ARTIFICIAL INTELLIGENCE
Human Natural Machine Intelligence of Evolution

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Abstract

Artificial Intelligence (AI) is a branch of computer science and refers to simulation of human intelligence in programmed machines to act and perform like humans. AI in its heart is a personified version of humans or breeds on an ontological approach. At present, with greater influxes in human rudiments, science and technology plays an incredible role. It is theoretically to relieve human of his/her anxiety and tension. AI has ventured into myriad spheres of human capabilities like Philosophy, Mathematics, Economics, Neuroscience, Psychology, etc. Unlike natural intelligence, AI executes merely on human input. Humanitarian approach or the affective domain is void in AI. The unique features of AI have credibility to be judgemental without bias. On the contrary, the functionality of human brain is, in itself under the scanner. Can the alarming banquet of AI, propound threat to human dominion? Can AI outmanoeuvre Natural Intelligence (NI)? This article encapsulates: the history of AI, its foundations, philosophical dimensions, design principles, ethical concerns, applications in diverse manner and ends up with AI's contribution amidst the pandemic Covid-19.

Keywords: Algorithms; Artificial Intelligence; Covid-19; Deep Learning; Machine Learning; Neural Networks; Reinforcement Learning; Strong AI; Supervised Learning; Unsupervised Learning; Weak AI

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Introduction

The paramount gift a man acquired from the Creator, is a highly developed brain capable of abstract reasoning, language, introspection and problem solving which led to freedom of thinking. It also opened the doors for new ideas and inventions. The 'newness' thus originating has a substantial 'reasoning' behind it and what makes a human being as he is, is this key feature. Each and every aspect of life has this rationale which is the key to any deed. This makes a human more philosophical about universe. Over the centuries the progressive reasoning capacity in human beings has been expansive and incredible. It has created a realm for scientific experiments moving to its application in various fields. Resulting in the usage of machines and other equipment, which made human's job easier. The catalyst behind this is human intelligence which is an acquired human ability to cognise or contribute to an individual's thinking process. Reasoning with intelligence has been a great contributor to the scientific development and evolution of this era. A step further, we stand at the threshold of developing the replica of this natural intelligence called Artificial Intelligence, which is one among the most researched areas of the time.

During the past decades, the most searched for terminology in Google would be AI. Educational systems have integrated this term into their curriculum. The machines available are incorporated with AI constituents. AI has become integral in one's life. The reason behind this intertwining of AI with human activities is nothing but its effectiveness.[1] Entire universe is connected with a medium of communication in several ways so that the artificial intelligence plays a foremost role in it. AI has become today's world with several abetted systems and it seems to act like natural intelligence.

1. Historical Background of AI

AI in its identity came into the picture in the year 1956 and the credit of the use of the term AI first goes to John McCarthy who organized a workshop on it at the Dartmouth Summer Research Project.[2] What was intended in the workshop was to show how a machine could be developed in the same manner as human beings

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[1]S. Lemaignan, Mathieu Warnier, E. Akin Sisbot, Aurélie Clodic and Rachid Alam, "Artificial Cognition for Social Human–Robot Interaction: An Implementation," *Artificial Intelligence* 247 (2017) 45-69.

[2]John McCarthy, Marvin L. Minsky, Nathaniel Rochester and Claude E. Shannon, "A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence, August 31, 1955," *AI Magazine* 27, 4 (2006) 12.

think and act. Technically, converting natural intelligence to artificial intelligence by the means in which machine could act as human beings. The roots of AI can be seen from world of ideas by Plato,[3] reasoning by Aristotle,[4] concept of probability by Thomas Bayes,[5] logical reasoning in systematic manner by George Boole,[6] electronic computers,[7] experimental sciences,[8] statistics,[9] robots,[10] etc. which all contributed to the formulation and development of AI as it is now in the 21st Century. Above all the major contribution is from Alan Turing known as the father of theoretical computer science and artificial intelligence who proposed formal model of computing in his classic essay "Computing Machinery and Intelligence."[11] Alan Turing investigated the possibility of machines acting like humans in which machines learn from the environment in an intelligent way so that after each experience it is acquiring a better knowledge for the next action.

2. Foundations of AI

2.1. Philosophy

AI foundations points to reasoning where the human mind has a major role. Aristotle formulated laws for proper reasoning in which conclusions are generated from the given premises.[12] It converges to

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[3] Asher Seidel, "Plato, Wittgenstein and Artificial Intelligence," *Metaphilosophy* 22, 4 (1991) 292–306, www.jstor.org/stable/24436846.

[4] Selmer Bringsjord and Konstantine Arkoudas, "The Philosophical Foundations of Artificial Intelligence," *Rensselaer Polytechnic Institute (RPI) Troy NY 12180 USA,* 2007, http://kryten.mm.rpi.edu/sb_ka_fai_aihand.pdf. (accessed on 30 April 2020).

[5] Glenn Shafer, "Probability Judgement in Artificial Intelligence," *Machine Intelligence and Pattern Recognition* 4 (1986) 127-135, https://doi.org/10.1016/B978-0-444-70058-2.50014-0.

[6] Luis de Ledesma et al., "A Computational Approach to George Boole's Discovery of Mathematical Logic," *Artificial Intelligence* 91, 2 (1997) 281-307. https://doi.org/10.1016/S0004-3702(97)00017-9.

[7] Maad M. Mijwel, "History of Artificial Intelligence," 3 (2015) 1-8, https://www.researchgate.net/publication/322234922_History_of_Artificial_Intelligence

[8] Bruce G. Buchana, "Artificial Intelligence as an Experimental Science," in James H. Fetzer, ed., *Aspects of Artificial Intelligence. Studies in Cognitive Systems*, Vol 1. Springer, Dordrecht, 1998, 209-250.

[9] Bin Yu and Karl Kumbier, "Artificial Intelligence and Statistics," *Frontiers of Information Technology & Electronic Engineering* 19 (2018) 6-9.

[10] Andrea L. Guzman and Seth C. Lewis, "Artificial intelligence and communication: A Human–Machine Communication," *New Media & Society* (2019) 1–17. See https://doi.org/10.1177/1461444819858691

[11] Alan M. Turing, "Computing Machinery and Intelligence," in Robert Epstein, Gary Roberts, Grace Beber, ed., *Parsing the Turing Test*, Springer, Dordrecht, 2009, 23-65.

[12] Bringsjord et al. "The Philosophical Foundations of Artificial Intelligence," http://kryten.mm.rpi.edu/sb_ka_fai_aihand.pdf. (accessed on 30 April 2020).

mind, and reasoning makes its impact as a consequence. Moving further, rationalism, dualism, materialism, empiricism, induction, logical positivism, confirmation theory, etc. contributes much for the development of AI theories.[13] Vital point is the relation between knowledge and action based on reasoning because intelligence requires both.

2.2. Mathematics

AI in most of the areas follow formal science in which mathematical fundamentals such as computations, logic and statistics are being used in wide range of analysis purpose. The working principle of AI known as 'algorithms'[14] is being developed out of mathematical calculations so that the computations as well as traceability of any problem generated is accounted for best solutions. In some instances, problem solving may be a process of incompleteness or lack of precision, then probability calculations are carried out on a chance of occurring an event or not. The combination of the mathematical fundamentals lays a ground and initiation for working principle—algorithms—which is to be fine-tuned at each stage to club in more precise AI results.

2.3. Economics

The foundation of Science of Economics traces back to 1776 by Scottish Philosopher Adam Smith in "An Inquiry into the Nature and Causes of the Wealth of Nations."[15] Scottish created a new platform and proposed that Economics is an analysis of making different choices with its various outcomes rather than mere money matters. This foundation leads to developing core of economics such as decision theory,[16] game theory,[17] operations research,[18] satisficing,[19]

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[13] David Vernon and Dermot Furlong, "Philosophical Foundations of AI," in Max Lungarella, Fumiya Iida, Josh Bongard, Rolf Pfeifer, ed., *50 Years of Artificial Intelligence: Essays Dedicated to the 50th Anniversary of Artificial Intelligence,* Springer-Verlag Berlin Heidelberg, 2007, 53-62.

[14] Algorithms are finite list of computer implemented instructions based on mathematical calculations to perform computation. Gurevich Y et.al, "What Is an Algorithm?" SOFSEM 2012: Theory and Practice of Computer Science, Lecture Notes in Computer Science, vol 7147. *Springer*, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-27660-6_3.

[15] Adam Smith, *An Enquiry into the Nature and Causes of the Wealth of Nations*, edited with an Introduction, Notes, Marginal Summary and an Enlarged Index by Edwin Cannan, Vol. 1, London: Methuen, 1904.

[16] Decision theory is an interdisciplinary approach, originated from economics which provides a formal structure to make rational choices in the situation of uncertainty. Himani Sharma and Sunil Kumar, "A Survey on Decision Tree Algorithms of Classification in Data Mining," *International Journal of Science and Research (IJSR)* 5 (2016) 2094-97.

etc. which is used for different applications amalgamated with different disciplines of science. Both the combinations have a valued input to AI decision building process.

2.4. Neuroscience

Neuroscience is a branch of science which encapsulates study of nervous system, particularly neurons and precisely brain. What makes AI so powerful depends upon the simulation of natural intelligence. Research studies and papers are progressing on how to interweave human involuntary stimulus like the working of a brain with neurons, the communication process like signals to and forth and timely actions in different situations, etc. to the innovative research area of AI in order to replicate the functioning of human brain with its responses. Neural networks[20] are the most specialized field of study in this area which could be developed with machine learning (ML)[21] and deep learning (DL)[22] as an integral part of AI.

2.5. Psychology

Before the word 'psychology' came into existence there had been a wide range of thinking on how humans and animals think and act.

[17] Game theory is the mathematical modelling of strategic interaction among rational decision makers. Bhuiyan and Bellal Ahmed, "An Overview of Game Theory and some Applications," *Philosophy and Progress* 59, 1-2 (2016) 111-128.

[18] Operations research is a branch of mathematics that deals with analytical process with an objective of optimization—to do best under the given circumstances. See Frederick S. Hillier, *Introduction to Operations research,* New Delhi: Tata McGraw-Hill Education, 2012.

[19] Satisficing is a decision making approach in view of fulfilling most acceptable one from possible solutions. Michael A Goodrich et al., "Satisficing Revisited," *Minds and Machines* 10 (2000) 79-109, https://doi.org/10.1023/A:1008325423033

[20] A Neural network is a series of algorithms called network of neurons or circuits designed like human brain to recognize patterns in dataset. In modern science it is known as artificial neural network. Alejandro B. et al., "Explainable Artificial Intelligence (XAI): Concepts, Taxonomies, Opportunities and Challenges toward Responsible AI," Information Fusion 58 (2019) 82-115, https://doi.org/10.1016/j.inffus.2019.12.012.

[21] Machine learning is an application of artificial intelligence that focuses on enabling computers to automatically learn and improve performance from experience without being programmed explicitly. Rene Y. Choi et al., "Introduction to Machine Learning, Neural Networks, and Deep Learning," *Translational Vision Science and Technology* 9, 2 (2020) 14, https://tvst.arvojournals.org/article.aspx?articleid=2762344.

[22] Deep learning is a machine learning technique that creates artificial neural network to imitate the structure and function of human brain in processing patterns for decision making. Jürgen Schmidhuber, "Deep Learning in Neural Networks: An Overview," *Neural Networks* 61 (January 2015) 85-117, https://doi.org/10.1016/j.neunet.2014.09.003.

After the emergence of psychology, there has been an intensified study with behavioural sciences in a wide range. Subjective nature of human being is analysed and studied in such a way that the behavioural pattern is concerned with thought incitements. This leads to tapered field of study called as cognitive psychology, a study of how people perceive, learn, remember and think about information.[23] Major contribution to this field by Kenneth Craik[24] who argues that there are three vital steps involved here such as:

• Stimulus to be translated into internal representation

• Cognitive process works on this representation to derive new internal representations.

• These representations are fed and put into action.[25]

These three major fundamental aspects lead to most innovative input for AI known as cognitive science[26] in such a way that the interconnection of intelligence and behaviour is studied for building AI principles and methods for better communication of humans which comes under the blanket of engineering psychology.

2.6. Computer Engineering

With the invention of computers, a tremendous development could be observed in areas of speed, capacity, performance, myriad software, etc. All these are the results of human brain so that later AI stimulated supportive systems are encouraged and developed especially in software for faster performance and better precision.

2.7. Cybernetics

As far as AI is concerned, acting intelligently is directly proportional to the stored information. When new information appears, it is again stored; given certain training and testing, then it tries to behave intelligently. On the contrary, human

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[23] Robert J. Sternberg and Karin Sternberg, *Cognitive Psychology*, Wadsworth, Cengage Learning, 2012, 3.

[24] Kenneth James William Craik was a Scottish philosopher and psychologist who contributed a lot to environmental psychology and personality psychology leading to an earlier practitioner of cognitive science.

[25] Daniel George Williams, "The Mind as a Predictive Modelling Engine: Generative Models, Structural Similarity, and Mental Representation," Dissertation, Trinity Hall College University of Cambridge, 2018. https://pdfs.semanticscholar.org/7eee/71b35fea8613f7ebad38fdafbb84d039c078.pdf (accessed on 04 May 2020).

[26] Huimin Lu and Yujie Li, "Editorial: Cognitive Science and Artificial Intelligence for Human Cognition and Communication," *Mobile Networks and Applications* 25 (2020) 995–996.

interactions are spontaneous with one's intelligence as far as one can. It is natural intelligence that works on human brain. To enable even AI to respond as natural intelligence instantly to situations, a new theory called cybernetics is materialized. Cybernetics focuses on taking actions to achieve a goal based on the feedback from the environment. Precisely, it is a combination of biological, mechanical, social and economic aspects which all try to behave like humans through responses as well as interaction. Though it is not developed yet, cybernetics is considered as a stepping stone.

2.8. Linguistics

Humans communicate verbally where language is the medium. There could be different languages in different areas, so they first study it and attune it to different circumstances. This could be same for AI intelligent systems where they need a medium for communication called programming languages developed on combination of 0's and 1's. But to behave like human they need an extra eye in order to understand human languages and the outcome, for it is computational linguistics. It is also known as natural language processing, a new field of research area where understanding of the sentence structure is not enough, but the accuracy of the outcome depends upon how far the context and subject matter is properly considered and applied.

3. What is AI?

As AI is considered one of the most imperative emerging fields of research and studies, the explanation and understanding of the same would also be enormous. The explanation of AI mainly centres upon its field of application. Certain core features are fundamental which contributes a vivid picture on what AI is. Basically, AI can be viewed from two angles or dimensions:

• human performance

• rationality

Each of these dimensions have four approaches:[27]

• Thinking Humanly

• Thinking Rationally

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[27]Stuart Russel and Peter Norvig, *Artificial Intelligence: A Modern Approach,* Pearson Education New Jersey, 2010, 2-5.

- Acting Humanly
- Acting Rationally

3.1. Thinking Humanly

How can a machine think like a human? It all needs a deep understanding of how a human mind works. Based on the foundational elements of psychology, three areas are to be ascertained. First, trying to figure out how thought pattern works, namely, introspection. Second, observing different actions of the person through various mechanisms, that is, by psychological experiments. Lastly, observing brain in action, a new field of study called brain imaging.[28] If all the three can be combined and properly put together theoretically, then it is possible to convert them into programming languages. If the input–output combinations of programming languages act like human behaviour, then it is considered a success. Actually, cognitive science is applied here in order to facilitate AI models with psychological experiments, to think like humans, as an outcome.

3.2. Thinking Rationally

In a thinking process, reason works precisely based on its inputs. There could be a structure to expedite this rational process. When correct premises are given, correct conclusions can be drawn from a scenario and it is called laws of thought.[29] What makes law of thought more substantial is the logic involved, which is able to direct the mind. The same logic is functional for creating intelligent AI computer aided systems. Even though this is the conceptual understanding it is a herculean task to convert human based informal knowledge into exact formal knowledge as inputs. At the same time, the validity of the knowledge is also a big factor for the human behaviour like outputs. Also, it is to be read that solving a problem theoretically and practically has a major difference.

3.3. Acting Humanly

The third approach encompasses how a computer can program to act like a human and it involves certain competencies. First of all,

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[28]Brain imaging or neuro imaging is a new discipline of study related to medicine, neuroscience and psychology which directly or indirectly image the structure and functionality of the brain.

[29] Laws of thought trace back to Aristotle, describes the fundamental principles by which thought can occur from correct inferences based on logic. See https://en.wikipedia.org/wiki/Law_of_thought (accessed on 23 April 2020).

communication through any medium of language especially in English. It would come under:

• Natural language processing (NLP).

• Knowledge representation

• Storage capacity of knowledge and its efficient retrieval depending on the scope. Automated reasoning comprising of answering certain questions and reaching to certain conclusions based on the information stored.

• The application of machine learning techniques to facilitate and deal with new circumstances by creating new models.

Along with these four competencies, robotics and computer vision are also value added to make an AI system more compact in nature. It is to be specifically mentioned that the base for this competency is nothing but 'Turing Test,'[30] proposed by Alan Turing.
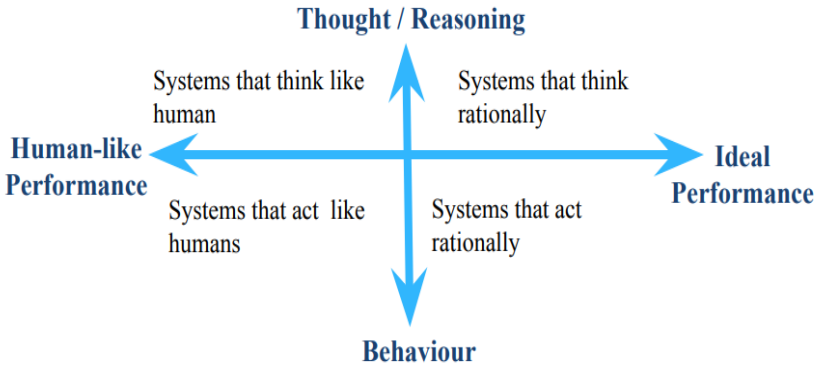
3.4. Acting Rationally

Continuing law of thoughts prevails acting rationally which means it acts to achieve certain goals based on proper inferences. This approach succeeds with two elements: an agent and a rational agent. An agent can be nominated when he observes something and delivers accordingly. When it embraces with AI approach, it turns to rational agent where the act is reasonably based on conclusions from the inferences and achieves the goals. At the same time when there is an uncertainty the best possible outcome will be generated. This approach is more general in nature and also more adaptable to scientific development.

Based on two dimensions of four approaches Artificial Intelligence is concerned with design of intelligence in an artificial device. Technically it is concerned with developing computer programs to solve complex problems by application processes that are analogous to human reasoning process. It is a branch of computer science that studies and develops intelligent machines and software. Therefore, AI can be defined as "activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately with foresight in its environment."[31]

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[30]French and Robert, "The Turing Test: The First 50 Years," *Trends in Cognitive Sciences* 4 (2000) 115-122, DOI: 10.1016/S1364-6613(00)01453-4.

[31] Nils J. Nilsson, *The Quest for Artificial Intelligence: A History of Ideas and Achievements*, Cambridge University Press, 2010, 13.

Thought / Reasoning

Systems that think like human

Systems that think rationally

Human-like Performance

Ideal Performance

Systems that act like humans

Systems that act rationally

Behaviour

4. Philosophical Dimensions of AI

Even before the emergence of AI there was a thought-provoking question from philosophers about how human mind works which is still the research area of AI. In other words, is it possible for machines to translate like humans? Answer to this very fundamental question can be countered by considering two concepts: 'Weak AI' and 'Strong AI'.

Weak AI deals with the creation of some Artificial Intelligence that cannot truly reason and solve problems but act as intelligent. It claims that machines which have been suitably programmed can stimulate human cognition. Whereas strong AI aims to build machines that can truly reason and solve problems. It is self-awareness and whose overall intellectual ability is indistinguishable from that of human being which deals with machines that really have mental states that think, reason, understand their behaviour.[32]

**Weak AI:** **Can Machines Act Intelligently?**

Strong AI: **Can Machines Really Think?**

4.1. Weak AI: Can Machine Act Intelligently?

Alan Turing is trying to ask the same question in different ways, namely, 'whether machines can pass a behavioural intelligence test' and he named it as Turing test. The standard interpretation of Turing

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[32]Mohammad Majid al-Rifaie and Mark Bishop, "Weak vs. Strong Computational Creativity," *Conference: AISB 2012: Computing and Philosophy* (2012), https://www.researchgate.net/publication/262223177_Weak_vs_Strong_Computati onal_Creativity

test is when the interrogator or player C is given the task to identify which player – A or B – is a computer and which is a human. The interrogator has limited resources to elicit the responses to written questions to make determination.[33] Most popular internet chatbots, Eliza programs, etc. are examples for this.
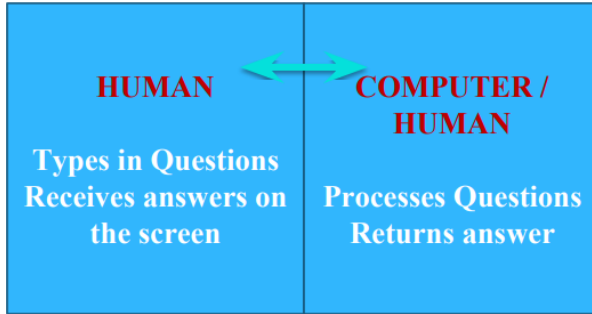
Answer to the first fundamental question can be perceived at various levels. From the view point of 'argument from disability,'[34] some of the characteristics of human can be replicated by machines and some cannot. Very interesting example can be seen from a recent Indian movie 'Yendhiran,'[35] in which the robot falls in love with the heroine. The same notion can also be seen in teddy bear.[36] Even though these inferences can be explained as fiction, no one can negate the possibility of it in future. Computers play chess and after each game it updates itself with better performance terming it as learning from experience. It involves judgement and pointers to segregate the right and wrong. Since 1999 Graduate Management Admission Test (GMAT) is examined by an Educational Testing Service using an automated program and the results are matching 97% with human graders.[37] In this era it is proven beyond doubt that computers assisted algorithms can perform like humans or even more in many applications. Still there are apprehensions on whether machines can act intelligently in contrast to the human gifted mental processes,

[33]https://www.geeksforgeeks.org/turing-test-artificial-intelligence/ (accessed on 10 May 2020).

[34]Russel and Norvig, *Artificial Intelligence: A Modern Approach,* 1021.

[35] https://www.amazon.com/Robot-Enthiran-Hindi-Rajnikanth/dp/B006O2NQRM (accessed on 22 July 2020).

[36] https://www.amazon.com/Teddy-Bear-English-Subtitled-Kold/dp/B00VZ1AJ8G (accessed on 22 July 2020).

[37]Jill Burstein, Claudia Leacock and Richard Swartz, "Automated Evaluation of Essays and Short Answers," Proceedings of the 5th CAA Conference, Loughborough: Loughborough University, 2001.

behavioural sense, and insights, etc. which are not imitated or incalculable by machines so far. For certain practical applications of open-ended conversation, the chatbots are not reliable.

Secondly, from a mathematical perspective, certain programmed calculations do not come up with an end because machines follow formal systems devised on general inputs. Timetable setting for different classes with different teachers may sound easy, but it is a herculean task monitored by human intelligence. No fully automated system is developed for setting timetable in any of the educational system. Famous Godel's incompleteness theorem[38] is an example in which mathematical formal calculations have failed. At the same time it is to be admitted that many mathematical calculations done by formal computer systems perform better than human intelligence, still combination of math-psycho human intelligence features are not at all fully determined by machines.

Third argument from 'Informality of behaviour' states that human behaviour is complex, and no rules or computers can fully capture it. No machine can generate behaviour as intelligent as humans.[39] In a deterministic world computer generated rules and calculations work better than human intelligence. But while dealing with non-deterministic features of the world no machine can succeed as human behaviour does. To understand how human agent functions, it is obligatory to understand the whole human agent and its related situations too. It is the theory of embodied cognition[40] which claims that brain with its environment only makes sense. Study on this system as whole is called as embodied cognition program[41] which considers robotics, vision and other sensors in its fullness and makes a progress to develop intelligent systems on par with human behaviour.

4.2. Strong AI: Can Machines Really Think?

Fundamentally this question aims at whether AI can equate to humans? In other words, whether a machine can write a poem or a story because of thoughts and emotions felt? Turing tries to analyse

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[38] Lev D. Beklemishev, "G¨odel Incompleteness Theorems and the Limits of their Applicability. I," *Russian Mathematical Surveys* 65, 5 (2011) 857-899.

[39] https://plato.stanford.edu/entries/turing-test/ (accessed on 12 June 2020).

[40] Lucia Foglia & Robert Wilson, "Embodied Cognition," *Wiley Interdisciplinary Reviews: Cognitive Science* 4 (2013), DOI: 10.1002/wcs.1226

[41] Tom Ziemke, "Embodied AI as Science: Models of Embodied Cognition, Embodied Models of Cognition, or Both?," in Fumiya Iida, Rolf Pfeifer, Luc Steels and Yasuo Kuniyoshi, ed., *Embodied Artificial Intelligence,* Lecture Notes in Computer Science, Vol. 3139 (2003), Springer, Berlin, Heidelberg.

from the philosophical background of consciousness that machine has to be aware of its mental state and actions. Professor Geoffrey Jefferson [42] points this to phenomenology [43] that machine has to actually feel emotions. Another perspective on intentionality [44] is whether machines deliberately stick to certain beliefs in the real world. Considering these two facts of phenomenology and intentionality the question is how a machine can be transformed as a human mind. Understanding of this consideration can be complimented by philosophical efforts of mind-body problem.[45] It is a question of how mind can control the body if they are in separate realms.

Coming to the field of AI, mind-body problem does not exist as modern physicists consider that mind and body are not separate entities and reiterates that mental states are physical states. It is coined as monist theory of mind in terms of physicalism. [46] This deliberation is the steppingstone towards strong AI in which determination of physical states can concurrently be mental states. It is all about human consciousness and research on how an AI machine can be developed on par with human consciousness.

5. AI Design Principles

The fundamental thought to be ascertained while considering the basic design models of AI is that its position is much beyond any other digital technology. It is not mere a machine which automates operations. For example, the use of calculator in mathematical calculations cannot be considered an AI machine. It only expedites

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[42]Geoffrey Jefferson was a physician, neurosurgery specialist and a philosopher who contributed a lot to the understanding of human mind and his work titled *The Mind of a Mechanical Man* is one of greatest insightful works to AI. https://archiveshub.jisc.ac.uk/search/archives/779be590-c832-3374-9c74-827a6e082ddc (accessed on 22 June 2020).

[43]Phenomenology is the study of things as they appear in one's experience. See https://plato.stanford.edu/entries/phenomenology/#:~:text=Phenomenology%20is%20the%20study%20of,of%20or%20about%20some%20object (accessed on 24 June 2020).

[44]Intentionality means the quality of mental states (e.g. thoughts, beliefs, desires, hopes) which consists in their being directed towards some object or state of affairs. Joel Krueger , "Intentionality," Joel Krueger , "Intentionality," *The Oxford Handbook of Phenomenological Psychopathology*, 2018, DOI: 10.1093/oxfordhb/9780198803157.013.37

[45]Gunne Grankvist, "The Relationship between Mind-Body Dualism and Personal Values," *International Journal of Psychological Studies* 8, 2 (2016) 126-132, DOI: 10.5539/ijps.v8n2p126

[46] Daniel Stoljar, "Two Conceptions of the Physical," *Philosophy and Phenomenological Research* 62, 2 (2002) 253-281, https://doi.org/10.2307/2653699

calculations than human brain. AI is more concerned with actions or behavioural traits of humans in the environment. As a result, AI design goes through rigorous steps technically and it needs a lot of inputs, preparation, training, testing, improvements and validations.
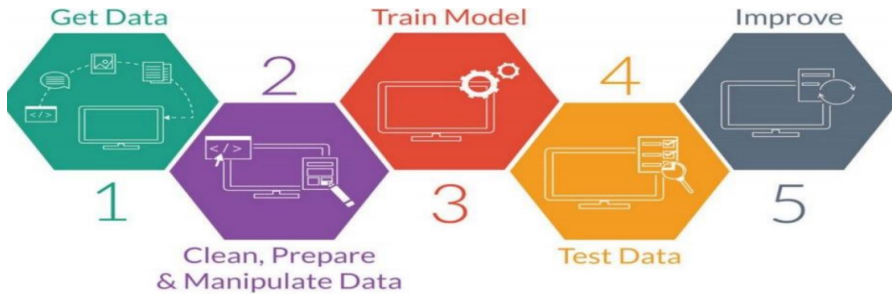
At the outset, developing an AI design is mainly structured on its application and demand. According to each circumstance the models have to be restructured and formulated. Fundamentally all AI systems follow certain standards starting with collecting, cleaning and normalizing data; applying rules, theories, programs and algorithms that perform intelligent tasks; and incorporate machine learning capabilities for the goal to be achieved.[47]

In the working principle, collection of data includes any information related to that particular application and arranged it in a systematic order. Sometimes while gathering data some unwanted contents like noise data has to be removed or cleaned for further processing. The main advantage of cleaning noise data is to accentuate the improvisation of accuracy of the results. At the same time the data contents may not be in a standard format, which has to be done with the process of normalizing. These three steps of collecting, cleaning and normalizing are called pre-processing techniques.[48] Most popular AI algorithms are linear regression,[49]

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[47]Ulrich Paschen et al., "Artificial Intelligence: Building Blocks and an Innovation Typology," *Business Horizons* 63, 2 (2020) 147-155. https://doi.org/10.1016/j.bushor.2019.10.004

[48] A. Sivakumar and R. Gunasundari, "A Survey on Data Preprocessing Techniques for Bioinformatics and Web Usage Mining," *International Journal of Pure and Applied Mathematics* 117, 20 (2017) 785-794, https://acadpubl.eu/jsi/2017-117-20-22/articles/20/68.pdf

[49]Shen Rong and Zhang Bao-wen, "The Research of Regression Model in Machine Learning Field," *MATEC Web of Conferences* 176, 3:01033 (2018), DOI: 10.1051/matecconf/201817601033.

classification, [50] clustering, [51] neural networks, etc. The use of algorithms mainly depends upon what the outcome is. To conclude, machine learning capabilities are being incorporated with these algorithms to reach out to the goal. Machine learning foundation on statistical tools are monitored with three approaches named as supervised learning, unsupervised learning and reinforcement learning.

5.1. Supervised Learning

In supervised learning[52] the outcome is known and tries to map the input to an output. It is a process of training or teaching the machine using the data collected and labelled with predicted output. The machine is given new data called test data which tries to match with trained data and provides the correct output. For example, a machine is trained with data of three colours such as red, green and yellow. After training, the machine is given with a new set of colours as input and easily identifies it accurately. Since the machine is trained with a set of previous data it is quite easy for the machine to identify and separate. Supervised learning is mainly working on two principles known as classification and regression. The example mentioned above comes under classification where the output is categorized. Regression is working with typical mathematical and statistical equations where the output is predicted based on relationship between past variables which can be either dependent or independent. For example, agricultural scientists would be using different amount of fertilizers and water on different fields to see how it affects crop yield.

5.2. Unsupervised Learning

Entirely different from supervised learning, unsupervised learning [53] focuses on finding what is new in data with certain assumptions and preconceptions. Here it is not labelling of the data that is happening but regrouping and integration of the similar

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[50] S. Kotsiantis et al., "Machine Learning: A Review of Classification and Combining Techniques," *Artificial Intelligence Review* (2006), DOI: 10.1007/s10462-007-9052-3.

[51] Z. Jianfeng and G. Huawei, "A Survey of Models and Applications of Clustering Algorithms in Artificial Intelligence Scenarios," *Academic Journal of Manufacturing Engineering* 16, 4 (2018) 7-12.

[52] Vladimir Nasteski, "An Overview of the Supervised Machine Learning Methods," *HORIZONS*.B. 4. (2017) 51-62. DOI: 10.20544/HORIZONS.B.04.1.17.P05.

[53] Memoona Khanam and Tahira Mahboob, "A Survey on Unsupervised Machine Learning Algorithms for Automation, Classification and Maintenance," *International Journal of Computer Applications* 119, 13 (2015) 34-39, DOI: 10.5120/21131-4058.

knowledge base which is not obvious for the observer. Machines are not insinuated to group on similarities and differences. For example, The input is 'a group of animals,' and based on the similarities the animals are segregated into dogs, tigers, elephants, etc. Unsupervised learning is categorised into two as clustering and association. Clustering is an intrinsic grouping among unlabelled data. It means dividing the data into number of groups in such a way that data in one group is more similar than data in another group. Technically speaking association is a rule-based approach,[54] which means that certain mathematical rules are applied to find out the relation between data. Best example for rule-based learning is defence against cyber-attack in such a way that the antivirus which is installed in our system is created on certain rules which detect the malware. In AI perspective this rule-based approach is not much beneficial as it is static in nature, whereas AI is dynamic.

5.3. Reinforcement Learning

Reinforcement learning[55] is an ontological approach[56] for learning machine. Reinforcement means "occurrence of an event in the proper relation to response that tends to increase the probability, in view that the response will ensue again in the same situation."[57] It is typically closed to human learning and the algorithms applied in a machine tries to learn and act according to the feedback. Then the action is rewarded which will direct algorithms to learn from the environment. Reinforcement learning constitutes three elements such as agents which are intelligent programs in a machine, environment which is an external condition and policies which defines agent's behaviour each time, mapping of states to actions and simple functions.[58] Reinforcement learning starts with an agent observing an input state. Then the action is determined by a policy of decision making and it will be rewarded either positively or negatively based upon its performance. The rewarded information of an action is

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[54]For rule based approach see https://www.tricentis.com/artificial-intelligence-software-testing/ai-approaches-rule-based-testing-vs-learning/ (accessed on 14 June 2020).

[55]Ahmad Hammoudeh, "A Concise Introduction to Reinforcement Learning," (2018). DOI: 10.13140/RG.2.2.31027.53285.

[56]An ontological approach looks at the things the data is about and uses them as the basis for the structure of the data.

[57] https://www.slideshare.net/cprakash2011/reinforcement-learning-40052403 (accessed on 17 June 2020).

[58] https://www.guru99.com/reinforcement-learning-tutorial.html#:~:text=The%20example%20of%20reinforcement%20learning,are%201)%20Positive%202)%20Negative (accessed on 17 June 2020).

recorded and used for next level. Most practical example for the use of reinforcement learning is that of designing a traffic light controller to solve congestion problem.[59]

6. AI Applications

Many apps which have become essential part of daily life are being made up of AI integrated systems. That is, AI is gradually becoming an inseparable part of human society.

6.1. Commuting

Very common AI supported google maps are very obliging in finding the traffic congestion, route and also the time and kilometres to reach the destination. Vast amount of data connected with machine learning algorithms in cloud helps to find the locations in and around the world. Within 15 years of launching, Google Map has mapped more than 220 countries with 200 million places and business.[60]

AI with the assistance of ML is also being used in Uber and Lyft apps in order to find the tariff, waiting time, pick up locations, meal delivering time on Uber Eats, etc. One of the other greatest achievements of AI is in fully automated aircraft in normal conditions with the software named Learn-to-Fly, developed by NASA. [61] AI assisted self-driving cars are now available, though realization of fully autonomous vehicles is yet to be confirmed.

6.2. Email

Filtering spam, a security measure of email system is assisted by AI. Google learns from one circumstance, so it improvises categorizing the wanted and unwanted emails. Recently updated version of email categorising into primary, social, promotion, important, etc. are assisted by AI which analyses user's preference.[62]

Even though google has introduced smart reply option to inbox, still it is in research to provide complex responses and google is trying to develop this with new instant messaging app 'Allo,'[63] but as updated, its end came recently.

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[59] For more on example see Itamar Arel, Chuanchang Liu, Tom Urbanik and Airton G. Kohls, "Reinforcement Learning-Based Multi-Agent System for Network Traffic Signal Control," *Iet Intelligent Transport Systems* 4, 2 (2010) 2-8.

[60] https://www.zdnet.com/article/how-ai-has-helped-improve-google-maps/ (accessed on 01 July 2020).

[61] https://aerospaceamerica.aiaa.org/features/a-i-in-the-cockpit/ (accessed on 01 July 2020).

[62] https://static.googleusercontent.com/media/research.google.com/en//pubs/archive/36955.pdf (accessed on 01 July 2020).

[63] For Allo app see https://allo.google.com/ (accessed on 02 July 2020).

6.3. Education

Contribution of AI to educational sector is very impressive especially in research field. The most used plagiarism checking software 'Turnitin' is assisted with ML supported AI algorithms. In earlier stages it was finding the similarity between texts of same language but now AI assisted tools is able to find out plagiarism of documents among different languages, apart from the sources not stored in databases, sources which are not digitalized by looking into styles it wrote, way of structuring the sentences, etc. Automated essay grading systems like robo-graders[64] are helping students as proof-reader than a grader by providing feedback in their writing. Robo-graders software like e-Rater[65] is under scrutiny as it lacks the option/ability to analyse the meaning of the text exactly.

6.4. Banking Sector

Apart from the usual practice of commuting to bank and submitting the cheque leaf for depositing, now most of the banks are allowing this feature labelled as mobile deposit[66] through AI and ML based apps like Mitek.[67] Fraudulent transactions can also be traced with the help of AI and the company Fair Isaac Corporation (FICO)[68] is working on it. The company offers software services for major banks to take quick decisions on sanctioning credit card as well as loans and analysing the risk factors in it. It is the aim in future to give personal advice for depositors on various schemes of investment with AI enabled support system.

6.5. Social Media

While uploading photos in Facebook it automatically recognizes faces and gives suggestions to tag friends. This is a contribution of AI with ML algorithms called as Facial recognition[69] software. Facebook also uses AI technique such as newsfeed[70] to connect people relevant

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[64]Lorna Collier, "Robo-Grading of Student Writing is Fueled by New Study—But Earns "F" from Experts," *The Council Chronicle* 22, 1 (2012) 1-9.

[65]For e-Rater see https://www.ets.org/erater/about (accessed on 04 July 2020).

[66] For mobile deposit see https://www.simple.com/blog/how-does-mobile-deposit-work#:~:text=Mobile%20deposit%E2%80%94or%20Photo%20Check,a%20 few%20images%20of%20it.&text=It%20takes%20just%20a%20few,or%20ride%20to% 20a%20bank! (accessed on 04 July 2020).

[67]For Mitek see https://www.miteksystems.com/ (accessed on 04 July 2020).

[68]For FICO see https://www.fico.com/ (accessed on 04 July 2020).

[69] Robert J. Baron, "Mechanisms of Human Facial Recognition," *International Journal of Man-Machine Studies* 15, 2 (1981) 137-178, https://doi.org/10.1016/S0020-7373 (81)80001-6

[70] For newsfeed see https://www.facebook.com/help/1155510281178725 (accessed on 06 July 2020).

to their interest with ads, videos, etc. while visiting the page. Facebook's text understanding engine known as Deep Text[71] tries to comprehend what a post means with its intent, sentiments, entities, etc. and categorize into various options and suggestions. Another application of AI known as 'Pinterest' is used to identify objects in images. Most popular Instagram and Snapchat have AI assisted platforms. In Instagram, AI is used for identifying contextual meaning of emoji and converting it into text. Snapchat[72] uses AI and ML supported Lenses help to augment reality[73] to add animated effects to human faces.

6.6. Online Shopping

Most credible contribution of AI is personalized shopping experience for the consumers. It is exciting while searching a product on online, a list of items of customer's interest is recommended for best solution. Customer centric search concept is behind this such that AI always monitors our likes and dislikes. If the customer spends long hours on a product, the next visit of the page recommends related products sponsored by AI supported search engine like Boomtrain.[74] It tries to think as humans do. Many e-commerce sites supported with Google are smart listeners and capture terms people speak and translate it to the search mode to cater to customer needs. For example, most popular online shopping site Amazon comes up with a lot of choices based on user's activity on sites and past purchases. Netflix offers movie recommendations based on individual choices. With the support of Augmented Reality people can try items like furniture by placing it virtually over the room before purchasing so that AI can suggest more options for the best. It is unimaginable for an individual to analyse or comprehend the tremendous contribution and efficient working of AI in online shopping.

6.7. Personal Assistants

Application of AI in its full smartness is used in the field of personal assistants such as Alexa, Cortana, Siri, Google Assistant,

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[71] For Deep Text see https://www.advertisemint.com/facebook-deep-text/ (accessed on 06 July 2020).

[72] For snapchat see https://lensstudio.snapchat.com/ (accessed on 06 July 2020).

[73] Julie Carmigniani et al., "Augmented Reality Technologies, Systems and Applications," *Multimed Tools*, *Springer*, 51 (2011) 341-377, DOI 10.1007/s11042-010-0660-6.

[74] For boomtrain see https://reviews.financesonline.com/p/boomtrain/ (accessed on 19 July 2020).

Tesla, Cogito, Boxever, Pandora, Nest, Spotify, etc.[75] One of the major contributions of these personal assistants is in the field of voice to text conversion. Voice commands like online shopping, play music, integrating home devices like switching off lights after a time, setting the reminders, etc. are done with ease. Personal Assistants also take queries, surf through the internet and find answers spontaneously. For example, "Alexa, What is the outside temperature?" Alexa: "36° Celsius, Summer."

6.8. Health Care

AI is being widely used in the health care domain by giving proper guidance and suggestions to the medical team. With the supportive ML algorithms, AI collects data from patients and clinically diagnoses faster than humans to prevent medical errors by offering support to arrive at decisions. AI also helps in using existing medication in the accurate way. Moreover, AI is now widely used in early cancer detection, symptom checking, diagnosing deadly blood diseases, radiology assistant, developing new medicines, biopharmaceutical development, treating rare diseases, cloud based digital drug discovery, clinical trials, real time patient flow optimization, personalized health care, faster hospital visits, risk prediction, virtual reality enabled robotics for surgery, revolutionizing endoscopy, pioneering robotic surgery, etc.[76]

6.9. Agriculture

Implementation of AI in agriculture with the help of agricultural robots is largely used for harvesting crops, soil monitoring, checking defective crops, improving the potential for healthy crop production, and predicting environmental impacts such as weather conditions in crop yielding. Foundational Satellite Machine Vision application[77] will be a boosting factor in coming years in the area of agriculture.

6.10. Robotics

The role of AI in robots is extensively significant because apart from general robots, AI assisted robots develops capacity to learn from the environment and experience without pre-programming. Humanoid robots such as Sophia and Erica have the capacity to talk

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[75]https://blog.adext.com/things-apps-artificial-intelligence/ (accessed on 06 July 2020).

[76]Guoguang Ronget et al., "Artificial Intelligence in Healthcare: Review and Prediction Case Studies," *Elsevier* 6, 3 (2020) 291-301, https://doi.org/10.1016/j.eng.2019.08.015.

[77] For SMV see https://emerj.com/ai-sector-overviews/ai-applications-for-satellite-imagery-and-data/ (accessed on 12 July 2020).

and behave like humans. Sophia [78] who became famous by interviewing world leaders and celebrities were given Saudi Arabian citizenship and has the capacity to express human gestures, facial expressions, conversations to certain extent, discussions on predefined topics and so on. Sophia uses AI integrated techniques of visual data processing,[79] facial recognition, complex and intelligent algorithms, and sensory systems to perform as humans. Indian made Miko by Emotix,[80] a companion robot, helps children in educational aspects, and Rashmi,[81] a Hindi speaking robot, is hosting show on Red FM.

Ten applications of AI are discussed here even though its area of utility is extremely vast like in manufacturing, automobile industry, privacy protection, AI modelled chips, AI powered Internet of Things (IOT) and Block chain, cyber security, media and entertainment, digital intelligence, sports and games, Chabot, astronomy, space exploration, cyborg technology, smart homes, retail, etc. With time it would be proven beyond doubt that the future generation will lead to mammoth second industrial revolution with AI new infrastructures impacting human lives and society with bunch of choices through diverse range of applications.

7. Impact of AI amidst the Pandemic COVID-19

The whole world is now immersed in developing vaccine against SARS-COV-2, one of the highest pandemic humankind has ever seen. A lot of research is happening in various fields of study for the same and the AI inputs are relevant in this scenario which includes:

• Early detection and diagnosis of the infection by using Computed Tomography (CT) and Magnetic resonance imaging (MRI) scan

• Automatic monitoring and prediction of the spread of the virus using neural network algorithm which extracts visual features of the disease

• Analysing the level of infection

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[78] For Sophia see https://www.hansonrobotics.com/sophia/ (accessed on 23 March 2020).

[79] Juhee Bae, Göran Falkman, Tove Helldin and Maria Riveiro, "Visual Data Analysis," in Alan Said, Vicenc Torra, ed., *Data Science in Practice. Studies in Big Data*, Springer, Cham, 2019, 46.

[80] For Miko see https://yourstory.com/2019/11/childrens-day-iit-mumbai-startup-emotix-miko (accessed on 20 July 2020).

[81] For Rashmi see https://www.newsbytesapp.com/timeline/india/28717/128726/india-to-get-its-own-social-humanoid-robot (accessed on 22 July 2020).

• Identifying the clusters and hot spots for contact tracing

• Predicting future occurrence of the disease

• Forecasting and tracking the nature of the virus and risk from available sources

• Drug research, drug delivery design and development, accelerating drug testing in real time with available dataset on COVID-19

• Analysing the condition of COVID-19 affected patient

Some of the resultant outcomes seen these days include that by scientists of Flinders University who created an AI program called synthetic chemist which generates trillions of synthetic compounds. Another AI program called Search Algorithm for Ligands (SAM) examines these compounds and determines good candidate for vaccine adjuvants.[82] Yet another contribution by a Canadian start-up and AWS customer 'BlueDot' claims to be one of the first that used AI to detect disease outbreaks in Wuhan China and anticipate the dispersion of the disease.[83]

'Closedloop,' an AI start-up developed a predictive model—COVID vulnerability index—used by several health care systems, insurance companies, care management organizations, etc. to identify high risk individuals.[84] Another contribution by UC Scan Diego Health uses AI supported machine learning algorithms connected to X-rays with colour coded maps that indicates pneumonia probability, a condition associated with COVID-19.[85] UK AI company and AWS partner 'Benevolent AI' produces ML algorithms which finds relationship between genes, diseases and drugs contributing in developing vaccine.[86] NYU college of Dentistry developed a mobile app that uses AI to assess the risk factors and identify biomarkers from blood tests to direct the clinicians to diagnose which COVID-19 patients are at high risk.[87]

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[82] Abhimanyu S. Ahuja, Vineet Pasam Reddy and Oge Marques, "Editorial: Artificial Intelligence and COVID-19: A Multidisciplinary Approach," *Integrative Medicine Research* 9, 3 (2020) 1-3. (accessed on 02 August 2020).

[83] https://www.weforum.org/agenda/2020/05/how-ai-and-machine-learning-are-helping-to-fight-covid-19/ (accessed on 02 August 2020).

[84] https://www.weforum.org/agenda/2020/05/how-ai-and-machine-learning-are-helping-to-fight-covid-19/

[85] https://www.weforum.org/agenda/2020/05/how-ai-and-machine-learning-are-helping-to-fight-covid-19/

[86] https://www.weforum.org/agenda/2020/05/how-ai-and-machine-learning-are-helping-to-fight-covid-19/

[87] https://www.healtheuropa.eu/using-artificial-intelligence-to-determine-covid-19-severity/100501/ (accessed on 02 August 2020).

There are numerous research studies taking place related to COVID-19 and as of now more than 28000 articles are available.[88] But it would be a herculean task for the researchers to find out the relevant information from these, so that AI supported systems like 'Goldbloom'[89] helps to find it out. Some research tools related to COVID-19 like COVIDScholar, SPIKE_CORD, SciSight, KnetMiner for COVID-19, COVID-19 Primer, Vilokana, CovidAsk, etc. are facilitating researchers to get data and information from all over the world.[90]

8. Ethical Concerns about AI

AI can segregate what is good and what is bad, but it does not have the capacity to discern whether it is good or bad for humankind. Many ethical concerns have been raised about AI, and we shall mention below a few of them:

• As AI can replace human in many scenarios it may affect the unique identity of human thinking process.

• Use of AI systems to any extent without looking into common good—especially in military operations.

• AI robots can isolate human from a social being.

• Many of the AI applications question the privacy, surveillance and freedom of human being.

• Use of information to manipulate behaviour and target any group.

• Automation and wealth inequality.

• Autonomy of higher end AI systems which may result in less control of humans.

• Singularity of surpassing human intelligence—Superintelligence.

• AI bias because of flawed data stored.

• Impact on environment such as use of natural resources, pollution, waste, energy concerns, etc.

Conclusion

AI definitional has already a role to play and its incredible expanse of growth is a greatest sign. Glimpses of it have been seen from early age and the unexceptional interventions in various sectors of the

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[88]https://github.com/jperkel/covidlit (accessed on 02 August 2020).

[89] https://ajn.timesofisrael.com/a-start-up-trying-to-slow-down-covid-19/ (accessed on 02 August 2020).

[90]https://www.nature.com/articles/d41586-020-01733-7 (accessed on 02 August 2020).

society is evident now. As a result, most of the life zones of human being are assisted with AI tools in their daily needs which tries to automate intelligence. Now the question is the inclusion of AI machines in the lives of people. Whether it surpasses human intelligence or assists human beings? In some areas it will definitely overcome human intelligence especially in speed, accuracy, precision, memory, etc. At the same time, it would not be an easy task to exercise the affective domain of human behaviour such as common sense, feelings, etc. However, we cannot brush away the possibility of AI machines to achieve such behavioural perspectives in future. The only concern for human beings in this context would be their subordination or mastery of AI over humanity.

God entrusted the human to take care of the universe along with other living beings in which the human has been gifted with the freedom to act and think. If God-given freedom is manipulated by human-made machines, the beauty and bliss of the entire universe is an act of conceding against the law of nature. Therefore, human created machines are virtuous if they nourish the wellbeing of the society. AI assisted machines continue to serve humanity and no one can neglect its immense contribution to the society. AI befriends humankind to work, engages in exploring and developing new innovative ideas, it assists the human to transit from Timbuktu. AI may well be a revolution in the world of tomorrow and become the numero uno innovation to help humans in history.