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Original Paper

An Overview of Concepts and Applications of Fintech with Emphasis on Simulation and Artificial Intelligence

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Abstract

This paper discusses the Concepts and Applications of Fintech with emphasis on Simulation and Artificial intelligence for Optimization of the Financial outputs. The true amalgamation of the two topics (Finance and Technology) has taken place to give rise to Fintech, a topic which is evolving very fast in recent times. This paper is expected to be very useful for the researchers and managers engaged in this important field.

Keywords

Fintech, Simulation, Artificial Intelligence, Trends in Fintech, Digital Assets

1. Introduction

The topic of finance studies has drawn a lot of interest during last decade owing to their importance in daily life. Now in the era pf Technology, an amalgamation of Finance and Technology has taken place to give rise to Fintech. Some premier Institutes have started imparting education in this newly developing field and giving degrees in this topic. Fintech, or financial technology, is the technological innovation in the design and delivery of financial services and products. It has been noticed that in the recent years, Technology in finance continues to evolve; advancements include the use of Big Data, artificial intelligence (AI), and machine learning for evaluating the investment opportunities, optimize portfolios, and mitigate risks. Focus has been constantly rising on customer outcomes. The desired outcome of Fintech is the ability to provide tailored, actionable advice to investors with greater ease of access and at lower cost. Fintech is now becoming an important part of the companies. A schematic of Fintech is given below:

Figure 1. Schematic of Fintech. Image Courtesy pixels.com

Some important careers in Fintech include more general technology careers, like as cybersecurity and AI, and those increasingly more pertinent to the asset management industry including blockchain development and quantitative analysis. A fintech career path needs a strong focus on computer science, programming, mathematics, and data science, besides a very deep and strong understanding of the financial market, including financial instruments and products. As a person with so varied qualities is difficult to find, some premier Institutes have started Engineering degrees covering syllabus according to these requirements.

It is necessary that Financial firms and practitioners change themselves for industry transformation, especially leveraging the benefits of both human and artificial intelligence. Realising the significant impact of fintech at present and on the asset management industry, including trading, and quantitative method, CFA Institute has taken initiative and included fintech topics (AI, machine learning, algorithmic trading, data science, blockchain, and robo-advising) into the science, which can help the future investment professionals with a roadmap to career success, including the types of roles coming with the rapid growth of fintech in the industry. In the future, some key technologies will drive business for the benefit of the competitive landscape of the financial industry. Technological progress and innovation have mainly resulted in Fintech development, and are expected to drive disruptive business models in financial services. The top financial McKinsey analysis has stated that some key technologies will drive Fintech development and will improve the competitive landscape of finance in future.

2. Artificial Intelligence

McKinsey has estimated that Artificial Intelligence (AI) can generate about $1 trillion additional value for the global banking industry annually. Banks and other financial institutions are expected to develop an AI-first mindset, which will better prepare them to resist harming their territory by expanding technology firms. AI semantic representation, knowledge graphs and graph computing will play an important role in improving the business because of their ability to assist in building associations and identifying patterns across complex financial networks. Another tool - Analytics, which incorporates enhanced privacy protections will lead to minimal data usage in the training of financial models, including federated learning, a form of decentralized machine learning that addresses the risk to privacy associated with centralizing datasets by bringing the computational power to the data, rather than vice versa. Advanced encryption is also useful for secure multi-party computing, zero-knowledge proofs, and other privacy-aware data analysis tools will drive a new frontier in consumer protection. AI applications are penetrating the entire spectrum of financial industry operations across front, middle, and back offices. Fintech has application for customers and office. Some of the important Customer-facing applications are: tailored products, personalized user experience and analytics services, intelligent service robots and chat interface. The office applications include smart processes, enhanced knowledge representation tools, and natural language processing for fraud detection. Interestingly, Some financial institutions use AI in some scattered ways, by applying the technology for specific cases. However, banks are transforming their operations by systemically deploying AI for the whole lifecycle of their digital operations. The financial industry is also realizing now that algorithms are only as good as their data. Attention is turning now to gaining competitive advantage from previously under-used customer behavior data collected via conventional operations, which will unlock the so far unused potential of ecosystem-based financing, in which banks, insurers. The AI-first institution are providing much greater operational efficiency through the extreme automation of manual tasks, and the upgradation of human decisions by using advanced diagnostics tools. Operational performance is improved greatly by the broad application of traditional and cutting-edge AI technologies, including machine learning and facial recognition, to real-time analysis of large and complex customer data sets. AI-first banks of the future are going to adopt the speed and agility enjoyed by digital native companies. They will innovate at a rapid clip, releasing new features in days and weeks instead of months and years. Banks are innovating and innovating extensively with non-bank partners to offer new value propositions, which are integrated across journeys and technology platforms.

3. Blockchain Impact on Financial Protocols

A new technology called Distributed Ledger Technology (DLT) has been developed, which allows the recording and sharing of data across multiple data stores, and also for transactions and data to be recorded, shared, and synchronized across a distributed network of participants in the real time. DTLs also use blockchains for storing and transmitting their data to record and synchronize the data across the network. In addition, the stakeholders, and funds, are gradually increasing the share of digital assets in their portfolios, which leads to the broadening access to financing and thereby elevating the potential of blockchain and DTL to disrupt established markets. Also, the Decentralized finance (DeFi), a form of blockchain- based finance which uses smart contracts to remove the need for a central intermediary. Some important related concepts are just briefly given below:

3.1 Real-time Transaction Settlement

Interestingly, banks are smart contracts to settle the collateral and cash part of a transaction at the same time; and in addition, the Transaction processing, securities lending, and equity trades can be settled on the blockchain for improving the efficiency and scalability of cross-border sales.

3.2 Digital Asset Support Services

Institutional investors are employing DLT capabilities, including tokenization for unlisted companies or private equity funds, spot exchange between established currencies and cryptocurrencies on digital exchanges, and custody services e.g. key escrow encryption on behalf of customers.

3.3 Authentication Ecosystems

It has been established that the customers are making use of the agreed-to-share information from their partner institutions for confirming their identity online, face-to-face, or even through phone calls, thereby simplifying authentication procedures and also providing streamlined access to health records. The good point is that only information required for each specific transaction is shared, and all other data remains safe on the server of the trusted provider; which makes this useful to follow.

3.4 Decentralized Finance (DeFi)

Decentralized non-custodial applications are able to replace intermediaries by automatically generating deterministic, which makes it possible to obtain loans, make investments, or trade financial products without the requirement of relying on financial entities under centralized management; as it adopts deterministic smart contracts, which eliminate counterparty risks and cut out the costs associated with rent- seeking intermediaries. DeFi based on blockchain technology is bringing in a new era of opportunities, by disrupting traditional value chains and structures.

4. Cloud Technology

According to McKinsey research, cloud technology will account for EBITDA (earnings before interest, tax, depreciation and amortization) in excess of Rs 100 trillion of the world's top 500 companies. Their research shows that effective use of the cloud can increase the efficiency of migrated application development and maintenance by 38 percent; raise infrastructure cost efficiency by 29 percent; and reduce migrated applications' downtime by ~57 percent, thus lowering costs associated with technical violations by 26 percent; and thereby getting an all-round improvement in all the aspects of Financial transactions.

The financial experts are of the opinion that the Financial institutions should be aware of three important forms of cloud services: public cloud, hybrid cloud, and private cloud. Public cloud means that the infrastructure is owned by cloud computing service providers, who sell cloud services to various types organizations or the public. Hybrid cloud infrastructure consists of two or more types of cloud-private and public, which are maintained independently, but at the same time connected by proprietary technology. In Private cloud the infrastructure belongs to an individual for his exclusive use, deployable in the company data centers, or through other hosting facilities.

4.1 Cloud Containers

As is expected, the Public cloud providers are pushing hard the implementation of container technology on cloud, allowing multiple workloads to run on a single operating system, and so reducing overheads and improving efficiency. This results in driving innovation of cloud delivery models on the platform as a service (PaaS) layer. Cloud technology providers are expected to increasingly focus on building platforms that incorporate container as a service (CaaS), and so it's role is going to be very useful in future transactions of finance.

4.2 AI-cloud in Integration

AI-cloud platform applications are rapidly increasing in numbers in fields like image and audio search, driving advances in high-value areas such as medical image. Also, Deep learning will improve services for a broad range of users via cloud platforms. Cloud computing frees financial companies from non-core businesses like IT infrastructure and data centers, and at the same time enabling access to flexible storage and computing services at a lower cost.

5. Open Source, SaaS and Server Less

Open source software, server less architecture, and software-as-a-service (SaaS) have now become must-haves for technology players and financial institutions launching new fintech businesses. SaaS allows companies to use software as required without owning or maintaining it themselves, while server less architecture removes the need for firms to run their own servers, and hence freeing up time and resources for customers and their operations.

5.1 No-code and Low-code

No-code development platforms (NCDPs), and their close relation low-code platforms, help programmers and financial users to develop applications through graphical user interfaces and configurations, e.g., drag-and-drop instead of traditional computer programming. These platforms can reduce the need to hire scarce and expensive software talent. NCDP is the combination and application of component reuse and assembly in various techniques including software engineering, DSL (Domain Specific Language), visual fast development tools, customizable workflow process orchestration, and design thinking. Google Cloud has made large investment in no-code software platform Unqork, and acquired AppSheet. Both services allow general staff to develop applications without having specialized coding skills.

5.2 Hyper Automation Process- Automation (RPA), and Other Technologies and Tools That Improve Decision-making Efficiency and Work Automation Capabilities

RPA makes it easy for companies to deploy software robots such as chatbots at scale, and is already a major component of digital transformation, but technology. RPA’s main function is to allocate the handling of workflow information and business interactions to robots, and thereby automating and standardizing business execution. High repeatability, clear logic, and solid stability are the main criteria to validate RPA tech feasibility, and therefore, RPA will become more deeply integrated with AI in future, for improving its effectiveness in dealing with more complex business scenarios, and further streamlining financial service provision.

6. Future Competitiveness

Some key technologies and trends are becoming increasingly integrated, giving massive impetus to fintech and financial industry innovation. The potential Fintech research topics are: Cryptography for financial markets, Digital asset pricing, trading, mechanism design, and smart contracts, Dynamic credit rating and asset pricing, Entrepreneurial Fintech models, Financial risk indicator, platform and network modelling, Modelling natural, online, social, economic, cultural, and political factors in finance, Modelling financial scenarios, emergence, uncertainty, and ill- to un-structured systemic risk, Innovation in credit loans and risk genes.

Innovations in P2P lending and crowd-funding, Machine Learning and financial datasets, Models for robo-advising, Novel digital payment platforms, Open banking and its implications, Real time financial valuations, Social implications of Fintech, Textual analysis of financial data, Novel theories and tools for digital assets and their valuation, risk analysis, and management, Blockchain and tools for cryptocurrency, Visualization of big data financial systems, Complex financial technology and socio-economic problems and networks, Modelling complex relations, dependencies, interactions, and networking in finance, Modelling regional and global financial activities, behaviours, events, and their impact and risk, and Cross-market, digital financial products.

7. Mathematics Education in Fintech

Mathematical ideas and methods are integrated into the management of very complex and large systems including spaceflights, manufacturing, and the financial technology industry, and the employees in high-tech companies must have a strong mathematical background for succeeding in business. Mathematics is essential in all areas of daily life, e.g., we use basic arithmetic operations to do shopping or manage our time; and every profession involves some mathematical calculations. Many jobs such as engineers, programmers, and physicists require a deep knowledge of mathematics. To pursue a career in finance, we require mathematics too. An evaluation function G(t) returns an estimate of the expected utility of the game from a give position, just as heuristic functions return an estimate of the distance to the goal. The AI Equation is very much commonly used in Artificial intelligence and is given by:

$$G_t = \sum_{k=0}^{\infty} \gamma^k R_{t+k+1} where \gamma \in [0,1)$$

$$R_{t+1} + \gamma R_{t+2} + \gamma^2 R_{t+3} \ldots$$

where the Function G(t) is calculated by taking the summation of (gamma raised to power k) times R(t+k+1) from k=zero to infinity for a given value of t. It is a cumbersome Computation and is to be solved by an expert in the field and also using a quantum computer.

7.1 Theory of Simulation Using Quantum Computing with Spins Based on Qubits

For understanding the complicated concepts of AI, it is important to understand the Theory of Quantum computing (important for simulation studies) with spins based on qubits, which is the concept of applied mathematics. In quantum computing, logical operations on individual spins are performed using externally applied electric fields, and spin measurements are made using currents of spin-polarized electrons. Interestingly, the realization of such a computer is dependent on future refinements of conventional silicon electronics. The quantum computing is done by using some architecture for Semiconductor implementations. The pioneering work done on this topic is quite important and relevant still at present. The commonly used architectures are given below (by taking the example of Quantum computing with electron/nuclear spin):

Quantum computing with electron/nuclear spins is done by using an ideal qubit given by:

$$|\uparrow\rangle = |0\rangle$$
$$|\downarrow\rangle = |1\rangle \quad (1)$$

In this ideal qubit, the spin in the upward direction is taken as zero, and that in the downward direction is taken as unity. It is to be understood that in quantum computing, and specifically the quantum circuit model of computation, a quantum gate (or quantum logic gate) is a basic quantum circuit operating on a small number of qubits, which are the building blocks of quantum circuits. However, unlike many classical logic gates, quantum logic gates are reversible. The interaction is studied in terms of two types of gates represented by:

1-qubit gate, which functions for Spin rotation, and is given by:

$$\left|\uparrow\right\rangle \rightarrow \alpha\left|\uparrow\right\rangle + \beta\left|\downarrow\right\rangle \tag{2}$$

and 2-qubit gate, which functions for Exchange interaction, and is given by

$$\vec{S}_1 \cdot \vec{S}_2 \qquad \frac{\left|\uparrow\right\rangle - \left|\downarrow\right\rangle}{\sqrt{2}}\left|\uparrow\right\rangle \rightarrow \frac{\left|\uparrow\downarrow\right\rangle - \left|\downarrow\uparrow\right\rangle}{\sqrt{2}} \tag{3}$$

where $S_1.S_2$ is the spin interaction, in the form of an exchange interaction between 1st and 2nd sites. Finally, Quantum algorithms for doing the functions of Factoring and searching are represented by:

$$U_N \ldots U_1 \underbrace{\left|01\ldots0\right\rangle}_{Input} = \sum_n a_n \left|n\right\rangle \xrightarrow{Measurement} \underbrace{\left|10\ldots1\right\rangle}_{Output} \tag{4}$$

where U is the controlled U-gate, represented as:

It can be understood that the input in the form of the first term on the LHS of this Eqn. is equal to the middle term, which on measurement gives the output in the form of the term on the LHS of this Eqn. Also, $\left|u\right\rangle$ is an eigenstate of U, $\left|1\right\rangle$ being the component in the first qubit.

7.2 Two Spins in Two Quantum Dots: Quantum Gates

The universal set of quantum gates are formed by the total effect of Heisenberg interaction and the local magnetic field .The Heisenberg Hamiltonian, H_{spin} is based on the Heisenberg model, and is given by:

$$H_{spin} = g^{*}\mu_B \sum_i S_i.B + \sum_{i,j} J_{i,j} S_i.S_j \tag{5}$$

where J of N dipoles, g is the g - factor, defined as the unit-less proportionality factor relating the system's angular momentum to the intrinsic magnetic moment; being unity in classical physics, μ_B is the magnetic dipole moment, $\vec{B}$ is the magnetic field experienced by the nuclei, i and j refer to the sites on a lattice, S_i are spin operators which live on the lattice sites, $S_i.S_j$ is the spin interaction, in the form of an exchange interaction between i'th and i'th sites, and $J_{i,j}$ are called exchange constants. It is important to note that S is an integer or half-integer.

The quantum gates are of the form:

$$T \exp\{-i\int_0^t dt' H_{spin}(t')\}$$

It has also to be noted that the Bloch's equation is used to study (i) the total effect of Spin-orbit and phonons, (ii) the total effect of Hyperfine and phonons, (iii) the total effect of Spin-orbit and photons. This Eqn. is given by:

$$\frac{d\vec{M}}{dt} = g\mu_B \vec{B} \times \vec{M} - \frac{1}{T_2}\vec{M}_\perp - \frac{1}{T_1}\vec{M}_\parallel \qquad (6)$$

where $\frac{d\vec{M}}{dt}$ is the rate of change of nuclear magnetization ($\vec{M}$), $\vec{M}_\perp$ is the transverse nuclear magnetization, $\vec{M}_\parallel$ is the longitudinal nuclear magnetization, T_1 and T_2 are respectively longitudinal and transverse relaxations. This Eqn. is also used to study the spectral diffusion, which is nothing but the summation of nuclear spins, and time dependent magnetic fields. However, the case of unresolved hyperfine structure is quite complicated to study. Also, many other factors like different g-factors, inhomogeneous fields, and dipolar/exchange between unlike spins pose problems in analyzing such cases. Fintech companies are always trying to find out how to provide financial services faster and more effectively with the help of information technology.

While programmers, developers and project managers are trained at universities to become a product manager, FinOps specialist or DevOps engineer have to study the basics yourself or take highly focused training courses. By the way, there are plenty of them at the moment. Employees for these positions are most often nurtured by companies themselves by developing new skills on the basis of mathematics education.

Fintech needs a lot of analysts, as every year a new record is set for the amount of data generated. Huge numbers of online transactions including purchases, bookings, subscriptions, payments, transfers, and settlements generate a huge amount of data, structuring and interpretation of which allows companies to maximize profits and minimize risks, for which these taskstneed a mathematical background.

7.3 Artificial Intelligence (AI) Algorithms

There are dozens of examples of AI that everyday consumers may use, including facial recognition, auto-correct, search engines, or social media algorithms. AI runs off of algorithms, though not all AI algorithms are the same, since they are developed with different goals and methods. The four major categories of AI algorithms and their working are briefly given below:

Artificial intelligence is a branch of computer science dealing with creating machines that can think and make decisions independently of human intervention. These AI programs can do complex tasks which were previously only able to be done by humans. Some AI programs can complete simple tasks, while some more complex can take in data to learn and improve, completely without the touch of a human developer.

7.4 AI Algorithm

The definition of an algorithm is "a set of instructions to be followed in calculations and other operations", which applies to both mathematics and computer science. An AI algorithm is much more complex than algebra. A complex set of rules drive AI programs, which determine their steps and their ability to learn. AI is completely based on algorithms. Though a general algorithm can be simple, but AI algorithms are by nature more complex. AI algorithms work by taking in training data which helps the algorithm to learn. The manner in which data is acquired and is labeled marks the key difference between different types of AI algorithms. An AI algorithm takes in training data, labeled or unlabeled, supplied by developers, or acquired by the program itself, and uses that information to learn and grow. Finally, it completes its tasks, using the training data as a basis. There are three major categories of AI algorithms, namely supervised learning, unsupervised learning, and reinforcement learning. The main differences between these algorithms are the manner in which they are trained, and function.

The first category of algorithms is "Supervised learning", which work by taking in clearly-labeled data while being trained and using that to learn and grow, and use the labeled data to predict outcomes for other data. A supervised learning algorithm that actually works, is made by taking a team of dedicated experts to evaluate and review the results, and data scientists to test the models; and the algorithm creates to ensure their accuracy against the original data, and detect any errors from the AI.

7.5 Classification

Classification means an either/or result using binary (0 = no, 1 = yes), and so the algorithm will classify something as either one or another, but never both. Another type- multi-class classification, deals with organizing data into defined categories or types relevant to a specific need.

7.6 Regression

Regression means the result will end with a real number- either round or a decimal point. We generally have a dependent variable and an independent variable, and the algorithm uses both points to estimate a possible other result- either forecast or estimate.

The most common supervised learning algorithms, decision trees get their name because of their tree-like structure though the tree is inverted one. The roots of the tree are the training datasets and they lead to specific nodes which denote a test attribute, the nodes often leading to other nodes, and a node that does not ead onward is called a "leaf". Decision trees classify all the data into decision nodes, which uses a selection criteria called Attribute Selection Measures (ASM), which takes into account various measures e.g. entropy, gain ratio, and information gain. The random forest algorithm is a broad collection of different decision trees, leading to its name. The random forest builds different decision trees and connects them to gain more accurate results. These can be used for classification and regression.

Another common AI algorithm is the support vector machine (SVM) algorithm, which i.s used for either classification or regression. Interestingly, SVM works by plotting each piece of data on a chart in N dimensional space where N is the number of datapoints. The algorithm classifies the datapoints by finding the hyperplace which separates each class. It has to be noted that there can be more than one hyperplane.

7.7 Linear Regression

Linear regression is a supervised learning AI algorithm, which is based on regression modeling, and is mostly used for discovering the relationship between data points, predictions, and forecasting. Like SVM, it works by plotting pieces of data on a chart with the X-axis as the independent variable and the Y-axis as the dependent variable. The data points are plotted in a linear fashion to determine their relationship and forecast possible future data.

7.8 Logistic Regression

A logistic regression algorithm generally uses a binary value (0/1) to estimate values from a set of independent variables. The output of logistic regression is either 1 or 0, yes or no respectively.

7.9 Unsupervised Learning Algorithms

Unsupervised learning algorithms are given data that is not labeled, and they use that unlabeled data to create models and evaluate the relationships between different data points for giving more insight to the data.

8. Neural Networks

Neural network algorithm is a term, which is used for a collection of AI algorithms that mimic the functions of a human brain. These are more complex than many of the algorithms discussed above, and have applications beyond those discussed here.

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