

Artificial intelligence: The Technology, Challenges and Applications

¹ Tulshi Bezboruah, ² Abhijit Bora

^{1,2}*Department of Electronics & Communication Technology, Gauhati University, India*
zbt_gu@yahoo.co.in, abhijit.bora0099@gmail.com

ABSTRACT

Artificial intelligence sometimes called machine intelligence highlights the simulation of intelligence based on human and animal nature. They are programmed in such a way that they can think like living intelligence and behave as like they do. The definition fits for any machine that can behave and think like human being while solving and learning specific problem. The ability of taking specific action while solving problem and achieving the goal is the ideal principle of artificial intelligence. In this work we will provide a thorough technical review of the technology, challenges and its applications.

Keywords: Artificial Intelligence, Applications, Challenges, Technology, Machine learning

1 Introduction

The machines are increasing their capability gradually, as such, different tasks and activities that require “intelligence” are removed periodically from the Artificial intelligence (AI) definition. Instead, a phenomenon is introduced as AI effect [1]. In the theorem of Tesler’s, it was stated that AI is whatever that is not completed yet [2]. For instance, the technology such as optical character recognition has become routine technology and is excluded from things that are usually considered as AI [3][4]. Machines now-a-days have modern capabilities are considered to be AI. They hold capacity for operating cars autonomously, simulation of military services [7], speech recognition [5], interactive game systems [6] and routing intelligent through network.

In the year 1955, AI was considered to be an academic discipline. Gradually, it gained grounds for optimism [8][9]. However, loss of funding [10-12], new approaches for success rate, followed by renewed funding strategy was also taken in the year since. In the historical domain of AI, the research of AI is divided into sub categories; however, they often fail to establish theoretical communication among them [13][14]. The sub categories highlights the technical consideration comprising deployment tools, goals and deep philosophical key points based on social factors [15-17].

In the early 1980s, the research activities under AI domain were revived by expert system [18-24]. It is a AI based program that utilizes the analytical skills and knowledge of mankind. Gradually, by 1985, the AI market had reached a billion dollar milestone. During that time, the fifth generation of computer system project under Japan had inspired the restoration of funding [9]. As such, the importance of investing in AI research was given gradually in the government of British and U.S. However, in the year 1987, the fall

down of Lisp Machine market has impacted the research domain of AI [11]. As such, the importance of AI was held in low esteem by funding agencies.

The development of artificial neural network (ANN) was influenced by the development of complementary metal oxide semiconductor (CMOS) and very large scale integration (VLSI) technology [25].

AI research began to work in the late season of 1990s to 21st century in the domain of medical diagnosis, logistics, data mining and other relevant areas [26-30]. The importance of AI domain has received contribution from researchers through the deployment of increased computational power, collaboration of AIs and economics, statistics and mathematical models, solving methodology for specific problem and scientific standards [31-33]. Renowned chess player world champion Garry Kasparov was defeated by a computer program Deep Blue in the year 1997.

Typically, the AI analyzes the environmental set up and takes necessary action to increase the success rate of problem solving task. The goal and utility functions of AI can be simple for specific goal or complex during execution.

The AI can have goals that can be included explicitly or implicitly. If the goal is set for reinforcement learning, then it can be set implicitly by assigning rewarding points or punishing other factors. Similarly, the evolutionary system can be developed with goals and functions to achieve the goals and replicate AI system for a model based on task of animal searching food. On the contrary, AI system, such as nearest-neighbor does not have goals or one goes with reason and training data set [34][35]. In the research community, the development of benchmark for such non goal based system where the task is to reach the classification of problems, is gaining popularity [36].

AI is executed based on algorithms. An algorithm for AI system is the set of instruction that a machine follows. The complex algorithms are developed followed by simple algorithm for problem solving. An example of simple algorithm for playing by using player at tic-tac-toe discussed elsewhere at [37]. The various steps of the algorithm is as follows:

- (1) If some agent contains "treat" (that means, two in a row), capture the remaining square. On the other hand,
- (2) If an action contains "forks" for creating two treats at once, play the move. On the other hand,
- (3) If it is free, proceed to center square. On the other hand,
- (4) Take opposite corner if the opponent is in a corner. On the other hand,
- (5) If one exists, then hold a corner that is empty. In other cases, Proceed for empty square.

The AI based algorithms are capable of processing and learning from data. They can solve problems through learning new things or can develop algorithm by themselves. Some deployment methodology through decision tree, Bayesian networks and nearest-neighbor can learn theoretically to approximate mathematical functions that would best elaborate the problem solving process. They can derive required knowledge through all possible hypothesis and data mapping. Practically, due to combinatorial explosion phenomenon, it is never possible to assess all problems solving possibility, where the problem solving time grows exponentially. The AI research involves finding out feasible solution from broad range of possibilities while avoiding possibilities that are not beneficial for the problem solving.

A scenario of looking for shortest travelling path while viewing in a map from a location of Denver to a location of New York in the East, can be a suitable example. Here, the traveler can avoid looking any sub path through San Francisco or far to the location of west. As such, the AI can deploy A* algorithm as path finder for suitable and short path for the traveler.

2 The Technology

Learning about the powerful algorithms that enable AI to interpret a wide range of data and perform complicated tasks. Explore advanced AI applications such as machine learning and unsupervised learning that allow systems to teach themselves, predict the unknown and defeat champion gamers. Like, a carpenter choosing the right tool for the job, the technologists who build AI systems face many options for how to develop these versatile, sophisticated creations. Useful data, robust software and capable hardware are certainly important, but those elements are secondary to knowing the problem you want to solve. A clearly defined goal is key to determine which AI approach is most appropriate for your task. Sometimes the solution will only require the output of a recommendation based on a fairly fixed dataset and a set of logical rules written by human programmers. This kind of AI formally known as symbolic AI, has been the main type of AI in use over the past 50 years. These systems are not designed to learn or otherwise adjust their programming; all they do is rapidly deliver an answer to a question. For other problems, however, one may want a system that can generate predictions or quickly adapt its behavior based on shifting or poorly organized data flows. A subset of AI known as machine learning uses mathematical models, probabilities and statistics to infer outcomes for this class of problem. Machine learning is used in autonomous vehicles, computer vision, fastest-route mapping, ridesharing apps, prevention of banking fraud and email spam filters. Once the problem is known and has a goal in mind, then it's time to choose the proper approach. It's all about the algorithm.

3 Challenges

The entire principle of AI is based on algorithm, science and technology that most of the people are unaware about it. Very few researchers or manpower are there that are involved in developing AI based algorithm and application. This is due to requirement of new technological metrics while implementing AI based system. The skill development of data science and analytics among researchers can enhance better utilization of AI domain.

With the demand in deployment of AI based system in industries, the business units are hiring professional of data scientist and analytics for their different business needs and progress. The business units train their professional for better utilization of AI based system. Since, AI based system requires expensive hardware resources basically for processing computing powers such as graphics processing units (GPU), FPGS and machine learning model that general business units cannot go with their available funding resources.

Although the adaptability of deploying AI in business unit getting high, it is not integrated at the expected sites that are supposed to be merged in business chain. Moreover, the business units that already have deployed the AI based system, still lacking behind for proper utilization of functional properties under machine learning models. After decades of discussion on pros and cons for deploying AI based system for black box problem and humankind, the investors are deep skeptical from investing in business units.

With the integration of algorithms and machines for controlling AI based tools, the decision making and problem solving ability is improved gradually for handling Black Box tools. The automation system causes difficulties to evaluate the malfunctions and mistakes during functional execution. Moreover, due to limited human resource for learning and understanding the working principles of such tools, the business units have no or little control over such deployment that can cause complex strategy in market.

The AI also has its limited boundary for solving task or it cannot resolve all complex business logics. However, the AI domain can provide prominent job profiles for industries worldwide. The research community of AI includes various expertise, scientist and technologist with different motivations, objectives and interests. But, the main focus is given over the study of mankind intelligence for solving task and deploying strategies for machines that can follow the thorough process of human. The functional strategy of AI's decision making and machine learning is based on processing classified dataset that are personal and often sensitive in nature. Sometimes, it becomes a difficult issue for understanding by people. As such, vulnerable issues like identity theft and data breach may arise. Mostly, many government organization and companies are striving for power and profits, exploits the use of AI based system that are connected globally. AI based system is all about data processing through algorithms. The accuracy metrics of decision making AI based system is evaluated purely based on how the system is trained by using unbiased and authenticate data. Unfair and unethical consequences can raise issues for vital decision making. AI based system trained with bad data can cause bias while solving problems.

The capabilities and power of AI based system and tools directly depends upon the accuracy of used supervised data sets, that is prepared for learning and training the machine learning model. In the research community, the lack of quality labeled data and its availability is a major concern. Although, different efforts are given through deep learning, active learning and unsupervised learning, to devise strategy for deployment of AI models besides scarcity of quality data. However, it will only aggravate the objective.

4 Applications

There are numerous applications of AI. Some of them are discussed below:

4.1 AI for Astronomy

AI can be deployed for solving universal problems. The AI tools and techniques can help understanding the working and origin principles of universe.

4.2 AI for Healthcare

- (a) In last decades, the AI based systems and tools are used more prominently for healthcare industries. It is going to create a significant service while delivering health services.
- (b) The algorithms of AI based system can deliver better diagnosis service than a human being. It can help doctors to understand the critical cases of patients and intimate them the worsening signal for emergency medical help.

4.3 AI for Gaming

The AI based system can participate in gaming purpose. The AI for a chess game, can develop algorithm for finding different possibilities of steps for a specific step from other player.

4.4 AI for Finance

The AI and financial institutions together can deliver better service while achieving financial goals. The deployment of algorithms for chatbot, trading, automation and machine learning can play a vital role.

4.5 AI for Data Security

The deployment of data security is getting essential component for industries world wide. The utilization of AI algorithm for determining bugs in software processing and finding the cyber attack is getting popularity among business units.

4.6 AI for Social Media

The social media sites contain many profiles of users and products. Arranging such a huge data set is a big issue for mankind. The AI can manage and arrange the data as per latest trends and requirement in the market.

4.7 AI for Travel & Transport

In the industry of travel and transport, the deployment of AI is getting popularity. The AI based systems are capable of managing orders, suggesting hotels and flights, finding best route for users. The business units deploy AI based Chatbot for better interactive session with their customers.

4.8 AI for Automotive Industry

- (i) Many prominent industries deploy virtual assistant for helping users. The TeslaBot from Tesla company provides the real time assistant service for the users
- (ii) Many organizations are engaged on development of self driven cars that provides more safety and secure journey than traditional drive.

4.9 AI for Robotics

- (a) With the help of AI, the robotics can solve the task with their past experience. However, the traditional general robots performs repetitive task. But, the integration of AI can enhance the thinking capability of such robots.
- (b) The deployment of AI algorithm for humanoid is another example of AI service. The humanoid robot named as Sophia and Erica can behave and talk like a human being.

4.10 AI for Entertainment

In the entertainment section of life, the algorithms of machine learning and AI can provide better service for the consumer. In applications such as NetFlix, Amazon Prime, such algorithms delivers the recommended programs based on the search fields of the users

4.11 AI for Agriculture

The traditional methods in agriculture require various resources like money, labor, and time for better cultivation. However, the deployment of AI tools can enhance the predictive analysis of the farmer and monitoring mechanism of crop.

4.12 AI for E-commerce

In the industry units of e-commerce, the AI based tools can provide better combination of products with size, colors and brand. The reviewers comment and analysis over that can predict the suitability of the product for the particular user over web.

4.13 AI for education

- (a) The deployment of AI algorithm for development of Chatbot can enhance the better teaching assistant for the students.
- (b) In future, it can work as personal tutor that will be available for access at any time.

5 Conclusion

AI and machine learning are products of both science and myth. The idea that machines could think and perform tasks just as humans do is thousands of years old. The cognitive truths expressed in AI and Machine Learning systems are not new either. It may be better to view these technologies as the implementation of powerful and long-established cognitive principles through engineering. We should accept that there is a tendency to approach all important innovations as a Rorschach test upon which we impose anxieties and hopes about what constitutes a good or happy world. But the potential of AI and machine intelligence for good does not lie exclusively, or even primarily, within its technologies. It lies mainly in its users. If we trust (in the main) how our societies are currently being run then we have no reason not to trust ourselves to do good with these technologies. And if we can suspend presentism and accept that ancient stories warning us not to play God with powerful technologies are instructive then we will likely free ourselves from unnecessary anxiety about their use.

REFERENCES

- [1] Santis, A., Siciliano, B., Luca, A. De, Bicchi, A., "An atlas of humrobot interaction," Mech. Mach. Theory, vol. 43, pp. 253–270, 2008.
- [2] Wirtz, B. W., Weyerer, J. C., Geyer, C., "Artificial Intelligence and the Public Sector—Applications and Challenges", International Journal of Public Administration. Vol. 42, Issue 7, pp. 596-615, [doi:10.1080/01900692.2018.1498103](https://doi.org/10.1080/01900692.2018.1498103), 2018.
- [3] Lieto, A., Lebiere, C., Oltramari, A., "The knowledge level in cognitive architectures: Current limitations and possible developments", Cognitive Systems Research. Vol. 48, pp. 39-55, [doi:10.1016/j.cogsys.2017.05.001](https://doi.org/10.1016/j.cogsys.2017.05.001), 2018.
- [4] Ikuta, K., Nokata, M., "Safety evaluation method of design and control of human-care robots," Int. J. Robot. Res., vol. 22, no. 5, pp. 281-297, 2003.
- [5] McCorduck, P., Machines Who Think (2nd ed.), Natick, MA: A. K. Peters, Ltd., ISBN. 1568812051, 2004, Available at http://www.pamelamc.com/html/machines_who_think.html

- [6] Buchanan, B. G., "A (Very) Brief History of Artificial Intelligence". AI Magazine, pp. 53-60, 2005, Available at <http://www.aaai.org/AITopics/assets/PDF/AIMag26-04-016.pdf>. Retrieved 2020-01-30.
- [7] Maker, M.H., "AI@50: AI Past, Present, Future". Dartmouth College, 2006, Available at http://www.engagingexperience.com/2006/07/ai50_ai_past_pr.html.
- [8] Minsky, M., The Emotion Machine. New York, NY: Simon & Schusterl. ISBN. 0743276639, 2006.
- [9] Intelligence, A., "Chatbot Market Size, Share & Trends Industry Forecast 2022". Arizton Advisory & Intelligence, 2016. Available at <https://www.arizton.com/market-reports/chatbot-market-global>.
- [10] Sumari, A.D.W., Ahmad, A.S., Wuryandari, A.I., dan Sembiring, J., "Brain-inspired Knowledge Growing-System: Towards A True Cognitive Agent, International Journal of Computer Science & Artificial Intelligence (IJCSAI). Vol. 2, No. 1, World Academic Publishing, pp. 26-36, 2012.
- [11] Goertzel, B., Lian, R., Arel, I., de Garis, H., Chen, S., "A world survey of artificial brain projects, Part II: Biologically inspired cognitive architectures". Neurocomputing. Vol. 74, Issue 1–3, pp. 30-49, [doi:10.1016/j.neucom.2010.08.012](https://doi.org/10.1016/j.neucom.2010.08.012), 2010.
- [12] Devi, K.K.A. Matthew, Y. and Sandra.L.A., "Advanced Neural Network in Artificial Intelligence Systems", IEEE Trans on Artificial Intelligence Systems, Vol. 4 - 9, pp. 100 –120, 2012.
- [13] Lily, D. Chan, B. and Wang, T. G., "A Simple Explanation of Neural Network in Artificial Intelligence," IEEE. Trans on Control System, vol. 247, pp. 1529–5651, 2013.
- [14] Rajani, S., "Artificial Intelligence – Man or Machine". International Journal of Information Technology and Knowledge Management. Vol. 4, Issue 1, pp. 173-176, 2011.
- [15] Ronald, E. M. A., Sipper, M., What use is a Turing chatterbox?, Communications of the ACM, vol. 43, no. 10, pp. 21-23, 2000.
- [16] Kulic, D., Croft, E., "Affective state estimation for human–robot interaction,"IEEE Trans. Robot., vol. 23, no. 5, pp. 991-999, 2007.
- [17] Serenko, A., Dohan, M., "Comparing the expert survey and citation impact journal ranking methods: Example from the field of Artificial Intelligence". Journal of Informetrics. Vol. 5 , Issue 4, pp. 629-649, [doi:10.1016/j.joi.2011.06.002](https://doi.org/10.1016/j.joi.2011.06.002), 2011.
- [18] Lindenbaum, M., Markovitch, S., Rusakov, D., Selective sampling for nearest neighbor classifiers. Machine learning, Vol. 54, Issue 2, pp.125-152, 2004.
- [19] Oudeyer, P. Y., "On the impact of robotics in behavioral and cognitive sciences: from insect navigation to human cognitive development". IEEE Transactions on Autonomous Mental Development. Vol. 2, Issue 1, pp. 2-16, [doi:10.1109/tamd.2009.2039057](https://doi.org/10.1109/tamd.2009.2039057), 2010.
- [20] Available at: <https://www.intechopen.com/books/artificial-intelligence-scope-and-limitations/introductory-chapter-artificial-intelligence-challenges-and-applications>
- [21] Available at: <https://www.javatpoint.com/application-of-ai>
- [22] Dautenhahn, K., "Methodology and themes of human–robot interaction: A growing research field" Int. J. Advance Robot. Syst., vol. 4, no. 1, pp. 103-108, 2007.

- [23] Martinez, A., Vitria, J., "Clustering in image space for place recognition and visual annotations for human–robot interaction," IEEE Trans. Syst., Man, Cybern. B, Cybern., vol. 31, no. 5, pp. 669-682, 2001.
- [24] Davis, E., Marcus, G., "Commonsense reasoning and commonsense knowledge in artificial intelligence". Communications of the ACM. Vol. 58, Issue 9, pp. 92-103. [doi:10.1145/2701413](https://doi.org/10.1145/2701413), 2015.
- [25] Ferguson, S., Luders, B.,Grande, R.C., How, J. P., Real-Time Predictive Modeling and Robust Avoidance of Pedestrians with Uncertain, Changing Intentions. Algorithmic Foundations of Robotics XI. Springer Tracts in Advanced Robotics. Springer, Vol. 107, pp. 161–177, [doi:10.1007/978-3-319-16595-0_10](https://doi.org/10.1007/978-3-319-16595-0_10). ISBN 978-3-319-16594-3, 2015.
- [26] Bertini, M. Del B. A., Torniai, C., "Automatic annotation and semantic retrieval of video sequences using multimedia ontologies". Proceedings of the 14th ACM international conference on Multimedia. 14th ACM international conference on Multimedia. Santa Barbara: ACM. pp. 679-682, 2006.
- [27] MCGarry, K., "A survey of interestingness measures for knowledge discovery". The Knowledge Engineering Review. Vol. 20, Issue 1, pp. 39-61, [doi:10.1017/S0269888905000408](https://doi.org/10.1017/S0269888905000408), 2005.
- [28] Jordan, M. I., Mitchell, T. M., "Machine learning: Trends, perspectives, and prospects". Science. Vol. 349, Issue 6245, pp. 255-260, [doi:10.1126/science.aaa8415](https://doi.org/10.1126/science.aaa8415), 2015.
- [29] Cambria, E., White, B., "Jumping NLP Curves: A Review of Natural Language Processing Research". IEEE Computational Intelligence Magazine. Vol. 9 , Issue 2, pp. 48-57, [doi:10.1109/MCI.2014.2307227](https://doi.org/10.1109/MCI.2014.2307227), 2014.
- [30] Cadena, C., Carlone, L., Carrillo, H., Latif, Y., Scaramuzza, D., Neira, J., Reid, I., Leonard, J. J. , "Past, Present, and Future of Simultaneous Localization and Mapping: Toward the Robust- Perception Age". IEEE Transactions on Robotics, Vol. 32, Issue 6, pp. 1309-1332, [doi:10.1109/TRO.2016.2624754](https://doi.org/10.1109/TRO.2016.2624754), 2016.
- [31] Roberts, J., "Thinking Machines: The Search for Artificial Intelligence". Distillations. Vol. 2, no. 2, pp. 14-23, 2016.
- [32] Schoenick, C., Clark, P., Tafjord, O., Turney, P., Etzioni, O., "Moving beyond the Turing Test with the Allen AI Science Challenge". Communications of the ACM, Vol. 60, Issue 9, pp. 60-64, [doi:10.1145/3122814](https://doi.org/10.1145/3122814), 2017.
- [33] Scassellati, B., "Theory of mind for a humanoid robot". Autonomous Robots, Vol. 12, Issue 1, pp. 13-24, [doi:10.1023/A:1013298507114](https://doi.org/10.1023/A:1013298507114), 2002.
- [34] Poria, S., Cambria, E., Bajpai, R., Hussain, A., "A review of affective computing: From unimodal analysis to multimodal fusion". Information Fusion, Vol. 37, pp. 98-125, [doi:10.1016/j.inffus.2017.02.003](https://doi.org/10.1016/j.inffus.2017.02.003), 2017
- [35] Chen, M., Zalala, A., "A genetic approach to motion planning for redundant mobile manipulator systems considering safety and configuration" J. Robot. Syst., vol. 14, no. 7, pp. 529-544, 1997.
- [36] Najmaei, N., Kermani, M.R., "Applications of Artificial Intelligence in Safe Human–Robot Interactions", IEEE Transaction on systems, man and cybernetics-part B, vol. 41, no. 2, pp. 448-459, 2011.