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The Influence of Data Structures on Optimal Algorithm Design and Performance in Fintech

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Abstract

This Present Study Topic is 'The Influence of Data Structures on Optimal Algorithm Design and Performance in Fintech' The efficient data structures play a critical role in improving algorithm design, computational speed, scalability, and memory optimisation within fintech systems. Recent fintech studies emphasise that modern financial platforms process massive real-time transactional data, requiring optimised algorithms supported by advanced data structures such as trees, graphs, hash tables, heaps, and distributed ledgers. Financial Technology applications, including digital banking, fraud detection, blockchain, algorithmic trading, and risk management, rely heavily on these computational techniques to maintain performance and security. Artificial Intelligence and reinforcement learning demonstrated that optimal algorithm design supports decision-making, portfolio optimisation, fraud detection, and automated trading systems. Researchers concluded that the integration of suitable data structures with intelligent algorithms improves prediction accuracy, computational efficiency, and operational scalability in fintech applications. These technologies are becoming increasingly important in modern digital financial ecosystems driven by big data and real-time analytics.

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1. INTRODUCTION

A data structure is a particular way of organising data in a computer so that it can be used effectively. The idea is to reduce the space and time complexities of different tasks. The choice of a good data structure makes it possible to perform a variety of critical operations effectively. An efficient data structure also uses minimum memory space and execution time to process the structure. A data structure is not only used for organising the data. It is also used for processing, retrieving, and storing data. There are different basic and advanced types of data structures that are used in almost every program or software system that has been developed. So we must have good knowledge of data structures. An optimal algorithm is defined as a method used to solve the optimal solution of a problem, such as the Virtual Network Function Placement Problem, by combining LP formulations and commodity solvers, as well as other convex optimisations and mathematical programming methods. Most of the optimal placements are solved by combining the LP formulations and commodity solvers. In addition, there are other convex optimisations and mathematical programming methods designed for obtaining the optimal placements. In the ever-evolving world of technology, algorithms form the backbone of innovation. From powering search engines to enabling artificial intelligence, algorithms are the invisible architects of modern computing. However, designing efficient, scalable, and robust algorithms is no small feat. It requires a deep understanding of algorithm design principles, a structured approach to problem-solving, and the ability to anticipate challenges.

The fintech, a combination of the words "finance" and "technology", was initially used by banks to describe technology that helped them track and manage their clients' accounts. However, in the last five years, the term has shifted to include more consumer-related services, such as apps and software that are used to create budgets, track spending and buy and sell stocks. Today, the term fintech can be used to describe technologies, services and companies in the financial sector that focus on various capabilities, including retail banking, financial education, fundraising, cryptocurrencies, investment management and more. As smartphones have crept into more and more areas of our lives, many industries have felt pressure to digitise more of their capabilities and services. From ride-hailing apps and refrigerators that know when you're out of milk, to virtual classrooms and chatbots, digitisation is everywhere you look. Fintech is just another example of an industry moving steadily into the digital age. Fintech is changing the world of finance for consumers in a myriad of ways. For example, you can now open a bank account over the internet, without physically visiting a bank. You can link the account to your smartphone and use it to monitor your transactions. You can even turn your smartphone into a "digital wallet" and use it to pay for things using money in your account.

Fig 1: Data Structure Algorithms
(Ref.; https://data-flair.training/blogs/data-structure-algorithms/)

1.1. Data Structure Algorithms

Fintech is also rapidly changing the insurance and investment industries. Car insurance providers now sell "telematics-based" insurance where your driving is monitored using data collected via your smartphone or a "black box" fitted in your car. This data can then be used to determine how much you pay for your insurance policy. In the future, it may be possible to buy insurance on a short-term or "pay as you go" basis. Fintech companies may be new to the financial industry and use different business models than traditional providers. This can make it harder to ascertain which ones are regulated, and what your rights are if something goes wrong. Financial products bought online may leave you more exposed to technology-based risks. For example, your personal data could be misused, or you could fall victim to cybercrime. FinTechs have transformed financial service delivery by leveraging technology to execute many traditional banking functions in a superior manner. Within technology usage, the adoption of disruptive technologies such as Artificial Intelligence has been the most discussed in the FinTech space. Performance is crucial for AI systems, and the efficiency of data structures directly impacts their operational speed. For instance, algorithms that utilise arrays may perform well for fixed-size problems but become inefficient when dealing with dynamic datasets. Meanwhile, trees provide logarithmic search times, making them more suitable for searching and decision-making tasks in sorted data.

2. REVIEW LITERATURE

2.1. Bo Li and Zeshui Xu stated that fintech development is driven by emerging technologies such as artificial intelligence,

blockchain, cloud computing, and big data analytics. Their bibliometric study explained that the efficiency of these technologies largely depends on robust algorithm design and effective data structures that support secure and scalable financial services. The researchers emphasised that algorithm optimisation helps reduce operational costs while improving processing performance in digital financial systems.

2.2. Donald Knuth, efficient data structures are fundamental to the development of optimal algorithms because they directly influence computational complexity, memory management, and processing speed. Knuth emphasised that selecting appropriate structures, such as trees, graphs, and hash tables, improves algorithmic efficiency and supports high-performance computing systems widely used in financial technologies and digital transaction processing.

2.3. Edsger W. Dijkstra argued that algorithm efficiency depends heavily on logical program design and suitable data organisation. His contributions to graph algorithms and shortest-path computation laid the foundation for modern fintech systems that require secure routing, transaction optimisation, and real-time financial analytics. Dijkstra believed that well-structured data models reduce computational errors and improve software reliability in complex systems.

2.4. Jian Huang, Junyi Chai, and Stella Cho explored the influence of deep learning and intelligent algorithms in banking and finance. Their findings demonstrated that algorithm performance in fintech systems depends significantly on data organisation methods and computational structures that support efficient training, prediction accuracy, and real-time analytics. Advanced data structures improve machine learning efficiency by reducing computational complexity and enhancing large-scale financial data processing.

2.5. Marta Barroso and Juan Laborda highlighted that digital transformation in the financial sector relies heavily on advanced computational techniques and optimised system architectures. Their systematic literature review identified blockchain systems, machine learning, and intelligent financial technologies as critical innovations requiring efficient algorithmic models and scalable data structures for enhanced fintech performance and service delivery.

2.6. Qianhua Liu, Ka-Ching Chan, and Ranga Chimhundu highlighted that fintech research increasingly integrates intelligent algorithms and scalable data-processing models to improve operational efficiency and digital financial services. Their systematic mapping study identified algorithm optimisation, financial data analytics, and intelligent systems as major research directions in fintech development. The study further explained that data-intensive fintech applications require efficient computational structures to handle large-scale banking and payment operations.

2.7. Ryan Randy Suryono, Indra Budi, and Betty Purwandari argued that technological advancement in fintech is strongly connected to intelligent information systems and optimised algorithmic frameworks. Their review emphasised the importance of big data processing, artificial intelligence, and scalable architectures in financial applications such as e-payments, peer-to-peer lending, digital wallets, and blockchain systems. The authors noted that selecting suitable data structures directly affects algorithm efficiency, response time, and transaction reliability in fintech ecosystems.

2.8. Robert Tarjan highlighted the importance of advanced data structures in improving algorithmic performance. His research on heaps, graphs, and amortised analysis demonstrated how optimised structures minimise processing time and increase scalability. These principles are highly relevant in fintech applications such as fraud detection, blockchain verification, and high-frequency trading systems, where rapid computation is essential.

2.9. Sartaj Sahni, the design and analysis of algorithms significantly affect the performance of modern computational systems. Sahni emphasised that efficient data structures improve execution speed, reduce complexity, and enhance scalability in applications involving large datasets and real-time operations. His contributions to algorithm optimisation and parallel computing are particularly important in fintech systems that process continuous streams of financial data.

3. RESEARCH METHODOLOGY

This Present Study Topic is 'The Influence of Data Structures on Optimal Algorithm Design and Performance in Fintech, ' which adopts a qualitative and quantitative research methodology to examine the influence of data structures on optimal algorithm design and performance in fintech systems. The research is based on a systematic review of secondary data collected from academic journals, conference papers, books, and reputable online databases related to computer science, financial technology, algorithms, artificial intelligence, blockchain, and data management systems. The study further applies a comparative analytical approach to evaluate different data structures, including arrays, linked lists, stacks, queues, trees, graphs, heaps, and hash tables, and their impact on algorithm efficiency in fintech applications such as digital payments, fraud detection, blockchain systems, algorithmic trading, and risk management. Performance indicators such as time complexity, memory utilisation, scalability, processing speed, and transaction efficiency were analysed to determine how data structures contribute to optimised algorithm design.

This research on "The Influence of Data Structures on Optimal Algorithm Design and Performance in Fintech" utilises both primary and secondary sources of data to achieve comprehensive and reliable findings. Primary data were collected through structured questionnaires, interviews, and discussions with software developers, fintech professionals, data analysts, and information technology experts involved in digital financial systems. The purpose of collecting primary data was to obtain practical insights into how different data structures influence algorithm efficiency, transaction processing speed, scalability, and system performance in real-world fintech

applications such as mobile banking, blockchain, fraud detection, and digital payment platforms. Secondary data were obtained from academic journals, textbooks, conference proceedings, research articles, industry reports, and reputable online sources. These secondary sources provided theoretical foundations and existing knowledge related to data structures, algorithm optimisation, artificial intelligence, blockchain systems, and fintech technologies. The collected information was carefully analysed and compared to identify patterns, technological advancements, and the relationship between efficient data structures and fintech performance. Combining both primary and secondary data enhanced the accuracy, validity, and depth of the research findings.

4. IMPACT of Data Structures

The integration of AI-driven solutions in risk management has revolutionised the way fintech companies approach this critical function. AI-powered systems can analyse vast amounts of structured and unstructured data, identify patterns and anomalies, and make intelligent predictions with greater accuracy and speed than traditional methods. By leveraging machine learning algorithms, natural language processing, and advanced analytics, fintech companies can automate and optimise their risk management processes, enhancing their ability to detect, prevent, and mitigate a wide range of risks. AI-powered systems can automate routine risk management tasks, such as fraud detection, credit risk assessment, and regulatory compliance monitoring.

This automation not only enhances efficiency but also frees up valuable human resources, allowing fintech companies to focus on more strategic and high-impact risk management initiatives. The financial data often contains errors, missing values, and inconsistencies. Data scientists employ data cleaning techniques to eliminate noise and ensure data quality. They preprocess the data by transforming it into a suitable format for analysis, including standardisation, normalisation, and feature engineering. AI is at the heart of driving new ideas and making FinTech services available to more people. Moreover, banks rely on AI to process loan applications, catch money laundering movements, generate business information, and improve how users interact through online tools (Kamaldeen, 2024).

Fig 2: The Impact of Fintech Platforms
(Ref.: https://www.bookmyforex.com/blog/the-impact-of-fintech-platforms-on-cross-border-money-transfers/)

4.1. The Impact of Fintech Platforms

According to Alemu (2024), nowadays AI is used in digital credit scoring systems to assess borrowers' risks with the help of data from their social media or phone use. This has opened more opportunities for financial services to those who do not have credentials or records. Addy et al. (2024) state that AI is helping both FinTech companies and regular banks become more efficient in their usual work while reducing the chances of errors and costs. AI is now being used widely in all areas of FinTech instead of just for some specialised tasks. AI and data science are the keystone enablers of FinTech and new-generation finance, economics and society. AIDS essentially and comprehensively transforms the way and effect financial businesses operate, transact, interact and collaborate with their consumers, markets, and regulators. AIDS innovates new and intelligent FinTech for more efficient, convenient, personalised, explainable, secure and proactive financial products and services.

To achieve these, on one hand, AIDS technologies, including knowledge representation, machine learning, pattern recognition, signal processing, data analytics, computer vision, natural language processing, biometrics, and computational intelligence, evolve to cultivate FinTech. On the other hand, FinTech is driving new AIDS research and innovation. Trading can be automatically made by computerised algorithms, called algorithmic trading, and high-frequency trading has become a critical trading method and behaviour in more and more markets. AI, machine learning and data science are crucial to identify positive trading signals, design trading strategies, and lodge and execute trading orders in markets with higher winning chances and profitability.

5. Table and Diagram Analysis

5.1. Scalability: 15%. Scalability is an important factor in FinTech systems because financial platforms must handle millions of users and transactions simultaneously. Efficient data

structures improve system scalability by organising and managing large datasets effectively. This helps banks, payment gateways, and trading platforms maintain high performance even during peak usage.

5.2. Real-time Processing: 20%. Real-time processing is essential in modern financial applications such as online banking, digital payments, and stock trading. Optimised data structures allow algorithms to process transactions quickly with minimal delay. Faster data access and execution improve customer experience and support instant financial decision-making.

5.3. Security and Reliability: 25%. Security and reliability have the highest impact in FinTech because financial systems manage sensitive customer information and monetary transactions. Advanced data structures help secure data storage, improve encryption support, and strengthen fraud detection systems. Reliable algorithms ensure accurate transaction processing and reduce system failures.

5.4. Data Structures: 7%. Data structures form the foundation of efficient algorithm design. They determine how data is stored, accessed, and modified in FinTech systems. Proper selection of data structures improves computational efficiency, reduces memory usage, and enhances overall software performance.

5.5. Arrays and Linked Lists: 10%. Arrays and linked lists are commonly used for managing transaction records and dynamic financial data. Arrays provide quick access to stored information, while linked lists support flexible insertion and deletion operations. These structures are useful in transaction queues and account management systems.

6.6. Trees Support: 15%. Tree-based data structures help organise hierarchical financial data efficiently. They improve searching, sorting, and database indexing operations in banking and trading applications. Balanced trees provide faster data retrieval, making them suitable for large-scale financial systems.

5.7. Graphs: 8%. Graphs are widely used in FinTech for fraud detection, blockchain analysis, and transaction network management. They help identify relationships between accounts and detect suspicious financial activities. Graph-based algorithms improve analytical capabilities and support intelligent decision-making in financial systems.

Table 1: Impact key

S.NO.	Impact key	Percentage
1.	Scalability	15 %
2.	Real-time processing	20 %
3.	Security, Reliability	25 %
4.	Data structures	7 %
5.	Arrays and linked	10 %
6.	Trees support	15 %
7.	Graphs	8 %

5.1. Table Shows Impact Key

Data structures play a vital role in improving the performance and efficiency of FinTech systems. They directly impact scalability, real-time processing, and especially security and reliability, which have the highest importance. Efficient use of arrays, linked lists, trees, and graphs helps in faster data handling, better transaction management, and advanced fraud detection.

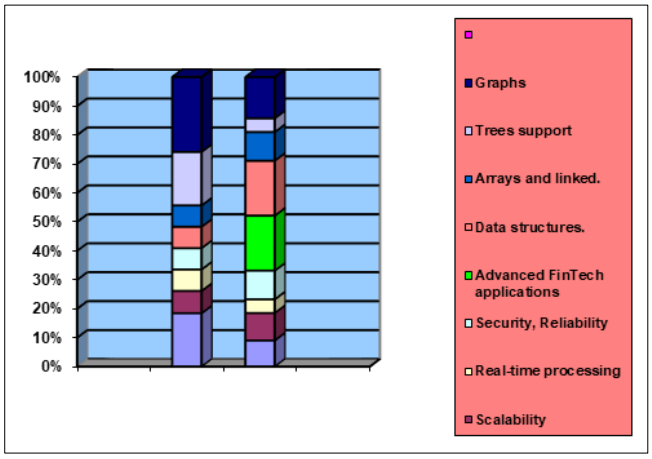

Fig 3: Impact Key

5.2. Diagram Shows Impact Key

Overall, well-designed data structures enable optimal algorithm performance, reduce time and space complexity, and support secure, fast, and scalable financial applications in modern FinTech systems

6. CONCLUSION

This Present Study Topic is 'The Influence of Data Structures on Optimal Algorithm Design and Performance in Fintech. Conclude, The Financial technology relies heavily on fast, secure, and scalable software systems to process transactions, analyse market trends, detect fraud, and manage customer data. At the core of these systems are data structures, which determine how efficiently data is stored, accessed, and manipulated. The choice of data structures directly influences algorithm design, execution speed, memory usage, and overall system performance. Data structures provide organised ways of storing and managing data so that algorithms can operate efficiently. Different FinTech applications require different data handling techniques depending on the type and volume of data involved. Data structures are essential in FinTech because they improve the efficiency, speed, and scalability of financial systems. Structures such as arrays, hash tables, trees, heaps, and graphs help organise and process large amounts of financial data effectively. They support important applications like transaction processing, fraud detection, blockchain systems, and high-frequency trading. Efficient data structures reduce time and memory complexity, enabling faster algorithms and real-time decision-making. For example, hash tables provide quick data retrieval, while trees and graphs help manage complex financial relationships and analytics. Choosing the right data structure enhances system performance, security, and reliability, making it a key factor in modern FinTech development.

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