NEED OF KNOWLEDGE INTEGRATION AND CRITICAL THINKING FOR THE RIGHTEOUS IMPLEMENTATION OF ARTIFICIAL INTELLIGENCE IN COMPUTATIONAL MATHEMATICS

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Abstract

Computational mathematics is a wide branch of mathematics that requires the efficient use of various mathematical models, numerical methods, algorithms, data collection and research, and emphasis on real-world problems with the help of computer software. Although artificial intelligence (AI) itself requires computational mathematics for its proper functioning/working to give the output related to the vitally emphasized topic, the extent to which AI should be used in such a critical field was emphasized in this paper. Integration of knowledge makes the use of AI in computational mathematics meaningful and capable of making the ways innovative and easy. Some of the recent examples were covered to show the critical thinking required for the righteous use of AI, along with the implementational measures that should be taken. In addition, the approach of the new generation towards AI in computational mathematics regarding its benefits and erosion through the critical analysis to evolve beyond the box, to question reason, and to grasp the 'why' in the specific instance was highlighted.

***Keywords**: Computational mathematics; artificial intelligence; integration of knowledge; critical thinking.*

Introduction:

Despite its recent development, computational mathematics, according to Yang (2014), boasts a vast array of applications and stands as one of the most renowned branches within the mathematical sciences. It generally solves the complex problems with the help of computer technology that are difficult to handle manually. Computational mathematics connects the two main branches of mathematics, viz., pure mathematics and applied mathematics, to computer sciences. Traditional mathematics provides us the exact solution; computational mathematics, on the other hand, provides the approximate solution through the help of a computational method, which requires a definite procedure to solve the mathematical problem.

The main focus of computational mathematics is the usage of approximate techniques like numerical integration (Davis, 2007), differentiation (Naumann, 2011), and optimization techniques (Mikhalevich, 1994) through computational software, coding (Blake), and algorithms. Computational mathematics uses various mathematical modelling (De Marchi, 2005) to obtain the solution. It has a wide range of applications in physical sciences, engineering, biology, economics, data sciences (Chen, 2015), and life sciences (Rubinstein, 2014).

AI is a well-known branch of computer science that is based on developing systems that can handle tasks that usually require human intelligence. It generally includes decision-making, problem-solving, and understanding. AI, when combined with other services, develops algorithms, mathematical models, software, etc., which leads to the improvement of performance over time through data and technique. AI so far is able to perform repetitive or complex tasks without human intervention and analyse situations to make logical decisions. Knowledge integration (Lv, 2023), on the other hand, combines the information, organizing it carefully to link it with new knowledge and apply it meaningfully to develop the efficient problem-solving skills. It acts as a bridge for various fields of arts, science, and technology. Critical thinking (Kannadass, 2023) is the ability to analyse, evaluate, and interpret information in order to form a decision that is based on curiosity, creativity, and open-mindedness to detect the reliable source.

Literature review:

The role of AI in computational mathematics is undoubtedly significant, as it provides the various ways to model, approximate, and solve the problem efficiently and effectively that traditional methods may prove difficult to address. For instance, AI models can approximate solutions to large linear systems of equations whose solutions would be rather difficult to find through normal analytical calculations. Thus, it pushes its boundaries further and further to evaluate the better and the best way to reach the goal. Through AI one can detect the pattern followed by the effect of disease, medication, and dosage on different age groups of people to predict the further details required to make the beneficial changes in each of the considered cases.

AI optimizes the parameters of computational models, such as in weather forecasts (Xiang, 2024),

to project the correct time of rain, storms, and earthquake-like natural calamities, along with wind and tides. AI, with the help of computer software, handles and manages data efficiently. For instance, it can efficiently handle bank customer data and services (Nicolescu, L., 2022), related information, daily transaction and balance information of various companies, and commodities, which in turn can be employed for policy making by the government and by the industries to employ their hard-core work, time, and money to invest in a particular product or not.

Integration of knowledge begins when a learner or researcher tries to implement new data into already existing data to get the advanced version of a previously known method, technique, or skill. Sometimes it fits easily, but other times it requires reorganizing or rethinking and gathering new sources to look upon for more vital details to fill in the gaps and build strong bridges between ideas. Critical thinking occurs when the learner or researcher is encouraged to examine each and every assumption and viewpoint to justify the answers with the mindset of exploring new ideas and to seek evidence in all steps.

Research work:

Knowledge integration deepens the ideas from different areas to build more understanding and links between various streams of pure and applied sciences and technology. Thus, applying knowledge across subjects is possible with its integration, which extends us to think about interdisciplinary areas of research. Applying abstract concepts to real-life situations is possible, and the righteous transfer of knowledge to the next level is achievable.

Critical thinking, on the other hand, breaks down information into minute parts, allowing individuals to evaluate the relevance of that information based on their needs and to draw logical conclusions according to their analytical and handling abilities. Thus, for the proper integration method, one must have the attitude of a critical thinker to connect different ideas and methods. Critical thinking improves knowledge integration to ensure that the available gathered knowledge is valid, logical, and meaningful.

In computational mathematics, for instance, knowledge integration helps create new mathematical models, while through critical thinking, one can decide if the particular model is authentic, well-organized, and relevant or not. Overall, AI-driven computational mathematics that incorporates knowledge integration and critical thinking is a beneficial approach to consider. In the following two subsections, the general connection between knowledge integration and critical thinking in AI and computational mathematics is shown for further emphasis.

Promoting knowledge integration in AI before applying to computational mathematics:

Knowledge integration brings knowledge from different sources, domains, and representations to develop more adaptable and easily applicable skills from various sources, streams, & branches of science and technology. For instance, raw data from multiple sources through the use of AI is integrated in autonomous cars to reflect the camera, radar, and GPS information available at one point.

Using multiple model algorithms together leads to the formation of a hybrid system and has its own immense significance. For instance, one can notice in the medical field where a large amount of data is integrated to analyse the patient's disease, and thus it helps in predicting the symptoms of another initial-stage patient case. Thus, knowledge integration promotes better problem-solving skills; it improves the accuracy of solutions by minimizing errors so as to discover new patterns and solutions beyond monotonous approaches.

Computational mathematics involves blending the theoretical knowledge of mathematical theorems, proofs, and mathematical models with the computational techniques of numerical analysis, simulation, and algorithms. Knowledge integration fastens the accuracy of the solution to a complex problem, hence bringing accuracy and efficiency to problem-solving skills, which clearly reduces the manual effort in tedious symbolic or numerical computations. Although knowledge integration of AI in a righteous manner helps computational mathematics enable us to enhance development in the fields of robotics, aerodynamics, computational fluid dynamics, and many such technical areas.

Promoting one's critical thinking in AI before applying to computational mathematics:

The ability to think clearly, logically, and independently about a situation, idea, or problem constitutes critical thinking. For instance, the foundation of critical thinking consists of carefully analysing, questioning, using logical reasoning, evaluating information, maintaining open-mindedness, and employing a problem-solving approach before framing the most effective solution.

Critical analysis of AI in solving computational mathematical problems generally involves the approach to answer the questions, 'Does AI truly solve the computational problem, or is it only approximating a pattern from the available data or most frequently used data?' and 'To what extent

can one trust the AI-generated result in the field where proof and exactness matter a lot? 'With the help of AI, it is possible to solve higher-dimensional, nonlinear, and complex problems that were previously difficult to address. But the righteous approach helps us to stay away from the side effects of fitting AI to each and every problem that can lead to deceptive mathematical conclusions.

Conclusions:

- Both AI and computational mathematics rely immensely on the mathematical concepts of linear algebra, probability and statistics, calculus and differential equations, numerical methods, and optimization theory. Thus, a deep knowledge of mathematics as a foundational subject must be unhesitatingly studied and understood.
- Integration of knowledge from different programming skills like Python, MATLAB, C++, etc. ensures the result for large simulations and explores new ways for higher performance in mathematical computation.
- Algorithm study has become easy from AI, but one must have sufficient knowledge before moving to computational tools like Python libraries like NumPy, SciPy, etc., which have developed their deeper roots in computational mathematics over the period of time.
- Critical thinking in AI while applying any algorithmic solution to a computational mathematical problem emphasizes verifying the technique, knowing each and every step through logical reasoning and open-mindedness, and having a problem-solving approach with the answers to 'how' and 'why' the process is to be followed.
- Focusing on AI in scientific learning paves the way to opening to new problem-solving skills. In addition, applied mathematics and machine learning empower us in the field of computational mathematics.

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