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A Concise Review of Cognitive Computing: Evolution and Applications

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Abstract

Cognitive computing systems have significantly advanced over the past two decades, driven by big data proliferation and breakthroughs in machine learning, data mining, and natural language processing. These systems assist human expertise by analyzing complex data to identify relationships and offer solutions. However, cognitive systems' concepts and applications remain unclear to many, limiting adoption in industries like oil and gas. This review raises awareness of cognitive technology and its business benefits. The paper outlines the evolution and core concepts of cognitive systems to provide a foundational understanding. Subsequent sections explore their applications and future trends across various industries. Cognitive computing enhances human cognition by interpreting large datasets using machine learning, data mining, and NLP. It transforms data processing by integrating advanced analytics with machine learning models, helping industries manage vast data, uncover patterns, and improve decision-making. Cognitive systems offer flexibility and transparency, allowing users to grasp underlying assumptions, data sources, and hypotheses. Hardware innovations, such as neuromorphic and quantum computing, are expected to boost performance, enabling cognitive systems to handle extensive data and respond contextually in real time. The future promises transformative advances in real-time processing and machine learning, driving change in healthcare (predictive diagnostics and personalized medicine), oil and gas (exploration and production optimization), sports (performance analytics and injury prediction), and security (enhanced threat detection and response).

Keywords: *Cognitive computing, Big data, Neurocomputing, Quantum computing*

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1. Introduction

The past few decades have been typified by a surge in data, especially unstructured data. This has led to the evolution of sophisticated computational systems such as cognitive computing. These systems are designed to broaden the frontiers of human cognition by exploring available data to discover correlations and context in order to provide relevant solutions. (Wang et al. 2010). According to modelers and system engineers, cognitive methods aid in design and deployment of complex intelligent systems. The origin of cognitive system dates back to cognitive science, a specialty that integrates psychology, linguistics, philosophy, computer science and recently neurocomputing. Cognitive computing may have emerged from artificial intelligence (AI), but has the potential to colligate AI's works due to the advent of huge computational power (Rozenblit 2005). The oil and gas industry, known for its vast and complex datasets, stands to benefit immensely from cognitive computing. As exploration and production activities generate terabytes of data from seismic surveys, well logs, and sensor networks, cognitive systems can interpret this information to identify patterns and anomalies that might elude human analysts (Allerin, 2021). By integrating machine learning algorithms and natural language processing, cognitive computing facilitates real-time monitoring of drilling operations, optimizing resource allocation, and predicting equipment failures (Schlumberger, 2021). This proactive approach enhances operational efficiency, reduces downtime, and minimizes risks associated with drilling and production activities. Moreover, cognitive systems assist in reservoir management by analysing geological and petrophysical data to improve recovery rates (Nikravesh, 2003). Advanced data analytics help identify untapped reservoirs and forecast production trends with greater accuracy (Offshore Magazine, 2021). Additionally, cognitive computing supports decision-making processes by providing insights derived from historical and current data, allowing operators to make informed choices in dynamic environments (Schlumberger, 2021). The adoption of cognitive technologies is paving the way for smarter oilfields, fostering innovation, and driving cost-effective operations (Brown et al. 2020). Despite the significant use and potential of cognitive computing in various industries, few papers have focused on its history, concepts, and applications. This review paper focuses on the evolution, concepts and applications of cognitive computing systems in order to create awareness of its present and future value in diverse industries.

2. Evolution of cognitive computing

The idea of intelligent machines can be traced back to the 19th century, when George Boole demonstrated in 1854 that logical operators formed the foundation for the laws of thought in his book "The laws of Thought". Concurrently, Charles Babbage conceptualized the development of an analytical engine. To address the artificial intelligence challenge, Alan Turing, a British computer scientist and mathematician, suggested an experiment in 1950 that later became known as the Turing test. This test evaluates a machine's capacity to exhibit intelligent human-like behaviour and was inspired by the Victorian-era "imitation game" (TEDAI, 2024). The test aims to determine if an interrogator can differentiate between human and computer responses. If the questioner fails to make this distinction, the computer would be considered capable of thought. The term "artificial intelligence" was coined by Professor John McCarthy at a Dartmouth College conference in 1956. He described it as the science and engineering of producing intelligent machines and computer programs. Later, in his ground-breaking 1960 paper "Man-Computer Symbiosis," computing visionary J.C.R. Licklider proposed a collaborative relationship between humans and computers. He predicted, "Man-computer symbiosis is an expected development in cooperative interaction between men and electronic computers. It will involve very close coupling between the human and the electronic members of the partnership." The main objectives were; 1) to allow formulated thinking by computers, 2) to encourage cooperation between humans and computers in handling complex challenges and decision-making. Precursory analyses suggest that this mutual affiliation will be more efficient in performing intellectual functions than standalone parties. Cognitive computing is revolutionizing the industry and changing the narratives in transportation, customer care, healthcare, oil and gas, and many others. This progression will lead to a new generation of users who comprehend cognitive technology well enough to envision novel business applications and construct a cognitive web. The evolution of cognitive computing is rooted in three distinct computing eras.

2.1 The phases of computing

The history of computing is critical in understanding the future of cognitive computing. There are three distinct phases of computing (Figure 1): the tabulating, programming, and cognitive computing eras. The latter represents the present and most transformational era (IBM, 2024).

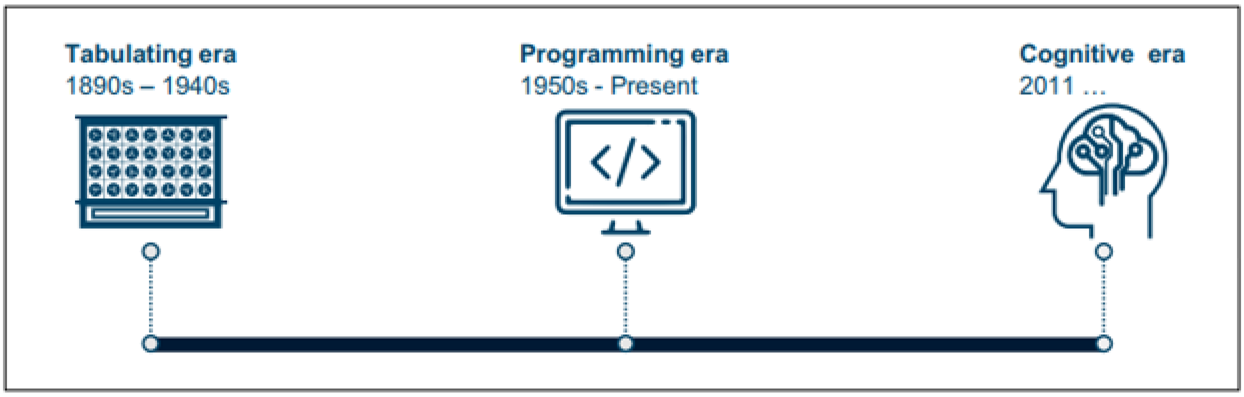

Fig. 1: The three phases of computing (IBM, 2024)

The phase of the tabulating machines (1890s - 1940s) represents the early era of data processing, marked by the invention of electromechanical systems that handled data input, storage, and basic machine instructions. The most notable example is Herman Hollerith's tabulating machine, developed for the 1890 U.S. Census, which utilized punched cards to automate population counting. These machines were pivotal for governmental tasks like census data and for businesses that needed to scale operations, but they were limited to performing specific tasks and lacked flexibility. Over time, these machines evolved into more sophisticated unit record systems, laying the foundation for the broader data processing industry (National Museum of American History n.d)

The phase of the programming machines **(**1950s - present) emerged during World War II, ushering in the age of digital computing. This period saw a shift from mechanical to electronic systems, which were influenced initially by military and scientific demands but later expanded into businesses and governments. The introduction of general-purpose digital computers, from mainframes to personal computers and eventually smartphones, revolutionized how data was processed and how tasks were automated. Despite their versatility, these systems still require manual programming and have limitations in human-computer interaction. This era continues today, as programming machines remain fundamental in solving societal and business challenges (Ceruzzi, 2012).

The phase of the cognitive machines (2011 - future) marks a new chapter in computing, following the natural progression from programmable machines to cognitive systems. Cognitive computing was first conceptualized in the 1960s by J.C.R. Licklider, who envisioned a system where humans and machines work symbiotically. These systems are designed to augment human abilities, helping to process and make sense of vast amounts of structured and unstructured data, which human cognition alone cannot efficiently handle (Licklider, 1960). Cognitive computing systems like IBM’s Watson, introduced in 2011, represent a key milestone in this era. Unlike traditional computers that operate based on pre-programmed rules, cognitive systems can learn, reason, and interact with humans in a more natural and dynamic way. These systems adapt and improve over time through interactions with data and humans, helping solve complex problems and providing actionable insights from large datasets (Kelly, 2015). The shift to cognitive computing is powered by big data and the need for more nuanced, evidence-based decision-making. For example, cognitive systems can help physicians diagnose diseases by quickly analyzing medical records and providing data-driven recommendations. They also enhance customer service experiences through intelligent chatbots and improve business decision-making by analyzing customer data. As John E. Kelly III stated, "Cognitive computing refers to systems that learn at scale, reason with purpose, and interact with humans naturally" (Kelly, 2015). Cognitive systems do not mimic human thinking but instead complement it, offering new ways to tackle challenges like climate change, healthcare, and global economic issues. The integration of human and machine intelligence creates a collaborative environment where cognitive computing tools support human expertise to make more informed and efficient decisions (Regli, 2023).

2.2 Basic concepts related to cognitive computing

Cognition

Cognition refers to the mental process of acquiring and processing knowledge through thoughts, experiences, and sensory inputs. This ability is foundational to human activities such as learning, social interactions, language development, and problem-solving. Cognitive processes help in transforming raw sensory data into meaningful knowledge, allowing humans to interpret the world and make informed decisions (Simplilearn, 2024).

Artificial intelligence (AI)

AI spans across multiple disciplines like computer science, psychology, and philosophy, aiming to replicate human cognitive processes in machines. These systems are designed to handle tasks that typically require human intelligence, such as decision-making, language processing, and visual recognition. AI technologies, which include machine learning and natural language processing, are often applied in fields such as automation, data analysis, and natural language understanding (Baeldung, 2024). AI automates complex workflows, allowing machines to process a wide range of tasks efficiently, which would otherwise require human intervention (Simplilearn, 2024).

Cognitive computing

Cognitive computing, on the other hand, enhances decision-making by combining the capabilities of human cognition with machine processing. Unlike AI, which strives for full automation, cognitive computing systems assist humans by simulating human-like thinking to provide insights. These systems leverage technologies like machine learning, data mining, and natural language processing to analyze both structured and unstructured data. Through this integration, cognitive systems help humans make better, more data-driven decisions without replacing human judgment entirely (Baeldung, 2024; Simplilearn, 2024).

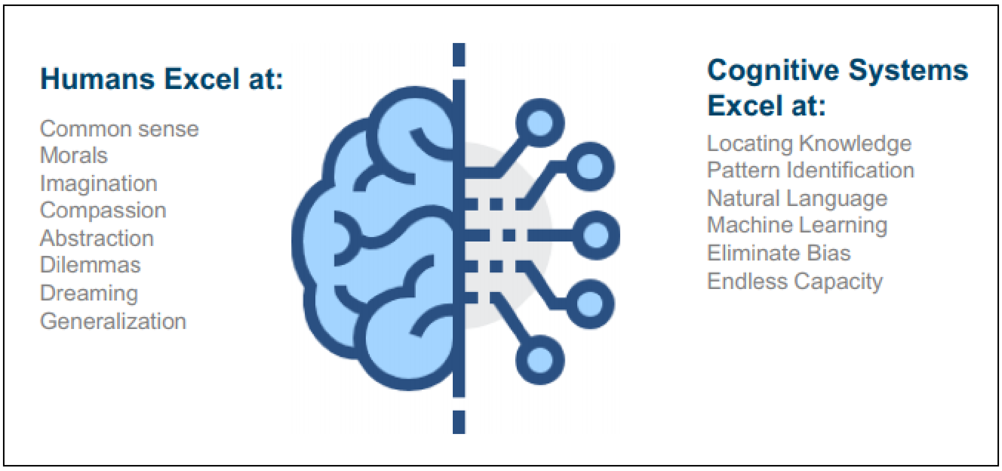

Fig. 2: Cognitive systems complement humans (IBM, 2022)

Big data

Big data is often identified by its unique properties which are captured in what is known as the five (5) Vs; variety, volume, velocity, veracity, and visibility. Big data can be structured (traditional datasets and databases), semi-structured and unstructured (videos, images, audio, social media information, web pages, presentations and many others) which is proliferating exponentially and fast becoming ubiquitous (Teradata, 2023; Technology Advice, 2023).

Question-answering (QA) technology

Cognitive computing provides answers to complex questions posed by humans in natural language by searching through several pages of text, thanks to its question-answering technology (Teradata, 2023). It is however different from the conventional search engines because it supports a conversational platform courtesy of advanced analytics and application programming interfaces (API) embedded in it.

Machine learning (ML)

This is a sub discipline of AI that enables computers to learn and perform tasks without being explicitly programmed. This means that the machine learning model becomes smarter as more data is made available for it to learn and can execute certain functions without being programmed (Rozenblit, 2005).

Natural language processing (NLP)

NLP is a branch of AI concerned with the processing of human language including English, French, Arabic, Spanish, Japanese, by computers. NLP has the ability to distinguish human language from computer languages like Java, Fortran or C++, and comprehend human speech. NLP allows users to gain valuable insights from content by analysing text and identifying concepts, entities, keywords, relations, emotions, sentiment and other characteristics (Teradata, 2023). A common example of NLP is the spam-detection software, which analyses the content of an email to determine whether it is a spam or not a spam.

Cloud computing

Services such as data analysis, social media, video storage, e-commerce, and cognitive computing are available in the Internet and supported by cloud computing through service providers worldwide (Technology Advice, 2023). Cloud computing ensures the delivery of these services on-demand and usually on a pay-per-use basis.

Application program interfaces (APIs)

Application Program Interfaces (APIs) serve as intermediaries that allow different software systems to communicate effectively by abstracting the underlying functionality. In essence, they provide a standardized way for software applications to interact with each other by exposing only the essential functions a user needs, without revealing the complexities of the internal operations. For cognitive computing systems, APIs play a crucial role in integrating machine intelligence into various applications, making it easier for users to incorporate cognitive abilities such as natural language understanding, machine learning, and data mining into their tools and services. Cognitive computing platforms, like IBM's Watson or Microsoft's Azure Cognitive Services, rely on APIs to enable developers to embed cognitive functionalities into digital applications without needing in-depth expertise in AI (Figure 3). These APIs offer access to services such as speech-to-text, natural language processing, and image recognition, and are typically cloud-based, which ensures scalability and ease of integration across different systems and applications (Techopedia, 2023).

In doing so, APIs simplify the development process by allowing interaction with cognitive systems through predefined endpoints, enabling flexible integration into broader digital infrastructures such as customer service systems, healthcare platforms, or e-commerce applications. This modularity accelerates innovation and enhances functionality by allowing external systems to easily tap into powerful cognitive services (Zeba Academy, 2023).

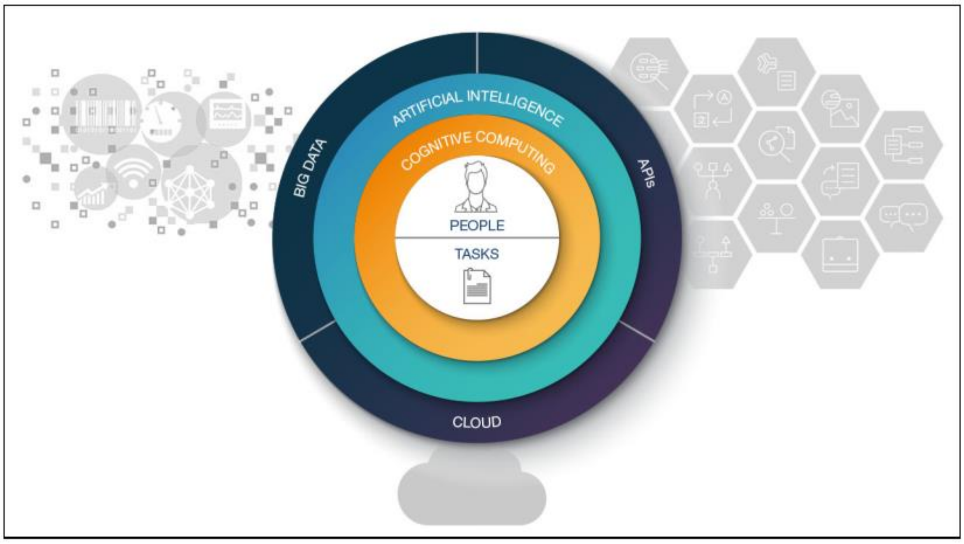

Fig. 3: Cognitive systems assist users to focus on building better solutions (IBM, 2024)

2.3 Integrating the concepts and technologies

Integrating various concepts and technologies is key to cognitive computing's effectiveness, enabling systems to process data efficiently and generate actionable insights. Cognitive computing aims to address the challenge of processing vast amounts of data by allowing experts to focus on patterns and decision-making rather than interpreting the data manually. These systems are enhanced by machine learning, which ensures that the quality of output improves over time as they observe more data. Additionally, natural language processing (NLP) and question-answering (QA) systems are advancing to understand user context and deliver more precise insights, making it easier for subject matter experts to extract meaningful information without needing deep technical expertise. Furthermore, cloud computing plays a crucial role in scaling these capabilities by offering a platform for storing, processing, and accessing data efficiently. Cloud environments allow users to access these powerful computational resources on-demand, often through a pay-per-use model. Vendors utilize the vast amounts of data available to provide tailored services, which are supported by Application Program Interfaces (APIs). APIs streamline interactions between applications, devices, and services, facilitating smoother integration and enabling developers to tap into cognitive computing functionalities without requiring specialized knowledge in programming. This combination of technologies ensures that cognitive computing is not only accessible but also continuously improving in delivering personalized, data-driven solutions across various sectors like healthcare, customer service, and finance (IBM, 2024; IABAC, 2024).

2.4 Characteristics of cognitive systems

Cognitive systems are increasingly viewed as essential tools to handle the exponential growth of data, offering capabilities that complement human cognitive processes. Their primary role is to enhance human intellect rather than to replace or replicate brain functions. While computers excel at quickly processing large volumes of data, humans remain superior at solving complex problems that require deep thinking. The integration of cognitive systems with human intelligence creates a synergistic collaboration, where the system synthesizes diverse information sources, applies reasoning, and supports decision-making processes (IBM, 2022; Mustafa, 2023). One of the key elements of cognitive systems is their intuitive interaction with humans, particularly through advancements like speech recognition. This allows for more natural engagement between users and machines (Figure 4), in contrast to the rigid interfaces of earlier technologies (APS, 2023). Machine learning plays a crucial role in this, but cognitive systems transcend traditional machine learning techniques by continuously adapting through feedback mechanisms. Over time, these systems evolve and improve based on user interactions, making them more efficient in problem-solving (Taye, 2023). Moreover, cognitive systems are not only defined by their ability to understand and manage structured and unstructured data, but also by their reasoning capabilities (Figure 5). They can hypothesize and infer new ideas, constantly learning from each interaction and becoming increasingly adept at interacting with humans in natural, multimodal ways—through sight, sound, and speech (APS, 2023; Mustafa, 2023).

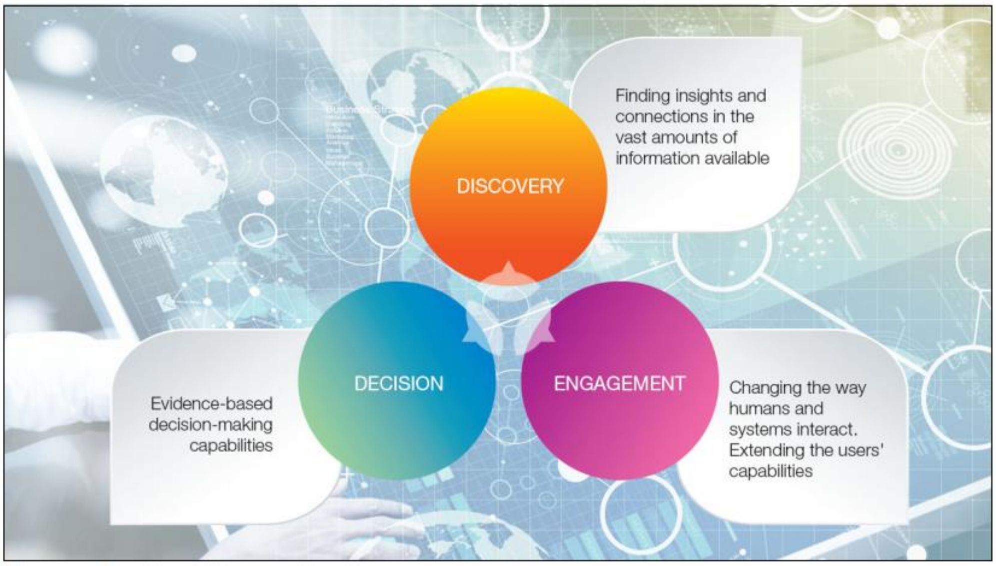

Fig. 4: Wide capacity areas of cognitive systems (IBM, 2022)

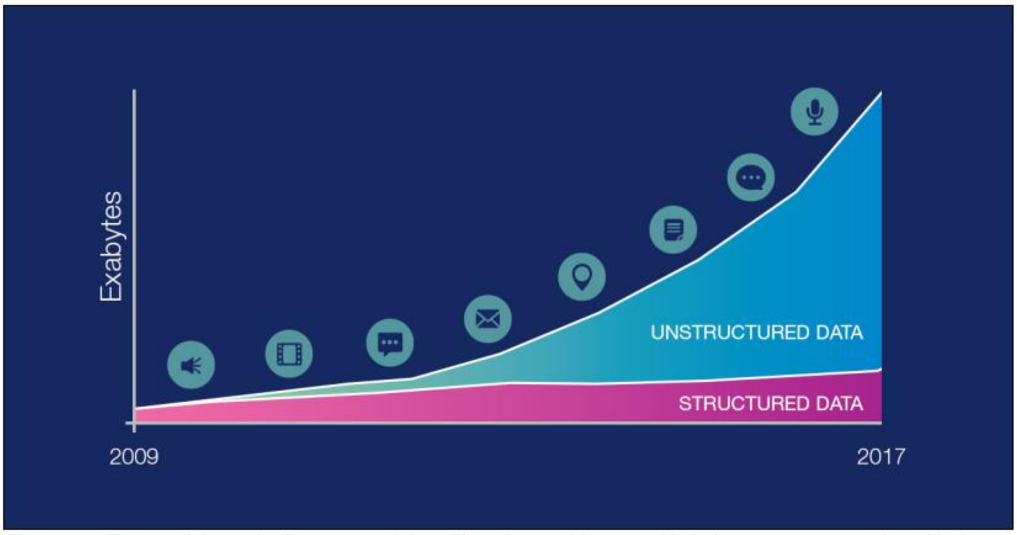

Fig. 5: Exponential growth of unstructured data drives the need for cognitive systems (IBM, 2022)

2.5 Addressing daily challenges with cognitive systems

Cognitive systems are increasingly seen as essential tools in addressing the challenges posed by the growing flood of data in both corporate and societal contexts. These systems enhance human capabilities rather than replace them, using advanced technologies such as ML, NLP, and data analytics to provide more efficient, personalized, and intelligent solutions across industries (Frontiersin, 2023). For instance, in the corporate world, cognitive systems integrate NLP and ML to comprehend complex, unstructured data. These systems not only analyze vast data sets to uncover insights but also engage in natural human-computer interactions to support decision-making, enhancing customer experiences and business operations (AnalyticsLearn, 2024). Applications in industries like healthcare, finance, and transportation demonstrate how cognitive systems process large amounts of data in real-time, offering personalized recommendations and improving operational efficiencies (Frontiersin, 2023). In particular, cognitive systems' ability to handle unstructured data, make decisions based on that data, and adapt through continuous learning sets them apart. For example, virtual assistants like Amazon's Alexa leverage NLP to interact naturally with users, while systems in healthcare can predict patient outcomes based on vast medical datasets (AnalyticsLearn, 2024; Frontiersin, 2023). These capabilities are crucial for solving complex problems in diverse fields, from providing personalized travel recommendations to optimizing traffic management and self-driving vehicles (AnalyticsLearn, 2024). Thus, cognitive systems represent a profound shift in how data is managed and utilized, transforming everything from customer service to predictive maintenance in manufacturing. The blending of human intuition and machine intelligence (Figure 4) facilitates deeper, more informed decision-making across sectors (Frontiersin, 2023).

3. Applications of cognitive computing systems

3.1 Cognitive computing as a tool for bias reduction

In modern computing systems, training with acquired knowledge is a complex and resource-intensive process that often involves human judgment and trial-and-error. This complexity stems in part from the overwhelming amount of unstructured data, which can introduce bias into the decision-making process. Human experts, even in specialized fields like medicine, often work with incomplete information and rely on personal experiences, leading to biased interpretations (NIST, 2022). Cognitive systems, as they evolve, are poised to reduce this bias by applying more powerful learning techniques that can identify and correct biases over time. In addition, the lack of standards for training cognitive systems contributes to the problem. When unstructured data is used, biases may arise from the data itself, as well as from the way humans interact with and interpret that data. Researchers have pointed out that biases in machine learning can emerge at different stages of the lifecycle of an AI model, from data collection to model deployment (Menychtas and Kyriazis, 2024). These biases can have serious implications, particularly when systems are used for decision-making in areas like healthcare, law enforcement, and finance. Therefore, addressing bias in cognitive systems requires a dual focus: improving the tools and methods used for training and increasing awareness of biases in both human decision-making and system design (NIST, 2022). These developments in cognitive systems promise to enhance fairness and reliability, helping experts make more informed and less biased decisions.

3.2 Integration and display of data

The integration of complex data from multiple sources is a key challenge in modern systems, especially when the data is unstructured. Cognitive computing provides solutions to this problem by employing processes that search for patterns across disparate datasets and identify anomalies. The goal is to automate this process to reduce manual effort and increase efficiency (Davenport and Ronanki, 2018; Wirth and Hipp, 2022). Ontologies play a crucial role in this integration process, serving as a structured way to represent shared understanding of relationships within a domain. However, in practice, ontologies can be limiting due to their static nature. Ideally, a cognitive system could dynamically build its own model of relationships and context from the data it processes, thereby bypassing the need for predefined ontologies. Yet, this level of dynamic processing is only feasible with sufficient data, experience, and processing power (Fensel and van Harmelen, 2001; Ghidini and Oren, 2016). Thus, while ontologies are currently used to organize data and ensure proper connections across systems, cognitive computing is moving toward a future where systems can create models of their own, enhancing adaptability and reducing reliance on rigid structures (Davenport and Ronanki, 2018; Wirth and Hipp, 2022).

3.3 Expanding various fields

Cognitive computing is transforming various sectors, including healthcare, manufacturing, customer service, and beyond, by enhancing decision-making, optimizing operations, and enabling greater efficiency. In healthcare, cognitive systems can analyze large datasets, such as patient records and medical research, to identify patterns for more accurate diagnoses, personalized treatments, and drug discovery (AnalyticsLearn, 2024; Dataspace Insights, 2024). These systems assist in making complex decisions that would be difficult for human practitioners to achieve on their own, allowing for quicker, more informed decisions. For manufacturing, cognitive computing helps with predictive maintenance, analyzing sensor data to detect anomalies in machinery that could signal potential failures (AnalyticsLearn, 2024). This reduces downtime and prevents costly repairs by enabling proactive maintenance. In addition, quality control processes are enhanced by real-time defect detection through image and sensor analysis. In customer service, cognitive systems like chatbots and virtual assistants use natural language processing to understand and respond to customer queries (AnalyticsLearn, 2024). They offer a more personalized, efficient customer experience, handling everything from product recommendations to resolving concerns in a conversational manner. Additionally, cognitive computing holds great promise in improving data management, decision-making, and problem-solving across industries. Innovations in hardware, like neuromorphic and quantum computing, are expected to significantly boost performance, offering new ways for cognitive systems to process vast amounts of data and respond contextually in real time (Dataspace Insights, 2024). These developments are only the beginning. As cognitive computing continues to evolve, it will play an even more critical role in automating processes and supporting industries in making smarter, more data-driven decisions.

3.4 Harnessing cognitive computing for enhanced prediction

The integration of advanced analytics with cognitive computing is setting the stage for more automated and intelligent data processing methods. As cognitive computing continues to evolve, businesses will increasingly rely on these systems to handle vast amounts of data and uncover hidden patterns that are often not visible to traditional analysis tools. By enhancing machine learning models with new data, these systems can better predict optimal next steps and identify anomalies, improving decision-making processes across various industries (Kasowaki and Zavier, 2024). Cognitive systems are becoming more adept at processing both structured and unstructured data, allowing organizations to streamline operations and predict trends with higher accuracy. For example, advanced analytics will be used to assess data quality and ensure that the insights generated are based on reliable sources (Dataversity, 2024). This will drive smarter predictions and automated responses, as these systems evolve with each interaction, gradually refining their predictions and adapting to new data patterns (Kasowaki and Zavier, 2024). These advances are not only enhancing business operations but also revolutionizing sectors like healthcare, manufacturing, and customer service, where the ability to detect patterns and propose solutions has profound implications (Kasowaki and Zavier, 2024; Dataversity, 2024).

3.5 Knowledge management and developing intuitive user-machine interactions

The concept of a new cycle of knowledge management, reflects the emerging processes of formulating hypotheses, collecting and vetting data, and applying natural language processing (NLP) and other visualization techniques. This iterative and dynamic approach aligns with current knowledge management practices that integrate big data analytics and predictive algorithms. These techniques allow for continuous refinement of knowledge and offer an agile approach to data management. In this evolving landscape, cognitive computing plays a pivotal role in automating the collection, analysis, and sharing of knowledge. By enabling more accurate and efficient data processing, these technologies help streamline the decision-making process, enhance data validation, and provide more actionable insights (Scheer and Markus, 1999; Probst et al., 1997). The application of NLP, voice recognition, and other emerging technologies will likely play a key role in future interactions with these systems, allowing for more intuitive and responsive user interfaces, especially in critical fields like healthcare and elderly care (Greenwood, 1998; Pitt et al., 1998). The ongoing development of these systems will significantly enhance the capacity of organizations to harness and apply knowledge more effectively across various domains, marking a shift towards more sophisticated, data-driven decision-making processes (Probst et al., 1997).

3.6 Strengthening the packaging of best practices

The need to strengthen the packaging of best practices in cognitive computing is a growing trend. As the technology matures, the codification of solutions developed through collaborations with subject matter experts can become generalized patterns, allowing other projects with similar challenges to benefit from these experiences (Chui, Manyika, and Miremadi, 2016). This will lead to the development of core services that organizations can adopt, and eventually, comprehensive packages that become industry standards. The distinction between conventional packaged applications and cognitive systems lies in the level of transparency in the latter. Cognitive systems offer more flexibility and visibility, enabling users to understand the assumptions, data sources, and hypotheses underlying the models (Mayer-Schönberger and Cukier, 2013). This enables organizations to adopt relevant components or customize packages for their specific needs, thus expediting the creation of new applications and reducing development times significantly (Brynjolfsson and McAfee, 2014). The transformation from custom-built cognitive solutions to standardized packages mirrors the evolution of technology from early innovations to widely adopted industry norms. In time, packaged cognitive systems will become a cornerstone of knowledge sharing and collaboration across industries, serving as a tool for training professionals and improving operational efficiency (Bessen, 2019).

3.7 Technical advancements and the future of cognitive computing

The future of cognitive computing is poised for ground-breaking advancements, particularly in the realms of real-time processing and machine learning. As cognitive systems evolve, the critical challenge will be improving the speed and accuracy of real-time data interpretation. Technologies that process massive amounts of unstructured data-such as speech, images, videos, and sensor outputs, must become faster, clearer, and more efficient in their ability to identify relationships and patterns in real time (Brynjolfsson and McAfee, 2014; Haenlein et al., 2020). This enhanced data comprehension is not just about collecting vast amounts of information, but about reducing the time to meaningful insights. A system that can quickly interpret actions in video streams, for example, to prevent security threats, will demonstrate the transformative power of cognitive computing. Future breakthroughs will also center on the integration of machine learning, where systems will become adept at recognizing patterns or connections in data as it is being collected, facilitating near-instantaneous insights. This evolution will significantly streamline workflows, minimizing manual intervention and accelerating the progression from raw data to actionable knowledge (Mayer-Schönberger and Cukier, 2013). The convergence of advancements in real-time analytics and machine learning will transform industries ranging from healthcare to security, enabling businesses to make informed decisions and discover new opportunities faster than ever before (Chui, Manyika, and Miremadi, 2016).

4. Conclusion

Cognitive computing systems have evolved over the past few decades due to the surge in unstructured data. Originating from cognitive science, these systems aim to broaden human cognition by exploring available data to discover correlations and contexts, providing relevant solutions. The concept of intelligent machines dates back to the 19th century, with George Boole demonstrating that logical operators formed the foundation for the laws of thought. Charles Babbage conceptualized the development of an analytical engine, and Alan Turing suggested the Turing test in 1950 to address the artificial intelligence challenge. Cognitive computing is revolutionizing industries like transportation, customer care, healthcare, oil and gas, and is rooted in three distinct computing eras: tabulating, programming, and cognitive computing. The Phase of the Cognitive Machines (2011-2022) is a significant shift in computing, focusing on the integration of human and machine intelligence. Cognitive systems complement human thinking by combining the capabilities of human cognition with machine processing, leveraging technologies like ML, data mining, and NLP to analyze both structured and unstructured data. Big data, which can be structured, semi-structured, or unstructured, is rapidly proliferating and becoming ubiquitous. Cognitive computing systems provide answers to complex questions in natural language through question-answering technology, ML, and NLP. Cloud computing offers services such as data analysis, social media, video storage, e-commerce, and cognitive computing, which are available on-demand and usually on a pay-per-use basis. Cognitive computing is increasingly viewed as essential tools to handle the exponential growth of data, offering capabilities that complement human cognitive processes rather than replace them. They currently play a critical role in a wide range of sectors and are predicted to be indispensable in the near future.

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