**Mathematics, Innovation, and Computer Science**

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Mathematics and computer science are, by nature, intrinsically linked. I would like to explore artificial intelligence and the topics of math that are required to develop it, algorithms, and finally the logical problem-solving methods that are prevalent in both mathematics and computer science. All of these will prove my point that a strong understanding of mathematics is necessary for innovation within the field of computer science.

Contrary to popular belief, artificial Intelligence is not magic. Rather, it is the accumulation of various math topics, two of which are calculus and linear algebra. The use cases vary depending on what part of the AI we talk about. Calculus, in my experience, is heavily integrated into the training of Artificial Intelligence. Whereas linear algebra is used more in the computation side of Artificial Intelligence (Geeks for Geeks, 2024).

I’ve used calculus in my neural networks for a process called backpropagation. This is a method in which the output of a neural network is fed into a function that calculates the cost, or accuracy, of the output then back through each layer of the network to train it to more accurately predict the expected output. Backpropagation is the backbone of a fundamental topic for machine learning algorithms called gradient descent. These math concepts are all very complicated. However, this is just one step in developing a neural network which is one of the simplest forms of artificial intelligence. Other forms of artificial intelligence such as generative pre-trained transformers or GPT models incorporate linear algebra topics such as vectors, matrices, and scalars to manipulate and transform data (Geeks for Geeks, 2024). All this information is necessary to know before any actual computer science happens in artificial intelligence development.

So how does this relate to my claim? Out of nine of the biggest recent breakthroughs in computer science, four of them are related to artificial intelligence development. Two of them are artificial intelligence and machine learning, while the other two are computer vision and natural language processing (Jessup, nd.). All four of these, however, are deeply integrated with mathematics. The base of all of them are neural networks which we already briefly discussed earlier.

While the connection between mathematics and AI is apparent, the role that math plays in algorithms is subtle and more abstract. The whole internet is powered by algorithms. Think about applications like YouTube, Google, Spotify, and Instagram. All of these have finely tuned algorithms that are designed to maximize time spent on the app. But how are these algorithms related to mathematics? First and foremost, the definition of an algorithm according to Merriam-Webster Dictionary is as follows “a procedure for solving a mathematical problem” (2025). The word math is literally in the definition of algorithm. But as I do not feel that is enough proof, let’s look at how the two are connected. Using mathematical functions as an example, both can be represented as input, operations on input, then output where the input and output for algorithms could be an unsorted list and a sorted list respectively. Using that as an example, it is apparent that algorithms are heavily abstracted versions of mathematical functions where the purpose of an algorithm is to do a specific task given any valid input. This does not directly prove the link between math and algorithms, but it does show the similarities between the two. It can be concluded from this that a strong understanding of mathematics, especially functions, can assist in making well-designed algorithms.

Finally, I would like to discuss the logical thinking similarities in problem-solving between computer science and mathematics. Firstly, given any mathematical equation, the first step is generally simplification. This is directly equivalent to a well-known programming concept called KISS or keep it stupid simple. Both are used in their respective fields to make the problem at hand easier to look at thus easier to solve. Second, is a little more specific but it is using math directly in the logic of our code. This could be something like using division and modulus to index into a two-dimensional array or wrapping an incremented number, again, using modulus. These can be achieved without using math as a shortcut, but the implementation of either is directly in disagreement with KISS. Third, there is another concept in computer science where any given method has a single purpose. This is like mathematical functions where every input directly corresponds to exactly one output. As you can see, math and computer science share many similarities in their structure and logical design. And mastery of these concepts in either field is fundamental to designing innovative technology.

In conclusion, mathematics is seen everywhere through computer science. From calculus and linear algebra powering artificial intelligence to the similarities between mathematical functions and programming. It is clear from these points that a strong foundation in mathematics is imperative for designing groundbreaking software.

**References**

algorithm. 2024. *Merriam-Webster.com.* Retrieved January 22, 2025, from <https://www.merriam-webster.com/dictionary/algorithm>

Geeks for Geeks. (2024, July 30). *Linear Algebra Operations for Machine Learning.* Geeks for Geeks.<https://www.geeksforgeeks.org/ml-linear-algebra-operations/#>

Jamal, M. (2024, January 19). *Why Math Is Vital to Thrive In Your AI Career.* builtin. <https://builtin.com/articles/math-for-ai>

Jessup University. (N.D.). *9 Emerging Technologies in Computer Science.* Jessup University. <https://jessup.edu/blog/engineering-technology/emerging-technologies-in-computer-science/>

*Checked for grammar by Grammarly (2025)*