A Review of the Trends in Artificial Intelligence Research

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Abstract

Rapid advancements in the field of science and technology has led to the increasing use of Artificial Intelligence in all fields, including space, transportation, health, science, finance, and the military. These developments are likely to have significant consequences for the society. From orbital prediction to solar energy harnessing, to language learning and storytelling, Artificial Intelligence is rapidly becoming a part of systems all across fields worldwide. This paper aims to review some of the research studies which have been carried out on the current trends in Artificial Intelligence. For this paper, specific search terms were used in Google Scholar search engine and the results were shortlisted according to the year of publication. From the review of the studies available on the subject, it was clear that the use of Artificial Intelligence across all fields is not just all-pervasive, but likely to increase multifold across the globe.

Keywords: Artificial Intelligence, Research, Trends, Review

Introduction

Artificial Intelligence is witnessing rapid advancements across the world, resulting in increased use of AI in all fields. These developments are likely to have a significant impact on human lives. According to Grace, Salvatier, Dafoe, Zhang & Evans (2018), advances in artificial intelligence (AI) will transform modern life by reshaping transportation, health, science, finance, and the military. Such developments are bound to have huge consequences for the society.

Methodology

In this paper, we will review some of the research studies which have been carried out on the subject of trends in Artificial Intelligence. Towards this end, specific search terms were used in Google Scholar search engine, such as "artificial intelligence + trends". The results of these searches were shortlisted as per the year of publication. For the purpose of this study, only studies published after 2010 were used, in order to examine the current trends in Artificial Intelligence.

Results and Discussion

The global importance of AI technology has been growing over the last decade. Countries such as Japan and the U.S. are actively involved in promoting AI technologies. According to Insel et al. (2013) and Hodson (2016), the 2015 Strategy for American Innovation established nine high-priority research areas, including the BRAIN initiative and the Precision Medicine initiative (as cited in Hidemichi & Shunsuke, 2017). The authors say that AI is also listed as a high-priority technology for a super-smart society in Japan's 5th Science and Technology Basic Plan (2016 to 2020). These research and development (R&D) strategies focus on the expansion of the AI business market and are intended to improve international market competitiveness.

According to Hidemichi & Shunsuke (2017), artificial intelligence technology can play a critical role in economic development, resource conservation, and environmental protection by

increasing efficiency. According to Stone et al. (2016), AI technology will significantly contribute to increases in human welfare across a wide range of sectors, including transportation, service robotics, healthcare, education, low-resource communities, public safety, employment, and entertainment (- as cited in Hidemichi & Shunsuke, 2017). The global market for AI applications and systems is going to rapidly expand in the coming years. According to Teactica (2015), market opportunities for AI systems will increase from USD 202.5 million in 2015 to USD 11.1 billion by 2024.

Artificial Intelligence in Aerospace

According to the study by Izzy, Märtens & Pan (2018), the developments in the field of artificial intelligence have also led to the space sector catching up to these developments. Every day, greater number of research studies are being published which talk about concepts related to artificial intelligence, such as natural language processing, knowledge representation, automated reasoning, computer vision, robotics, etc. The space field is interested in artificial intelligence applications varying from preliminary spacecraft design to mission operations, from guidance and control algorithms over navigation to the prediction of the dynamics of perturbed motion and towards classification of astronomical objects and refinement of remote sensing data etc. (Izzy, Märtens, & Pan, 2018).

Rapid developments in the field of artificial intelligence have also meant a significant influence on aerospace engineering. There have been developments in aerospace, especially in Spacecraft Guidance Dynamics and Control. According to Izzo, Märtens & Pan (2018), the key technologies and drivers for both current and future research in the field include evolutionary optimisation, tree searches and machine learning, including deep learning and reinforcement learning.

According to the study by Izzo, Märtens, & Pan (2018), the ideas and research results generated amongst the artificial intelligence research community have been helpful in fields such as orbital prediction, planetary landing, spacecraft guidance, interplanetary trajectory optimisation and low-thrust propulsion. This has allowed the evolution of newer methods, and competitive and superior architectures. Izzo, Märtens, & Pan state that they are confident that once these techniques, currently known only in academia, are made more widespread, the level of automation and the performance of space systems will increase. “This trend has already begun and is continuing, taking now advantage of the increased attention on AI that happened worldwide thanks to the success of paradigms such as Deep Learning in the IT industry” (Izzo, Märtens, & Pan, 2018).

We expect that more success stories in new domains such as formation flying, rendezvous and docking, in-orbit self-assembly, or autonomous detection on planet/steroid surface will appear in the next decades with Deep Learning and Deep Reinforcement Learning powering many developments in all areas as per their novelty and increasing attractiveness. Work on the validation of AI based system is also expected to appear to provide methods for increasing the trust in trained models (like DNNs), which are often regarded with skepticism when seen as a black box.

A.I. Patents

According to Hidemichi & Shunsuke (2017), the priority has shifted from biological- and knowledge-based models to specific mathematical models and other AI technologies, especially in Japan and the U.S.

In case of new inventions, it is seen that usually the patents to these inventions grant inventors exclusive rights for protection of their knowledge and technology from the competitors (Maresh et al., 2016 – as cited in Hidemichi & Shunsuke, 2017). The same phenomenon holds true for A.I. technology patenting. According to Bajpai (2016), the world's largest A.I. patent inventor IBM, projected that Watson will have reached one billion consumers 2017-end, mainly through IBM's partnerships with other companies (- as cited in Hidemichi & Shunsuke, 2017). Bajpai (2016) identified that IBM has a lead on companies which have just entered the field of A.I., due to sufficient A.I. patenting. Hence, according to Hidemichi & Shunsuke (2017), A.I. patenting has become a major corporate R&D strategy to collaborate with businesses, while at the same time, protecting intellectual property and gaining position in a rapidly growing market.

Solar Energy Applications

There are various possibilities of using Artificial Intelligence applications in the field of solar energy, including the estimation of solar radiation, solar heating, photovoltaic (PV) systems, sun tracking systems, solar air-conditioning systems and many others (Kalogirou & Şencan, 2010).

By using AI techniques such as artificial neural network (ANN), fuzzy logic (FL), Adaptive Network based Fuzzy Inference System (ANFIS), Genetic Algorithms (GA) and Data Mining (DM), better, quicker and more practical predictions can be made (Kalogirou & Şencan, 2010).

a. Artificial Neural Networks (ANN) – Examples of ANN being used in the field of solar energy include development of applications in prediction of solar radiation, modelling of solar steam-generator, prediction of energy consumption of a passive solar building, efficiency of flat-plate solar collectors, heating controller for solar buildings, and modelling of solar air heater. Sözen et al. (2008) developed a new formula based on artificial neural network techniques to determine the efficiency of flat plate solar collectors (Kalogirou & Şencan, 2010). Benghanem et al. (2009) have developed artificial neural network (ANN) models for estimating and modelling daily global solar radiation (- as cited in Kalogirou & Şencan, 2010). Mellit and Pavan (2010) developed a Multi-Layer Perceptron (MLP) network for forecasting 24 hours ahead solar irradiance. Elminir et al. (2007) used an artificial neural network model to predict the diffuse fraction on an hourly and daily scale using as input the global solar radiation and other meteorological parameters, like long-wave atmospheric emission, air temperature, relative humidity and atmospheric pressure (- as cited in Kalogirou & Şencan, 2010). Soares et al. (2004) used artificial neural networks to estimate hourly values of diffuse solar radiation at a surface in Sao-Paulo City, Brazil, using as input the global solar radiation and other meteorological parameters. It was found that the inclusion of the atmospheric longwave radiation as input improves the neural-network performance. Kalogirou and Bojic (2000) used artificial neural networks for the prediction of the energy consumption of a passive solar building. Rehman and Mohandes (2008) used the air temperature, day of the year and relative humidity values as input in a neural network for the prediction of global solar radiation (GSR) on horizontal surfaces (- as cited in Kalogirou & Şencan, 2010). Tymvios et al. (2005) used artificial neural networks for the

estimation of solar radiation on a horizontal surface. In addition, they used the traditional and long-utilized Angström's linear approach which is based on measurements of sunshine duration. Sozen et al. (2004) estimated the solar potential of Turkey by artificial neural networks using meteorological and geographical data (latitude, longitude, altitude, month, mean sunshine duration and mean temperature). (- as cited in Kalogirou & Şencan, 2010).

b. Fuzzy Logic (FL) – Examples of FL being used in the field of solar energy include development of applications in photovoltaic solar energy systems, sun tracking system, prediction of solar radiation, control of solar buildings and controller of solar air-conditioning system (Kalogirou & Şencan, 2010).
c. Adaptive Network based Fuzzy Inference System (ANFIS) – An example of ANFIS being used in the field of solar energy include development of application for prediction of solar radiation and temperature (Kalogirou & Şencan, 2010).
d. Genetic Algorithm (GA) – Examples of GA being used in the field of solar energy include development of applications for photovoltaic solar energy systems, determination of Angström equation coefficients, solar water heating systems, hybrid solar-wind system, PV-diesel hybrid system, solar cell and flat plate solar air heater (Kalogirou & Şencan, 2010).
e. Data Mining (DM) – An example of DM being used in the field of solar energy includes the development of application for solar cells (Kalogirou & Şencan, 2010).

AI and Language Learning

According to Kannan & Munday (2018), AI started being used in language learning from 1980s in the form of Intelligent Tutoring systems (ITS). Early versions of ITS were computer-based learning systems flexible to the needs of learners and were therefore seen as "systems which attempt to 'care' about learners in that sense." (Self, 1998 – as cited in Kannan & Munday, 2018). ITS was thought to be vital for individualized, custom learning as the tutoring feature allowed for unlimited repetitions, and practice exercises.

But, as per a review study related to 22 types of ITS in higher education, ITS had only a "moderate positive effect on college students' academic learning" (Steenbergen-Hu& Cooper, 2014 – as cited in Kannan & Munday, 2018). According to Kannan & Munday (2018), this could also be attributed to the restricted pedagogical design of ITS applications. As per Reiland (2017), advances in AI is broadening the potential for AI in education and personalized learning. (– as cited in Kannan & Munday, 2018).

In Stanford University's 2016 "100-year report on AI" report, education was mentioned amongst the eight factors related to AI which was deemed as a part of envisaging future directions. (Stone et. Al, 2016 – as cited in Kannan & Munday, 2018). The report presented findings related to language learning and AI, and stated that "while AI showed great promise for language learning, the early work of AI diminished because of its limited ability to promote deep learning in systems such as the ITS". Today, AI has permeated many aspects of everyday lives, from smart applications on our mobile devices to self-driving cars (Kannan & Munday, 2018).

According to Kannan & Munday (2018), within the field of AI modeling, Natural Language Processing (NLP) has played a significant role in the development of CALL. One example is the E-Tutor, which used NLP techniques to teach German as a second language (Heift, 2010 – as cited in Kannan & Munday, 2018). Heift explored the benefits of using such AI based systems

for teaching second languages. According to Kannan & Munday (2018), NLP uses cell phones for speech-recognition patterns and hence, AI's contribution in this field of language processing has led to greater number of applications that are wider in scope. According to Stone et al. (2016), the algorithms used for speech-understanding on our phones are being applied to many other areas, including web search and healthcare informatics (– as cited in Kannan & Munday, 2018). The Stanford University 2016 report says that the work of NLP has included research in reasoning, even though scaling up has been a challenge as it is usually designed and customized for specific projects. Advances in AI have led to a variety of applications which rely on pattern recognition. Early AI systems could not expand this pattern recognition to more complex scenarios suitable for language learning. According to Hof (2015), almost eighty percent of advances in AI over the last decade have been credited to the greater power of computing available today. (– as cited in Kannan & Munday, 2018).

AI and Storytelling

The advancements in AI are even reaching into the field of storytelling. According to Kasunic & Kaufman (2018), we can categorize AI in storytelling into three:

a. Teaching AI to generate and understand stories;
b. helping human storytellers as a cocreator;
c. modeling story elements.

Early research studies on storytelling and AI focused on improving AI's understanding of stories using scripts, or "boring little stories" (Schank et al., 1975; Schank and Abelson, 1975 – as cited in Kasunic & Kaufman, 2018). As technology developed, greater research attention shifted to using AI to actually create stories. According to Bolter & Joyce (1987), advances in technology led to the evolution of the hypertext fiction model, where branching narratives made it possible for stories to get branched (as cited in Kasunic & Kaufman, 2018).

Research in Artificial Intelligence has led to advances in story generation, developing AI story, world, and character generators that are planning- or event-sequence-based (Fairclough and Cunningham, 2004; Lebowitz, 1987; Porteous and Cavazza, 2009; Riedl and Young, 2010; Young et al., 2004; Barber and Kudenko, 2007; Min et al., 2008 – as cited in Kasunic & Kaufman, 2018).

The goals of AI research in story narratives are not solely focused on AI story generation; some work also strives to teach machines how to be more "human" through stories (Huang et al., 2016; Riedl and Harrison, 2016 – as cited in Kasunic & Kaufman, 2018). Some earlier work has also positioned AI as co-creator, encouraging and guiding humans in creating their own stories (Ryokai and Cassell, 1999; Bers and Cassell, 1998; Van Broeckhoven et al., 2015 – as cited in Kasunic & Kaufman, 2018). There has also been research carried out in the interactive drama space in which human-allowed actions are more open-ended, positioning humans to act more like actors on a stage than characters that must conform to a limited story world (Mateas and Stern, 2003). In addition, some research in modeling stories has focused not on story generation, but on understanding (and subsequently improving) human experiences of narratives.

Attitude towards AI

According to Cave, Coughlan, & Dihal (n.d.), developments in Artificial Intelligence need to be communicated to the general public. The manner in which they perceive these developments will influence both the adoption and the use of this technology.

a. Views about A.I. exceeding Human Performance

Many people, including academicians, have talked about A.I. exceeding human performance in the future. Researchers have predicted that A.I. will outperform humans in many activities in the next decade. By 2024, A.I. could outperform humans in translating languages; by 2026, writing high-school essays; by 2027, driving a truck; by 2031, working in retail; by 2049, writing a bestselling book; and by 2053, working as a surgeon. According to researchers, there is a 50% chance of A.I. outperforming humans in all tasks in 45 years and of automating all human jobs in 120 years. Asian researchers expect this to happen sooner than North Americans (Grace et al., 2018).

Grace et al. (2018), in their study, use several research studies as evidence, to talk about future A.I. advances – such as trends in computing hardware (Nordhaus, 2007), task performance (Grace, 2013), and the automation of labor (Brynjolfsson & McAfee, 2012). The predictions of AI experts provide crucial additional information (Baum, Goertzel, & Goertzel, 2011; Müller & Bostrom, 2016; Walsh, 2017) (-as cited in Grace et al., 2018).

According to Sidorova & Rafiee (2019), over decades of research and development, today, AI is not only being used in mainstream business operations, but also in the personal lives of "unsuspecting individuals" (pg. 5837). According to the McKinsey Global Institute, "it is poised to cause the next wave of digital disruption" and there is a forecast which says that by 2022, AI will know more about the emotional state of an individual than the people they are closest to (Gartner, 2018 - as cited in Sidorova & Rafiee, 2019).

In their study, Wogu, Misra, Assibong, Adewumi et al. (2018) say that the use of Artificial Intelligence Machines (AIMs) is can be considered to be one of the most significant influences on humans in the 21st century. The authors postulate that AIMs are likely to gain the capacity to reshape every aspect of human life in the near future. On a wider scale, AIM technologies and other related technologies will be capable of transforming both the security and economic status of nations. Wogu et al. (2018) say that the benefits offered by AIMs are likely to be redistributed amongst nations which make the leap into AI the quickest.

b. Questions about Machine Learning

As per Lipton & Steinhardt (2018), the 'troubling trends' about Machine Learning scholarship include the following:

i. Failure to differentiate between explanation and speculation.
ii. Failure to recognize the sources of empirical gains, e.g. highlighting redundant alterations to neural architectures when gains actually arise from hyper-parameter tuning.
iii. The use of mathematics that complicates rather than simplifies, e.g. by confusing technical and non-technical concepts.
iv. Misuse of language, e.g. by choosing terms of art with colloquial connotations or by overloading established technical terms.

Conclusion

In this paper, we reviewed studies which have been carried out on the latest trends in Artificial Intelligence across the world. From the study, it was clear that Artificial Intelligence is likely to become all-pervasive across the world in the years to come. It is also clear that the current trends in Artificial Intelligence are likely to have a significant impact on all of humanity.

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