Demystifying Cognitive Computing and its Use Cases

Chellammal Surianarayanan[1*], Sharmila Rengasamy[2], Pethuru Raj Chelliah[3], Baby Nirmala. M[4]

Abstract

The worldwide enterprises are embarking on digital transformation initiations and implementations in order to be right and relevant to their constituents, clients and consumers. By the smart leverage of digital technologies and tools, there arise billions of connected devices and trillions of digital entities. These empowered and everyday elements, when interacting with one another in the vicinity and with remotely held software applications, generate a massive amount of multi-structured digital data. In short, with digital transformation getting accelerated, the era of big data is dawning. In order to sensibly and speedily tackle the exponentially growing digital data, we need sophisticated self-learning systems in place.

The hugely popular cognitive computing is to deal with potential cognition-enablement technologies to set up and sustain cognitive systems. In this paper, we are to throw some light on the emerging field of cognitive computing and how it is turning out to be a game-changer for accomplishing not only business-enablement but also a people-empowerment. A variety of industrial and individual use cases of cognitive computing is being meticulously described in this paper for enlightening our esteemed readers on the growing scope of cognitive computing.

KeyWords: Cognitive computing, deep learning, reinforcement learning, cognitive robot, cognitive car, limitations of cognitive computing, benefits of cognitive computing

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Introduction

Cognitive computing deals with development of systems that can learn at scale, reason with purpose and interact with humans naturally[1]. Cognitive systems receive data from various sources, understands the context and suggest best possible outputs to humans. Cognitive computing is a combination of Artificial Intelligence and cognitive science. Cognitive computing is beyond artificial intelligence. Cognitive computing uses self-learning algorithms, Natural Language Processing and visual recognition techniques to interact with humans naturally. Cognitive systems are expected to perform a task like a human. So, they should be capable of dealing both structured and unstructured data in a given context and identify patterns to suggest possible solutions. In nut shell, cognitive systems learn and interact naturally with humans to extend capabilities of either machine or human and ultimately assists human to take better decisions by analysing huge amount of data. Data analytics is the key aspect of decision making. There are different types of analytics such as business analytics, text analytics, image analytics, video analytics, graph analytics, spatial analytics, visual analytics etc. These different types of analytics are incorporated with cognitive computing so that intelligent and effective goals of concerned domains can be attained[2]. Cognitive computing combines the advanced computing power with brain like intelligence so that it can be used to solve complex problems which otherwise cannot be solved manually.

Corresponding author: ChellammalSurianarayanan
Address: [1]Department of Computer Science, Government Arts and Science College, Navalurkuttapattu, Srirangam Tk., Affiliated to Bharathidasan University, Tiruchirappalli, Tamilnadu, India, [2]Department of Computer Science, Government Arts and Science College, Navalurkuttapattu, Srirangam Tk., Affiliated to Bharathidasan University, Tiruchirappalli, Tamilnadu, India, [3]Edge AI, Reliance Jio Ltd, Bangalore, India, [4]Department of Computer Applications, Holy Cross College, Tiruchirappalli, Tamilnadu, India
E-mail: chelsganesh@gmail.com[1], sharmiparam@gmail.com[2], peterindia@gmail.com[3], babynirmala7@yahoo.co.in[4]

Cognitive computing versus artificial intelligence

Cognitive computing and artificial intelligence may look alike, but cognitive computing differs from artificial intelligence in the following ways

(i) includes a human interaction whereas AI based systems avoid human intervention or interaction.

(ii) it mimics human intelligence and behaviour while finding solutions for complex problems. Here, cognitive computing not only mimic human intelligence but also includes emotions such as mindset/mood.

(iii) the primary contrast point against artificial intelligence is that the cognitive systems go beyond AI in analyzing the huge amount of data typically that occur in domains like business, healthcare, finance, education, etc and provide the possible outputs to humans and humans only will decide the output whereas in the case of artificial intelligence, the machines are trained to perform a particular task with huge data and after learning, the algorithms automatically take decisions for new inputs without human intervention.

Characteristics of cognitive computing

The basic characteristics of cognitive computing include

Understandable - Cognitive systems should be capable of identifying information in terms of both context and meaning. They must mine contextual data, such as syntax, time, location, domain, etc. They need to understand multiple sources of information, including structured and unstructured data and visual, auditory or sensor data

Reasonable - Cognitive systems should be capable of organizing the collected data and reasoning the organized data so that they can explain what the data really means

Learned - Cognitive systems should be capable of learning through the data as well as from the interactions of human

Interactive - Cognitive systems interact with humans naturally.

Adaptive: Cognitive systems must adapt to understand the changes in the information as the data generated in many domains are dynamic in nature. The cognitive system must make adjustments as the data and environment change.

Stateful – cognitive systems should remain stateful so that they become capable of providing information that is suitable to a specific application at a particular time

Iterative – cognitive systems should be iterative to solve problems with ambiguity

In order to attain the above characteristics, cognitive computing tends to develop algorithms by using the theories in cognitive science and makes the systems to possess certain degree of brain-like cognitive intelligence[3]. The cognition of machine is improved using two major learning paradigms, reinforcement learning and deep learning [4]

Key enablers of cognitive computing

One of the major limitations of traditional learning is that they are based on closed learning in the sense that the input data is more frequently fixed in its format so these algorithms lack improvement in intelligence. In contrast to conventional machine learning, reinforcement learning enables an agent to learn in an interactive environment by trial and error using feedback from its own actions and experiences. The important aspect of reinforcement learning is the feedback to the agent to correct its actions while performing a task. In addition, the reinforcement learning paradigm involves rewards and punishments according to the positive and negative behaviour in the given situation. The core concept of reinforcement learning is shown in Fig. 1

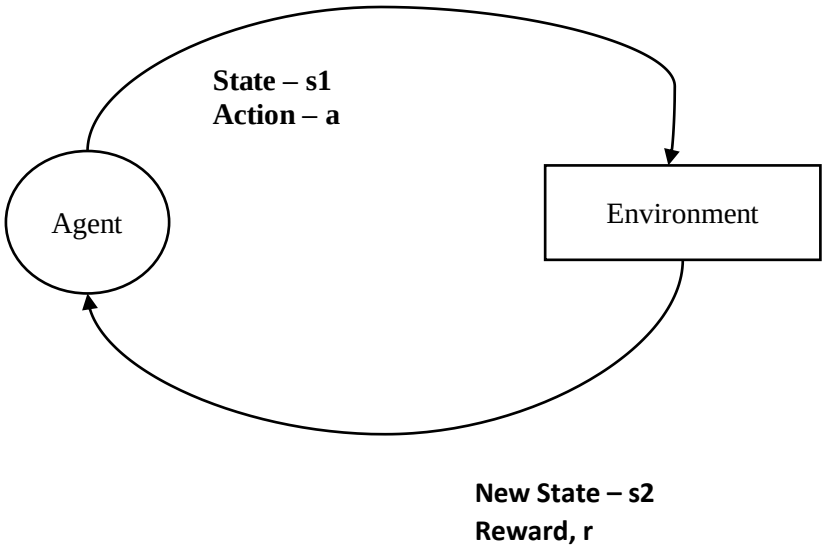

Fig. 1 Reinforcement learning

The agent in Fig. 1 refers to a software agent and it takes an action say 'a' according the state 's1' of the given environment. The environments gives a response in the form of a new state say 's2' and a reward or punishment based on the action taken by the agent. If the action is favourable for the given environment, the it gets a reward. Otherwise, it gets a punishment so that the agent correct its action. So, the learning of the agent follows trial and error method. This kind of reinforcement learning is one of the key enabler for cognitive computing

The cognitive computing should be cognitive enough for the given input and context.

Secondly, learning features with deep learning models is another key enabler for cognitive computing. Basically, human way of recognizing nature involves both rational and perceptual methods. Rational method is based on strict definitions and concepts whereas perceptual method is based on mapping the relationship between input and output. Here, the perceptual learning is incorporated in deep learning which stimulates the visual recognition in machines.Deep learning uses deep neural networks in order to process extract complex patterns from the input data. Deep neural networks enable the cognitive systems to perform human like tasks such as recognizing real objects. Here also, as in cognitive science, the deep learning takes a particular output option remains abstract. Cognitive systems employ deep learning in visual recognition applicationsto extract patterns from input data like photo, video, images of scenes, objects, text, and other subjects. An example of visual recognition is the Google Lens, a cognitive visual recognition systemcaptures images usingmobile phone's camera and provide information about the object

Thirdly, cognitive computing is enabled by Natural Language Processing(NLP), which is an interdisciplinary field that applies statistical and rules-based modeling to interpret the meaning of human language. NLP helps in extracting words, identifying relationship among words and extract meaning and insights. NLP facilitates cognitive systems to interact with humans naturally. An example of cognitive application which exploits NLP is the smart compose feature of Gmail, where it suggests next words and sentences to write.

Ultimately the other technologies namely advanced development in computer processing, smart devices, industry 4.0, 5G communication, the Internet, sensors, data mining algorithms, pattern recognition technologies serve as key enablers for cognitive computing

Cognitive use cases

Initially, the cognitive computing landscapes are filled by major enterprises viz., IBM, Microsoft and Google. IBM Watson is a supercomputer that combines artificial intelligence and cognitive analytical software for developing a "question answering" machine which interacts naturally with humans.

Microsoft cognitive services help developers to make their applications more intelligent by adding features such as emotion and sentiment detection,

vision and speech recognition, knowledge, search and language understanding.

Google DeepMind learns how to play video games similar to humans. DeepMind keeps on advancing in solving the problem of protein folding and predicted over 200 million protein structures. Recently DeepMind has been developed to play the game Stratego at the level of human expert.

Cognitive chatbot - When one chats with an automatic cognitive responder tool, it understands the demands of user based on the conversation and gives suggestion. This kind of cognitive chatbot plays crucial role during pandemic situations. For example, individuals can interact with chatbot systems via remote facility and gets feedback about the symptoms that one have. The chatbot assists the individuals by supplements whether he/she needs to go to hospital immediately or not

Cognitive robot – In cognitive robots, the robots are equipped with cognitiveprocessing technologies which provides enhanced autonomy and the become capable of serving as effective human assistant or even as companions[5-6].

As companions these robots keep the aged people very happy. Another example is that cognitive robots equipped with various sensors can give safety alert to people during disasters. As mentioned in [7], cognitive cars which are equipped with many integrated sensors and GPS navigations systems sense various road related parameters in the near vicinity and communicate them to other vehicles so that the transportation will be done safely at the same time with permitted speed.

Web search engines – cognitive google assistant helps users to interact with search engine in natural language through speech. Here, the google assistant interprets the speech and responds with relevant web sites

Speech recognition means having computers recognize the words and even the tone or emotion in human speech. Cognitive speech recognition serves humans in various applications including business enterprises, government, health-care, and entertaining[8]

Cognitive sentiment analysis – In [9], employ sentiment analysis over unstructured data to extract sentiment polarity using linguistic and semantic technologies. This kind of cognitive sentiment analysis enhances knowledge management, revenue generation, customer satisfaction,etc.

Face detection – face detection is basically a cognitive vision task which should detect one of more than one human faces from a given input image.

Cognitive Internet of Things(IoT) – The IoT applications are equipped with cognition with the by using semantic web technology such as Resource Description Framework(RDF)which facilitate context-awareness, interoperability, and reasoning in IoT[10] .

Conclusion

In this paper, use cases of cognitive computing are presented after a brief overview about cognitive computing, its key enablers. Cognitive systems are highly-efficient in collecting, and analyzing data from multiple sources in multiple formats and provide best possible solutions according to the given situation. Basically cognitive systems speeds up the analysis of big data with deeper understanding. So, the accuracy of possible solutions is sufficient enough to serve many domains. Cognitive computing helps in designing efficient business processes in spite of the changing demands of the stakeholders. It helps in enhancing customer satisfaction.

Despite the use cases, cognitive computing has some limitations also. Firstly, the cognitive systems have limitation in analyzing the risk which is missing in the unstructured input data. Secondly, there are legal and privacy implications while extracting information of people from email exchanges, or search queries etc. Thirdly, training cognitive systemsneed not only a sufficient data set, but also skilled resources who can invest time in tuning the cognitive engine before valuable outputs can be gained. That may create an initial barrier to entry for some organizations. In addition, cognitive computing suffers from the scarcity of data scientists and developers relative to the existing demand that arises due to big data

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