



Cognitive Computing



Cognitive computing research aims to build systems which mimic the processes of the human brain. New systems are designed to learn from past experiences, adapt in real-time and draw inferences from data. New systems will no longer be limited to knowledge-base processing but will increasingly have the ability to perceive and extract useful information and context from sensory data, build causal models, assess evidence based on hypotheses, predict, reason and basically think autonomously.

Enabling Science and Technology

Human Computer Interaction (HCI) and Trust



Trust is identified as a requirement in effective human-agent decision-making, and is a key aspect of HCI. Advancing autonomous decision-making involves transferring more of the final decision-making to the system. This will require significant amounts of confidence which can be augmented by increasing the transparency of the machines' decision-making process. Embedding emotional intelligence in cognitive computers would improve HCI by further increasing trust but this remains a major challenge in the field.

Adaptive Capabilities and Systems



Adaptive capabilities are a key feature of cognitive systems, allowing them to learn from other agents or humans and adjust to incoming data in

real-time. Some of the growing adaptive capabilities relate to improved interaction with humans, improved decision support, robot control and navigation functions. Adaptability can be embedded in systems through cognitive architectures or learning algorithms, amongst other approaches.

Applications (Radar & Social Media)



Key emerging applications for cognitive computing include radar and social media. Cognitive radar, arguably the next generation of radar, selects transmission and reception parameters in real-time and can adaptively select algorithms as the environment changes. Design and optimization of the waveform to maximize performance is a current need. Other applications of cognitive computing are expected to become pervasive in our daily lives as they are integrated into social media.

Neuromorphic Computing



Neuromorphic computing offers immense possibilities in the development of self-learning, fault-tolerant, adaptive cognitive systems. It can offer massive neural network parallelism and density as well as large-scale energy efficiency and support the detection of patterns in complex data with minimal training. Neuromorphic cognitive computing systems make use of memristive devices and spiking time dependent plasticity (STDP) which is a method of implementing unsupervised learning in spiking neural networks.

◆ *Th(ere) is a phenomenal shift in the market to better exploit the value of data, and much of the activity will involve cognitive computing... And we have just begun to see the possibilities.*

– IDC Canada

Signals

Academic



The International Institute of Cognitive Informatics and Cognitive Computing at the University of Calgary focuses on intelligent computing methodologies and systems based on cognitive informatics and mimicking the mechanisms of the brain.

Government



DARPA-funded researchers recently created a cognitive-computational model of human norms which can be coded into machines and allows them to learn norms in unfamiliar situations from human data.

Collaboration



The Cognitive Computing Consortium is a cross-disciplinary group of experts from industry, academia and the analyst community who are striving to provide a non-proprietary definition of cognitive computing, its value and applications.

Collaboration



Canadian universities of Guelph and Ryerson, along with Nuptek Systems Ltd., have developed cognitive robots that use observational social learning to support decision making in highway crossing tasks.

Corporate



IBM foresees three areas of future cognitive computing capabilities: engagement, decision and discovery. Each demonstrate increasing levels of cognitive capability and can be combined in a single solution.

◆ *By empowering machines and applications with human-like cognitive capabilities such as learning, reasoning, problem solving, planning, and self-correction, AI is enabling automated decision making with very high accuracy and speed based on data driven intelligence, coupled with self-learning abilities.*

– Frost and Sullivan

Impact

Social



Robot ethics consider how robots are designed, deployed and treated. Rapid intuitive responses, reasoned reflection and social interaction need to be guided by a moral architecture to ensure robots behave according to ethical principles.

Policy



Policies specific to cognitive computing are limited since most focus on the broader field of artificial intelligence (e.g. Asilomar Principles). Google, Amazon and Facebook want to keep regulations at a minimum, arguably to maintain innovation speed.

Economic



The global cognitive computing market is expected to reach USD 49.36 billion by 2025. Primary industries include banking, insurance, healthcare, security, retail, IT & Telecom, and aerospace & defence.

Environmental



Cognitive computing has the potential to autonomously and adaptively optimize efficiency and real-time visibility of the power grid, transportation, water & air quality and building operations leading to safer and greener solutions.

Defence



The US Army is seeking to apply cognitive computing, AI and computer automation to support tactical decision-making to reduce commanders' cognitive burden and enable more informed decisions.

◆ *We start from the premise that all AI applications should remain under meaningful human control, and be used for socially beneficial purposes. Understanding what this means in practice requires rigorous scientific inquiry into the most sensitive challenges we face.*

– DeepMind Ethics and Society team

Contact the author:

EDT-TEP@forces.gc.ca

Please provide feedback

Produced in partnership by the National Research Council and Defence Research and Development Canada.

January 2018
Également disponible en français

© His Majesty the King Right of Canada as represented by the Minister of National Defence, 2023

Cat. No.: D69-84/2023E-PDF
ISBN: 978-0-660-49822-5