeNet, which utilizes conceptual primitives—basic building blocks of knowledge that can be combined to form more complex knowledge structures. The aim is to represent commonsense knowledge in a more structured and fundamental way.

The work titled “PDD: Pruning Neural Networks During Knowledge Distillation” proposes a pruning method that optimizes student models in the knowledge distillation process by identifying and removing redundant parameters and structures. Unlike traditional approaches, which prune models after training, this method performs pruning simultaneously with knowledge distillation, enhancing efficiency and model performance.

In the work “Enhancing Pre-trained Deep Learning Model with Self-Adaptive Reflection,” the authors seek to enhance the performance of machine learning models in Aspect-Based Sentiment Analysis and Topic Mining by incorporating interpretability and reflection mechanisms. They propose a self-adaptive reflection-enhanced model that integrates both local and global salient features into the decision-making process of deep learning models, aiming to improve overall model performance and interoperability.

Next, “Probing Fundamental Visual Comprehend Capabilities on Vision Language Models via Visual Phrases from Structural Data” evaluates the ability of various Vision Language Models to understand and process visual information using specific visual phrases. The findings reveal that models trained on specialized tasks outperformed those trained on combined datasets. However, as task complexity increased, particularly in scenarios involving multi-hop reasoning, the models' performance declined, with Vision Language

Models losing their discriminative capacity more rapidly than Multimodal Language Models.

In "Multi-View Cooperative Learning with Invariant Rationale for Document-Level Relation Extraction," the authors present a framework, termed Multi-View Cooperative Learning with Invariant Rationale (MCLIR), which adopts a multi-view approach to capture information at the entity, sentence, and document levels. The framework integrates an invariant rationale mechanism to eliminate redundant data and highlight essential relational information.

Finally, "Cognitive-Inspired Deep Learning Models for Aspect-Based Sentiment Analysis: A Retrospective Overview and Bibliometric Analysis" employs bibliometric analysis to analyze publication and citation patterns in the field. Additionally, they employ structural topic modeling to identify and analyze recurring themes within the Aspect-Based Sentiment Analysis domain. The collaboration networks among researchers are also visualized in this work.

Acknowledgements The guest editors would like to thank the reviewers for their contributions to the decision process.

Funding Rui Mao and Erik Cambria are supported by the Ministry of Education, Singapore under its MOE Academic Research Fund Tier 2 (STEM RIE2025 Award MOE-T2EP20123-0005) and by the RIE2025 Industry Alignment Fund – Industry Collaboration Projects (IAF-ICP) (Award I2301E0026), administered by A*STAR, as well as supported by Alibaba Group and NTU Singapore. Amir Hussain is supported by the UK Engineering and Physical Sciences Research Council (EPSRC) Grants Ref. EP/T021063/1 (COG-MHEAR) and EP/T024917/1 (NATGEN).

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