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The impact of artificial intelligence on entrepreneurial activities and the global market

Shend Musliu¹ and Ermal Lubishtani²

Abstract. In recent years, one can see the emergence of a large number of intelligent products and services, their commercial availability and socio-economic impact. This raises the question of whether the current emergence of artificial intelligence (AI) is simply hype or really has the ability to transform the world. This paper investigates the wide range of implications of artificial intelligence (AI) and delves deeper into the positive and negative impacts on governments, communities, companies, and individuals. This paper investigates the overall impact of AI - from research and innovation to deployment. The paper addresses influential academic achievements and innovations in the field of AI, their impact on entrepreneurial activities and thus on the global market. The paper also contributes to the investigation of factors responsible for AI advancement. For exploring entrepreneurial activities towards AI. The conclusions drawn from the research will provide an improved understanding of innovation and the impact of AI on businesses and society at large. It will also provide a better understanding of how AI can transform business operations and thus the global economy.

Keywords: Artificial intelligence, entrepreneurship, innovation, economy, products, services.

1. Introduction

Innovation has always been the main engine of an improved standard of living throughout history. However, the process of innovation is often highly disruptive because it makes conventional technologies obsolete. Cloud computing, Internet of things (IoT), big data, data science, computing (AI), and blockchain are the rising technologies that may create winners and losers across the planet. A number of these technologies are a minimum two and a half decades old [0-3] but were neither within the mainstream nor were viable for commercial applications. However, in the last few years, things have changed dramatically. Today, almost every field employs one or more of those technologies. There are many factors for this, including advancements in technology (high-performance computing, grid, and cloud computing), increase in transparency through code sharing (services like GitHub, GitLab, BitBucket) and an outsized number of open source software. Currently, the large uses of those technologies in every field including healthcare, automobiles, finance, gaming, environmental monitoring, agriculture, sports, energy management, security, etc are changing the way, people in general, live, work and entertain themselves. Further advancement of those technologies can contribute to develop hyper-automation and hyper-connectivity, which might bring us at the dawn of the Fourth historic period or Industry 4.0 [4]-[7]. Primarily, the advancement in AI is that the heart of the improved performance of all other technologies and also the evolution of Industry 4.0. There are sufficient pieces of evidence available within the literature that proves that the AI technology offers new opportunities that may result in notable transformation in businesses and also the overall economic system [4], [6], [7]-[11]. At the business level, a number of the advantages of AI are: the fast unveiling of patterns in big data, speedy visualization and analytics, improved product design, delivering meticulous insights, and more.

These benefits are expected to introduce new levels of services, increased profits, expansion of companies, improved efficiency and value structures [7], [10], [11]. During this paper, the new growth economics, Neo-Schumpeterian Economics, is employed as a base model to investigate the impact of AI in business [12]. The three forces which drive the Neo-Schumpeterian Economics are innovation, knowledge, and entrepreneurship. Particularly, the paper uses these forces as a foundation to explore the success of AI algorithms, investigate their deployment commercially, and investigate investors, the entrepreneurial actions, and thus the world market. For the exploration of entrepreneurial activities towards AI, the two lists of top 100 AI start-ups are considered. The points of the paper are summarized below:

- Recognition of the factors that are leading today's AI exponential growth
- Identification of educational achievements in AI which are advancing the commercially available intelligent products.
- Determination of the highest AI industries and investment trends in AI.
- Exploration of geographically strong AI locations.
- The data analysis done proves that AI isn't a hype.

The inferences obtained from the research will provide a more robust understanding of the innovations and also the impact of AI on businesses and society in general. It will also provide a higher understanding of how AI can transform the organization of

research & development, business operations and also the global economy. The results obtained can aid the countries with the adoption of AI in near future.

The present work is organized as follows: Sect. 2 focuses on the research objectives and list of information sources, Sect. 3 provides the state-of-the-art (SOTA) research (datasets and algorithms) and innovative applications in AI; Sect. 4 illustrates the results obtained from the worldwide market research of top AI start-ups, Sect. 5 provides some conclusions and directions for future research.

2. Research Objectives and Data Collection

The present age is possibly the most exciting period of human history where technological innovations are happening at the blink of an eye. Robots working in industries, cars driving themselves, smartwatches monitoring patients' health, and AI playing games (e.g. Chess and Go) better than world champions are a number of the technological innovations under AI.

2016 has been an incredible year for machine learning, deep learning, and AI. Almost every high-tech CEO claimed to form their company an 'AI company'. The question arises:

- Why is it so? Why does every company want to be an AI company or want to amass AI companies? Are all other technologies slowly being augmented (or replaced) with AI?
- How does AI impact all the lines of business across the planet specified there's not even one field left where its impact cannot be seen? Which countries are leading the race of AI?
- AI is 60-year-old technology yet wasn't able to show its impact until the current era. Then what are the factors which are leading to today's AI exponential growth?

Through this paper, the intention is to answer the above questions. The research was initiated by scanning variety of business newsletters, AI magazines, journal papers, conference articles, machine learning posts, annual reports of the businesses, press releases, exchange websites, online forums, and plenty of other platforms to collect the information required to assist us within the investigation. The answers to those questions will help human society to induce prepared for future challenges. this may also aid in accepting the transformations occurring as a results of the infusion of AI in human life and business.

3. State-of-the-art of AI: Datasets, Algorithm, and Products

The "Artificial intelligence" [13] was founded as a field by John McCarthy, professor emeritus of technology at Stanford in 1956. He organized the famous Dartmouth conference at Dartmouth College, Hanover and commenced AI as a field. He had the assumption that there'll be systems which can evolve intelligence of human order. In 1973, Firschein and Coles [14] postulated a listing of twenty-one hypothetical products that will result from the advances of AI by the 1990s. a number of the products which were predicted by them became a reality today and are listed in Table 1. This table provides an insight into the advancement of AI within the last 48 years.

Table 1. AI technologies predicted in 1973 [14] with definitions and today's reality.

S. No.	Products postulated	Abilities proposed (Firschein 1973)	Today's Reality
1.	Automatic language translator	"Language translating device capable of high-quality translation of text in one foreign language to another. (Both technical and commercial material)."	Google Translator, Bing Microsoft Translator
2.	Automatic identification system	"System for automatically determining a person's identity by recognizing his voice, fingerprints, face, etc"	Apple Face ID, Mastercard Identity Check with NuData Security
3.	Automatic diagnostician	"A system capable of interactive and/or automatic medical diagnosis based on querying the patient, an examination of biological tests, etc."	Qualcomm Tri-corder, Medtronic Sugar.IQ Cognitive App in collaboration with IBM Watson
4.	Industrial robots	"An autonomous industrial robot capable of product inspection and assembly in an automated factory, using both visual and manipulative skills."	Kiva warehouse robots, FANUC intelligent robots, Mitsubishi Robots
5.	Robot chauffeu	"Robot cars capable of operation on standard city streets and country highways, using visual sensors"	Google Waymo, MercedesBenz E-Class, Volv
6.	Universal game player	"A system capable of playing Chess, Checkers, Kalah, Go, Bridge, Scrabble, Monopoly, etc., at a controllable level of proficiency, from master level to novice."	AlphaGo, Deep Blue

The journey of AI has not been smooth; the amount of hype was followed by periods with reduced funding (also called AI winters). However, despite these hindrances, today AI is back in the spotlight due to the event of 'deep learning neural networks with many hidden layers. This progression of AI is accredited to two main factors: the availability of an oversized amount of knowledge (big data), and hardware accelerators (graphics processing units (GPUs) and tensor processing units (TPUs)) [15]-[17]. Behind all the real-world applications (table 1), there's an intelligent agent (IA). It interacts with the environment in a very repetitive cycle of sense-think-and-act. It explores the computer file (big data) in order to learn correlations, extract features, detect similarities, and know good depiction at multiple levels. Earlier, the unavailability of knowledge and efficient hardware was hindering the progress of AI. However, within the previous few years, the accessibility of low-cost and low-power sensors has resulted with the production of an unlimited amount of data. An investigation of a list of dataset providers is completed to elucidate the amount, diversity, and accessibility of datasets available online. Next, the exploration of computer files requires AI or machine learning tools like support vector machines (SVM), decision trees, Bayesian algorithms, deep learning networks (DLN), and ensemble configurations. Among them, the DLNs became the most popular approach within a previous few years. These DLNs were in theory and practice since 1943 but insufficient processing speed and data was hindering their progress. The use of NVIDIA GPUs (graphics processing units) allowed researchers to program them conveniently and train their networks 10 or 20 times faster [19] than conventional computers. Variety of the DLNs have reported surpassing human-level accuracy in certain tasks [15] - [35]. The successful AI applications are categorized under four broad areas computer vision, speech recognition, text analysis, and computer games. Table 2 summarizes a brief description of each DL area, their successful applications, and thus the DL algorithms preferred for each area.

Table 2 Broad areas of DL, their description, successful applications, and the DL algorithms preferred for each area.

Broad areas	Description	Applications	Deep learning algorithm
Computer Vision	This area deals in making machines capable of analyzing and understanding images or sequence of images.	Face recognition, Image restoration, Computer-aided diagnosis (CADx), People counting, Gesture recognition, Iris recognition, Product defect , detection	Convolutional Neural Networks (CNNs)
Text Analysis	The area focuses on deriving high-quality information from the text data.	Information extraction, Question answering (Q/A), Search engines, Query Processing, Recommendation/ Personalization, Sentiment analysis, Document summarization, Fraud detection, Demand forecasting, Product search ranking, Translation	Gated-Recurrent Neural Networks (RNNs) (both Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU))
Speech Recognition	The area deals in making machines capable of responding to vocal instructions.	Speech-to-text processing Voice search and dialing	CNNs, RNNs, and their combination
Game playing	The area deals in making machines capable of playing games against humans and other computer agents.	Go, Chess, Atari	Policy Gradient Reinforcement Learning, Deep Autoencoder, Deep QNetworks.

The success and the hype generated by DLNs in the last few years have propelled many companies to become AI companies and have spawned a plethora of AI-based start-ups. In the next section, the top 200 AI start-ups are analyzed, the investors' and entrepreneurial actions are investigated in launching AI-based services in existing and new industries.

4. Global Market Analysis

In a knowledge-based society, start-ups are considered because the innovation and growth drivers of the economy; their analysis would help to achieve valuable insights into the exploration of the transformational impact of AI on businesses. Two lists of top 100 AI start-ups obtained with the assistance of the CB Insights Mosaic algorithm [36] are considered. The algorithm identifies the highest AI start-ups by evaluating the factors like profile, mosaic score, financing history, investor quality, business model, funding history, etc. The lists were made available by investigating, 1650+ and 2000+ global start-ups, using the Mosaic algorithm. Within the remainder of the paper, the AI startups list for 2017 and 2018 is remarked as AI17 and AI18 respectively. Part of those results has been presented at a global conference DIGITS 2018 [22] jointly organized by the University of Maryland and Birla Institute of Management and Technology. The extended version of the manuscript has been submitted to the Journal of Business Research, Elsevier for consideration as a journal research article [23].

4.1. Sectors and Industries

AI start-ups initiated everywhere around the planet are categorized in 22 different fields including autonomous vehicles, business intelligence, healthcare, etc. Fig. 1 depicts the proportion of 200 AI start-ups (AI17 and AI18) in numerous lines of business which majorly covers all the fields where AI is showing its impact. It may be seen

clearly that the spread of AI is all-pervasive, from education to healthcare, from home to industry; there's no place where AI isn't getting used or explored.

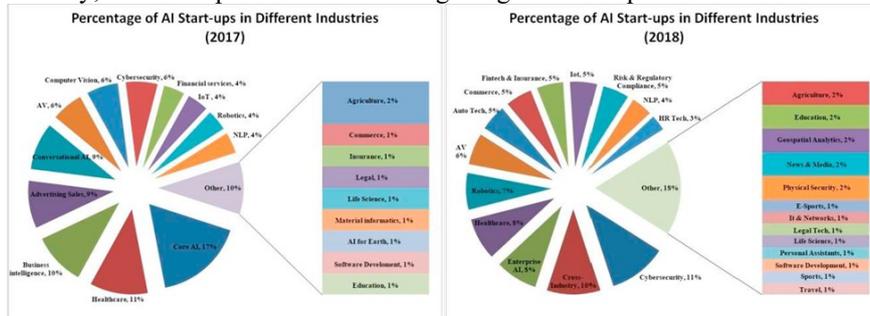


Fig. 1 Percentage of AI start-ups in different industries for (a) 2017 (b) 2018

Fig. 1 Illustrates that in AI17, Core AI gained the maximum attention and in AI18, cybersecurity was maximally benefitted from the AI technology. The detailed analysis of the data uncovered the top six industrial sectors of AI17 and AI18 viz. cybersecurity, healthcare, business intelligence, enterprise AI, core AI, and cross-industry. These pre-eminent AI start-ups are creating technological and process-oriented innovations that would generate efficiency gains and business opportunities in the near future. Some of the processes under the above top six industrial sectors that would be responsible for technological transformations in the global market are explored. The processes are medical image analysis, drug discovery, robotic surgery, virtual nurses, health monitoring, personalized product search and recommendation, sale and demand prediction, customer segmentation, cyber-attacks prediction, and automated manufacturing.

4.2. Funding

In 2011 the total investment in these AI start-ups across the world was \$25.88 million (in 7 start-ups) which increased exponentially to \$1.866 billion (in 64 start-ups) in 6 years (2011 to 2016). Fig. 2. depicts a 71.13% increase in investment in these AI start-ups (AI17). Across the world, the U.S. is leading this revolution with maximum investment.

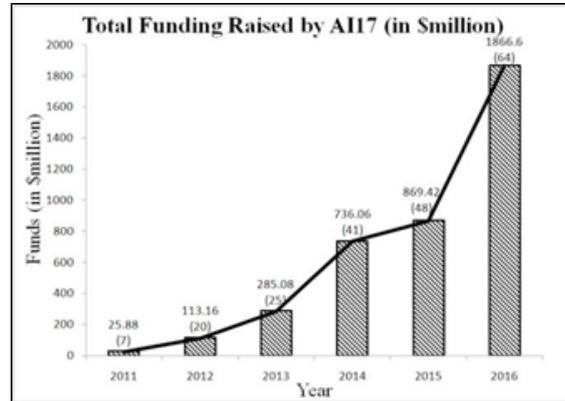


Fig. 2 Year-wise investment (in \$ Million) in 100 AI start-ups

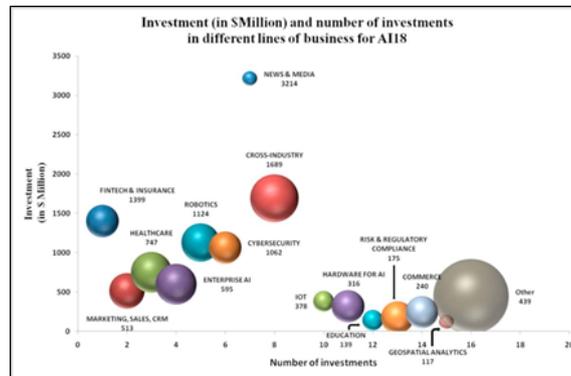


Fig. 3 Investment (in \$ Million) in different lines of business in AI18. The size of the bubble indicates the number of start-ups working in each line of business

Furthermore, the entire investment in AI18 is \$12.74 billion i.e. 2.27 times more compared to the whole investment in AI17 (2011 to 2016). This shows the rising interest of investors in AI. Fig. 3. shows the investment (in \$million) made in several industries in AI18. the dimensions of the bubble indicates the quantity of start-ups working in each line of business. A very important observation that may be made of the chart is there are only 2% start-ups in news and media, but it received the biggest investment share of 25.22% of the overall investment. The 2 start-ups that received one-fourth of the worldwide investment made in AI18 are California-based SoundHound Inc. and Beijing-based Bytedance. Both of them aim to create the human-machine interaction as simple as human-human interaction. California-based SoundHound Inc. has immeasurable users, telling smartphones to accomplish tasks without even touching them. Hound and SoundHound are two example products applying AI technology to speech (get weather information, make calls and send text, etc.) and music (find songs by singing or simply by humming) respectively. On the opposite hand, Toutiao by Bytedance is China's largest mobile platform for personalized news recommendations with 120 million daily active users as of September 2017. Toutiao is featured to spot fake news

by analyzing posts and comments with AI technologies. From the above analysis, it may be estimated that there's interest within the use of AI for personalized services. Almost every company is thinking to implement AI in their respective sector with the common goal of constructing their products and services intelligent in order to grow their business.

4.3. Geographical Analysis

In this section important understanding from the geographical distribution of AI17 and AI18 are inspected. Fig. 4 shows the area of AI17 and AI18 start-ups in different parts of the world. The data analysis revealed surprising results; top global AI start-ups are located in only 6.6% of the countries on the earth i.e. out of a total of 195 countries in the world, AI17 and AI18 are located only in 13 countries. The U.S. is leading this revolution with the headquarters of approximately three fourth of the total start-ups with the majority in California, Silicon Valley, the heart of AI.

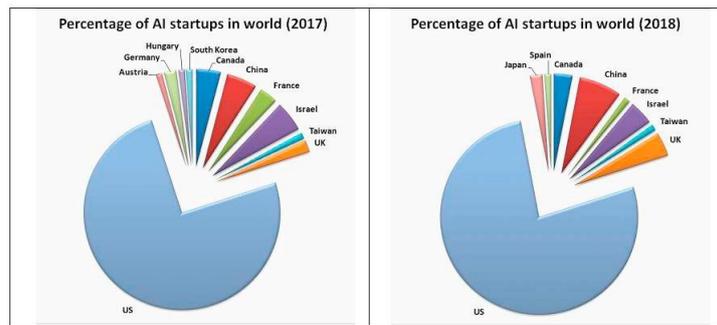


Fig. 4 Percentage of AI17 and AI18 in different parts of the world

5. Discussion and Conclusion

The present work illustrates the prominent achievements and influential technological innovations within the field of AI. The commercial availability of AI-driven products, proposed 48 years ago, proves that AI isn't hype but has the flexibility to remodel the business and thus the worldwide economy. This progressive growth and deployment of AI-driven systems are attributed to 2 major factors: big data and fast processing units (GPUs and TPUs). The work identifies four broad areas of deep learning (computer vision, text analysis, speech recognition, and game playing); preferred DL algorithm for every one of them, and various successful applications which have surpassed human-level accuracy. The work also has an exclusive list of dataset providers and their URLs. The results summarized in tables can aid researchers and industries working within the field of AI. The analysis of the highest 200 AI start-ups explicitly shows the influence of advanced research and innovation in AI on the world market. The study shows that the AI wave is on and has the potential to increase. The investment in AI is showing an upward trajectory within the last 6 years and may remain identical for the upcoming years. The study also uncovers the highest AI industries which will generate

more opportunities in near future viz. business intelligence, core AI, healthcare, cybersecurity, and marketing & sales. A number of the key advantages of automation, cognitive technologies, and data analysis using AI algorithms are rising in productivity, time and price efficiency, human error reduction, faster business decisions, customer preference prediction, and sales maximization. However, the study shows that AI technology is confined only to some regions within the world. This is often creating an “AI divide”. This divide, just like the digital divide, would strengthen the inequality in social, economic, and cultural sectors; would create a chasm. Moreover, AI is software dominant and software is vulnerable to vulnerabilities. A number of the deep learning algorithms/methods are the backbone of AI; these require passing through multiple factors to be used for real-time applications. Identifiable systemic failure modes, repeatability, transparency, explainability, path tracing, penetrability, etc. are a number of the most important factors established at the time of assessment of software. Even after passing through these factors, there are cases where DL algorithms have produced unreliable results. But these, challenges like trust, ethics, bias, and lack of AI talent also need attention for commercial usage of AI applications.

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