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New Trends in Computer Algebra Systems



Abstract: - We live in a world where everything is evolving very fast. The development of all sciences contributed greatly to this. Artificial intelligence is one of the most important factors of evolution. Furthermore, mobile phones have become the most widespread technological achievement. In recent years, some Computer Algebra Systems (CAS) have followed this trend and offered a mobile version to users. These Apps are on the rise, but the incorporated AI is in the primary stage. The integration of AI into these Apps will optimize their performance. Furthermore, it will have several advantages, such as bettering App functionality, facilitating personalized interaction, and improving user experiences. In this paper, we will see all these factors and reveal why it is important for the new generation of CASs to move forward in this direction.

Keywords: Computer Algebra Systems, CAS, CAS performance, AI, CAS Apps, CAS with AI technology.

I. INTRODUCTION

Our learning environment has changed dramatically over the last three decades. Today's education uses a lot of the information technology that has been developed. Among them is the endorsement of using mobile phones for educational purposes [1]. Pawluk's research [2] states that mobile phones today are multi-tools. The most advanced smartphones can connect to the Internet and have processing power comparable to a Personal Computer (PC). Globally, there are more smartphones and mobile devices than there are PCs. M-learning is the study in which students work whenever and wherever they choose using portable electronics like cell phones, tablets, etc. [3]. This kind of study is on the rise today and affects CAS design.

Mathematics and Artificial Intelligence (AI) combine in many ways and interact on many levels. AI is a field of computer science concerned with the design, and implementation of computer systems that mimic human intelligence and behavior. Thanks to AI hard mathematical problems are now faced and solved more easily. With the clearest excellence and ability, it has to analyze and process a large amount of data, it gives us an optimal solution quickly.

In this paper, we are going to examine the benefits of AI integration in mobile CASs. We will see why the new generation of CASs must move to an AI software implementation and what are the advantages of this. In the following Part 2 the existing Computer Algebra Systems on mobile phones are presented in detail.

II. COMPUTER ALGEBRA SYSTEMS ON MOBILE PHONES

Mobile learning is a part of a new landscape, as the process of technological change in education continues to progress [4]. The use of smartphones in math education and learning has a positive effect on independent learning [5]. Mobile phones are an integral part of students' daily lives both inside and outside of the classroom, so using them to teach Mathematics in the classroom is beneficial. Due to its portability, connectivity, and social interaction, mobile devices are the preferred learning platform [6]. Now, students find a whole process of learning Mathematics in their hands. Moreover, they can have CASs on their mobile phones equal to many things to computer versions. Notes, step-by-step solutions, computational tools, social networking features, and many other things make the use of mobile versions easier in many ways [7]. In the following Table 1, we can see the CASs that exist for Android and iOS devices.

To provide users with a quick and responsive experience, application performance is essential. Users may become irate with slow or high latency performance. What counts in an App are load time, network performance, battery usage, and memory usage. When an App performs optimally, it meets or surpasses user expectations by operating quickly and offering a smooth, effective user experience. So, the reasons that cause App latency are the following:

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- Too much data,
- Slow network connectivity,
- Slow server response times,
- Poor algorithms,
- and excessive use of CPU, memory, and network resources.

To reduce CAS latency problems there are some tips for CAS developers such as:

- Monitoring and analyzing with metrics to find speed problems,
- Use in-memory databases,
- Reduce the transferred data with compression,
- Storing and retrieving data more quickly with efficient algorithms,
- and use distributed databases or caching systems.

Table 1. CASs that exist for Android and iOS devices

CAS	iOS Requirements	Android Requirements	Capabilities/Limitations
MATLAB	iOS 15 or later	Android 10 or later	One of the most famous with many capabilities in solving any mathematical problem. Some features are not supported in the mobile edition (such as curve fitting, creating apps with App Designer, interacting with 3D figures, and opening or creating models using the Simulink graphical environment).
Mathematica	N/A	N/A	Mathematica does not run on smartphones. A touch-enabled interface to Wolfram notebook documents is offered by the Wolfram Cloud App .
Maple	N/A	N/A	While Maple does not support smartphones, Maplesoft does provide two distinct methods for students to use their phone or tablet to learn math. MapleCloud and the Maple Calculator App . Even if you are not familiar with Maple, you can visualize and experiment with mathematical concepts with ease thanks to the hundreds of interactive MathApps available in the MapleCloud.
Maxima	N/A	Android 10 or later	It is a mashup of numerous open-source apps. Numerous mathematical operations, including integration, differentiation, matrix operations, and rational numbers, can be performed.
CAS for Android	N/A	Android 10 or later	It supports solving ordinary differential equations, tangent lines, line integrals, derivatives, partial derivatives, Taylor series, and many others.
MathStudio	iOS 15 or later	Android 10 or later	Very good for Regression Analysis, Algebra & Calculus, 3D Graphing.

III. ARTIFICIAL INTELLIGENCE TECHNOLOGY AND COMPUTER ALGEBRA SYSTEMS

Artificial Intelligence is a technology that essentially imitates human intelligence. But how is it possible to do this? If we think about how we humans learn, it's not that hard to understand. Experience is what teaches us. So, in AI, computers learn through experience, using data. Therefore, in each "successful round" of data they process, they also learn something new, as a result, they acquire excellent expertise in the field they deal with. So, until now we had machines that could do the job faster than a human. But they had one drawback. They could not think and act like a human.

AI has had a big impact on the tech sector recently by providing creative methods to improve performance. The main advantage that AI offers us is speed. Because of the functions described above, a computer can learn much faster than a human brain. In this way, we are given the possibility to evolve at speeds that were unimaginable in the past. Another speed-related advantage is faster decision-making. Moreover, AI algorithms can recognize patterns through the analysis of large datasets and create monitoring and forecasting models. Finally, AI is essential to the generation of conjectures and the proof of theorems. This technology will inevitably change the way that CAS applications are developed.

The primary goal of the CAS that uses symbolic computation algorithms is to generate precise answers; numerical computation is infrequently used in favor of symbolic solutions. Symbolic computation is one area where Machine Learning (ML) techniques can be applied to optimize or select algorithms. According to Huang (2016), Machine Learning can be used to help with algorithm selection in CASs [8]. Lample and Charton (2020) have attempted to use AI to perform Mathematics directly by training a transformer to integrate expressions and solve differential equations analytically. Compared to CASs, the transformer correctly solved more problems in the allotted time [9]. He (2022) provides an overview of various efforts utilizing Machine Learning to forecast characteristics of mathematical structures like graphs and groups [10]. Many other studies encourage the use of ML. In Table 2, we can see why CASs should move towards AI.

Table 2. Why CAS should move towards AI

Traditional CASs	CASs with AI technology
They are simple computer software that manipulates symbolic expressions and can be used in a manner akin to manual computations.	They are computer software that simulates human thought processes to carry out sophisticated tasks like learning, reasoning, and analysis.
Use symbolic expression manipulation to carry out exact Mathematics.	Use statistical methods that extract rules from data.
Algorithms frequently include solutions and calculations that can significantly affect the resources needed (memory usage, processor usage, etc.) without adding anything to solving even though they are exposed to more data.	It automates the process of creating analytical models that mine data for hidden insights using AI techniques (E.g. neural networks etc.). As these algorithms are exposed to more data, they perform better over time. AI can use predefined rules; it doesn't always need big datasets.
Usually, there are one or a few methods of solving that don't change over time.	It includes a variety of methods (such as reinforcement learning, unsupervised and supervised learning, etc.) that improve solving over time. Chatbots can solve basic mathematical problems or give you advice for solving them.

The future trend in CAS development is quantum computing because of the ability to solve complicated problems that classical computers can't handle. Although still in their infancy, quantum-enhanced algorithms have the potential to accelerate ML and optimization processes greatly.

AI can improve user experience, help predict customer behavior, and help with data-driven decision-making. The forward-looking analysis also assists CASs in predicting user actions, which simplifies tasks and improves convenience by prognosticating the exact needs of the user. There are several significant distinctions between AI-driven and simple CASs, in the following Table 3, we can see them in detail.

Table 3. AI-driven CASs vs Simple CASs

Simple CAS	AI-driven CAS
The way they handle data is based on the guides established by programmers.	In contrast, AI models learn directly from the data.
Static content.	Personalized content. AI enables CAS-Apps to understand user behavior and preferences, resulting in customized interactions that meet the needs of each user.
Traditional security protocols.	Enhanced security and customized access.
Repetitive tasks slow down efficiency.	Enhances efficiency by automating repetitive tasks.

IV. RESULTS

The process we work to solve problems is being completely transformed by the incorporation of AI into CAS. This development represents a change toward a more personalized, intuitive user experience that holds the potential to completely upend our preconceptions about what CASs are capable of. The method users interact with CAS changes dramatically, paving the way for a time when these systems will be able to recognize and adjust to each user's unique preferences and behaviors. With cutting-edge deep learning (DL) and machine learning (ML) technologies, the new CAS Apps have improved user experiences by offering personalized services, product recommendations, or even suggested actions within the App.

ML uses algorithms to find relationships and patterns in information that are not instantly obvious or predictable by straightforward extrapolation. ML models continuously improve their accuracy by adjusting their predictions with fresh data. CASs with this technology can extract rules from data. As these algorithms are exposed to more data, they perform better over time. It includes a variety of methods (such as reinforcement learning, unsupervised and supervised learning, etc.) that improve solving over time.

Traditional software is not as predictive as ML, even though it can still make simple predictions based on past data. Algorithms frequently include solutions and calculations that can significantly affect the resources needed (memory usage, processor usage, etc.) without adding anything to solving even though they are exposed to more data.

The most famous CASs for Android and iOS devices today are MATLAB and MathStudio. MATLAB has many capabilities for solving any mathematical problem but some features are unsupported on the mobile edition (such as curve fitting, interacting with 3D figures, and others). MathStudio supports regression analysis, Algebra & Calculus, 3D Graphing, and other basic calculations.

V. CONCLUSIONS

The swift progress in AI has permanently altered our everyday lives and holds great potential for future revolutionary shifts. It is changing the world, improving our lives, and surpassing what we previously believed was possible. The influence is evident in everything we see around us. Its impact has increased dramatically, and its uses are wide-ranging and deep-rooted.

On the other side, every part of our lives has been impacted by mobile phones, including how we work, study, communicate, and pass the time. CAS will also be affected by this development. Future versions of CASs will inevitably target mobile phone users. The integration of AI into these Apps will optimize their performance. Furthermore, it will have several advantages, such as bettering App functionality, facilitating personalized interaction, and improving user experiences. To be exceptional in the ever-changing world of mobile App development, one must be innovative. That's why CASs will certainly continue to follow the science trends.

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