Mathematics in Artificial Intelligence

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ABSTRACT

There is a lot of study going on in the field of Artificial Intelligence these days and many goals have already been met, while others are still being worked on. In this paper we discussed about the role of Mathematics in artificial intelligence. AI is not a form of magic; it is simply mathematics. The principles behind thinking machines and the ability to replicate human behaviour are accomplished via the use of mathematical concepts. Artificial intelligence = Mathematics.Maths is at the heart of every AI success.Mathematics is at the root of all great advances. Linear Algebra, Calculus, Game Theory, Probability, Statistics, Advanced Logistic Regressions, and Gradient Descent are all key underpinnings of data science. Linear algebra, calculus, and probability are the three basic disciplines of mathematics that make up a successful career in AI, which we will discussed in this paper.

KEYWORDS*:* AI (Artificial intelligence), Advance technology, Mathematics, Machine Learning

INTRODUCTION: Machine intelligence is referred to as artificial intelligence. It has the ability to replicate human intellect and do tasks that human can perform. Learning, reasoning, perceptionand creativity which were previously solely possessed by humans, are now being emulated by AI utilizing various algorithms. To put it another way, artificial intelligence uses computer science, Mathematicsand a large data collection to solve a problem[1]. It comprises machine learning and deep learning, which assist machines in becoming better at a job even if the machine was not particularly built to execute that activity. As a result, it eliminates the need to write a large program for the task. One example of AI is Live Chat on

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various corporate websites, which answers client queries based on a large data collection of potential questions that a consumer may ask, it has happened. Many researchers have claimed that AI will soon replace numerous humans in many domains, however this has yet to materialize. At the Dartmouth Conference in 1956, American computer scientist John McCarthy invented the phrase "artificial intelligence". Algorithms for solving mathematical problems were invented in 1966. Joseph Weizenbaum also built the first chatbot, ELIZA. Japan produced the first humanoid robot, the WABOT-1, in 1972. Expert systems capable of making human-like judgements were created in 1980. In 1987, IBM developed Deep Blue, a computer that defeated world-class chess champion Gary Kasparov. It was the first computer to win a game of chess. Roomba, an AI Vacuum cleaner, was also designed in 2002. Companies such as Twitter, Facebook, and Netflix began integrating Artificial Intelligence in their operations in 2006. IBM's computer Watson won a quiz by solving difficult questions was introduced in 2011.

ROLE OF MATHEMATICS IN ARTIFICIAL INTELLIGENCE: Artificial intelligence is the intelligence possessed by machines. Learning (Machine Learning & Deep Learning), Communication utilizing NLP, Knowledge Representation & Reasoning, Problem Solving, Uncertain Knowledge & Reasoning are all sub-fields of artificial intelligence[1].AI relies heavily on Mathematics. There are some main branches of mathematics in AI like Linear algebra, calculus, Probability, Statics, Linear graphs, Information Theory[2].

Linear Algebra in AI: Linear algebra improves your understanding of data science algorithms.Vector, Matrices, and Tensors are Linear Algebra or Mathematical Objects–[3]. You must select the appropriate object to store and analyze your data based on its dimensions[4]. Linear algebra objects are given in Figure

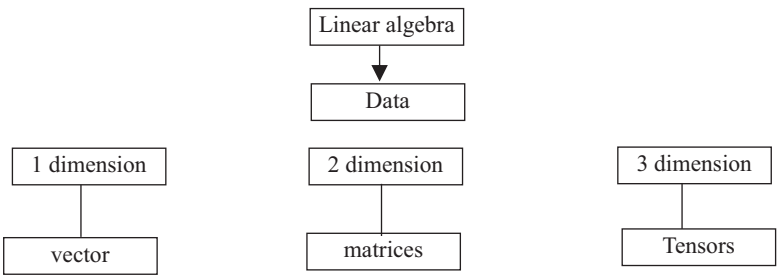

Figure 1

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1. **Calculus in AI:** Changes in parameters, functions, mistakes, and approximations are all dealt with in calculus. In Artificial Intelligence, having a working graph of multi-dimensional calculus is essential[2].
   - Derivatives include rules (such as addition, product, and chain rule), hyperbolic derivatives (such as tanh, cosh, and so on), and partial derivatives.
   - Gradient Algorithms — localmaxima and minima, saddle points, convex functions, batches and mini-batches, stochastic gradient descent, and performance comparison.
   - Vector/Matrix Calculus — distinct derivative operators (Gradient, Jacobian, Hessian, and Laplacian).

Three-dimensional graph of the error surface generated when slops and intercepts are varied given in figure 2

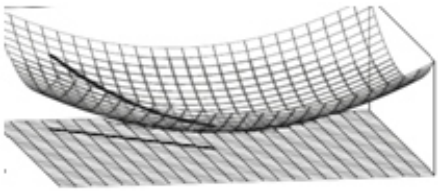

Figure 2.

1. **Statistics in AI:** The topic of Artificial Intelligence is concerned with creating predictions and locating patterns in data structures to create such predictions. This enables the machine to do numerous analytical activities without the need for human interaction–[5]. Statistics is a collection of concepts that is used to gather knowledge about data in order to make judgments. It establishes relationships between numerous pieces of data and with itself. As a result, statistics play a crucial part in AI, and anybody working in the subject of AI should be familiar with the concepts of probability and statistics–[6].

   To solve issues in AI, you must first understand how data is distributed, as well as knowledge about dependent and independent factors.

   Clearly state the problem, as well as define and characterise the scope.

   The quality of the data has a significant impact on the outcome. Invest time in cleaning, comprehending, and converting your data.

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The procedure begins with descriptive statistics and graphics. It is capable of detecting unanticipated patterns that contribute to biased learning.

Update models on a regular basis as factors continue to influence results in various ways. Finally, build methods to ensure that the AI model is successfully contributing to the goals for which it was designed.

2. **Probability in AI:** Probabilistic reasoning is a method of knowledge representation in which the idea of probability is used to show uncertain in knowledge–[7]. Probability Theory may be employed in the AI field, as can Learning (especially Machine Learning) and Natural Language Processing (NLP), which are also part of AI but are included separately owing to their popularity and importance in comprehending–[8]. Probability plays effective role in Artificial Intelligence discussed in figure 3.

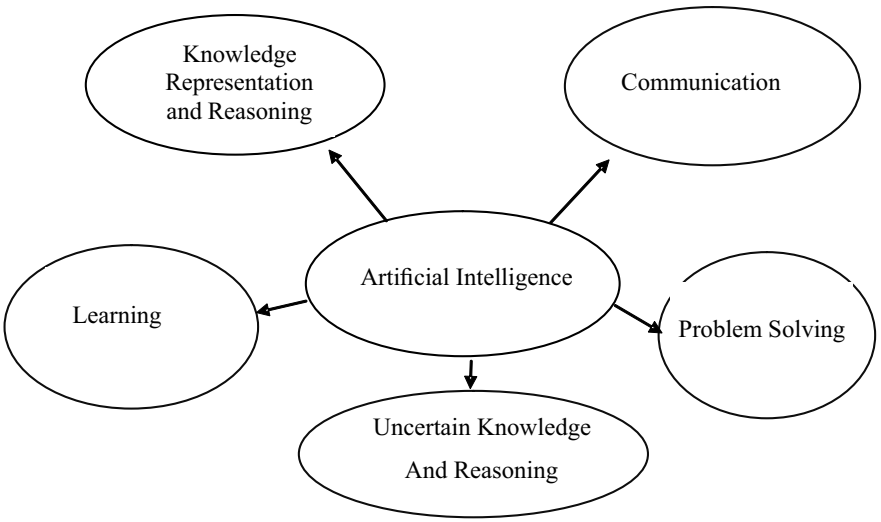

Figure 3

INFORMATION THEORY IN AI: Many people are unaware that information theory is a key topic that has made substantial contributions to deep learning and AI. Information theory may be thought of as a complex aggregation of deep learning's fundamental building blocks: calculus, probability, and statistics. Here are some examples of AI principles derived from information

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theory or related fields:

- Entropy also known as Shannon Entropy. Used to quantify the degree of uncertainty in an experiment.
- The Viterbi Algorithm is frequently used in Natural Language Processing (NLP) and speech recognition.
- Kullback-Leibler Divergence – another metric for comparing the similarity of two probability distributions.
- Cross-Entropy – analyses two probability distributions and determines their similarity.

CONCLUSION:

Mathematics is crucial to Artificial Intelligence and Machine Learning because it gives a way of implementing how their objectives might be met. Mathematics is at the heart of every AI success. The principles behind thinking machines and the ability to replicate human behaviour are accomplished via the use of mathematical concepts. The goal of artificial intelligence is to provide an adequate model for human comprehension. And these models may be built using concepts and tactics from numerous fields of mathematics. Mathematics is at the root of all great advances. Linear Algebra, Calculus, Game Theory, Probability, Statistics, Advanced Logistic Regressions, and Gradient Descent are all key underpinnings of data science.

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