

R55 Fintech in Investment Management

1. Introduction and What is Fintech	2
1.1 What is Fintech?.....	2
2. Big Data	2
2.1 Sources of Big Data	3
2.2 Big Data Challenges	3
3. Advanced Analytical Tools: Artificial Intelligence and Machine Learning.....	4
4. Data Science: Extracting Information from Big Data.....	5
4.1 Data Processing Methods.....	5
4.2 Data Visualization	5
5. Selected Applications of Fintech to Investment Management; Text Analytics & Natural Language Processing	6
5.1 Text Analytics and Natural Language Processing.....	6
6. Robo-Advisory Services.....	6
7. Risk Analysis	7
8. Algorithmic Trading	7
9. Distributed Ledger Technology, and Permissioned and Permissionless Networks	8
9.1 Permissioned and Permissionless Networks.....	9
10. Applications of Distributed Ledger Technology to Investment Management	10
Summary	12
Practice Questions	13

This document should be read in conjunction with the corresponding reading in the 2022 Level I CFA® Program curriculum. Some of the graphs, charts, tables, examples, and figures are copyright 2021, CFA Institute. Reproduced and republished with permission from CFA Institute. All rights reserved.

Required disclaimer: CFA Institute does not endorse, promote, or warrant the accuracy or quality of the products or services offered by IFT. CFA Institute, CFA®, and Chartered Financial Analyst® are trademarks owned by CFA Institute.

Version 1.0

1. Introduction and What is Fintech

This reading is divided into seven main sections. Section 2 covers 'What is Fintech?' Sections 3 and 4 cover 'Big data', 'artificial intelligence', and 'machine learning'. Section 5 covers data science. Section 6 covers applications of fintech to investment management. Finally, section 7 covers distributed ledger technology.

1.1 What is Fintech?

The term 'Fintech' comes from combining 'Finance' and 'Technology'. Fintech refers to technological innovation in the design and delivery of financial products and services.

Though the term 'Fintech' is relatively new, its earlier forms involved data processing and automation. Fintech's recent advancement include developing several decision-making applications.

The major drivers of fintech have been:

- Rapid growth in data
- Technological advances

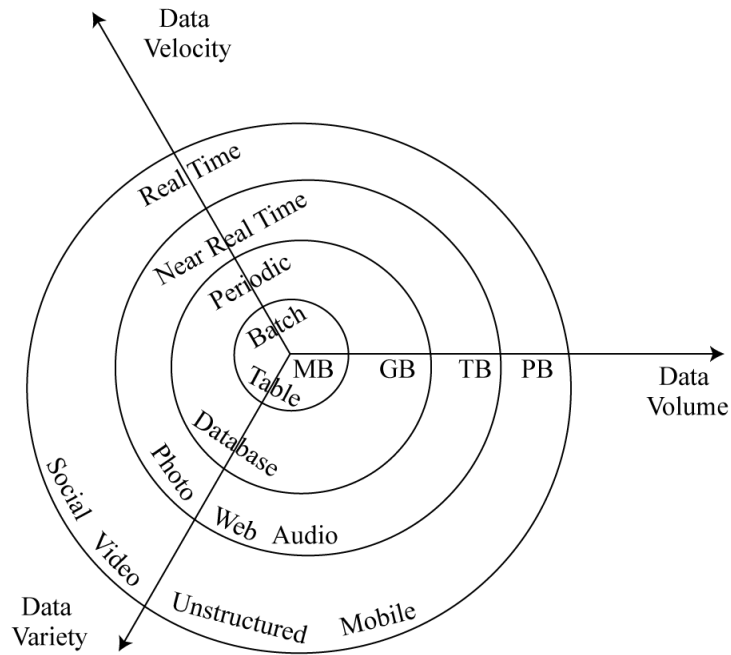
While Fintech spans the entire finance space, this reading focuses on fintech applications in the investment management industry. The major applications are:

- Analysis of large datasets
- Analytical tools
- Automated trading
- Automated advice
- Financial record keeping

2. Big Data

Big Data refers to vast amount of data generated by industry, governments, individuals, and electronic devices. Characteristics of big data typically include:

- Volume: Over the last few decades, the amount of data that we are dealing with has grown exponentially.
- Velocity: It refers to the speed at which data are communicated. In the past we often worked with batch processing; however, we are now increasingly working with real time data.
- Variety: Historically we only dealt with structured data. However, we are now also dealing with unstructured data such as text, audio, video, etc.



Data	Volume Key	Bytes of Information
MB	Megabyte	One Million
GB	Gigabyte	One Billion
TB	Terabyte	One Trillion
PB	Petabyte	One Quadrillion

2.1 Sources of Big Data

Traditional data sources include annual reports, regulatory filings, trade price and volume, etc. Alternate data include many other sources and types of data. A simple classification of alternate data sources is shown in Exhibit 2 of the curriculum.

Individuals	Business Processes	Sensors
Social media	Transaction data	Satellites
News, reviews	Corporate data	Geolocation
Web searches, personal data		Internet of Things
		Other sensors

2.2 Big Data Challenges

While big data can be a huge asset, there are also several challenges. The quality of data may be questionable. The data may have biases, outliers, etc. The volume of data collected may not be sufficient. We might be dealing with too much data or too little data. Another concern is the appropriateness of data. In most cases working with Big Data usually involves cleansing and organizing the data before we start analyzing it.

3. Advanced Analytical Tools: Artificial Intelligence and Machine Learning

Artificial intelligence (AI) computer systems perform tasks that have traditionally required human intelligence. They exhibit cognitive and decision-making ability comparable or superior to that of human beings. An important term in this context is ‘neural networks’. It refers to programming based on how the brain learns and processes information. There are examples of AI all around us. For example, chess playing computer programs, digital assistants like Apple’s Siri, etc.

Machine learning (ML) refers to computer-based techniques that “extract knowledge from large amounts of data by “learning” from known examples and then generating structure or predictions” without relying on any help from a human. ML algorithms aim to “find the pattern, apply the pattern.”

In ML, the dataset is divided into three distinct subsets:

- i. **Training dataset:** It allows the algorithm to identify relationships between inputs and outputs based on historical patterns in the data.
- ii. **Validation dataset:** It is used to validate and model tune the relationships identified by training dataset.
- iii. **Test dataset:** As the name implies, this dataset is used to test the model’s ability to predict well on new data.

Once an algorithm has mastered the training and validation datasets, it can be used to predict outcomes based on other datasets.

Broadly speaking there are three main approaches to machine learning:

1. **Supervised learning:** In supervised learning, both inputs and outputs are identified or labeled. After learning from labeled data, the trained algorithm is used to predict outcomes for new data sets.
2. **Unsupervised learning:** In unsupervised learning, the input and output variables are not labeled. Here we want the ML algorithm to seek relationships on its own.

Deep learning: In deep learning, (or deep learning nets), neural networks are used by the computers to perform multistage, non-linear data processing to identify patterns. Deep learning can use supervised or unsupervised machine learning approaches. With terms like AI and ML one might think that human judgment is not required, but that is far from the truth. For ML to work well, good human judgment is required. Human judgment is required for questions like: which data to use, how much data to use, which analytical techniques are relevant in the given context. Human judgment may also be needed to clean and filter the data before it is fed to the ML algorithm. Deep learning algorithms are used for image, pattern, and speech recognition.

Some challenges associated with machine learning are:

- **Over-fitting the data:** Sometimes an algorithm may try to be too precise in the way it

interprets data and predicts outcomes. This leads to over-trained models and may result in data mining bias. We try to mitigate this issue by having a good validation dataset.

- **Black box**: ML techniques can be opaque or black box, which means we have predictions that are not very easy to understand or to explain.

Despite these challenges and weaknesses, the importance of ML in finance and investment management has been growing substantially. In the next few sections, we will look at specific applications of AI and ML in the context of investment management.

4. Data Science: Extracting Information from Big Data

Data science leverages advances in computer science, statistics, and other disciplines for the purpose of extracting information from Big Data.

4.1 Data Processing Methods

Data processing methods include:

- **Capture**: Refers to how data is collected from various sources and transformed into a format that can be used by the analytical process.
- **Curation**: Refers to the process of ensuring data quality and accuracy through data cleaning.
- **Storage**: Refers to how data will be recorded, archived, and accessed. It also refers to the underlying databases design. An important consideration here is whether the data is structured, unstructured, or both. We also need to be concerned whether the analytical tools need real time access to the data or not.
- **Search**: Refers to how we can find what we want from the vast amount of data.
- **Transfer**: Refers to how data will move from the underlying source to the analytical tools that are being used.

4.2 Data Visualization

Another aspect of data science is data visualization. This refers to how the data will ultimately be presented to the analyst/user. Historically, data visualization happened through graphs, charts, etc. However, in more recent times tools such as heat maps, tree diagrams, and tag clouds are also being used.

An example of a heat map is a map of a city where routes with high traffic congestion are shown in red. A tag cloud is a technique applicable to textual data. Words that appear more often are shown in a larger font, whereas words that appear less often are shown with a smaller font. This helps us to quickly evaluate how consumers/users are talking about a given product.

5. Selected Applications of Fintech to Investment Management; Text Analytics & Natural Language Processing

So far, we have discussed Fintech in general, now we will look at selected applications of Fintech to investment management. There are four broad areas that we will consider:

5.1 Text Analytics and Natural Language Processing

Text analytics refers to the use of computer programs to derive meaning from large, unstructured text- or voice-based data. For example, text analytics can be used to gauge the consumer sentiment about a new product by analyzing what is being said about the product on blogs, forums, YouTube, etc. Based on this analysis, we can determine if the sentiment is very positive, positive, neutral, or negative.

Natural language processing is an application of text analytics whereby computers analyze and interpret human language. For example, NLP analysis can be used for communications from policy makers such as the US Federal Reserve. Officials at these institutions may send subtle messages through their choice of words and inferred tone. NLP analysis can provide insights into these subtle messages. Such processing is possible because of access to Big Data and processing power.

6. Robo-Advisory Services

This refers to providing investment solutions through online platforms. This replaces a human advisor with an online platform. Robo-advice typically starts with an investor questionnaire, which may include questions about income, spending, age, goals, investment horizon, etc. Based on the responses to these questions, the robo-adviser software uses algorithmic rules and historical market data to come up with recommendations. The types of solutions offered through robo-advisory services include:

- Automated asset allocation
- Rebalancing
- Tax strategies
- Trade execution

Robo-advisers typically have low fees and low account minimums. This has increased the penetrating power of these services in reaching mass market segments, and people with relatively low wealth can now afford these services.

Robo-advisers cover both active and passive investment styles, but passive styles tend to be more common. They are usually more conservative in nature.

There are two major types of robo-advisory services

- **Fully automated digital wealth managers:** As the term implies, there is absolutely no human involved in this model. These services offer low-cost investing solutions

and usually recommend an investment portfolio composed of ETFs.

- **Adviser-assisted digital wealth managers**: In addition to the online system, an investor also has access to a human advisor over the phone. The advisor can assist by giving a more customized advice based on the financial situation of the investor.

We need to recognize that robo-advice has its limits. There might be times, when an investor needs to speak to a person, especially in times of economic crises. Also, in instances where investors have specific needs or want to invest in alternative investments, robo-advice is not useful. However, despite these limitations robo-advisory services are becoming increasingly popular.

7. Risk Analysis

Stress testing and risk assessment involves a vast amount of risk data. This data can be in different forms – for example, structured or unstructured, quantitative or qualitative, etc. Also, there is an increased interest in monitoring risk in real time.

Instructor's tip: These characteristics correspond to the three V's of big data – volume, variety, and velocity. Hence this data can be considered Big Data.

Big Data and ML techniques can provide insight into changing market conditions. This can allow us to predict adverse market conditions and adverse trends.

Machine learning techniques can also be used to assess data quality. Faulty data, errors, outliers, etc., can be identified and removed from the analysis.

Big Data and ML techniques are also used in scenario analysis. Scenario analysis helps in evaluating the risk of a portfolio. For example, we can evaluate what would happen to our portfolio if the 2007 financial crisis scenario were to repeat itself. A common term used here is 'what-if' analysis. Here we evaluate what would happen to our portfolio under different market conditions.

These techniques have become increasingly popular because of our ability to deal with big data and the advanced analytical techniques that have been developed over the last few years.

8. Algorithmic Trading

Algorithmic trading refers to computerized trading based on pre-specified rules and guidelines. It can help us decide when, where, and how to trade. For example, after analyzing lots of past data an algorithmic program might tell you that trading during a certain time of day, on a particular exchange using limit orders is the most cost effective.

Algorithmic trading also allows us to take large orders and slice them into smaller pieces. These smaller pieces can be executed using the most appropriate exchanges and trading

venues.

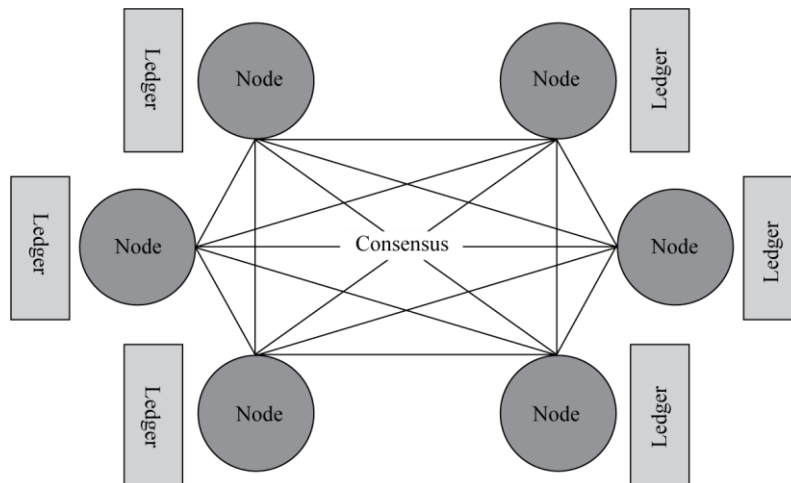
The benefits of algorithmic trading include:

- **Speed of execution**: Since trading is done by computer programs based on predefined rules, the speed of execution is much faster.
- **Anonymity**: Since large orders can be broken into smaller pieces and traded through different exchanges anonymity can be achieved, which may be important for some investors.
- **Lower transaction costs**: As discussed above, by identifying the most cost-effective way to trade, algorithmic trading helps lower transaction costs. Also, because large orders are broken down into several smaller orders, the market impact (which is a significant component of the transaction costs) of the order is reduced.

High-frequency trading (HFT) is one form of algorithmic trading. Here orders or trades are automatically placed when certain conditions are met. Time is a crucial factor for such trades. Therefore, HFT takes place on ultra-high-speed, low-latency networks.

9. Distributed Ledger Technology, and Permissioned and Permissionless Networks

A distributed ledger is a database which can be shared across computer entities (or nodes) in a network. This is illustrated in Exhibit 5 from the curriculum.



There can be thousands of nodes in a network. Every node will have a copy of the distributed ledger. There is a consensus mechanism which ensures that all these ledgers are kept in sync. Through the consensus mechanism all nodes agree on a new transaction and update their ledgers. New records are considered immutable, which means once a record is created it cannot be changed.

DLT uses **cryptography**, which refers to encrypting and decrypting data. Through encryption, we ensure that the data remains secure.

DLT also accommodates **smart contracts**. These are computer programs that self-execute on the basis of pre-specified terms and conditions. For example, contracts that automatically transfer collateral from the borrower to the lender in the event of default.

DLT networks allow us to create, exchange, and track ownership of financial assets on a peer-to-peer basis. There is no central authority to validate the transactions.

DLT benefits include:

- Accuracy, transparency, and security in the record keeping process.
- Faster transfer of ownership.
- Peer-to-peer interactions.

Blockchain is a type of distributed ledger. Its characteristics are:

- Information is recorded sequentially within blocks.
- Blocks are chained and secured using cryptography.
- Each block contains a grouping of transactions and a secure link to the previous block.

The following steps outline the process of adding new transactions to the Blockchain network.

1. A transaction takes place between buyer and seller.
2. The transaction is broadcast to the network of computers (nodes).
3. The nodes validate the transaction details and parties to the transaction.
4. Once verified, the transaction is combined with other transactions to form a new block (of predetermined size) of data for the ledger.
5. This block of data is then added or linked (using a cryptographic process) to the previous block(s) containing data.
6. The transaction is considered complete and the ledger has been updated.

9.1 Permissioned and Permissionless Networks

DLT can take the form of permissionless or permissioned networks.

Permissionless networks are open to any user who wishes to make a transaction. Once a transaction is added, it cannot be changed. All users can see all transactions on the block chain. These networks do not depend on a central authority.

In **permissioned** networks, network members may be restricted from participating in certain network activities. Controls or permissions might be used. Different users may have different levels of access to the ledger. For example, participants may be allowed to enter transactions while regulators may be allowed to view the transaction history.

10. Applications of Distributed Ledger Technology to Investment Management

Cryptocurrencies:

They are also called digital currency or electronic currency. These do not have any physical form, but allow transactions to take place between buyers and sellers. They are issued by private individuals or organizations. There is no central authority, like a central bank backing these currencies.

Many cryptocurrencies have a self-imposed limit on the total amount of currency they may issue. For example, a well-known cryptocurrency, Bitcoin has a self-imposed limit of 21 million.

We should also recognize the fact that with cryptocurrencies there is a lack of fundamentals underlying the value of the currency. Hence, they tend to be very volatile relative to major currencies like the Dollar or the Euro.

An *initial coin offering* (ICO) is an unregulated process whereby companies sell their crypto-tokens to investors. Through this process, investors fund the company and the tokens can be used to buy products and services from the company at a latter point in time.

Tokenization:

It is the process of representing ownership rights to physical assets on a blockchain or distributed ledger. Usually transactions involving physical assets, such as real estate, require substantial efforts in ownership verification and examination. DLT can streamline this process by creating a single digital record of ownership.

Post-Trade Clearing and Settlement:

In the financial securities market, the post-trade clearing and settlement process is quite cumbersome. DLT has the ability to streamline this process by providing near-real-time trade verification, reconciliation, and settlement. This can significantly reduce the complexity, time, and cost involved with processing transactions.

Compliance:

Over the last few years regulators have made reporting requirements stricter. They also demand greater transparency and access to data. Due to this, the cost and time associated with compliance activities has gone up substantially. In fact, in many companies the number of staff employed in compliance departments has gone up.

DLT can streamline the compliance process and bring down these costs. It can allow firms and regulators to get near-real-time access to transaction data, as well as other relevant compliance data. This will help firms and regulators to quickly uncover fraudulent activities. DLT can also reduce compliance costs associated with know-your-customer and anti-money-laundering regulations which require verification of the identities of clients and business

partners.

There are several challenges to DLT that need to be addressed before it is successfully adopted by the investment industry. They include:

- There is a lack of DLT network standardization.
- There is also difficulty in integrating DLT with existing systems.
- DLT processing capabilities are expensive.
- DLT systems require substantial storage resources.
- Due to immutability of transactions, mistakes can be undone only by submitting an equal and offsetting trade.
- DLT requires huge amounts of computational power. This results in high electricity usage. This can be a challenge in certain countries.
- Regulatory approaches towards DLT can vary across jurisdiction.

Summary

LO.a: Describe “fintech.”

Fintech refers to the technological innovation in the design and delivery of financial products and services.

LO.b: Describe Big Data, artificial intelligence, and machine learning.

Big Data refers to vast amounts of data generated by industry, governments, individuals, and electronic devices.

Artificial intelligence (AI) computer systems perform tasks that have traditionally required human intelligence. They exhibit cognitive and decision-making ability comparable or superior to that of human beings.

Machine learning (ML) refers to computer-based techniques that “extract knowledge from large amounts of data by “learning” from known examples and then generating structure or predictions” without relying on any help from a human. In ML, the dataset is divided into three distinct subsets, training dataset, validation dataset, and test dataset. There are three main approaches to machine learning, i.e., supervised learning, unsupervised learning, and deep learning.

LO.c: Describe fintech applications to investment management.

Major fintech applications include:

- Text analytics and natural language processing.
- Robo-advisory services
- Risk analysis
- Algorithmic trading

LO.d: Describe financial applications of distributed ledger technology.

Major DLT applications include:

- Cryptocurrencies
- Tokenization
- Post-trade clearing and settlement
- Compliance

Practice Questions

1. Fintech is *best* described as:
 - A. systems that provide execution of decisions based on certain rules and instructions.
 - B. technological innovation in the design and delivery of financial services and products.
 - C. processing of large traditional datasets with automation of routine tasks.
 2. The term Big Data typically means:
 - A. alternative data, arising from electronic devices, social media, sensor networks, and company exhaust.
 - B. datasets with data volumes growing from megabytes to petabytes available on a real-time or near-real-time basis in structured formats.
 - C. datasets having large volume, high velocity, and a variety of formats.
 3. Data generated by sensors *most likely* include:
 - A. structured data such as direct sales information, credit card data, as well as corporate exhaust.
 - B. data collected from smart phones, cameras, satellites, and internet of things.
 - C. data produced in text, video, photo, and audio formats.
 4. One of the challenges of using Big Data is *most likely* the:
 - A. dataset is structured and needs to be cleansed and organized before analysis.
 - B. dataset is quantitative instead of qualitative in nature.
 - C. dataset may have selection bias, missing data or data outliers.
 5. Which of the following statements on the use of fintech in the investment industry is correct?
 - A. Robo-advisors provide investment services to retail investors at lower cost than human advisors.
 - B. DLT with the help of financial intermediaries provide secure ways to track ownership of assets on a P2P basis.
 - C. Analysis of large datasets can be integrated into the portfolio's asset allocation process as part of investment strategies other than alpha generation.
 6. In machine learning (ML) the computer algorithm "learns" from:
 - A. data by modelling inputs to outputs (if provided) or identifying underlying data structures (if outputs are not given).
 - B. identifying relationships between inputs and outputs based on future patterns expected in the data.
 - C. training datasets to arrive at easily understood outcomes through "black box"
-

approaches.

7. A “tag cloud” is a Big Data visualization technique where:
 - A. words that appear less frequently are shown with a larger font and words that appear more often are displayed with a smaller font.
 - B. the relationship between different concepts is shown.
 - C. words are sized and displayed based on the frequency of the word in the data file.
 8. Which of the following statements is *least* accurate? Natural language processing may be used to detect:
 - A. trends in aggregate output, interest rates, or inflation.
 - B. fraud or inappropriate conduct in adherence to company policies.
 - C. trends and indicators about a stock by incorporating traditional data only.
 9. Which of the following investment advisory services may *not* be provided by robo-advisors?
 - A. Automated asset allocation and trade execution.
 - B. Tax-loss harvesting and rebalancing of portfolios.
 - C. Customized allocation for high-net-worth clients investing in different asset types.
 10. Risk analysis using Big Data provides:
 - A. real-time identification of changing market conditions and adverse trends.
 - B. stress testing excluding qualitative data.
 - C. insight into future stock performance by segregating traditional and alternative data with ML techniques.
 11. The benefits of algorithmic trading are:
 - A. speed and anonymity but higher transaction costs.
 - B. best limit or market order and most appropriate trading venue.
 - C. seeking to earn a profit from investment decisions based on the end-of-day market prices.
 12. Which of the following is *not* a step in adding a transaction to a blockchain distributed ledger?
 - A. Transaction between a buyer and seller is broadcast to a network of computers (nodes).
 - B. Nodes validate the transaction details and parties to the transaction.
 - C. Each verified transaction forms a new block which is not linked with previous data as the ledger updates.
 13. Which of the following is a feature of cryptocurrencies?
-

- A. Cryptocurrencies have clear fundamentals which help to stabilize volatility.
 - B. Cryptocurrencies have a self-imposed limit on the total amount of currency they may issue.
 - C. Cryptocurrencies are government backed but not regulated.
14. Which of the following is *most likely* correct about permissioned networks?
- A. Permissioned networks do not depend on a central authority.
 - B. Different users may have different levels of access to the ledger.
 - C. Networks are open to any user who wishes to make a transaction.

Solutions

1. B is correct. Fintech refers to technological innovation in the design and delivery of financial services and products. Fintech can also refer to companies (often new, startup companies) involved in developing new technologies and their applications, as well as the business sector that comprises such companies.
 2. C is correct. The term Big Data refers to datasets having the following characteristics:
 1. Volume: Vast amount of data collected in files, records, and tables growing from megabytes (MB) and gigabytes (GB) to larger sizes, such as terabytes (TB) and petabytes (PB).
 2. Velocity: Data communicated at very high speed available on a real-time or near-real-time basis.
 3. Variety: Data collected in a variety of formats including structured, semi-structured and unstructured data.
 3. B is correct. Sensor data are collected from such devices as smart phones, cameras, RFID chips, and satellites. Sensor data can be unstructured, arising from microprocessors and networking technology that are present in most personal and commercial electronic devices. Extended to office buildings, homes, vehicles, and many other physical forms, this forms a network arrangement, known as the Internet of Things. A is incorrect because data generated by business processes include structured data from corporations and other public entities. It comprises direct sales information, such as credit card data, as well as corporate exhaust. C is incorrect because data generated by individuals are often produced in text, video, photo, and audio formats.
 4. C is correct. Big Data poses several challenges when used in investment analysis, including the quality, volume, and appropriateness of the data. Key issues include dataset with selection bias, outliers, or missing data. A & B are incorrect because qualitative dataset which is associated with unstructured data is more difficult to source, cleanse, and organize than quantitative data.
 5. A is correct. Robo-advisers or automated personal wealth management services provide investment services to retail investors at lower cost than traditional adviser models can provide. B is incorrect because although DLT may provide secure ways to track ownership of financial assets on a peer-to-peer (P2P) basis but it reduces the need for financial intermediaries. C is incorrect because large datasets can now be integrated into a portfolio manager's investment decision-making process for generating alpha and reducing losses.
 6. A is correct. In ML, the computer algorithm is given "inputs" (a set of variables or
-

datasets) and may be given “outputs” (the target data). The algorithm “learns” from the data provided by finding the best way to model inputs to outputs (if provided) or how to identify or describe underlying data structures if no outputs are given. B is incorrect because the training dataset allows the algorithm to identify relationships between inputs and outputs based on historical patterns in the data. C is incorrect because the ML algorithm after mastering the training and validation datasets, predicts outcomes based on other datasets. ML techniques that arrive at unexplainable outcomes are known as “black box” approaches.

7. C is correct. A Big Data visualization technique applicable to textual data is a “tag cloud,” where words are sized and displayed on the basis of the frequency of the word in the data file. A is incorrect because words that appear more often are shown with a larger font, and words that appear less often are shown with a smaller font. B is incorrect because a “mind map”, another data visualization technique, shows how different concepts are related to each other.
8. C is correct. After analyzing the analyst’s commentary, NLP can assign sentiment ratings ranging from very negative to very positive for each company. NLP can be used to detect, monitor, and tag shifts in sentiment, potentially ahead of an analyst’s recommendation change. NLP may also be employed in compliance functions to review employee electronic communications for adherence to company or regulatory policy, inappropriate conduct, or fraud. Similarly, communications and transcripts from policymakers, such as the Central Bank offer an opportunity for NLP-based analysis to provide insights about trending or waning interest rates, aggregate output, or inflation expectations. NLP analysis may incorporate non-traditional information too, in an attempt to identify trends and short-term indicators about a company, a stock, or an economic event that might impact future performance.
9. C is correct. If the complexity and size of an investor’s portfolio grows, robo-advisers may not be able to cater to the particular preferences and needs of the investor. For example, extremely affluent investors who may own a greater number of asset types— including alternative investments (e.g., venture capital, private equity, hedge funds, and real estate)—in addition to global stocks and bonds would need customization, hence they demand human advisers rather than robo-advisers. A & B are services typically provided by robo-advisers to mass market segments.
10. A is correct. Big Data may provide insights into real-time and changing market circumstances to identify weakening market conditions and adverse trends in advance, allowing managers to use risk management techniques and hedging practices. B is incorrect because stress testing may consider qualitative information also. C is incorrect because valuation of alternative data using ML techniques may help foreshadow declining

company earnings and future stock performance. After validation by ML techniques, alternative data is integrated with traditional data and used in risk models.

11. B is correct. Algorithmic trading provides benefits of speed of execution, anonymity, and lower transaction costs. Algorithms may also determine the best way to price the order (e.g., limit or market order) and the most appropriate trading venue (e.g., exchange or dark pool) to route for execution. High-frequency trading (HFT), is a form of algorithmic trading which decides what to buy or sell and where to execute on the basis of real-time prices and market conditions, seeking to earn a profit from intraday market mispricings.
12. C is correct. Once verified, the transaction is combined with other transactions to form a new block (of predetermined size) of data for the ledger. This block of data is then added or linked (using a cryptographic process) to the previous block(s) containing data. The transaction is considered complete and the ledger has been updated.
13. B is correct. Many cryptocurrencies have a self-imposed limit on the total amount of currency they may issue. Although such limits may maintain their store of value, but cryptocurrencies have experienced high levels of price volatility. A is incorrect because cryptocurrencies lack clear fundamentals which contribute to their volatility. C is incorrect because cryptocurrencies are neither government backed nor regulated.
14. B is correct. In permissioned networks, network members may be restricted from participating in certain network activities. Controls or permissions might be used. Different users may have different levels of access to the ledger. Permissionless networks are open to any user who wishes to make a transaction. Once a transaction is added, it cannot be changed. All users can see all transactions on the block chain. These networks do not depend on a central authority.