Artificial Intelligence

1st Review

AI (artificial intelligence) is one of the most trending topics these days. Artificial Intelligence can think like people. The need of Artificial Intelligence is increasing every single day.

Pros and Cons of AI –

- Pros: -
  - Reliable
  - Cost Affective
  - Solves complicated problems
  - Make decisions
- Cons: -
  - Scientists predicts that AI humanity could extinct.
  - People will be jobless.
  - Losing the sense of living.

Artificial Intelligence is designed using lot of algorithms. We use AI daily basis like voice recognition, virtual agents, Machine learning platform.

Reference – Research Paper

2nd Review

The goal of AI research is to create systems that can reason, learn, and act intelligently, and to develop algorithms and technologies that can enable computers to perform tasks that normally require human intelligence, such as pattern recognising, learning from data and making decisions.

AI has the potential to transform many fields and industries, and it is already being used in a variety of applications, including healthcare, finance, transportation, and education.

- Working of AI: -
  - Machine Learning
  - Deep Learning
  - Cognitive Computing
  - Computer Vision
- Applications of AI: -
  - Chat bots
  - Smart assistants
  - Disease Mapping and Prediction
  - Healthcare
  - Spam Filters
  - Self-Driving Cars

Reference – Research Paper

3rd Review

Artificial Intelligence is mind blowing technology, which works in computer science fields. AI becoming more popular because of its advanced algorithms, improvement in computing power.

- AI can impact on different categories like:
  - Economy
  - Environment
  - Agriculture
  - Education
  - Government
  - Innovation
  - Military and Defence
  - Healthcare
  - Labour Market
  - Medicine

The concept of machines with human-level competence is emerging and should be carefully monitored. The applications of Artificial Intelligence have transformed in every way of almost every area in modern society.

Reference – Research Paper

4th Review

There are many differences between human thinking and artificial intelligence (AI). Humans are able to think, reason, and make decisions based on their experiences and knowledge, while AI is able to process large amounts of data and make decisions based on programmed rules and algorithms.

One key difference is that human thinking is flexible and adaptable, while AI is more limited by the specific rules and algorithms it has been programmed with. Humans are also able to learn and adapt over time, while AI systems require explicit programming in order to learn or adapt to new situations.

Another difference is that human thinking is often subjective and influenced by emotions, while AI is more objective and does not experience emotions in the same way that humans do.

Overall, while there are many similarities between human thinking and AI, there are also significant differences that set them apart.

Reference – Research Paper

5th Review

Artificial intelligence (AI) has the potential to significantly impact the global market in a variety of ways. Some industries that are expected to be particularly affected by AI include manufacturing, healthcare, and finance.

In the manufacturing industry, AI can be used to improve efficiency and productivity by automating certain tasks, such as quality control and assembly line processes. AI can also be used to optimize supply chain management and improve forecasting accuracy.

In the healthcare industry, AI can be used to analyse medical images and assist with diagnosis, as well as to assist with administrative tasks such as scheduling and managing patient records.

In the finance industry, AI can be used to analyse market data and make investment decisions, as well as to detect and prevent fraudulent activity.

Overall, AI is expected to have a significant impact on the global market and to revolutionize many industries.

Reference – Research Paper

Conclusion

Artificial Intelligence and the technology are one side of the life that always interest and surprise us with the new ideas, topics, innovations, products …etc. AI is still not implemented as the films representing it (i.e., intelligent robots), however there are many important tries to reach the level and to compete in market, like sometimes the robots that they show in TV. Nevertheless, the hidden projects and the development in industrial companies.

At the end, we've been in this research through the AI definitions, brief history, applications of AI in public, applications of AI in military, ethics of AI, and the three rules of robotics. This is not the end of AI, there is more to come from it, who knows what the AI can do for us in the future, maybe it will be a whole society of robots

Future Scope

The goal is to create computer intelligence programmes that can handle real-time problems and help organisations and everyday people achieve their goals. Machine games, speech recognition, language detection, computer vision, expert systems, robotics, and other fields have potential. The more you understand machine learning sciences, such as physics or biology, the better.

Reference

1. **Artificial Intelligence: Advanced Analysis and Design**

   By Dr. Hiba Tabbarah & Mr. Abdulla Abdulgafar

2. **Artificial Intelligence**

   By Anant Manish Singh and Wasif Bilal Haju

3. **Impact of Artificial Intelligence on Society**

   By Ashish Naidu

4. **Artificial Intelligence and Human Thinking**

   By Robert Kowalski

5. **Artificial Intelligence in Business: From Research and Innovation to Market Deployment**

   By Neha Soni, Enakshi Khular Sharma, Narotam Singh, Amita Kapoor

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Artificial Intelligence

Advanced Analysis and Design: CNIT 380

Instructors: Dr. Hiba Tabbarah & Mr. Abdullah Abdulghafar

Semester: Fall 2017

Section: U1

Mariam Khaled AlSedrah 24985

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Artificial Intelligence

Introduction

I have chosen this topic to spotlight on one of the most technological trend these days known as AI *(Artificial Intelligent*). Therefore; I will discuss some of the most important aspects related to *AI* in which it will help in a better understanding of Artificial Intelligent and both its advantages and disadvantages to be able to protect ourselves from the upcoming technological trend. This paper will also discuss some of the algorithms used in AI systems.

History of Artificial Intelligence:

Artificial Intelligence was first proposed by John McCarthy in 1956 in his first academic conference on the subject. The idea of machines operating like human beings began to be the center of scientist's mind and whether if it is possible to make machines have the same ability to think and learn by itself was introduced by the mathematician Alan Turing. Alan Turing was able to put his hypotheses and questions into actions by testing whether "*machines can think*"? After series of testing (later was called as Turing Test) it turns out that it is possible to enable machines to think and learn just like humans. Turing Test uses the pragmatic approach to be able to identify if machines can respond as humans. ("Smith", (n.d.)).

Description Artificial Intelligence

Artificial Intelligence is: the field of study that describe the capability of machine learning just like humans and the ability to respond to certain behaviors also known as (A.I.). The need of

Artificial Intelligence is increasing every day. Since AI was first introduced to the market, it has been the reason of the quick change in technology and business fields. Computer scientist are predicting that by 2020, *"85% of customer interactions will be managed without a human".* ("Gartner", (n.d.)). This means that humans simple request will depend on computers and artificial intelligence just like when we use Siri or Galaxy to ask about the weather temperature. It is very important to be prepared for AI revelation just like UAE have by installing a state minister for AI in Dubai.

Pros and Cons of Artificial Intelligence

AI offers reliability, cost- effectiveness, solve complicated problems, and make decisions; in addition, AI restrict data from getting lost. AI is applied nowadays in most fields whether business or engineering. One of the great tools in AI is called "reinforcement learning" which is based on testing success and failure in real life to increase the reliability of applications. Unfortunately, AI is limited with its capability and functionality. ("Sadek",(n.d.))

Although Artificial Intelligence made our lives much easier and saved us more time than ever, scientists are predicting that by the huge dependency on AI humanity could extinct. Scientists argue that by having a AI machines, people will be jobless and that will conclude in losing the sense of living. Since machines are learning and doing thigs more efficiently and effectively in a timely manner, this could be the reason of our extinction.

AI Algorithms and Models

AI is mainly based on algorithms and models as a technique which is designed based on scientific findings such as math, statists, and biology (Li& Jiang, (n.d.)). AI works based on several models such as: Ant Colony Algorithm, Immune Algorithm, Fuzzy Algorithm, Decision Tree, Genetic Algorithm, Particle Swarm Algorithm, Neural Network, Deep Learning and in this report, I will discuss some of the most known models which are: Support Vector Machine, and the Artificial Neural Network.

- Support Vector Machine (SVM) where it is used to build a classification model by finding an optimal hyperplane based on a set of training examples as shown in (figure A-1). It is also have been used for pattern classification and trend prediction lots of applications for instance: power transformer fault diagnosis, disease diagnosis and treatment optimization. (Li& Jiang, (n.d.)).

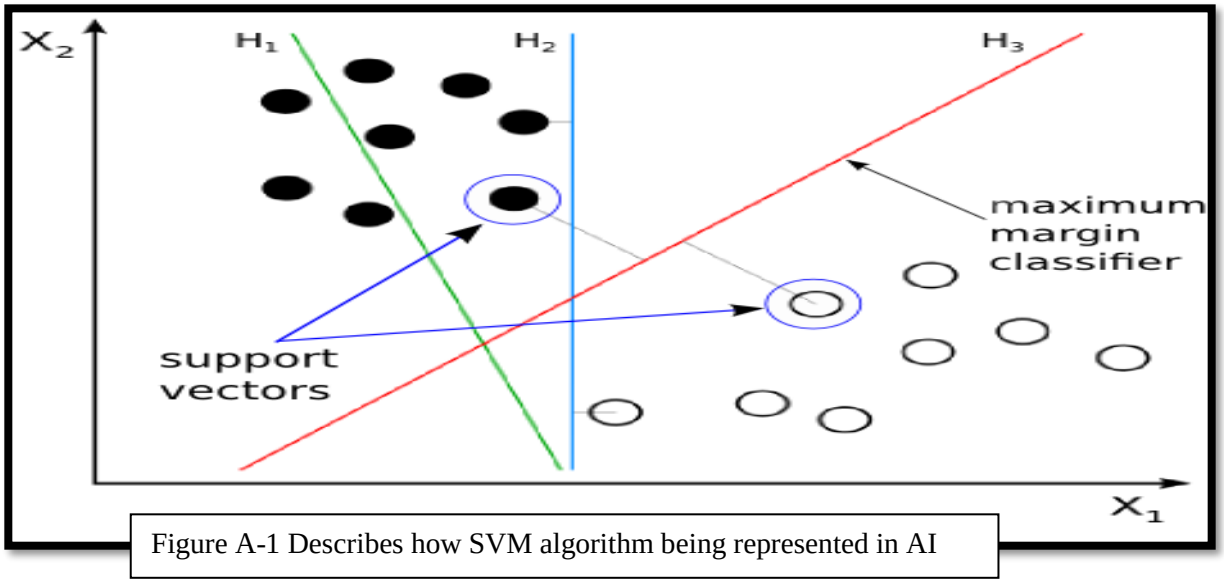

Figure A-1 Describes how SVM algorithm being represented in AI

- Artificial Neural Network (ANN) is a representative model of understanding thoughts and behaviors in terms of physical connection between neurons. ANN has been used to solve variety of problems through enabling the machine to build mathematical models to be able to imitate natural activities from brains perspective as shown in (figure A- 2). By using this algorithm, the machine will be able to identify the solution of any problem just like human's brain.

Figure A-2 Describes how ANN algorithm being represented in AI

Some Applications on Artificial Intelligence:

AI can be designed using lots of algorithms. These algorithms help the system to determine the expected response which will basically tell the computer what to expect and work accordingly. Here are some of the greatest AI applications that we are probably using in our daily life without knowing:

- Voice recognition
- Virtual agents:
- Machine learning platform

- Ai optimized hardware
- Decision management
- Deep learning platform
- Biomatters
- Robotic process automation
- Text analytics and NLP
- Adaptive Manufacturing:
    - Machines that are “able to learn a multitude of tasks from demonstrations, just like their human counterparts can.” (“Yoa”,2017))

AI Design Models

AI application are a lot around us and in this paper, I will discuss some of the most common application of AI that we always use nowadays which is Virtual Assistants such as Siri, Cortana...etc. Over the past few years smart assistants are becoming a very common technology in most of the smart devices and most importantly, that these assistants are getting smarter than ever. In addition to the awesome help they provide us with, is that every one of these apps has unique features. Artificial Intelligence works according to the following phases: getting the data, clean/manipulate/ prepare the data, train model, test data, and improve the data as mentioned in (figure A-3). Before accessing the data, a business must verify the quality of the data to ensure that it meets the requirement.

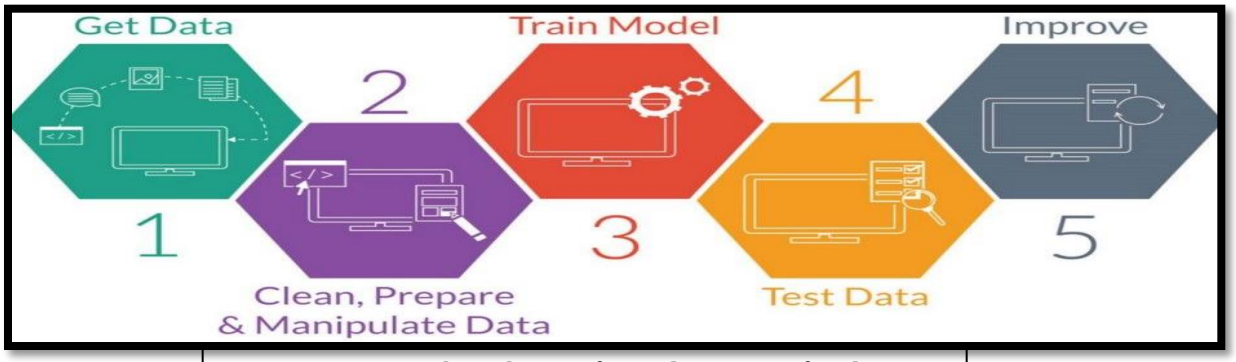

Figure A- 3 Describes Phases of Developing Artificial

Siri Virtual Assistant:

Siri is the well-known virtual assistant which uses voice recognitions and typed command in order to perform a certain task within a device. Siri is considered one of AI most used applications. The application simply takes the input from the user such as (e.g. Call dad) and try to find the most related keywords used in this command. Siri tries to eliminate inconsistent result through using the language pattern recognizer and from there to active ontology by searching through the contacts, then it tries to relate the contact named “Dad” and perform the task which is in this case is “Calling” and finally the output of this action will be “calling dad” and to consider all the possible situations refer to (figure A-4).

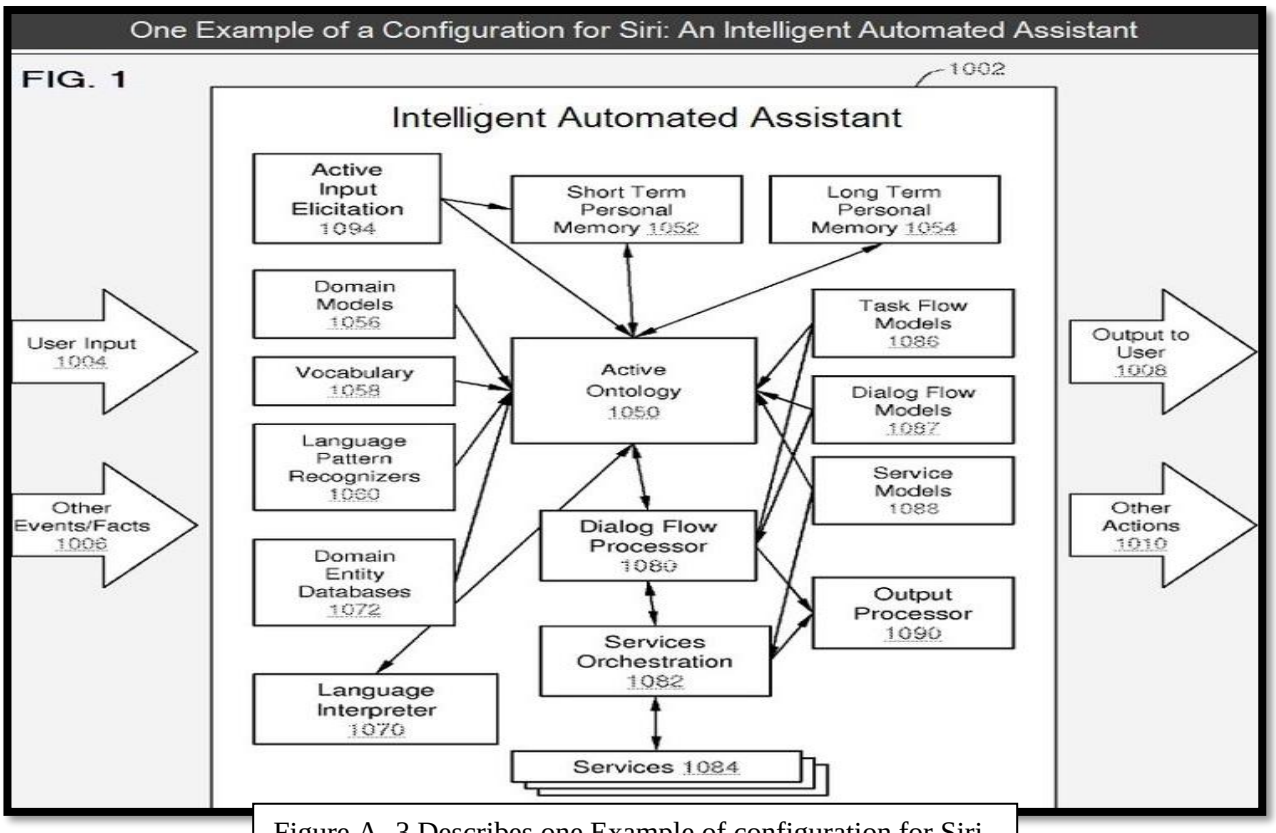

Figure A- 3 Describes one Example of configuration for Siri

In another scenario the architecture of the virtual assistant is shown in (figure A – 5) as we can see the flow of the system starts by taking the input from the user, after that the system decide the conversation strategy module to be used which is a respond from the dialog management module, meanwhile a classification module response to an NLP module. Finally, using the conversation history database is used to analyze the knowledge base construction module which will response back to the domain knowledge based as explained in detail in (figure A- 5)

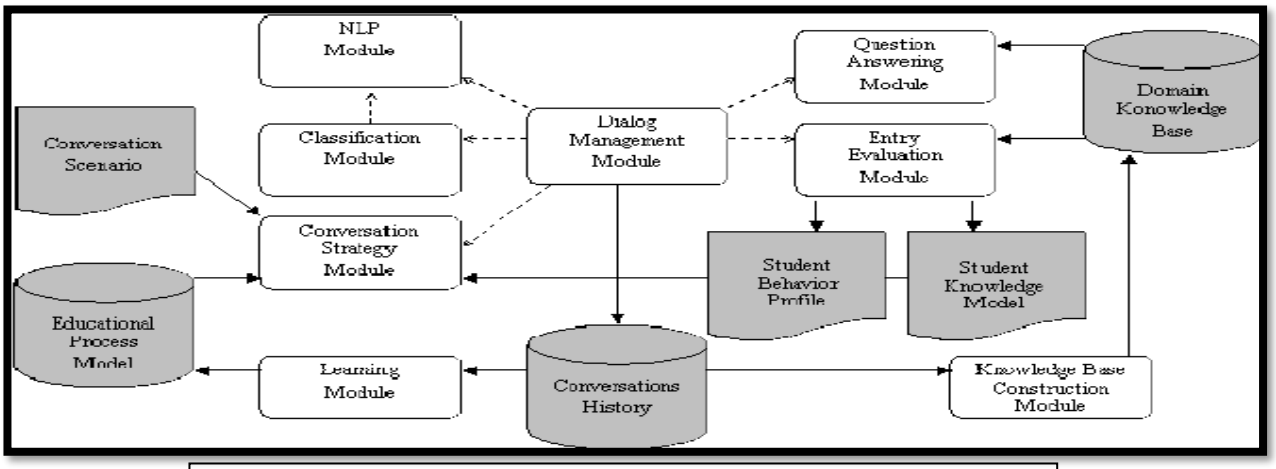

Figure A-5 Describes Proposed conversational agent architecture

Conclusion

AI nowadays is being implemented in almost every field of study through several models such as SVM and ANN. We should be able to proceed with knowing and understanding the consequences of every technological trend. In my opinion, we are in the AI revelation era and therefore; we should adopt into this change and welcome it too by embracing AI and moving toward a better society.

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Artificial Intelligence

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Department of Computer Engineering, Thakur Polytechnic

Abstract: ***Artificial intelligence (A.I.) is a multidisciplinary field aimed at automating tasks that currently need human intelligence. Despite its lack of general familiarity, artificial intelligence (AI) is a technology that is revolutionizing every aspect of life. This article aims to educate laypeople about AI and encourage them to utilize it as a tool in many disciplines to rethink how we combine data, analyze it, and make choices. We quickly covered what artificial intelligence (AI) is, how it works, and how it may be applied in our daily lives in this article.***
Keywords: Artificial Intelligence, Machine Learning, Deep Learning, Cognitive Computing, Computer Vision.

I. INTRODUCTION

Artificial intelligence (AI) is defined as the ability of an artificial entity to solve complicated problems using its own intelligence. Computer science and physiology are combined in Artificial Intelligence. In layman's terms, intelligence is the computational component of one's capacity to attain goals in the real world. Intelligence is defined as the capacity to think, envision, memorize, and comprehend, see patterns, make decisions, adapt to change, and learn from experience. Artificial intelligence is focused with making computers behave more human-like and in a fraction of the time it takes a person to do it. As a result, it is known as Artificial Intelligence. Artificial intelligence is also concerned with pushing the boundaries of practical computer science in the direction of systems that are adaptable, flexible, and capable of forming their own analyses and solution techniques by applying general knowledge to specific situations.

II. OVERVIEW OF AI

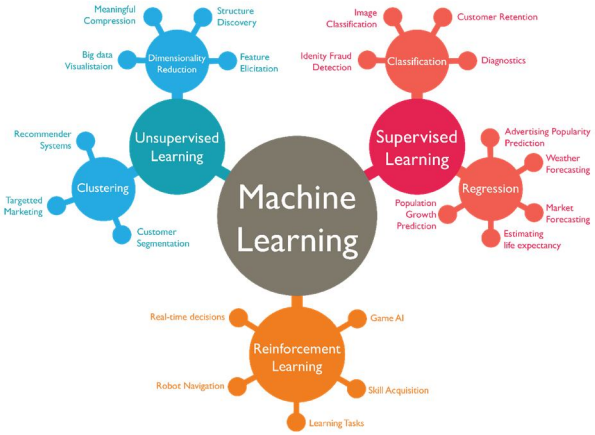
Machine or software intelligence is referred to as artificial intelligence. Perceive + Analyze + React = Intelligence. Artificial intelligence is a subject of computer science that is rapidly gaining popularity since it has improved human existence in a variety of ways. Artificial intelligence has substantially enhanced the performance of manufacturing and service systems during the previous two decades. Expert systems are a fast emerging technology that originated from artificial intelligence research. Intelligent machines will replace or augment human capabilities in many sectors in the future.

III. WORKING OF AI

AI is frequently misplaced on an island with robots and self-driving cars, according to popular belief. This method, however, overlooks one of artificial intelligence's most important practical applications: analyzing the massive volumes of data created every day. Insight gathering and job automation may be done at a previously inconceivable velocity and scale by carefully applying AI to particular activities. AI systems execute sophisticated searches through the mountains of data generated by people, deciphering both text and pictures to detect patterns in complicated data and then acting on their findings. Computer systems that can grasp the meaning of human language, learn from experience, and make predictions, thanks to cutting-edge technologies. Following are a few subfields of AI.

A. Machine Learning | Learning fromexperience

Machine learning, or ML, is an AI application that allows computers to automatically learn and grow from their experiences without having to be explicitly programmed. The goal of machine learning is to create algorithms that can analyze data and generate predictions. Machine learning is being utilized in the healthcare, pharma, and life sciences sectors to improve illness detection, medical picture interpretation, and medication acceleration, in addition to predicting what Netflix movies you would like.

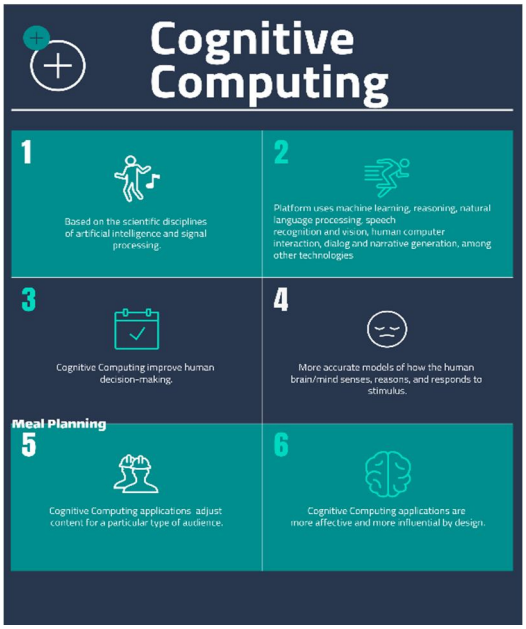


B. Deep Learning | Self-educating machines

Artificial neural networks that learn by analyzing data are used in deep learning, which is a subset of machine learning. Artificial neural networks are designed to look like organic neural networks in the brain. Several layers of artificial neural networks collaborate to produce a single output from a large number of inputs, such as detecting a facial picture from a mosaic of tiles. The machines learn by receiving positive and negative reinforcement for the tasks they perform, which necessitates ongoing processing and reinforcement in order for them to advance.

C. Cognitive Computing | Making inferences from context

Cognitive computing is another essential component of AI. Its purpose is to imitate and improve interaction between humans and machines. Cognitive computing seeks to recreate the human thought process in a computer model, in this case, by understanding human language and the meaning of images. Together, cognitive computing and artificial intelligence strive to endow machines with human-like behaviors and information processing abilities. Another form of deep learning is speech recognition, which enables the voice assistant in phones to understand questions like, “Hey Siri, howdoes artificial intelligence work?”



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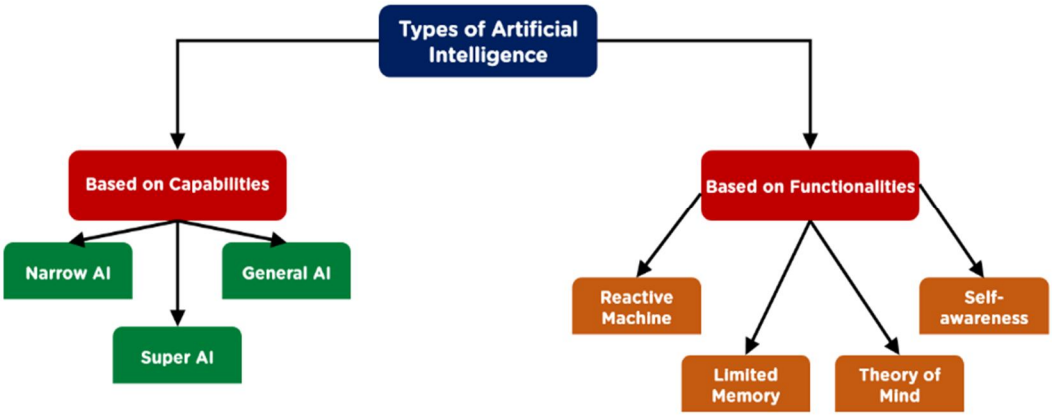
D. Computer Vision | Understanding images

Computer vision is a method of interpreting image material, such as graphs, tables, and photographs within PDF documents, as well as other text and video, using deep learning and pattern recognition. Computer vision is a branch of artificial intelligence that allows computers to recognize, analyze, and interpret visual input. This technology's applications have already begun to transform areas such as research and development and healthcare. Computer Vision and machine learning are being used to analyze patients' x-ray images in order to diagnose patients faster.

IV. TYPES OF AI



A. AI type-1: Based on Capabilities

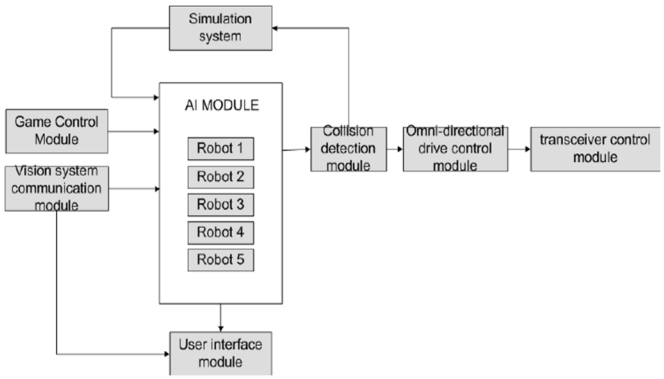
1) *Narrow AI:* Narrow AI is a sort of AI that is capable of doing a certain task intelligently. In the area of artificial intelligence, narrow AI is the most frequent and currently accessible AI. Because narrow AI is exclusively educated for one single activity, it cannot perform outside its field or boundaries. As a result, it's also known as "weak AI." When narrow AI reaches its boundaries, it might fail in unexpected ways. Apple Siri is an excellent example of Narrow AI, yet it only performs a restricted set of duties. Playing chess, purchasing suggestions on an e-commerce site, self-driving automobiles, speech recognition, and picture identification are all examples of narrow AI.
2) *General AI:* General AI is a sort of intelligence that is capable of doing any intellectual work as well as a human. The goal of general AI is to create a system that can learn and reason like a person on its own. Currently, no system exists that can be classified as general AI and execute any work as well as a person. Researchers from all across the world are now concentrating their efforts on creating robots that can do general AI tasks. Because generic AI systems are still being researched, developing such systems will take a lot of work and time.
3) *Super AI:* Super AI is a degree of system intelligence at which machines may outsmart humans and execute any task better than humans with cognitive qualities. It's a result of AI in general. Some fundamental properties of powerful AI are the capacity to understand, reason, solve puzzles, make judgements, plan, learn, and communicate independently. Super AI is still a futuristic Artificial Intelligence idea. The creation of such systems in the actual world is still a world changing effort.

B. AI type-2 Based on Functionality

1) *Reactive Machines:* The most basic kinds of Artificial Intelligence are pure reactive robots. Such AI systems do not keep track of memories or previous experiences in order to make decisions in the future. These robots just consider current circumstances and respond in the best way feasible. Reactive machines, such as IBM's Deep Blue system, are one example. AlphaGo, developed by Google, is another example of reactive machines.
2) *Limited Memory:* This sort of AI, like Reactive Machines, has memory capabilities, allowing it to leverage prior data and experience to make better judgments in the future. This category encompasses the majority of the commonly used apps in our daily lives. These AI applications may be taught using a huge amount of training data stored in a reference model in their memory. Example: Many self-driving automobiles have limited memory technology. They save data like as GPS position, neighboring automobile speeds, the size/nature of barriers, and a hundred other types of data in order to drive like a person.

3) *Limited Memory:* While the first two categories of AI have been and continue to be abundant, the next two types of AI exist only as an idea or a work in progress for the time being. The next level of AI systems that researchers are actively working on is theory of mind AI. A theory of mind level AI will be able to identify the needs, emotions, beliefs, and mental processes of the creatures with whom it interacts. While artificial emotional intelligence is now a burgeoning business and a focus for prominent AI researchers, reaching the level of Theory of Mind AI would need advancements in other AI areas as well. Because AI computers will have to view humans as individuals whose brains may be changed by a variety of elements in order to genuinely grasp human needs, they will have to "understand" humans.
4) *Self-Awareness:* This is the last step of AI development, which exists only in theory at the moment. Self-aware AI is an AI that has matured to the point where it is so similar to the human brain that it has gained self-awareness. The ultimate goal of all AI research is and will always be to create this form of AI, which is decades, if not centuries, away from becoming a reality. This form of AI will not only be able to recognize and generate emotions in individuals with whom it interacts, but will also have its own emotions, wants, beliefs, and maybe goals. And this is the kind of AI that sceptics of the technology are concerned about. Although the growth of self-awareness has the potential to accelerate our progress as a civilization, it also has the potential to lead to disaster. This is because, once self-aware, AI may have ideals like self-preservation, which could either directly or indirectly mark the end of mankind, since such an entity could easily outmaneuver any human brain and create sophisticated schemes to take over humanity. The categorization of technology into Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Superintelligence (ASI) is an alternative method of classification that is more commonly used in tech jargon (ASI).

V. AI SYSTEM ARCHITECTURE



A main thread runs through the artificial intelligence system, looping and calling each of the several modules. To determine the position and orientation of robots, the main system thread first connects with the visual system. Aside from the ball's location. The system then checks the referee's control of the game state. After that, the system invokes the AI module function, which provides the required robot movement position as well as extra actions to take. Following the specification of motions, the system calculates collision avoidance trajectories to prevent colliding with other robots. The algorithm then estimates the speed of each of the robots' four wheels. Finally, the system broadcasts communication packets corresponding to orders to take action via the transceiver.
The following is a full description of each of the modules depicted in the above diagram:

A. Vision System Communication Module

This module offers vision system commands for the game scenario, which correlate to robot and ball coordinates, as well as robot angles, through packets.

B. Game Control Module

Through a serial interface, this module takes referee orders and returns the game's current status.

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C. AI Module

This module gets the locations of the robots and the ball, as well as the orientations of the robots, the game state, the roles of the robots, the firing direction, and the field setup. The system uses all of this data to calculate each robot's future position and actions. The chosen approach is determined by the configuration of a tree containing all feasible actions. The activities are categorized based on their significance. One or more evaluations are utilized for each node in the tree. Each evaluation has a set of possible outcomes linked to a certain score. The tree is assessed during the program's loop. The path to travel from root to leaf (final action) is determined by the highest score of each level's assessment result using the Best First Search technique. The robot movement vector, its linear and rotational velocity, and the employment of the kicker and dribbler devices are determined after the system has achieved a final action such as passing, shooting, or blocking. The robots also include a roll motion to help them coordinate joint operations. Different roles are used to coordinate the robots: goalkeeper, defense, first, second, and third forward. The goalie's job is to keep the ball out of the net. When the ball is far away, it takes a block path; when the ball is close, it kicks it. The region around the goal is the only place where you may move. The defense is responsible for assisting the goalkeeper in defending the goal from long-range shots, as well as developing collaborative plans with the three strikers. When near to their own area, defenders clear the ball out and follow opposite robots to prevent a pass and goal. The three forwards have a shared goal, but their priorities differ. They travel over the entire field, coordinating various forms of passing and shooting. When necessary, they may migrate in groups.

D. User Interface Module

Positions, orientations, motor speeds, intended positions, ids, actions, game status, and referee instructions are all shown in real time for each robot in this module. Robot positions, orientations, desired locations, and actions are visually shown in an OpenGL-based GUI.

E. Simulation System

This module simulates the functioning of an artificial intelligence system without requiring the use of a real vision system or robotics. The artificial intelligence module may be used to debug and test activities. The construction of things that think using decision logic is referred to as intelligent object-based simulation. Simio, for example, selects jobs or resources using intelligent objects packed with decision logic. As a result, the item has intelligent behaviour that can predict future performances. The usage of intelligent objects in the context of AI in simulation emphasizes the integration of rule-based AI into simulation models. Manually developing complicated rule-based reasoning is a time-consuming operation, and the rule's performance is also determined by the creator's expertise level. AI, with a focus on the use of neural networks, eliminates the need for manual construction. Manually developing complicated rule-based reasoning is a time-consuming operation, and the rule's performance is also determined by the creator's expertise level.

F. Collision Detection Module

This module simulates the functioning of an artificial intelligence system without requiring the use of a real vision system or robotics. The artificial intelligence module may be used to debug and test activities. An infrared obstacle avoidance sensor with customizable detection distance is created for wheeled robot obstacle avoidance. One infrared transmitter and one detector make up the module. When an obstacle is in front of the sensor, the emitter's infrared light is reflected back to the receiver. A comparator squares the signal to generate a digital signal. The production is high when there are no obstacles. The output is low when an obstruction is within range. A potentiometer knob can be used to change the sensitivity.

G. Transceiver Communication Module

This module gets the speed of each robot motor as well as the activities to be performed. This module creates the packets that our transceiver sends out. It also ensures that communication is always active.

H. Omni-Directional Drive Control Module

This module takes the movement vector, which includes linear and angular velocities, and calculates the speed of each of the four robot motors. This module calculates the speed of each motor for the robot's four omnidirectional wheels in order to travel in the correct direction.

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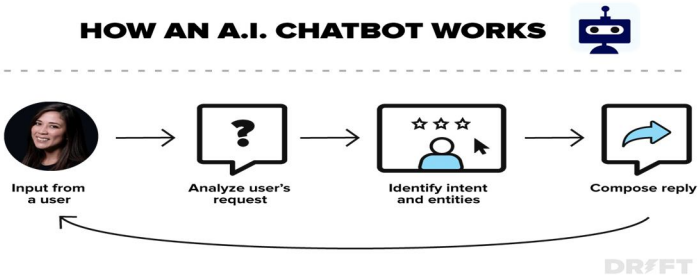
VI. APPLICATIONS OF AI

There are many ways in which the average technology consumer interacts with artificial intelligence technologies in their daily lives, but most people don't realize what technologies actually use AI. Here are a few examples of artificial intelligence technologies that many people encounter in their lives.

A. Chat bots

If you've ever come across a chat bot on a website or social media messenger, it is powered by AI. Chat bots are one of the more simple examples of AI, since they are simply coded to send messages based on rules about how they should interact with users. Sort of an "if this, then that" type of programming.

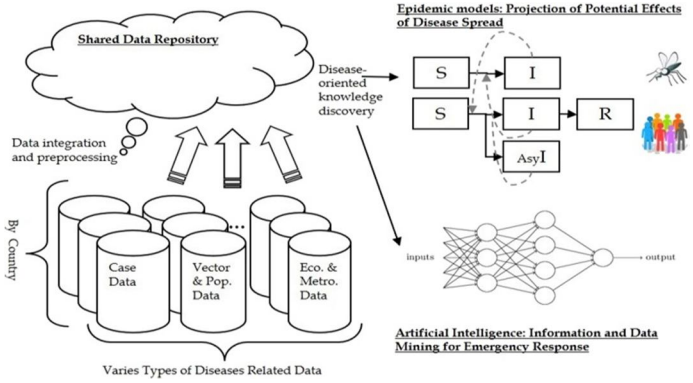


B. Smart Assistants

Siri, Alexa, and all the other smart assistants are examples of artificial intelligence. They understand what users say to them and can follow directions and respond accordingly. These are like the next level of chat bots, since they use speech recognition and are connected to larger databases of information such assearch engines.

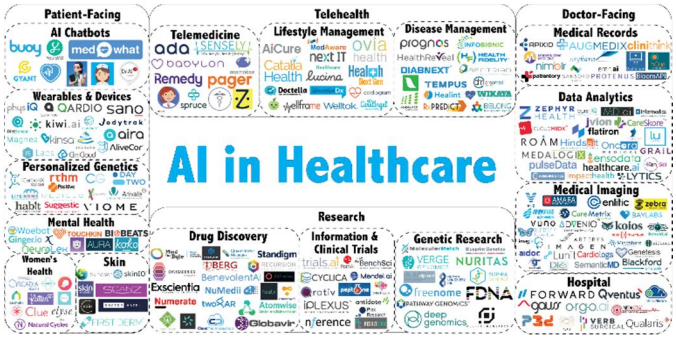
C. Disease Mapping and Prediction

Epidemiologists have always worked to try to understand how diseases spread in order to be able to predict and hopefully avoid them. Artificial intelligence is making this easier. This is an example where it's easy to see how artificial intelligence simply allows for quicker progress on data analysisand prediction modelling than humans could doalone.



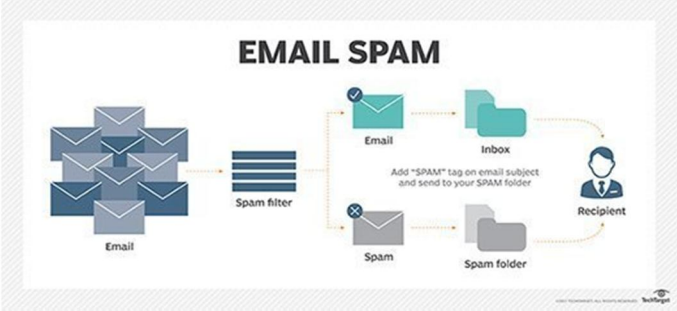
D. Healthcare

Because of its crucial role in a productive, healthy society, healthcare is one of the most important areas in the larger landscape of big data. The use of AI in healthcare data can actually mean the difference between life and death. Doctors, nurses, and other healthcare personnel can benefit from artificial intelligence in their regular job. AI in healthcare may improve patient outcomes through improving preventative care and quality of life, as well as producing more accurate diagnosis and treatment regimens. By analyzing data from the government, healthcare, and other sources, AI can help anticipate and track the spread of contagious illnesses. As a result, AI has the potential to be a critical instrument in the fight against diseases and pandemics in global public health.



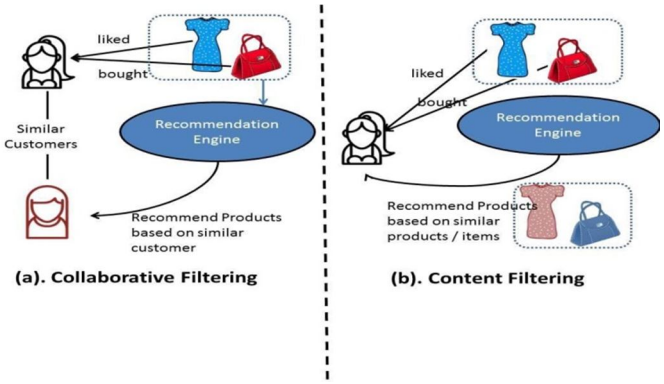
E. Spam Filters

Everyone who uses email knows about spam filters. Email inboxes are equipped with filters that send spam emails to a separate folder so they don't clutter users' inbox with useless messages. Spam filters also exist for phone calls, to filter out scammers and other spam phone calls. AI powers these spam filters by using previous knowledge of what spam emails or phone calls look like from a data perspective, and filtering out the ones that match.



F. Recommendation Engines

The recommendation engines on Netflix and Spotify are some of the most well-known. They use data about which shows you've previously watched or songs you've previously listened to in order to recommend other shows you should watch or songs you should listen to. These are only a couple examples. Recommendation engines also exist in social media platforms to recommend people you should connect to or to show you content you might like.



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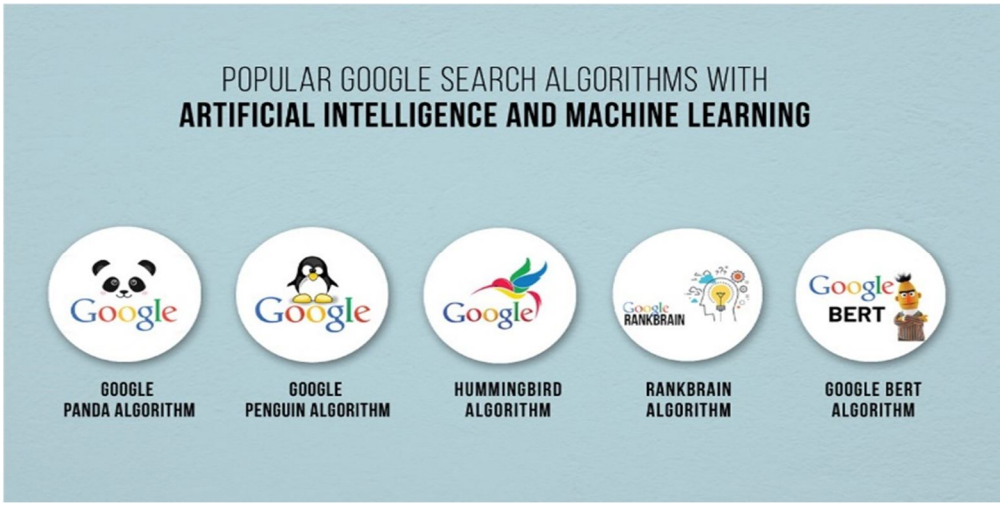
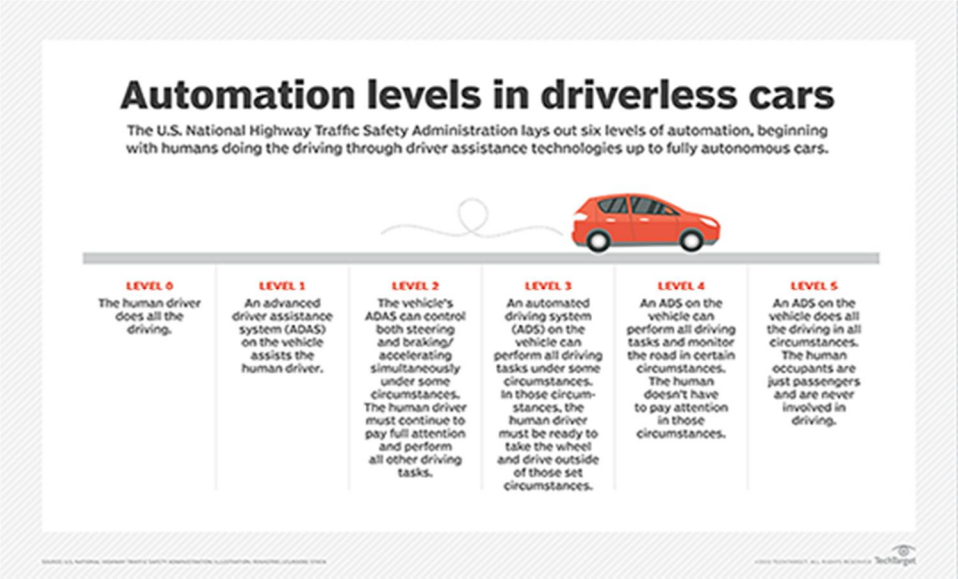
G. Search Engines

Search engines have such huge databases that the only way they are able to sort through all of their potential results to show you the best results for your search is with AI. Search engine algorithms are some of the best examples of robust algorithms out there. For example, Google is said to use something like 200 data points to determine where each result ranks on each results page. With billions of pages in their database, that is a lot of data running through their algorithm with every query.



H. Self-driving cars

Although fully self-driving cars aren't widely available yet, they are well in the works with multiple companies, and some self-driving features are already available in cars today. Companies like Google and Uber are vying to be the first to develop a consumer-ready self-driving car, but you can already buy cars with sensors that alert you to close objects, break automatically, and can parallel park themselves. Just like how AI can detect cancer better than the human eye, self-driving cars can probably drive better than a lot of humans too.



VII. ADVANTAGES OF AI

A. Reduction in Human Error

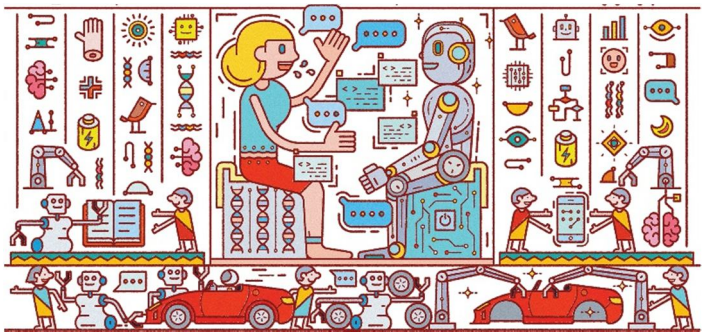
Because people make mistakes from time to time, the term "human error" was coined. Computers, on the other hand, do not make these errors if they are correctly programmed. Artificial intelligence makes choices based on previously obtained data and a set of algorithms. As a result, mistakes are decreased, and the prospect of achieving better precision and accuracy is increased.

- *For Example:* AI has removed the bulk of human mistake in weather forecasting.

B. Takes risks instead of Humans

One of the most significant advantages of artificial intelligence is this. By constructing an AI Robot that can do the dangerous tasks for us, we can transcend many of humanity's risky limits. It can be utilized efficiently in every type of natural or man-made disaster, whether it is travelling to Mars, defusing a bomb, exploring the deepest regions of the oceans, mining for coal and oil.

- *For Example:* Have you heard about the explosion at the Chernobyl nuclear power facility in Ukraine? There were no AI-powered robots available at the time to assist us in minimizing the effects of radiation by controlling the fire early on, since any human who came near to the core died in minutes. They ultimately used helicopters to drop sand and boron from a safe distance. AI Robots can be utilized in circumstances when human interaction is risky.



C. Available 24x7

Without breaks, an average human will labor for 4–6 hours every day. Humans are created in such a manner that they can take time off to replenish themselves and prepare for a new day at work, and they even have weekly off days to keep their professional and home lives separate. But, unlike humans, we can use AI to make robots work 24 hours a day, seven days a week with no breaks, and they don't grow bored.

- *For Example:* Educational institutions and helpline centres get a large number of requests and difficulties that AI can successfully address.

D. Digital Assistance

Digital assistants are used by some of the most modern enterprises to engage with people, reducing the requirement for human personnel. Many websites now utilize digital assistants to supply items that consumers seek. We can discuss what we're searching for with them. Some chatbots are created in such a manner that it's difficult to tell whether we're conversing with a machine or a person.

- *For Example:* We all know that businesses have a customer service staff that is responsible for answering customers' questions and concerns. Organizations may use AI to create a voice bot or a chatbot that can assist consumers with all of their questions. Many firms have already begun to use them on their websites and mobile applications.

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VIII. DISADVANTAGES OF AI

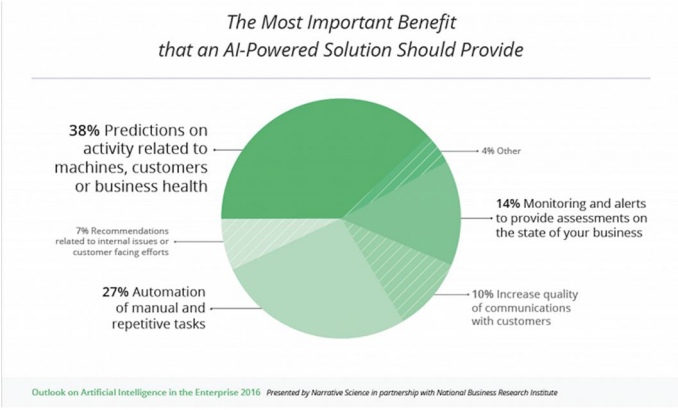
A. High Cost of Implementation

Setting up AI-based machines, computers, etc. entails huge costs given the complexity of engineering that goes into building one. Further, theastronomical expense doesn't stop there as repair and maintenance also run into thousands of dollars.

B. Doesn't Improve With Experience

One of the most amazing characteristics of human cognitive power is its ability to develop with age and experience. However, the same can't be said about

AIs as they are machines that can't improve with experience, rather it starts to wear and tear with time.

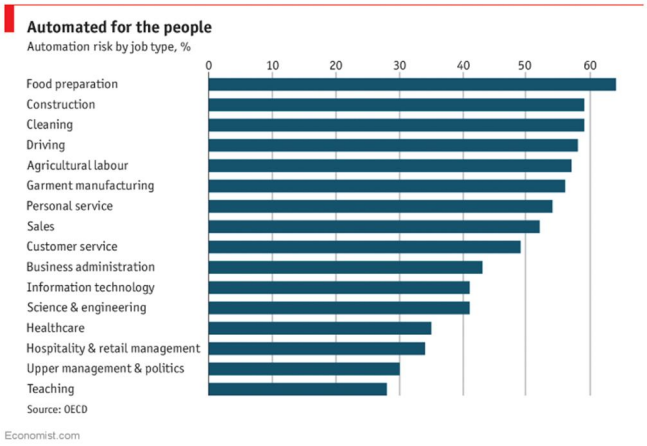


C. Lacks Creativity

As already mentioned above – AIs are not built for creative pieces of work. So, it should be crystal clear by now that creativity or imagination is not the forte of the AIs. Although they can help you in designing and creating something special, they still can't compete with the human brain. Their creativity is limited to the creative ability of the person who programs and commands them.

D. Risk Of Unemployment

With rapid development being made in the field of AI, the question that plagues our intuitive brain is that – will AI replace humans? Honestly, I am not sure whether AIs will lead to higher unemployment or not. But AIs are likely to take over the majority of the repetitive tasks, which are largely binary in nature and involve minimum subjectivity.



IX. CONCLUSION

While concluding, it can be analyzed that AI has benefited computer science because it is the artificial psychology that made the machines to focus on the philosophical arguments. AI performs tasks faster than human beings and the major goal of artificial intelligence is to create the technology in an intelligent manner. It is proved that artificial intelligence is the computer knowledge that has human traits, however, these computers and robots help the environment to grow, and they respond rationally to help human beings. AI has already impacted lives of people in various fields and will surely continue to do more in the future.

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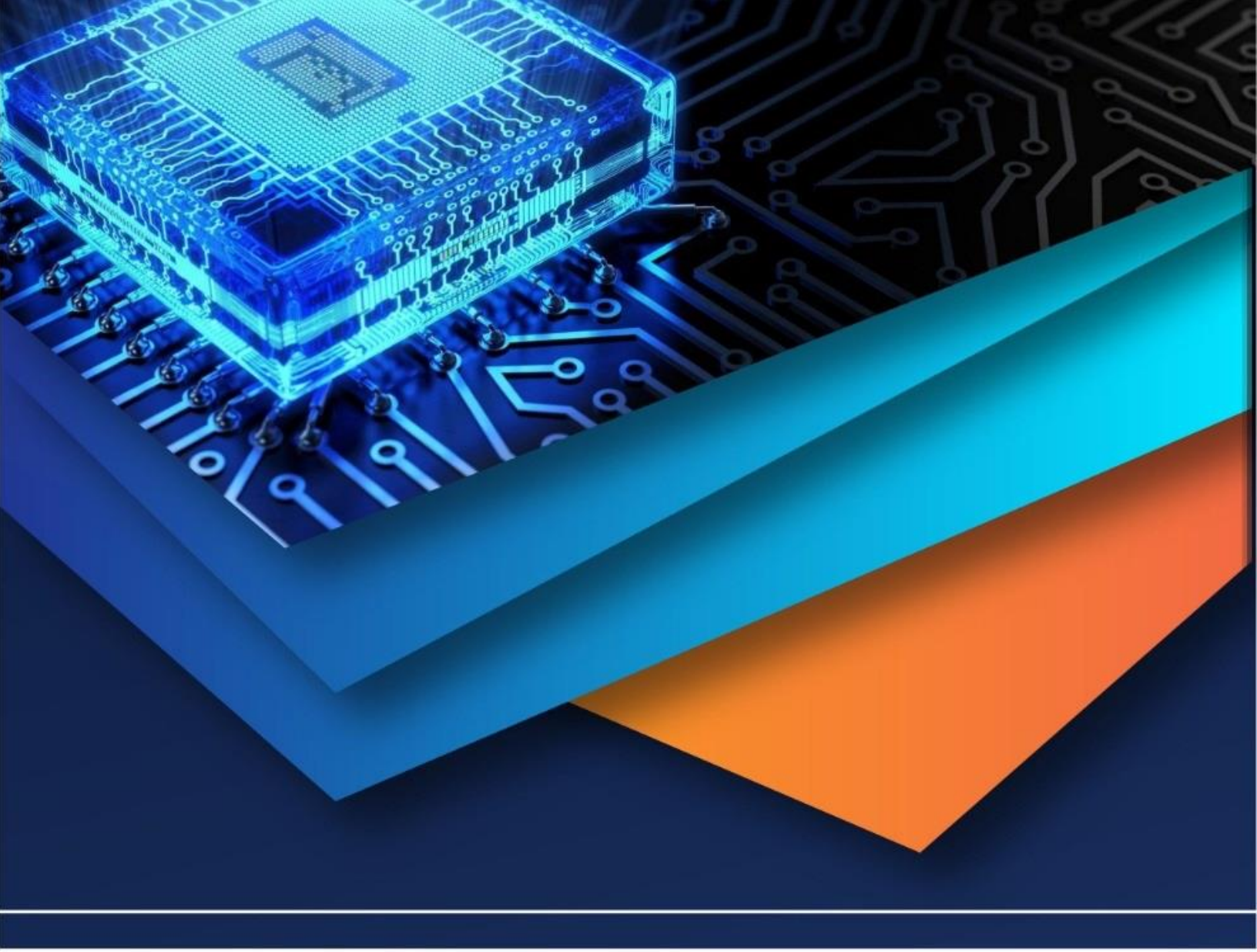

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INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Ashish Naidu [1]

1. Introduction

Artificial intelligence is a transformative technology, which works in the field of computer science and emphasizes on the creation of an intelligent machine that works such as speech recognition, learning, planning and problem solving, robots, games, modelling (Firschein et al., 1973). AI is all about making machines smarter so, they can think, work, and perform humanly task. At present, some of the examples of AI can be about playing chess on the computer to self-driving cars, which relies on deep learning and natural learning process.

AI is becoming more popular with each passing day because of increased data volumes, advanced algorithm and improvement in computing power and storage. Therefore, people in business are increasingly looking for ways to make their products and services more intelligent through AI. Google's search algorithms are a glaring example of an AI-driven tool. Amazon's Alexa is another. Social media platforms also rely heavily on AI. The current evolution of AI technologies is not that scary – or quite that smart. Instead, we keep reading for modern examples of artificial intelligence in health care, retail and more. In the near term, the goal of keeping AI's impact on society beneficial motivates research in many areas, from economics and law to technical topics such as verification, validity, security and control.

When considering how AI might become a risk, experts told multiple scenarios that are most likely to happen in future. Like unemployment, because the labour society is concerned primarily with automation as we have invented ways to automate jobs. We could create room for people to assume more complex roles, moving from the physical work that dominated the pre-industrial globe to the cognitive labour that characterizes strategic and administrative work in our globalized society. Inequality of our economic system is based on compensation, where the contribution to the economy is often assessed using hourly wages.

The majority of companies are still dependent on hourly work when it comes to products and services. However, by using artificial intelligence, a company can drastically cut down on relying on the human workforce, and this means that revenues will go to fewer people. Consequently, individuals who have ownership in AI-driven companies will make all the money. Devastating in

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nature, autonomous weapons are artificial intelligence systems that are programmed to kill. In the hands of the wrong person, these weapons could easily cause mass casualties.

Moreover, an AI arms race could inadvertently lead to an AI war that also results in mass casualties. Security with AI becomes more powerful as it can be used for an outrageous reason. This applies not only to robots that are invented to replace human soldiers or autonomous weapons but also to AI systems that can cause damage if used maliciously. This study aims to understand and provide an overview of the impact of Artificial Intelligence on society.

2. Methodology

This study aims to explore the literature on the impact of artificial intelligence on society and its transformation. Recently AI has penetrated its roots into a range of fields. To cover various societal aspects, literature has been retrieved from various disciplines where AI is applied. These areas include healthcare, automobiles, commerce, governance, defence, entertainment, computation, and sports. These articles are retrieved from peer-reviewed sources based on the keywords suggesting the role of AI, forecasting & assessment of impact, behavioural & ecological aspects of AI, and AI's relation to employment. Various reports from governments or their agencies are also retrieved and reviewed to put forward their opinions, studies, and measures to strengthen their position in AI-led futures.

3. Review

AI has been around for decades. It is now gaining popularity in the technology world for two main reasons: large data sets and computational power. In 2010 Techonomy conference Eric Schmit suggested that in every two days now we create as much information as we did from the dawn of civilization up until 2003". Today we are generating from mobile phones and the Internet of things. We are creating quintillion bytes of data daily. We now also have the computational power to process such large amounts of data. Nowadays, AI is currently is using in education, healthcare. Soon, intelligent machines will replace or enhance human capabilities in many areas, pre¬viously considered strictly within the human domain. On the other hand, we tend to make decisions practically every day that must reach beyond a decade, or occasionally even a century, for example, new buildings usually are designed for the occupancy of one hundred years. Because computer systems also have the potential for long term effects on human life and society.

4. Impact of Artificial Intelligence on Economy

The rising tide of Artificial Intelligence adoption across industries will drive significant growth in the next decade, with AI software revenue set to reach almost $90 billion by 2025. AI's presence is tantalizing to data scientists and business managers alike who seek to let machines do the number crunching to make the business smarter on a holistic level.

The advancements in AI have been made possible thanks to the confluence of three different, albeit related developments (Ernst et al., 2018):

A phenomenal drop in computing costs has led to an explosion in installed computing power and storage capacity. Simple smartphones today are significantly more powerful than the computer that brought the first man to the moon. The costs for producing an iPhone 7, for instance, currently stands at around US$220; in the 1980s it would have been around US$1.2 million in today's terms to pay for the memory capacity of such a phone.

Second, the development and widespread adoption of the Internet and other forms of digital communication has led to a significant increase in the supply and storage of digital information, including in central locations (cloud computing), which allow the comparison and analysis of substantial amounts of data for statistical purposes that are necessary to develop tools based on AI principles.

Finally, the drop in capital costs for digital technologies has significantly lowered barriers of entry for start-ups, making it less necessary than in the past to mobilize massive amounts of capital before starting a new venture while at the same time offering substantial first-mover advantages. This shift in business models towards small, rapidly growing tech companies were often driven by university spin-offs funded through innovative financial products and supported by a seemingly endless supply of highly educated software engineers. A paradoxical consequence of the digital nature of latest innovations is that the lower barriers to entry have allowed new players to uproot incumbents while at the same time quickly leading to new forms of industry concentration (Bessen, 2017).

The current wave of technological change based on advancements in (AI) has created widespread fear of job losses and further rises in inequality large opportunities in terms of increases in productivity can ensue, including for developing countries, given the vastly reduced costs of capital that some applications have demonstrated and the potential for productivity increases, especially among the low skilled. At the same time, risks in the form of further increases in inequality need to be addressed if the benefits from AI-based technological progress are to be broadly shared. For this, skills policy are necessary but not sufficient. Also, new forms of regulating the digital economy are called for that prevent further rises in market concentration, ensure proper data protection and privacy and help share the benefits of productivity growth through a combination of profit-sharing, (digital) capital taxation and a reduction in working time. The paper calls for a moderately optimistic outlook on the opportunities and risks from artificial intelligence provided policymakers, and social partners take the particular characteristics of these new technologies into account. (Méda, 2016).

Most observers are not reassured, however. Many analysts are warning that advances in both robotics and artificial intelligence over the next few decades could lead to significant job losses or job polarization and hence widen income and wealth disparities (Korinek&Stiglitz, 2017). A recent

report by Bank of America Merrill Lynch in 2015 pointed to the potential for a rise in inequality as a result of increased automation. The report cited research by Oxford University, which found that up to 35 per cent of all workers in the United Kingdom, and 47 per cent of those in the United States, are at risk of being displaced by technology over the next 20 years (Frey and Osborne, 2017). According to the World Bank (2016), in developing countries many more jobs are at risk: 69 per cent in India, 72 per cent in Thailand, 77 per cent in China and a massive 85 per cent in Ethiopia.

5. Impact of Artificial Intelligence on Ecological Studies (Environment)

The field of ecology being vast and variant revolves around analysis and statistics for the betterment of studies and technology, hence results. The complexity found in various ecological systems possesses many challenges in front of both, researchers and managers including a collection of data on a large scale and analysing the very same, having there an extensive sample spAce and unpredictable and ever-changing ability of organisms to evolve. In addition to that, the range keeps expanding.

Due to the enormous challenge as the work itself, there has always been scope for tools that can facilitate ecological reasoning rather than just helping in the collection and analysis of data. AI-derived techniques and modelling have revolutionised ecology in the aspects of both primary and applied studies and has played a significant role in the development of the same. The implementation of artificial intelligence in ecology aids the apparent impotence in organisation and analysis of broad ecological knowledge, making the overall process more efficient and cures the limitations of data collection. Researchers have been successful in utilising methodologies like expert systems involving knowledge engineering, which can be referred to as a process of extracting and implementing an expert's knowledge in a computer program. (Coulson et al.,1987).

Development in ecological sciences because of AI include "OOPS" I.e. object-oriented programming systems, which is coded programming based on representing objects and building models using them in a particular data structure using variables, understood by the ecologists.

Ecology is a qualitative study rather than quantitative research is difficult to be incorporated into mathematical expressions (Brooks, 1999). Artificial intelligence provides tools for the meaningful manipulation of qualitative knowledge like ecological relationships into a computer-friendly quantitative form, which can be used to arrive at a qualitative decision. The limits of artificial intelligence in the development of ecology, are yet to be discovered, as the application is premature, and is expected to be exposed in the coming decade.

6. Impact of Artificial Intelligence on Agriculture

As per the United Nations Food and Agriculture Organisation, the world population will increase by 2 billion by 2050. In contrast to this only, 4% of additional land will be cultivated by then. Also, this won't be enough to feed the entire population. Thus to deal with such critical worldly problem of underproduction, modernization of agriculture is prerequisite. AI is highly likeable to change the current old school outlook of the agricultural landscape.

AI technology can be used on numerous occasions like harvesting, airborne surveillance, remote sensing, proximity sensing, pest and weed control and advisory services etc. Currently, Microsoft is working to provide advisory services regarding sowing seeds, usage of fertilizer, and so on to 175 farmers in Andhra Pradesh, India (Bagchi, 2019). This initiative has led to a 30% high yield per hectare on an average when compared to the previous year. Harvest technologies like Harvest Croo have developed an independent berry picking machine through which AI mimics human cognition. The Israeli start-up Prospera found in 2014 has developed a cloud-based solution which correlates between data labels and makes predictions through this information. There are a plethora of such examples where AI technology is helping in making farming smart and changing the world. AI technology still encounters the problem of funding and lack of validation and only if these hurdles are overcome, the current agricultural scenario may modify/ improve.

7. Impact of Artificial Intelligence on Government

Artificial intelligence is emerging as the most significant asset for humankind. Similarly, it is also helpful for the government of any country and is playing a crucial role in our day-to-day life. In a survey, conducted it was founded that AI is capable of reducing administrative burdens, helps in resolving difficulties related to the allocation of resources. Many AI studies can generally be divided into five major categories:

1. Answering Questions
2. Filling Documents
3. Request Routing
4. Translation Process
5. Drafting Documents

So, the above-mentioned categories helped governmental organizations a lot in completing tasks more efficiently. (Mehr et al., 2017)

Further advancements of AI can be seen as a path to drive the future of any economy in an era of modern technologies which requires big data— Accenture estimated that AI has the ability to increase economic growth rates twice by 2035. However, every proper technique also comes with a price. In case of AI in public sectors, it can raise questions regarding privacy questions around

privacy, increase in pace and adopting digital tools, and whether humans can cooperate or maintain the speed according to machinery or not. Research highly varies in finding the warning AI is for jobs over the next two decades over a range of 9 to 47 per cent.

8. Impact of Artificial Intelligence on Education

As the world continues to invest in AI, it will affect the education system also. As we discussed earlier, experts think that by 2025, Artificial intelligence will create more jobs than it displaces, but the new jobs created will need more skills compared to old jobs. As new skills emerge, governments, educational institutions and employers should consider how they can most effectively develop learning programmes that equip people with the skills they will need to keep up with the modern economy (Perisic, 2018).

Hence, the educational institutions will need to train the students for the industries. Business disciplines, such as accounting, auditing, finance, and marketing, may be challenged. Those disciplines that have fixed and codable rules, policies, and processes can be automated (Siau,2017). Once artificial general intelligence (or strong AI) starts to emerge, students in higher education may be pursuing their interests and robots now staff hobbies (e.g., arts, history, music, philosophy, political science) since many of the jobs that the students are training for!

Also, there is a need for focus further research on the new role of teachers on new teaching paths, with a new set of graduate attributes, with a focus on imagination, creativity, and innovation; the set of abilities and skills that can hardly be ever replicated by machines. (Popenici & Kerr, 2017).

9. Impact of Artificial Intelligence on Innovation

Artificial intelligence has traits which can help in increasing the efficiency of the economy existing. Moreover, it can contribute more to the field of "innovation" in the market. These innovations have the ability to affect both productions as well as a wide range of products along with the services provided by it. If we consider the case of "atomwise" which is a new company and mainly focuses on the identification of drug candidates by the use of neural networks to depict the bioactivity of specific individual molecules and atomwise's example shows two methods in which use of artificial intelligence can be easily seen in fields of innovation. (Cockburn et al., 2018).

AI is also impactful as it is cost-efficient as well as more accurate when it comes to technical issues as discussing or learning any point for long will eventually lead to a better understanding of the same with the help of which anyone can have preliminary information about the work they are trying to do.

10. Impact of Artificial Intelligence on Military and Defence

Artificial Intelligence (AI) is becoming a critical part of modern warfare. Compared with conventional systems, military systems equipped with AI are capable of handling larger volumes of data more efficiently. Additionally, AI improves self-control, self-regulation, and self-actuation of combat systems due to its inherent computing, decision-making capabilities. AI is deployed in almost every military application, and increased research and development funding from military research agencies to develop new and advanced forms of artificial intelligence is projected to drive the increased adoption of AI-driven systems in the military sector.

Existing capabilities in AI have significant potential for national security. For example, current machine learning technology could enable high degrees of automation in labour-intensive activities such as satellite imagery analysis and cyber defence (Allen & Chan, 2017). For instance, the US Department of Defense's (DoD) Defense Advanced Research Projects Agency (DARPA) is financing the development of a robotic submarine system, which is expected to be employed in applications ranging from detection of underwater mines to engagement in anti-submarine operations. Additionally, the US DoD overall spent USD 7.4 billion on artificial intelligence, Big Data, and cloud in the fiscal year 2017, while China is betting on AI to enhance its defence capabilities and is expected to become the world leader in this field by 2030. Future progress in AI has the potential to be transformative national security technology, on a par with nuclear weapons, aircraft, computers and biotech. An analysis by Markets and Markets indicates that the market size of artificial intelligence in the military is expected to reach USD 18.82 billion by 2025, at a CAGR of 14.75% from 2017 to 2025. Here are eight major military applications where AI will prove its importance in the years to come.

AWS or autonomous weapon systems, another revolution in military operations. While Civil Society and the international community is concerned with the systems, military planners and reseArchers see the potential utility in autonomous systems, expecting them to perform tasks in ways and contexts that humans cannot or that they may help in to save costs or reduce military capabilities(Roff & Moyes, 2016). Questions arise about the level of acceptability of autonomous weapons in certain critical functions such as identification, selection and application to force to tArgets. So what comes as a conclusion is that, There are pros and cons in the application of AWS in military systems which are yet to be discovered.

11. Impact of Artificial Intelligence in Healthcare and Medicine

Role of AI technology in healthcare and medicine leaves us with an overwhelming question whether AI is just overhyped practice, or it can help clinicians in delivering the required results. AI in this field collects information by patients through testing and interviewing them, processing and analyzing and subsequently helps in diagnosis and treatment of diseases. Majorly it helps in the treatment of cancer, neurology and cardiology.

The first application of AI technology in this field dates back to 1976 when Gunn used computer analysis in the diagnosis of acute abdominal pain. (Ramesh et al., 2004)

AI increases the ability to comprehend the pattern and needs of people for health care professionals. The startup named sense.ly has created a virtual nurse Molly who helps monitor the patients and their doctor visits (Novatio, 2019). AI also increases the availability of data and increment in the development of analytical techniques. In 2016, an app Alexa for Amazon was developed by Boston Children's hospital that provides health information and suggestions to the parents of sick children. The national institutes of health have developed the AiCure app to supervise the use of medication by the patients. These examples compel us to believe that AI will play a vital role in future. Apart from these innovations, the major obstacle that remains is to bridge the gap between human cognition and digital data/AI and improving the decision making the process by AI technology as per some clinicians.

12. Impact of Artificial Intelligence on Labour Market

Many concerns are there regarding the impact of Artificial Intelligence and the labour market. According to a Research Survey of experts conducted by Pew Research Center, it was observed that half the experts(48%) believe that AI will displace more jobs than it will create and the other half of the experts who responded to this survey (52%) expect that technology will create more jobs than it displaces by 2025. (Smith & Anderson., 2014). This group also commented that the new jobs that will be created would need will more skill-based compared to the current jobs.Human interventions still required for the tasks that are difficult to automate and automize.

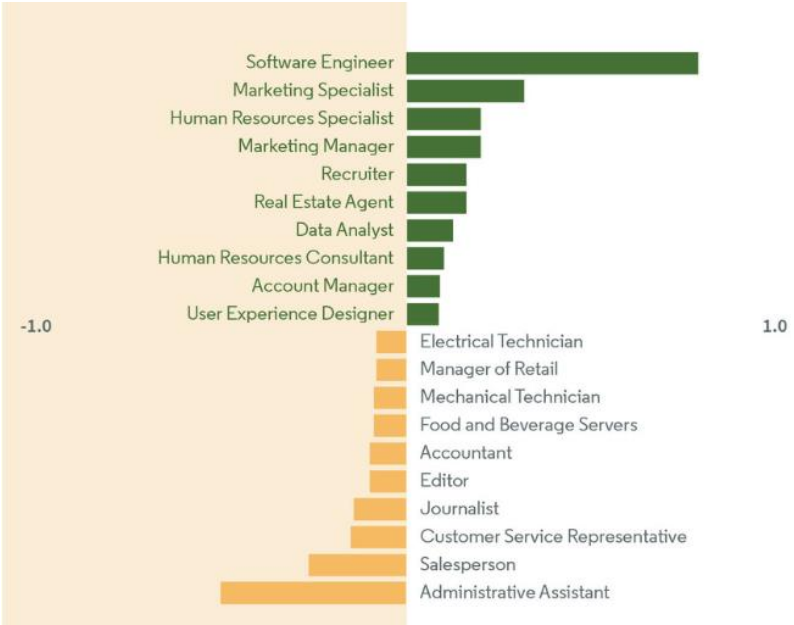

Figure 1:-Growing and declining of occupations globally *Source: Perisic (2018)*

While talking about Occupations, Tech jobs such as software engineers and data analysts are on the increase in most sectors and across all areas, along with technical abilities such as cloud computing, mobile application development, software testing and AI. (Perisic,2018)

However, a proportion of extremely "automated" employment fall into the top 10 most decreasing employment-i.e. employment that has seen the most significant employment share declined in the last five years. These jobs include administrative assistants, representatives of customer services, accountants and electrical/mechanical engineers, many of whom are dependent on more repetitive tasks.

It is estimated that by 2025, the amount of work done by machines will jump from 29 per cent to over 50 per cent-but that new requirements will accompany this fast change on the labour market, hich may result in more employment rather than fewer.

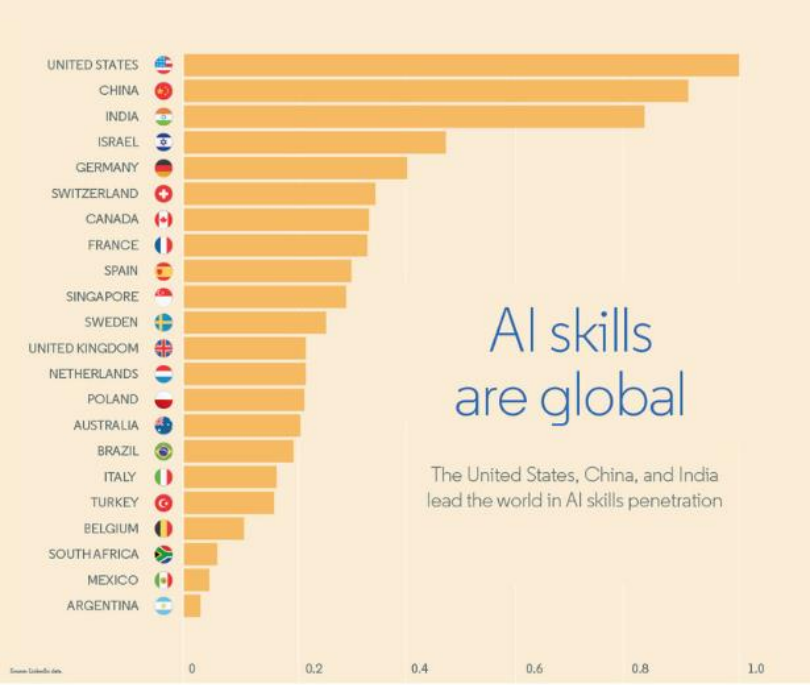

Figure 2:- AI skills are global, and the countries with the highest penetration of AI skills are the United States, China, India, Israel and Germany. *Source: - Perisic (2018)*

13. Impact of Artificial Intelligence on Manufacturing Industry

Artificial Intelligence (AI) is a cognitive science with rich research activities in the areas of image processing, natural language processing, robotics, machine learning etc. Historically, Machine Learning and AI have been perceived as black-art techniques and there is often a lack of compelling evidence to convince industry that these techniques will work repeatedly and

consistently with a return on investment. At the same time, the performance of machine learning algorithms is highly dependent on a developer's experience and preferences. Hence, the success of AI in industrial applications has been limited. On the contrary, Industrial AI is a systematic discipline, which focuses on developing, validating and deploying various machine learning algorithms for industrial applications with sustainable performance. It acts as a systematic methodology and discipline to provide solutions for industrial applications and function as a bridge connecting academic research outcomes in AI to industry practitioners. (Lee et al,2018)

The key elements in Industrial AI can be characterized by 'ABCDE'. These key elements include Analytics technology (A), Big data technology (B) Cloud or Cyber technology (C), Domain knowhow (D) and Evidence (E). Analytics is the core of AI, which can only bring value if other elements are present. Big data technology and Cloud are both essential elements, which provide the source of the information (data) and a platform for Industrial AI. While these elements are essential, domain knowledge and Evidence are also important factors that are mostly overlooked in this context. D main knowhow is the key element from the following aspects:

1) Understanding the problem and focus the power of Industrial AI into solving it;

2) Understanding the system so that right data with the right quality can be collected;

3) Understanding the physical meanings of the parameters and how they are associated with the physical characteristics of a system or process; and

4) Understanding how these parameters vary from machine to machine.

Evidence is also an essential element in validating Industrial AI models and incorporate them with cumulative learning ability. By gathering data patterns and the evidence (or label) associated with those patterns can only we improve the AI model to become more accurate, comprehensive and robust as its ages. (Lee, et al,2018)

14. Conclusion

Currently, Artificial Intelligence is bringing a significant transformation in the industry. Conventional ways of doing commerce are changing. "Machines, with human-level competence" the idea is both terrifying and exciting. This concept of machines with human-level competence is emerging and should be carefully monitored.

Artificial intelligence and machine learning are becoming more and more deeply rooted. Hence, the extent of their interaction and involvement will be a topic of research in the nearest future.

Overall, Artificial Intelligence and the Idea of Autonomy both have been a major development in the field of consideration. However, in some cases, there are still concerns about, to what extent the application of autonomy is safe. The Information and Communication Technology (ICT) is the core of new modern, digital world. Although in some of the cases, AI also raises concerns, much like side effects. Like in Military, there has been a discussion on putting parameters on the utility of autonomy. This technology, even in communication & market systems threatens privacy. Information and communication technologies (ICT) are becoming more integrated than ever. AI and its adoption will project high-level capabilities in defence and agriculture areas. The impact of AI on society is subject to its application.

To conclude everything. Artificial Intelligence has been a revolution in every field that I've studied. The application of AI has transformed the conventional ways of almost every area in modern society.

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Artificial Intelligence and Human Thinking

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Abstract

Research in AI has built upon the tools and techniques of many different disciplines, including formal logic, probability theory, decision theory, management science, linguistics and philosophy. However, the application of these disciplines in AI has necessitated the development of many enhancements and extensions. Among the most powerful of these are the methods of computational logic.

I will argue that computational logic, embedded in an agent cycle, combines and improves upon both traditional logic and classical decision theory. I will also argue that many of its methods can be used, not only in AI, but also in ordinary life, to help people improve their own human intelligence without the assistance of computers.

1 Introduction

Computational logic, like other kinds of logic, comes in many forms. In this paper, I will focus on the abductive logic programming (ALP) form of computational logic.

I will argue that the ALP agent model, which embeds ALP in an agent cycle, is a powerful model of both descriptive and normative thinking. As a descriptive model, it includes production systems as a special case; and as a normative model, it includes classical logic and is compatible with classical decision theory.

These descriptive and normative properties of the ALP agent model make it a dual process theory, which combines both intuitive and deliberative thinking. Like most theories, dual process theories also come in many forms. But in one form, as Kahneman and Frederick [2002] put it, intuitive thinking "quickly proposes intuitive answers to judgement problems as they arise", while deliberative thinking "monitors the quality of these proposals, which it may endorse, correct, or override".

In this paper, I will be concerned mainly with the normative features of the ALP agent model, and on ways in which it can help us to improve our own human thinking and behaviour. I will focus, in particular, on ways it can help us both to communicate more effectively with other people and to make better decisions in our lives. I will argue that it provides a theoretical underpinning both for such guidelines on English writing style as [Williams, 1990, 1995], and for such advice on better decision-making as [Hammond *et al.,* 1999]. This paper is based upon [Kowalski, 2011], which contains the technical underpinnings of the ALP agent model, as well as references to related work.

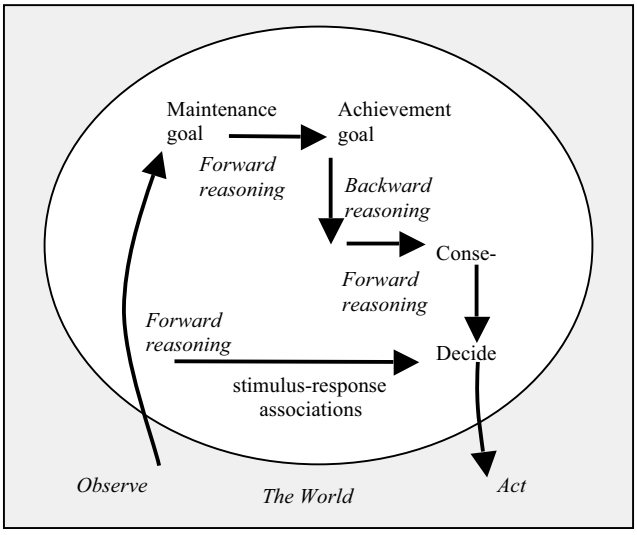

Figure 1. The basic ALP agent cycle

2 A Brief Introduction to ALP Agents

The ALP agent model can be viewed as a variant of the BDI model, in which agents use their *beliefs* to satisfy their *desires* by generating *intentions*, which are selected plans of actions. In ALP agents, beliefs and desires (or goals) are both represented as conditionals in the clausal form of logic. Beliefs are represented as logic programming clauses, and goals are represented as more general clauses, with the expressive power of full first-order logic (FOL). For example, the first sentence below expresses a goal, and the other four sentences express beliefs:

If there is an emergency
then I deal with it myself or I get help or I escape.
There is an emergency if there is a fire.
I get help if I am on a train
and I alert the driver of the train.
I alert the driver of the train if I am on a train and

I press the alarm button.
I am on a train.

In this paper, goals are written conditions first, because, like production rules, they are always used to reason forwards. Beliefs are usually written conclusion first, because, like logic programs, they are usually used to reason backwards. But beliefs are sometimes written conditions first, because in ALP they can be used to reason backwards or forwards. In the semantics, it does not matter whether conditionals of any kind are written forwards or backwards.

2.1 Model-theoretic and Operational Semantics

Informally speaking, in the semantics of ALP agents, beliefs describe the world as the agent sees it, and goals describe the world as the agent would like it to be. In deductive databases, beliefs represent the data, and goals represent database queries and integrity constraints.

More formally, in the model-theoretic semantics of the ALP agent model, the task of an agent having beliefs B, goals G and observations O is to generate a set Δ of actions and assumptions about the world such that:

$G \cup O$ is *true* in the minimal model
determined by $B \cup \Delta$.

In the simple case where B is a set of Horn clauses, $B \cup \Delta$ always has a unique minimal model. Other cases can be reduced to the Horn clause case, but these technicalities are not important here.

In the operational semantics, ALP agents reason forwards from observations, and forwards and backwards from beliefs, to determine whether some instance of the conditions of a goal is *true*, and to derive the corresponding instance of the conclusion of the goal as an *achievement goal*, to make *true*. Forward reasoning from observations is like forward chaining in production systems, but it has the semantics of aiming to make the goal *true* by making its conclusion *true* whenever its conditions become *true*. Conditional goals understood in this way are also called *maintenance goals*.

Achievement goals are solved by reasoning backwards, searching for a plan of actions whose execution solves the goals. Backwards reasoning is a form of goal-reduction, and executable actions are a special case of atomic sub-goals.

Suppose, for example, that I observe *there is a fire*. I can then reason with the goal and beliefs given above, concluding by forward reasoning that *there is an emergency*, and deriving the achievement goal *I deal with it myself or I get help or I escape*. These three alternatives represent an initial search space. I can solve the achievement goal by reasoning backward, reducing the goal *I get help* to the consecutive sub-goals *I alert the driver of the train* and *I press the alarm button*. If this last sub-goal is an atomic action, then it can be executed directly. If the action succeeds, then it makes the achievement goal and this instance of the maintenance goal both *true*.

In the model-theoretic semantics, the agent needs to generate, not only actions, but also assumptions about the world. These assumptions explain the use of the term *abduction* in ALP. Abduction is the generation of assumptions Δ to explain observations O. For example, if instead of observing fire, I observe *there is smoke*, and I believe:

there is smoke if there is a fire.

then backwards reasoning from the observation generates an assumption that *there is a fire*. Forward and backward reasoning then continue as before.

In the model-theoretic and operational semantics, observations O and goals G are treated similarly, by reasoning forwards and backwards to generate actions and other assumptions Δ, to make $G \cup O$ *true* in the minimal model of the world determined by $B \cup \Delta$. In the example above, given O = {*there is smoke*}, *then* Δ = {*there is a fire, I press the alarm button*} together with B makes G and O both true.

The operational semantics is sound with respect to the model-theoretic semantics. With modest assumptions, it is also complete.

2.2 Choosing the Best Solution

There can be several, alternative Δ that, together with B, make G and O both *true*. These Δ can have different values, and the challenge for an intelligent agent is to find the best Δ possible within the computational resources available.

In classical decision theory, the value of an action is measured by the expected utility of its consequences. In the philosophy of science, the value of an explanation is measured similarly in terms of its probability and explanatory power. (The more observations explained the better.) In ALP agents, the same measures can be used to evaluate both candidate actions and candidate explanations. In both cases, candidate assumptions in Δ are evaluated by reasoning forwards to generate consequences of the assumptions in Δ.

In ALP agents, the task of finding the best Δ is incorporated into the search strategy for reasoning backwards to generate Δ, using some form of best-first search, like A* or branch-and-bound. This task is analogous to the much simpler problem of conflict resolution in production systems.

Conventional production systems avoid complex decision-theory and abductive reasoning mainly by compiling higher-level goals, beliefs and decisions into lower-level heuristics and stimulus-response associations. For example:

if there is smoke and I am on a train
then I press the alarm button.

In ALP agents, such lower-level rules and higher-level thinking and decision-making can be combined, as in dual process theories, to get the best of both worlds.

Like BDI agents, ALP agents interleave thinking with observing and acting, and do not need to construct complete plans before starting to act. However, whereas most BDI agents select and commit to a single plan at a time, ALP agents select and commit only to individual actions.

Unlike most BDI agents, ALP agents can interleave the pursuit of several alternative plans, to improve the chances

of success. For example, in an emergency an agent can both press the alarm button and try to escape more or less at the same time. Whether an ALP agent works on one plan or several alternative plans at a time depends on the search strategy. Depth-first search works on one plan at a time, but other search strategies are often more desirable.

The ALP agent model can be used to develop artificial agents, but it can also be used as a descriptive model of human thinking and deciding. However, in the remainder of this paper I will argue that it can also be used as a normative (or prescriptive) model, which combines and improves upon both traditional logic and classical decision theory.

The argument for basing a better decision theory on the ALP agent model depends on the claim that the clausal logic of ALP is a plausible model of the language of thought (LOT). In the next few sections, I will support this claim by comparing clausal logic with natural language. Moreover, I will argue that people can use this model to help them communicate with other people more clearly and more coherently. I will return to the use of the ALP agent model, to help people make better choices, in section 6.

3 Clausal Logic as an Agent's LOT

In the philosophy of language, there are three main schools of thought regarding the relationship between language and thought:

- The LOT is a private, language-like representation, which is independent of public, natural languages.
- The LOT is a form of public language; and the natural language that we speak influences the way that we think.
- Human thinking does not have a language-like structure.

The ALP agent model belongs to the first school of thought, opposes the second school, but is compatible with the third. It opposes the second school, partly because the ALP logical model of thinking does not require the existence of natural languages and partly because, by AI standards, natural language is too ambiguous and incoherent to serve as a useful model of human thinking. But it supports the third school, because, as we will see in section 4, it has a connectionist implementation, which conceals its linguistic nature.

In AI, the notion that some form of logic is an agent's LOT is strongly associated with GOFAI (good old fashioned AI), which has been partly overshadowed in recent years by connectionist and Bayesian approaches. I will argue that the ALP model of thinking potentially reconciles the conflict between logic, connectionism and Bayesian approaches. This is because the clausal logic of ALP is much simpler than standard FOL, has a connectionist implementation that accommodates Bayesian probability, and bears a similar relationship to standard FOL as the LOT bears to natural language.

The first step of the argument is based on relevance theory [Sperber and Wilson, 1986], which maintains that people understand natural language by attempting to extract the most information for the least processing cost. It follows, as a corollary of the theory, that, the closer a communication is to its intended meaning, the easier it is for a reader (or listener) to extract that meaning of the communication.

Thus one way to determine whether there is a LOT, and what it might look like, is to look at situations where it can be a matter of life or death that readers understand a communication as intended and with as little effort as possible. We will see that, in the case of the London underground Emergency Notice, the communication is easy to understand because its English sentences are structured explicitly or implicitly as logical conditionals.

3.1 What to do in an Emergency

Press the alarm signal button to alert the driver.
The driver will stop if any part of the train is in a station.
If not, the train will continue to the next station,
where help can more easily be given.
There is a 50 pound penalty for improper use.

The first sentence is a goal-reduction procedure, whose underlying logic is a logic programming clause:

the driver is alerted
if you press the alarm signal button.

The second sentence is explicitly in logic programming clausal form, but is ambiguous; and one of its conditions has been omitted. Arguably, its intended meaning is:

the driver will stop the train in a station
if the driver is alerted
and any part of the train is in the station.

The logic of the third sentence is two sentences, say:

the driver will stop the train in the next station
if the driver is alerted
and not any part of the train is in a station.

help can more easily be given in an emergency
if the train is in a station.

Presumably, the relative clause beginning with *where* adds an extra conclusion to the sentence rather than an extra condition. If the relative clause were meant to add an extra condition, then this would mean that the driver will not necessarily stop the train at the next station, but at the next station where help can more easily be given.

The fourth sentence is also a conditional, but in disguise:

You may be liable to a £50 penalty
if you use the alarm signal button improperly.

Arguably, the Emergency Notice is relatively easy to understand, because its expression is relatively close to its intended meaning in the LOT. Moreover, it is coherent, because the consecutive sentences are logically connected both with one another and with the reader's likely pre-existing goals and beliefs about what to do in an emergency.

One reason the English sentences are not closer to their intended meaning is because omitting conditions and other details sometimes promotes coherence. Williams [1990, 1995] emphasizes another way of achieving coherence: by placing old, familiar ideas at the beginning of sentences and new ideas at their end. In a succession of sentences, a new idea at the end of one sentence becomes an old idea that can be put at the beginning of the next sentence.

The first three sentences of the Emergency Notice illustrate Williams' advice. Here is another example, which incidentally illustrates the kind of reasoning that is catered for in the ALP agent model:

It is raining.
If it is raining and you go out without an umbrella, then you will get wet.
If you get wet, then you may catch a cold.
If you catch a cold, then you will be sorry.
You don't want to be sorry.
So you do not want to go out without an umbrella.

I will argue in section 4 that the kind of coherence illustrated in these sentences can be understood in terms of logical connections between the conclusions and conditions of sentences.

3.2 Natural Language and the LOT

In contrast with the problem of understanding communications that are designed to be as clear and coherent as possible, the problem of understanding ordinary, every-day natural language communications is much harder. This harder problem has two parts. The first part is to identify the intended meaning of the communication. For example, to understand the ambiguous English sentence "he gave her the book" it is necessary to identify the individuals, say John and Mary, referred to by "he" and "her".

The second part is to represent the intended meaning in a canonical form, so that equivalent communications are represented in the same way. For example, the following English sentences all have the same meaning:

John gave Mary the book.
John gave the book to Mary.
Mary received the book from John.
The book was given to Mary by John.

The use of a canonical form in a mental representation makes it easier to reason with the representation later. In this case, the common meaning of the different sentences could be represented either in the logical form *give(john, mary, book)* or in the more precise form:

event(e1000). *act(e1000, giving).*
agent(e1000, john). *recipient(e1000, mary).*
object(e1000, book21). *isa(book21, book).*

The more precise form is one way of distinguishing between similar events and similar books.

It follows from the tenets of relevance theory that, if you want your communications to be easy to understand, then you should express them in a form that is close to their mental representations. They should be clear, so that extracting their meaning is easy, and they should be simple, so that their meaning is close to the canonical form in which they are represented.

For example, don't say "Every bird which belongs to class aves has feathers ". But say:

every bird has feathers.
every bird belongs to class aves.
or *a bird has feathers if the bird belongs to class aves.*

depending on what you mean. In written English, the different meanings can be signaled by the presence or absence of commas before and after the relative clause beginning with the word "which". In clausal logic, they are represented by the difference between conclusions and conditions.

Examples such as these suggest that the difference and the relationship between conditions and conclusions are a fundamental feature of the LOT, and they add further support to the thesis that something like the conditional form of clausal logic is a plausible candidate for the LOT.

3.3 Standard FOL and Clausal Logic

Various forms of logic have been used for knowledge representation in AI, and rival clausal logic as a candidate for the LOT. But compared with standard FOL, not only does clausal logic stand out because of its simple, conditional form, but it is just as powerful. It compensates for the lack of explicit existential quantifiers by employing Skolemization to give individuals that are supposed to exist a name, like the names *e1000* and *book21* above. In another respect, it is also more powerful than FOL, when it is used in conjunction with the minimal model semantics.

Reasoning is also much simpler in clausal logic than in standard FOL, and for the most part can be reduced to just forward and backward reasoning. In conjunction with the minimal model semantics, reasoning in clausal logic also includes default reasoning with negation as failure.

Arguably, the relationship between standard FOL and clausal form is similar to the relationship between natural language and the LOT. In both cases, inferences can be partitioned into two kinds, performed in two stages. The first kind converts sentences into canonical form, and the second kind reasons with the resulting canonical form.

In FOL, the first kind of inference rule (including both Skolemization and the replacement of *not(A or B)* by *not A and not B*) can be viewed as converting sentences into clausal form. The second kind (including the inference of *P(t)* from $\forall X P(X)$) can be viewed as reasoning with clausal form, and is built into forward and backward reasoning.

As we have seen, in natural language, there are many ways of expressing the same information. Similarly in FOL, there are infinitely many, arbitrarily complex ways of expressing information equivalently. For example, to express

that all birds have feathers and john is a bird, we can write, not only $\forall X(bird(X) \rightarrow feathers(X)) \wedge bird(john)$, but also:

$\neg(\exists X((\neg feathers(X) \vee \neg bird(john)) \wedge (bird(X) \vee \neg bird(john))))$.

In clausal form there is only one way of expressing the same information canonically, in this example in the form of two clauses: *feathers(X) if bird(X)* and *bird(john)*.

Thus clausal logic stands in relation to standard FOL, as the LOT stands in relation to natural language. In the same way that the LOT can be regarded as a simplified and canonical form of unambiguous sentences in natural language, clausal logic is a simplified, canonical form of FOL. This analogy further supports the argument for viewing clausal logic as a formalisation of the LOT.

Certainly in the case of artificial agents in AI, clausal logic has proved to be a practical knowledge representation language, independent from any language an agent might use for communicating with other agents. In the case of human agents, clausal logic can also help people communicate more effectively, by expressing their communications in a form that is closer to the LOT.

Clausal logic can help people communicate more coherently, by helping them to link new information with old information. This model of coherence exploits the fact that clausal logic lends itself to a connectionist representation, in which information is stored in a connection graph of goals and beliefs [Kowalski, 1975, 1979, 2011].

4 A Connectionist Form of Clausal Logic

Similar to the way that clausal logic implements FOL, by first converting sentences into canonical form, the connection graph proof procedure implements clausal logic, by precomputing links between conditions and conclusions, and by labeling links with their unifying substitutions. These links can then be activated later, either forwards or backwards, as and when the need arises. Links that are activated frequently can be compiled into shortcuts, which achieve the same effects more directly, in the manner of heuristic rules and stimulus-response associations.

Although clausal logic is a symbolic representation, once all the links and their unifying substitutions have been computed, the names of the predicate symbols no longer matter. All further reasoning can be reduced to the activation of the links, and to the generation of new clauses, whose new links are inherited from the links of their parent clauses. In many cases, parent clauses can be deleted or over-written, when all their links have been activated.

Any link can be selected for activation at any time. But most of the time, it makes sense to activate links only when new clauses are added to the graph as the result of new observations, including observations of communications.

The activation of links can be guided by assigning different strengths to different observations and goals, reflecting their relative importance (or utility). In addition, different weights can be assigned to different links, reflecting statistical information about how often their activation has contributed to useful outcomes in the past.

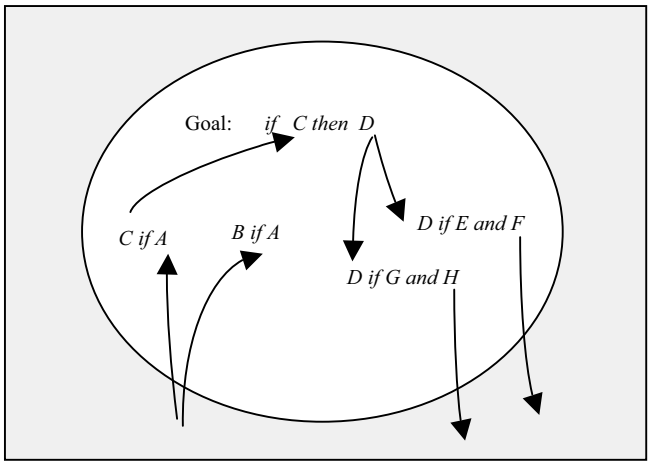

Figure 2. A simplified connection graph of goals and beliefs. Notice that only A, F and H are "grounded" in the world. B, C and D are mental concepts that help the agent organize its thoughts and regulate its behaviour. The status of E and G is unspecified. Notice too that the same effect can be obtained more directly by means of the lower-level goal *if A then ((E and F) or (G and H))*.

The strength of observations and goals can be propagated throughout the graph in proportion to the weights on the links. The resulting proof procedure, which activates links with the current highest weighted strength, is similar to the activation networks of [Maes, 1990]. Moreover, it automatically implements an ALP style of forward and backward reasoning, combined with a form of best-first search.

The connection graph model of thinking can give the misleading impression that thinking does not have a linguistic or logical character at all. But the difference between thinking in connection graphs and reasoning in clausal logic is nothing other than the conventional computer science distinction between an optimized, low-level implementation, which is close to the hardware, and a high-level representation, which is close to the problem domain.

The connection graph model of the mind adds further support to the argument that thinking takes place in a LOT that is independent from natural language. The LOT may facilitate the development of natural language, but it does not depend upon its prior existence.

The connection graph model also suggests that expressing thoughts in natural language is like decompiling low-level programs into higher-level program specifications. In computing, decompiling programs is hard. This may help to explain why it is often hard to put our thoughts into words.

5 Representing Uncertainty

The links in connection graphs include internal links, which organize the agent's thoughts, and external links, which ground the agent's thoughts in reality. The external links are activated by observations and by the agent's own actions. They may also include links to unobserved properties of the world. The agent can make assumptions about these properties, and can attempt to judge their probabilities.

The probability that an assumption is *true* contributes to the probability that an agent's actions will have a particular outcome. For example:

You will be rich if you buy a lottery ticket
and your number is chosen.
It will rain if you do a rain dance
and the gods are pleased.

You can control your own actions (like *buying a ticket* or *doing a rain dance*), but you cannot always control the actions of others or the state of the world (*your number is chosen* or *the gods are pleased*). At best, you might be able only to judge the probability that the world is or will be in a particular state (*one in a million?).* David Poole [1997] has shown that associating probabilities with such assumptions gives ALP the expressive power of Bayesian networks.

6 Better Decision-making

Uncertainty about the state of the world is only one of the complications contributing to the problem of deciding what to do. To reduce this complexity, classical decision theory makes simplifying assumptions. The most restrictive of these is the assumption that all of the alternatives to be decided between are given in advance. For example, if you are looking for a new job, it would assume that all of the job options are given, and it would focus on the problem of deciding which of the given options is most likely to result in the best outcome.

But as [Keeney, 1992; Hammond *et al*., 1999; Carlson *et al.*, 2008]] and other decision analysts point out, this assumption is not only unrealistic as a descriptive model of human decision making, but it is unhelpful as a normative (or prescriptive) model: To make a good decision between alternatives, it is necessary first to establish the goals (or problem) that motivate the alternatives. These goals might come from explicitly represented maintenance goals or they might be hidden implicitly in lower-level heuristic rules or stimulus-response associations.

For example, you might receive an offer of a new job when you are not looking for one, and you may be tempted to limit your options simply to deciding between accepting or rejecting the offer. But if you step back and think about the broader context of your goals, then you might generate other alternatives, like perhaps using the job offer to negotiate an improvement in your current employment.

Decision analysis provides informal strategies for making better choices by paying greater attention to the goals that motivate the alternatives. The ALP agent model provides a simple framework, which can help to formalize such strategies, by integrating them with a comprehensive model of human thinking. In particular, it shows how the same criteria of expected utility, which are used in classical decision theory to choose between alternatives, can also be used to guide the search for alternatives in some form of best-first search. Moreover, it shows how heuristics and even stimulus-responses can be integrated with logical thinking and decision theory in the spirit of dual process models.

7 Conclusions

I have sketched two ways in which the ALP agent model, building upon many different developments in Artificial Intelligence, can be used by ordinary people to improve their own human intelligence. It can help them express their thoughts more clearly and coherently, and it can help them make better choices. I believe that the application of such techniques is a fruitful direction of research for the future, and a promising area for collaboration between researchers in AI and researchers in more humanistic disciplines.

Acknowledgments

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Artificial Intelligence in Business: From Research and Innovation to Market Deployment

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Abstract

For the last few years, one can see the emergence of a large number of intelligent products and services, their commercial availability and the socioeconomic impact, this raises the question if the present emergence of AI is just hype or does it really have the capability of transforming the world. The paper investigates the wide range of implications of artificial intelligence (AI), and delves deeper into both 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 the influential academic achievements and innovations in the field of AI; their impact on the entrepreneurial activities and thus on the global market. The paper also contributes in investigating factors responsible for the advancement of AI. For the exploration of entrepreneurial activities towards AI, two lists of top 100 AI start-ups are considered. The inferences obtained from the research will provide an improved understanding of the innovations and the impact of AI on businesses and society in general. It will also provide a better understanding of how AI can transform the business operations and thus the global economy.

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Keywords: Artificial Intelligence; Fourth Industrial Revolution; Business Analytics; Machine Learning; Deep Learning; Business Intelligence

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1. Introduction

Innovation has always been the main engine of an improved standard of living throughout history. However, the process of innovation can be highly disruptive as it makes conventional technologies obsolete. Cloud computing, Internet of things (IoT), big data, data science, artificial intelligence (AI), and blockchain are the rising technologies that may create winners as well as losers across the world. Some of these technologies are at least two and a half decades old 0-[3] but were neither in the mainstream nor were viable for commercial applications. However, in the last few years, the situation has changed dramatically, today, almost every field employs one or more of these technologies. There are many factors responsible for this, including advancements in computer technology (high-performance computing, grid, and cloud computing), increase in transparency through code sharing (services like GitHub, GitLab, BitBucket) and a large number of open source software. At present, the enormous uses of these technologies in every field including healthcare, automobiles, finance, gaming, environmental monitoring, agriculture, sports, energy management, security, etc are changing the way, human beings, live, work and amuse themselves. Further advancement of these technologies can contribute to develop hyper-automation and hyper-connectivity, which would bring us at the dawn of the Fourth Industrial Revolution or Industry 4.0 [4]-[7].

Primarily, the advancement in AI is the heart of the enhanced performance of all other technologies and the evolution of Industry 4.0. There are sufficient pieces of evidence available in the literature that proves that the AI technology offers new opportunities that can lead to notable transformation in businesses and the overall economic system [4], [6], [7]-[11]. At the business level, some of the benefits of AI are: the quick unveiling of patterns in big data, speedy visualization and analytics, improved product design, delivering meticulous insights, and many more. These benefits are expected to introduce new levels of service, increased profit, expansion of businesses, improved efficiency and cost structures [7], [10], [11]. In this paper, the new growth economics, Neo-Schumpeterian Economics, is used as a base model to analyze the impact of AI in business [12]. The three forces which drive the Neo-Schumpeterian Economics are innovation, knowledge, and entrepreneurship. In particular, 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 global market. For the exploration of entrepreneurial activities towards AI, the two lists of top 100 AI start-ups are considered. As per the knowledge of the authors, this novel methodology has not been used before; therefore a comparative analysis is not possible. The novel points of the paper are summarized below:

- Recognition of the factors which are resulting in today's AI exponential growth
- Identification of academic achievements in AI which are advancing the commercially available intelligent products.
- Determination of the top AI industries and investment trends in AI.
- Exploration of geographically strong AI locations.
- The data analysis done proves that AI is not hype.

The inferences obtained from the research will provide a better understanding of the innovations and the impact of AI on businesses and society in general. It will also provide a better understanding of how AI can transform the organization of research & development, business operations and the global economy. The results obtained can aid the countries to get prepare for the adoption of AI in near future.

The present work is organized as follows: Sect. 2 focuses on the research objectives and list of data 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 global market analysis 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 taking place at the rate of the blink of the eye. Robots working in industries, cars driving themselves, smart watches

monitoring patient's health, and AI playing games (e.g. Chess and Go) better than world champions are some of the technological innovations under AI.

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

- Why is it so? Why does every company want to be an AI company or want to acquire AI companies? Are all other technologies slowly being augmented (or replaced) with AI?
- How does AI impacting all the lines of business across the world such that there is not even a single field left where its impact cannot be seen? Which countries are leading the race of AI?
- AI is 60-year-old technology yet was not able to show its impact until the present era. Then what are the factors which are resulting in today's AI exponential growth?

Through this paper, the intention is to answer the above questions. The research was initiated by scanning a number of business newsletters, AI magazines, journal papers, conference articles, machine learning posts, annual reports of the companies, press releases, stock market websites, online forums, and many other platforms to gather the data required to help us in the investigation. The answers to these questions will help the human society to get prepared for the future challenges. This will also aid in accepting the transformations occurring as a result 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 computer science at Stanford University in 1956. He organized the famous Dartmouth conference at Dartmouth College, Hanover and started AI as a field. He had the belief that there will be systems which will evolve intelligence of human order. In 1973, Firschein and Coles [14] postulated a list of twenty-one hypothetical products that would result from the advances of AI by the 1990s. Some of the products which were predicted by them have become a reality today and are listed in Table 1. This table provides an insight into the advancement of AI in 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 Tricorder, 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 chauffeur	"Robot cars capable of operation on standard city streets and country highways, using visual sensors"	Google Waymo, Mercedes-Benz E-Class, Volvo XC60
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 period of hypes was followed by periods with reduced funding (also known as AI winters). However, despite these hindrances, today AI is back in limelight due to development of 'deep learning' neural networks with many hidden layers. This progression of AI is accredited to two main factors: the availability of a huge amount of data (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 is an intelligent agent (IA). It interacts with the environment in a repetitive cycle of sense-think-and-act. It explores the input data (big data) in order to learn correlations, extract features, detect similarities, and discover good depiction at multiple levels. Earlier, the unavailability of data and efficient hardware was hindering the progress of AI. However, in the last few years, the accessibility of low-cost and low-power sensors has resulted in the production of a huge amount of data. An investigation of a list of dataset providers is done to elucidate the amount, diversity and accessibility of datasets available on the web (Appendix A). The extensive list of dataset providers with their URLs and related information is given below as Appendix A.

Next, the exploration of input data 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 have become the most popular approach in the last 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. Some of the DLNs have reported surpassing human-level accuracy in certain tasks [15] - [35]. The successful AI applications are categorized under four broad areas viz. computer vision, speech recognition, text analysis, and computer games. Table 2 summarizes a brief description of each DL area, their successful applications and 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 Q-Networks.

The success and the hype generated by DLNs in the last few years have propelled many companies to become an AI company 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 as the innovation and growth drivers of the economy; their analysis would help to gain valuable insights into the exploration of the transformational impact of AI on the businesses. Two lists of top 100 AI start-ups obtained with the help of the CB Insights' Mosaic algorithm† [36] are considered. The algorithm identifies the top 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. In the rest of the paper, the AI start-ups list for 2017 and 2018 is referred to as AI17 and AI18 respectively. A part of these results has been presented at an international conference DIGITS 2018 [22] jointly organized by University of Maryland and Birla Institute of Management and Technology. The extended version of the manuscript has been submitted to Journal of Business Research, Elsevier for consideration as a journal research article [23].

4.1. Sectors and Industries

AI start-ups initiated all over the world are categorized in 22 different fields including autonomous vehicles, business intelligence, healthcare, etc. Fig. 1. depicts the percentage of 200 AI start-ups (AI17 and AI18) in different lines of business which majorly covers all the fields where AI is showing its impact. It can be seen clearly that the spread of AI is all pervasive, from education to healthcare, from home to industry; there is no place where AI is not being used or explored.

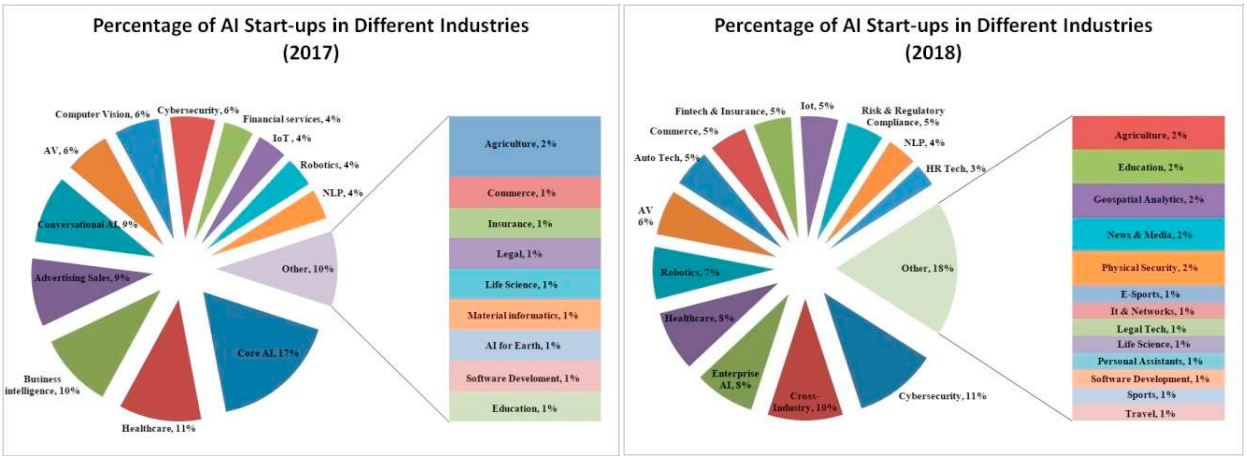

Fig. 1 Percentage of AI start-ups in different industries for (a) 2017 (b) 2018

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 viz. medical image analysis, drug discovery, robotic surgery, virtual nurses, health monitoring,

† Mosaic algorithm: It is a data- driven technology developed by CB Insights to measure the growth of private companies. The algorithm uses machine learning and advanced language processing techniques to understand these companies.

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 $1866.6 million (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.

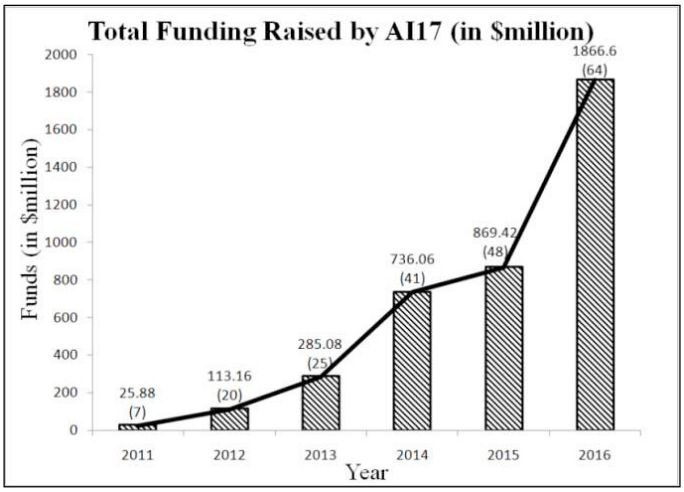

Fig. 2 Year-wise investment (in $ Million) in 100 AI start-ups

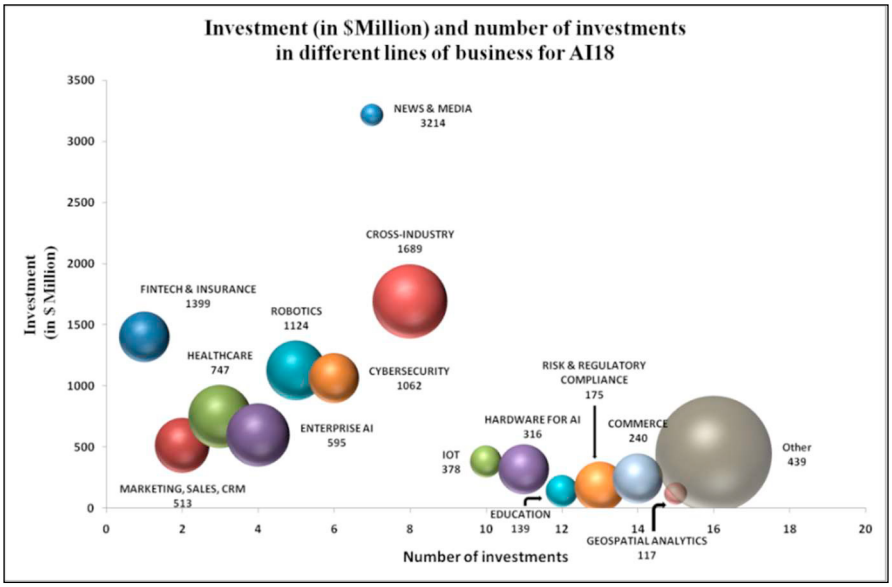

Fig. 3 Investment (in $ Million) in different lines of business in AI18. The size of the bubble indicates the number of start-ups working in each line of business

Furthermore, the total investment in AI18 is $12.74 billion i.e. 2.27 times incremented in comparison to the total investment in AI17 (2011 to 2016). This shows the rising interest of investors in AI. Fig. 3. shows the investment (in $million) made in different industries in AI18. The size of the bubble indicates the number of start-ups working in each line of business. An important observation that can be made from the chart is there are only 2% start-ups in news and media, but it has got the highest investment share of 25.22% of the total investment.

The two start-ups that received one-fourth of the global investment made in AI18 are California based SoundHound Inc. and Beijing based Bytedance. Both of them aim to make the human-machine interaction as simple as human-human interaction. California based SoundHound Inc. has millions of users, telling smartphones to accomplish tasks without even touching them. Hound and SoundHound are its two example products applying AI technology to speech (get weather information, make calls and send text, etc.) and music (find songs by singing or just by humming) respectively. On the other 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 identify fake news by analyzing posts and comments with AI technologies.

From the above analysis, it can be estimated that there is special interest in the use of AI for personalized services, almost every company is thinking to implement AI in their respective sector with the common goal of making their products and services intelligent in order to grow their business.

4.3. Geographical Analysis

In this section important insights 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.

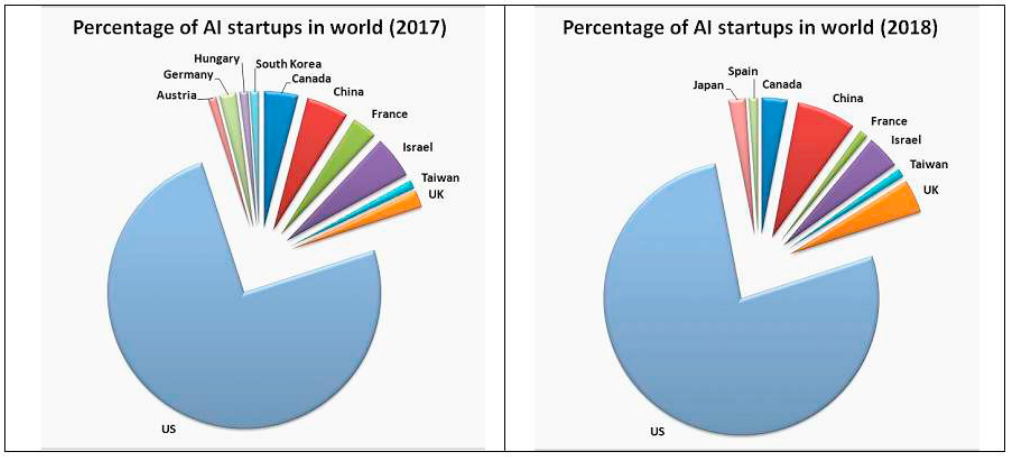

Fig. 4 Percentage of AI17 and AI18 in different parts of the world

5. Discussion and Conclusion

The present work illustrates the prominent achievements and influential technological innovations in the field of AI. The commercial availability of AI-driven products, proposed 48 years ago, proves that AI is not hype but has the ability of transforming the business and thus the global economy. This progressive growth and deployment of AI-driven system is attributed to two 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 each of them and various successful applications which have surpassed human-level

accuracy. The work also explores an exclusive list of dataset providers and their URLs. The results summarized in tables can aid researchers and industries working in the field of AI.

The analysis of the top 200 AI start-ups explicitly shows the influence of advance research and innovation in AI on the global market. The study shows that the AI wave is on and an appetite for AI growth is exponential. The investment in AI is showing an upward trajectory in the last 6 years and should remain the same for the upcoming years. The study also uncovers the top AI industries that will generate more opportunities in near future viz. business intelligence, healthcare, core AI, cybersecurity, and marketing & sales. Some of the key advantages of automation, cognitive technologies, and data analysis using AI algorithms are an increase in productivity, time and cost efficiency, human error reduction, faster business decisions, customer preference prediction, and sales maximization.

However, the study shows that the AI technology is confined only in a few regions in the world. This is creating an "AI divide". This divide, 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 prone to vulnerabilities. Some 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, explainable, path tracing, penetrability, etc. are some of the major factors established at the time of assessment of software; even after passing through these factors, there exist cases where DL algorithms have produced unreliable results. Apart from these, challenges like trust, ethics, bias, and shortage of AI talent also needs attention for commercial usage of AI applications.

Acknowledgements

One of the authors, Ms. Neha Soni, wants to thank Department of Science & Technology, Ministry of Science & Technology, New Delhi, India for sponsoring this work.

Appendix A. List of dataset providers, their URLs, data charges, API support, amount and type of data available.

S.No	Dataset Provider	URL	Free/ Paid	API Support	Number of datasets	Type of datasets
1	Kaggle	https://www.kaggle.com/datasets	Free	Yes	10,043	Food, Internet, Linguistics, Finance, Business, Demographics, Politics, World, Crime
2	NASA	https://data.nasa.gov/browse?limitTo=datasets#	Free	Yes	42,966	Aerospace, Applied Science, Earth Science, Space Science
3	University of California Machine Learning Repository (UCI ML)	https://archive.ics.uci.edu/ml/datasets.html	Free	Third party API support	440	Life Sciences, Physical Science, Engineering, Computer Science, Social Science, Game
4	UNICEF datasets	https://data.unicef.org/resources/resource-type/datasets/	Free	Third party API support	111	World data: Migration, Immunization, Education, Maternal mortality, Child marriage, child labor, sanitation and hygiene, gender and education, malnutrition
5	AWS Public Datasets	https://registry.opendata.aws/	Free	Yes	112	Satellite images of earth, Customer reviews, Trade data, Climate data
6	Quandl	https://www.quandl.com/search?query=	Both	Yes	187	Equities, Currencies, Interest rates and Fixed Income, Mutual Funds, Real-Estate, Energy, Economy and Society, Agriculture, Metals

7	Google Cloud Public Datasets	https://cloud.google.com/bigquery/public-data/	Free	Yes	39	Bike and Taxi Share Trips Data, Crime Data, Traffic Fatality, Air Quality, Police Report, Disease Data, Educational Statistics, Basketball Data
8	ProPublica Data Store	https://www.propublica.org/datastore/	Both	Yes	Not Applicable	Health, Environment, Criminal Justice, Transportation, Education, Politics, Business, Military
9	U.S. Government's open data	https://www.data.gov	Free	Yes	302614	Agriculture, Climate, Consumer, Ecosystem, Education, Energy, Finance
10	Indian Government's open data	https://data.gov.in/	Free	Yes	4281	Annual Budget of India, Crime Data, Water Irrigation Schemes, Traffic Statistics, Transport Statistics, Financial Statistics, Education, Health, Government Schemes
11	HealthData	https://healthdata.gov/	Free	Yes	3061	Assessment of Healthcare Providers and Systems, Restaurant Scores, Food Inspection, Mortality Rate, Management Reporting, Hospital Survey Reports from patients, Hospital Inspections
12	IMDb	https://www.imdb.com/	Free	Yes	Not Applicable	TV episodes information, Directors and Writers information, Movies rating and votes, TV series information, Cast and Crew in movies
13	Nasdaq	https://www.nasdaq.com/	Free	Yes	Not Applicable	Stock Data, Financial data, Revenue, EPS, Ownership Summary, Company News
14	StackExchange Data Explorer	https://data.stackexchange.com/	Free	Yes	Not Applicable	Questions, Answers, Comments, and Tags in various subjects.
15	GitHub	https://github.com/datasets https://github.com/awesomedata/awesome-public-datasets	Free	Yes	118	Natural Gas Prices, Gold Prices, Global Temperature, Language Codes, CO2 Emission
16	Gapminder	https://www.gapminder.org/data/	Free	Yes	519	Employment rate, agricultural land, alcohol consumption rate, Life expectancy, children per women, Foreign Direct Investment, Flood-deaths, Government Health Spending.
17	The World Bank	https://datacatalog.worldbank.org/	Free	Yes	3294	Climate Investment Funds, Demographic and Health Survey, Afrobarometer survey, Enterprise Survey
18	Datashop	https://www.datashop.biz/	Paid	Yes	55	Car, Economy, Finance, Linguistics, Geography, Postcodes, Media
19	Data & Sons	https://www.dataandsons.com/	Both	No	Not Applicable	Attorney E-mail List, Business Information and Financials, Earth Science, Education, Health and Medicine, Politics, Social Media Audience
20	AggData	https://www.aggdata.com/data	Both	Yes	4500	Arts and Entertainment, Clothing and Accessories, Computer and Electronics, Food and Dining
21	Socrata	https://opendata.socrata.com/browse?limitTo=datasets	Free	Yes	4796	Business, Education, Fun, Government, Public Safety

22	Academic Torrents	http://academictorrents.com/browse.php?cat=6	Free	Yes	392	News Articles, License Plates, Twitter Dataset.
23	Quantopian Data	http://academictorrents.com/browse.php?cat=6	Both	Yes	56	Sentdex Sentiment Analysis, Dividend, Stock Splits, Issue Equity, Earning Guidance
24	data.world	https://data.world/search?q=datasets	Both	Yes	5022	Agriculture, Geospatial, Country Codes, Ground Water Quality, Daily Weather, Ecosystem observation
25	Million Song Dataset	https://labrosa.ee.columbia.edu/millionsong/pages/additional-datasets	Free	Yes	4	Cover Songs, Lyrics, Last.fm, beat tunes.
26	Figure Eight	https://www.figure-eight.com/data-for-everyone/	Both	No	Not Applicable	Finance, Medical, Chatbots, Aerial Imagery, Autonomous Vehicles
27	YouTube-8M Dataset	https://research.google.com/youtube8m/index.html	Free	Yes	Not Applicable	6.1 Million (with 3 average labels) videos
28	BuzzFeedNews	https://github.com/BuzzFeedNews/everything	Free	Yes	Not Applicable	Live News Headlines, News Articles, Standalone Datasets
29	Entaroadun	https://gist.github.com/entaroadun/1653794	Free	No	Not Applicable	Movies, Music, Book, Food, Merchandise, Healthcare, Dating, Scholarly Paper Recommendation
30	Reddit-top-2.5-million	https://github.com/umbrae	Free	No	Not Applicable	1000 Posts on from 2500 subscribers on reddit.
31	Webscope Datasets	https://webscope.sandbox.yahoo.com/	Free	No	Not Applicable	Advertising and market data, Computing Systems Data, Language Data, Image, Graph, and Social Data.
32	ChemDB Chemoinformatics Portal	http://cdb.ics.uci.edu/cgibin/LearningDatasetsWeb.py	Free	No	32	Chemicals and isomers

Recently, Google has made available a search engine specifically for dataset.

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