Concepts n Clarity®

Risk Management

1. **The Risk Management Process** a. define risk management; b. describe features of a risk management framework;

2. **Risk Governance** c. define risk governance and describe elements of effective risk governance; d. explain how risk tolerance affects risk management; e. describe risk budgeting and its role in risk governance;

3. **Identification of Risks**
   f. identify financial and non-financial sources of risk and describe how they may interact;

4. **Measuring and Modifying Risks** g. describe methods for measuring and modifying risk exposures and factors to consider in choosing among the methods.

Subject 1. The Risk Management Process

Risk is exposure to uncertainty. In investment, risk includes the possibility of losses. Taking risks is an active choice by institutions and individuals. Risks must be carefully understood, chosen, and well-managed.

Risk exposure is the extent to which an entity's value may be affected through sensitivity to underlying risks.

Risk management is a process that defines risk tolerance and measures, monitors, and modifies risks to put them in line with that tolerance.
It is NOT about minimizing, avoiding or predicting risks. It is about understanding, measuring, monitoring, and modifying risks.

A risk management framework is the infrastructure, processes, and analytics needed to support effective risk management. It includes:

- **Risk** governance is the top-level foundation for risk management. It provides the overall context for an organization's risk management, which includes risk oversight and setting risk tolerance for the organization. It directs risk management activities to align with and support the goals of the overall enterprise.
- **Risk** identification and measurement is the quantitative and qualitative assessment of all potential sources of risk and risk exposures.

- **Ris**k infrastructure comprises the resources and systems required to track and assess an organization's risk profile.

- **Risk** policies and processes are management's complement to risk governance at the operating level.

- **Risk** monitoring, mitigation and management is the active monitoring and adjusting of risk exposures, integrating all the other factors of the risk management framework.

- **Communication** includes risk reporting and active feedback loops so that the process improves decision making.

- **Strategic risk analysis and integration** involves using these risk tools to rigorously sort out the factors that are and are not adding value as well as incorporating this analysis into the management decision-making process, with the intent of improving outcomes.

Subject 2. Risk Governance

Governance and the entire risk process should take an enterprise risk management perspective to ensure that the value of the entire enterprise is maximized. For example, a corporate pension fund manager should consider not only the pension assets and liabilities but also the parent corporation's business risk profile. In other words, the focus should be on the organization as a whole.

Useful approaches to ensuring a strong risk governance framework:

- Employ a risk management committee.
- Appoint a chief risk officer.

Risk Tolerance

Risk tolerance, a key element of good risk governance, establishes an organization's risk appetite.

Ascertaining risk tolerance starts from an inside view and an outside view. What shortfalls within an organization would cause the organization to fail to achieve some critical goals? What are the organization's risk drivers? Which risks are acceptable and which are unacceptable? How much risk can the overall organization be exposed to?

Risk tolerance is then formally chosen using a top-level analysis. The organization's goals, expertise in certain areas, and strategies should be considered when determining its risk tolerance. This process should be completed and communicated *before* a crisis.

Risk Budgeting

While risk tolerance determines *which risks* are acceptable, risk budgeting decides *how* to take risks. It is a means of implementing risk tolerance at a strategic level.

Risk budgeting is any means of allocating investments or assets based on their risk

characteristics. Single or multiple dimensions of risk can be used. Common single-dimension risk measures are standard deviation, beta, value at risk, and scenario loss. The risk budgeting process forces the firm to consider risk trade-offs. As a result, the firm should choose to invest where the return per unit of risk is the highest.

Some risk budgeting practices:

- Limit the standard deviation of the entire portfolio to within 15%.
- Allocate 10%, 35% and 55% of total capital in T-bills, long-term corporate bonds, and stock market index-linked mutual funds, respectively.
- Use a risk factor approach to allocate assets.

Subject 3. Identification of Risk

There are two general categorizations of risks.

Financial Risks

Financial risks originate from the financial markets.

- **Market risk** arises from movements in stock prices, interest rates, exchange rates, and commodity prices.
- **Credit risk** is the risk that a counterparty will not pay an amount owed.
- **Liquidity risk** is the widening of the bid-ask spread on an asset. It is usually caused by degradation in market conditions or a lack of market participants.

Non-Financial Risks

Non-financial risks arise from actions within an entity or from external origins, such as the environment, the community, regulators, politicians, suppliers, and customers. They include:

- **Settlement risk**: one party fails to deliver the terms of a contract with another party at the time of settlement.
- **Legal risk**: the risk of being sued, or of the terms of a contract not being upheld by the legal system.
- **Compliance risk**: **regulatory risk**, **accounting risk** and **tax risk**. Companies may fail to respond quickly when laws and regulations are updated.
- **Model risk**: the risk of improperly using a model. An example is tail risk which suggests that distribution is not normal, but skewed, with fatter tails.
- **Operational risk**: the risk that arises from within the operations of an organization and includes both human and system or process errors.
- **Solvency risk**: the risk that the entity does not survive or succeed because it runs out of cash to meet its financial obligations.

Individuals face many of the same organizational risks outlined here, as well as health risks, mortality or longevity risks, and property and casualty risks.

Risks are not necessarily independent. because many risks arise as a result of other risks; risk interactions can be extremely non-linear and harmful. For example, fluctuations in the interest rate cause changes in the value of the derivative transactions but could also impact the creditworthiness of the counterparty. Another example might occur with an emerging-market counterparty, where there is country and possibly currency risk associated with the counterparty (however creditworthy it might otherwise be).

Subject 4. Measuring and Modifying Risks

Drivers

To understand how to measure risk, we need to first understand what drives risk. Risk drivers are the fundamental global and domestic macroeconomic and industry factors that create risk.

- All risks come from uncertainties.
- Financial risks come from fundamental factors in macro-economies and industries.
- There are systematic risks and unsystematic (diversifiable) risks.

Risk management can control some risks but not all.

Metrics

Common measures of risk:

- Probability
- Standard deviation: measures dispersion in a probability distribution. This has significant limitations.
- Beta: measures the sensitivity of a security's returns to the returns on the market portfolio.
- Measures of derivatives risk: delta, gamma, vega and rho.
- Duration measures the interest rate sensitivity of a fixed income security.
- Value at Risk: measures the potential loss in value of a risky asset or portfolio over a defined period for a given confidence interval. If the VaR on an asset is $100 million at a one-week, 95% confidence level, there is only a 5% chance that the value of the asset will drop more than $ 100 million over any given week.
- CVaR: scenario analysis and stress testing, can be used to complement VaR.

It is difficult to measure rare events such as operational risk and default risk.

Methods of Risk Modification

There are four broad categories of risk modification.

Risk prevention and avoidance. Completely avoiding risk sounds simple, but it may be

difficult or sometimes impossible. Furthermore, does it even make sense to do so? Almost every risk has an upside. There is always a trade-off between risk and return.

Risk acceptance. Risk can be mitigated internally through self-insurance or diversification. This is to bear the risk but do so in the most efficient manner possible.

Risk transfer. This is to pass on a risk to another party, often in the form of an insurance policy. An insurer attempts to sell policies with risks that have low correlations and can be diversified away.

Risk shifting. This refers to actions that change the distribution of risk outcomes. The principal device is a derivative which can be used to shift risk across the probability distribution and from one party to another. There are two categories of derivatives: forward commitments and contingent claims.

The primary determinant of which method is best for modifying risk is weighing the benefits against the costs, with consideration for the overall final risk profile and adherence to risk governance objectives.

1. **Fintech fundamentals**

   a. describe fintech
   b. describe Big Data, artificial intelligence, and machine learning

2. **Fintech applications to investment management**

   c. describe fintech applications to investment management

3. **Financial applications of distributed ledger technology**

   d. describe financial applications of distributed ledger technology.

Subject 1. Fintech fundamentals

Fintech

Fintech is financial technology: finance + technology. It is to describe new tech that seeks to improve and automate the delivery and use of financial services.

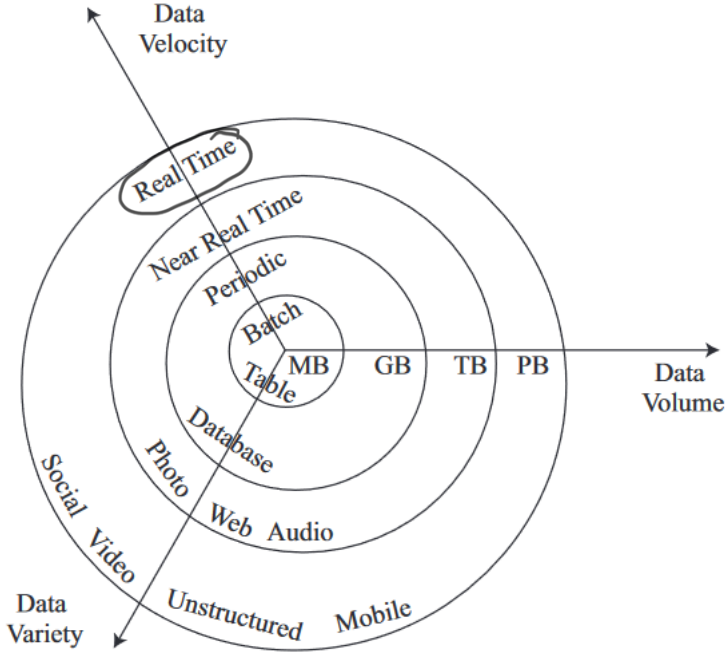
Drivers of fintech include extremely rapid growth in data (including quantity, types, sources and quality) and technological advances enabling the capture and extraction of information from it. In the investment industry, fintech development areas include

analysis of large datasets, analytical tools (AI and ML) , automated trading, automated advice, and financial record keeping.

Big Data

The term Big Data has been in use since the late 1990s and refers to the vast amount of data being generated by industry, governments, individuals, and electronic devices. Big Data includes data generated from traditional sources—such as stock exchanges, companies, and governments—as well as non-traditional data types, also known as alternative data, arising from the use of elec-tronic devices, social media, sensor networks, and company exhaust (data generated in the normal course of doing business).

Exhibit 1 Big Data Characteristics: Volume, Velocity, and Variety



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

The three Vs are fundamental to Big Data:

- **Volume**: huge amount of data.
- **Velocity**: the speed at which data must be stored and analyzed.
- **Variety**: data are gathered from various sources in a variety of formats (e.g. structured data, unstructured data).

The non-traditional sources include data generated by individuals, business processes and sensors, while the traditional sources are financial markets, businesses (e.g. financials, credit card purchases) and governments (e.g. employment and payroll data).

Exhibit 2 Classification of Alternative Data Sources

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

Artificial Intelligence and Machine Learning

As data sets get larger and more complex, investors need to use sophisticated data analysis techniques. The tools used for these tasks include:

- **Artificial intelligence**: Artificial intelligence computer systems are capable of performing tasks that traditionally required human intelligence at levels comparable to those of human beings.

An early example of AI was the "**expert system**," a type of computer programming that attempted to simulate the knowledge base and analytical abilities of human experts in specific problem-solving contexts. This was often accomplished through the use of "if-then" rules. By the late 1990s, faster networks and more powerful processors enabled AI to be deployed in logistics, data mining, financial analysis, medical diagnosis, and Since the 1980s, financial institutions have made use of AI—particularly, **neural networks,** programming based on how our brain learns and processes information—to detect abnormal charges or claims in credit card fraud detection systems.

- **Machine learning**: ML computer systems can "learn" how to complete tasks and improve their performance over time. It involves training itself, validating dataset and predicting outcomes.

Main types of ML include:

- **Supervised learning**: Using historical data points as training samples to infer a rule or equation capable of predicting future outcomes.
- **Unsupervised learning**: Aims to identify the common drivers behind the data points by identifying relationships between input variables.

In **supervised learning,** computers learn to model relationships based on labeled training data. In supervised learning, inputs and outputs are labeled, or identified, for the algorithm. After learning how best to model relationships for the labeled data, the trained algorithms

are used to model or predict outcomes for new datasets. Trying to identify the best signal, or variable, to forecast future returns on a stock or trying to predict whether local stock market performance will be up, down, or flat during the next business day are problems that may be approached using supervised learning techniques.

In **unsupervised learning,** computers are not given labeled data but instead are given only data from which the algorithm seeks to describe the data and their struc-ture. Trying to group companies into peer groups based on their characteristics rather than using standard sector or country groupings is a problem that may be approached using unsupervised learning techniques.

- **Deep learning**: Analyzes data via multiple iterations, or "layers of learning" - starting by learning simple concepts, and then combines these to formulate more complex concepts. This can be accomplished by passing the data through multiple layers of non-linear processing units in a manner similar to neutrons within the human brain.

Subject 2. Fintech applications to investment management

Data science can be defined as an interdisciplinary field that harnesses advances in computer science (including machine learning), statistics, and other disciplines for the purpose of extracting information from Big Data (or data in general)

Data Processing Methods

To help determine the best data management technique needed for Big Data analy-sis, data scientists use various data processing methods, including capture, curation, storage, search, and transfer.

5.1 **Capture**—Data capture refers to how the data are collected and transformed into a format that can be used by the analytical process. Low- latency systems—systems that operate on networks that communicate high volumes of data with minimal delay (latency)—are essential for automated trading applications that make decisions based on real-time prices and market events. In contrast, high-latency systems do not require access to real-time data and calculations.

5.2 **Curation**—Data curation refers to the process of ensuring data quality and accuracy through a data cleaning exercise. This process consists of reviewing all data to detect and uncover data errors—bad or inaccurate data—and making adjustments for missing data when appropriate.

5.3 **Storage**—Data storage refers to how the data will be recorded, archived, and accessed and the underlying database design. An important consideration for data storage is whether the data are structured or unstructured and whether analytical needs require low- latency solutions

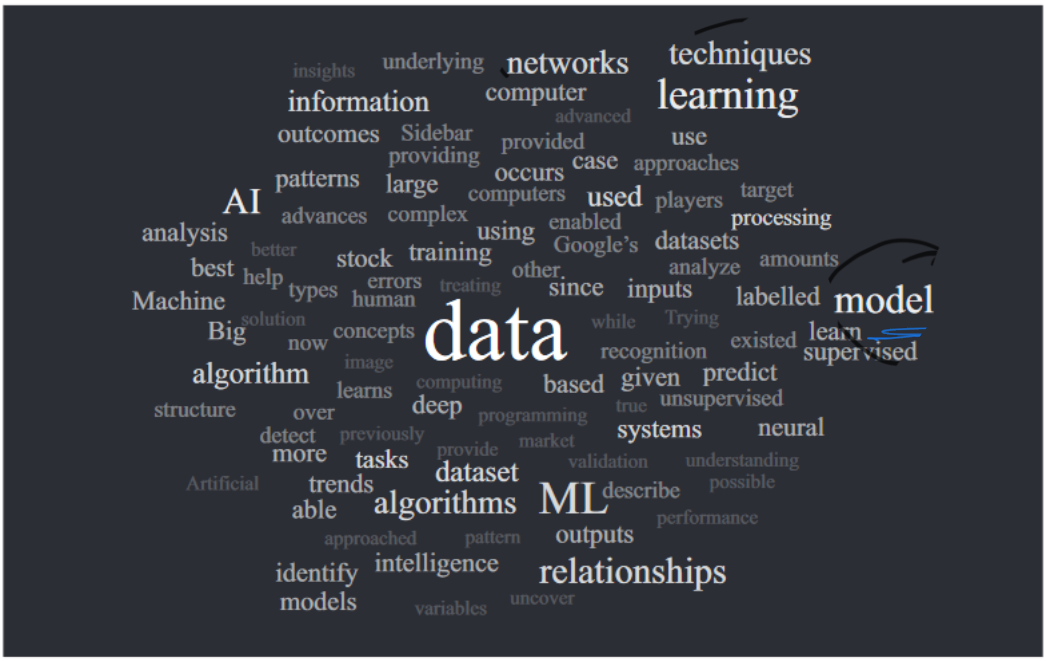
5.4 **Search**—Search refers to how to query data. Big Data has created the need for advanced applications capable of examining and reviewing large quantities of data to locate requested data content.

5.5 **Transfer**—Transfer refers to how the data will move from the underlying data source or storage location to the underlying analytical tool. This could be through a direct data feed, such as a stock exchange's price feed.

Data Visualization

Data visualization is an important tool for understanding Big Data. Visualization refers to how the data will be formatted, displayed, and summarized in graphical form. Traditional structured data can be visualized using tables, charts, and trends, whereas non-traditional unstructured data require new techniques of data visualization. These visualization tools include, for example, interactive three- dimensional (3D) graphics, where users can focus in on specified data ranges and rotate the data across 3D axes to help identify trends and uncover relationships.
Another valuable Big Data visualization technique that is 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**.**

Exhibit 3 Data Visualization Tag Cloud: Section 4, Advanced Analytical Tools



SELECTED APPLICATIONS OF FINTECH TO INVESTMENT MANAGEMENT

Text analytics uses computer programs to analyze and derive meaning typically from text- and voice-based data.
Natural language processing is an application of text analytics to evaluate what people are saying in order to identify economic signals, trends and sentiments.
Robo-advisors provide digital financial advice based on math rules or algorithms. These financial services include asset allocation, portfolio optimization, trade execution, rebalancing and tax strategies.

There are two types of digital wealth management services: fully automated ones and adviser-assisted ones.

Robo-advisors are a good option for people with a simple financial situation. When the situation is complex (e.g. at the time of market crash), investors may be better off by

combining a robot advisor with a human adviser.

AI-based techniques can be used in **risk analysis**, which includes risk assessment, real time risk monitoring, financial data quality assessment and scenario analysis.

Algorithmic trading (automated trading, black-box trading or simply algo-trading) is the process of using computers programed to follow a defined set of instructions (an algorithm) for placing a trade in order to generate profits at a speed and frequency that is impossible for a human trader. Benefits include speed of executions, lower trading costs, and anonymity.

High frequency trading (HFT) attempts to capitalize on placing a large number of orders at very fast speeds across multiple markets and multiple decision parameters, based on preprogrammed instructions.

DISTRIBUTED LEDGER TECHNOLOGY

Distributed ledger technology—technology based on a distributed ledger (defined below)—represents a fintech development that offers potential improvements in the area of financial **smart record keeping.** DLT networks are being considered as an efficient means to create, exchange, and track ownership of financial assets on a peer-to-peer basis.

Potential benefits include greater accuracy, transparency, and security in record keeping; faster transfer of ownership; and peer-to-peer interactions. However, this tehnology is not fully secure, and breaches in privacy and data protection are pos-sible.

In addition, the processes underlying DLT generally require massive amounts of energy to verify transaction activity

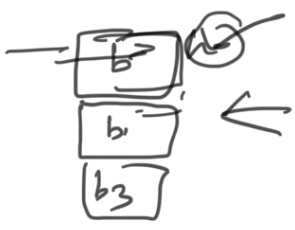
A distributed ledger is a type of database that may be shared among entities in a network. In a distributed ledger, entries are recorded, stored, and distributed across a network of participants so that each participant has a matching copy of the digital database.

Basic elements of a DLT network include a **digital ledger, a consensus mechanism** used to confirm new entries, and a participant network.

DLT include the use of cryptography—an algorithmic process to encrypt data, making the data unusable if received by unauthorized parties—which enables a high level of network security and database integrity. For example, DLT uses cryptographic methods of proof to verify network participant identity and for data encryption.

Blockchain is a type of digital ledger in which information, such as changes in ownership, is recorded sequentially within blocks that are then linked or “chained” together and secured using cryptographic methods. Each block contains a grouping of transactions (or entries) and a secure link (known as a hash) to the previous block.

New transactions are inserted into the chain only after validation via a consensus mechanism in which authorized members agree on the transaction and the preceding order, or history, in which previous transactions have occurred.The consensus mechanism used to verify a transaction includes a cryptographic problem that must be solved by some computers on the network (known as miners) each time a transaction takes place. The process to update the blockchain can require substantial amounts of computing power, making it very difficult and extremely expensive for an individual third party to manipulate historical data.



DLT can take the form of permissionless or permissioned networks. Permissionless networks are open to any user who wishes to make a transaction, and all users within the network can see all transactions that exist on the blockchain. In a permissionless, or open, DLT system, network participants can perform all network functions.T**he main benefit of a permissionless network is that it does not depend on a cen-tralized authority to confirm or deny the validity of transactions,** because this takes place through the consensus mechanism. This means no single point of failure exists, since all transactions are recorded on a single distributed database and every node stores a copy of the database. Once a transaction has been added to the blockchain, it cannot be changed, barring manipulation; the distributed ledger becomes a permanent and immutable record of all previous transactions. In a permissionless network, trust is not a requirement between transacting parties.**A well- known example of an open, permissionless network is bitcoin**. Using blockchain technology, Bitcoin was created in 2009 to serve as the public ledger for all transactions occurring on its virtual currency. Since the introduction of bitcoin, many more cryptocurrencies, or digital currencies, which use permissionless DLT networks, have been created.In permissioned networks, network members may be restricted from participating in certain network activities. Controls, or permissions, may be used to allow varying levels of access to the ledger, from adding transactions (e.g., a participant) to viewing transactions only (e.g., a regulator) to viewing selective details of the transactions but not the full record.

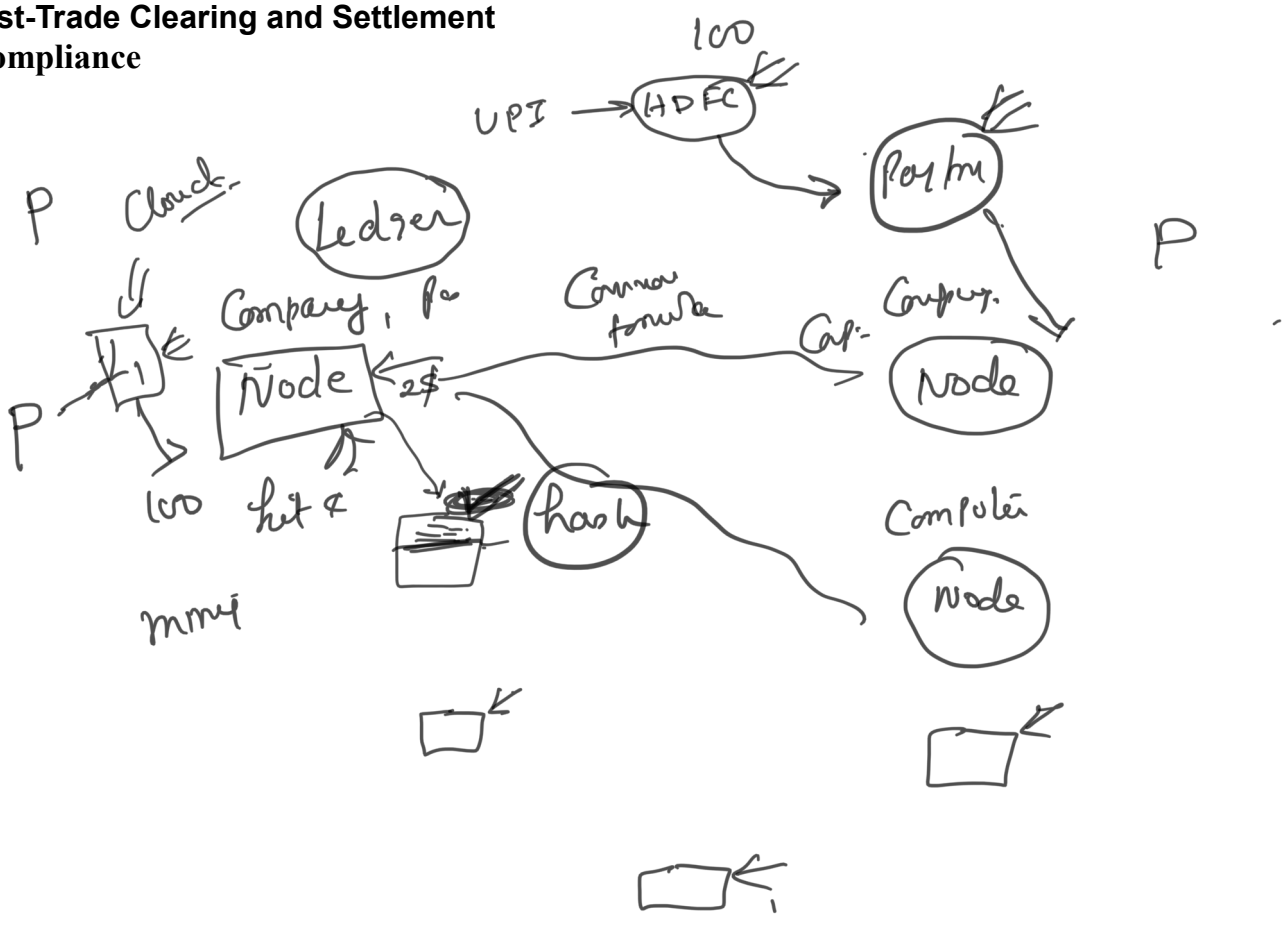
Applications of Distributed Ledger Technology to Investment Management

1**.cryptocurrency,**

2.Tokenization Transactions involving physical assets, such as real estate, luxury goods, and com-modities, often require substantial efforts in ownership verification and examination each time a transfer in ownership takes place. Through tokenization, the process of representing ownership rights to physical assets on a blockchain or distributed ledger, DLT has the potential to streamline this process by creating a single, digital record of ownership

3.Post-Trade Clearing and Settlement

4. Compliance



PRACTICE PROBLEMS

1 A correct description of fintech is that it:

A is driven by rapid growth in data and related technological advances.

B increases the need for intermediaries.

C is at its most advanced state using systems that follow specified rules and instructions.

2 A characteristic of Big Data is that:

A one of its traditional sources is business processes.

B it involves formats with diverse types of structures.

C real-time communication of it is uncommon due to vast content.

3 In the use of machine learning (ML):

A some techniques are termed "black box" due to data biases.

B human judgment is not needed because algorithms continuously learn from data.

C training data can be learned too precisely, resulting in inaccurate predictions when used with different datasets.

4 Text Analytics is appropriate for application to:

A economic trend analysis.

B large, structured datasets.

C public but not private information.

5 In providing investment services, robo-advisers are *most likely* to:

A rely on their cost effectiveness to pursue active strategies.

B offer fairly conservative advice as easily accessible guidance.

C be free from regulation when acting as fully-automated wealth managers.

6 Which of the following statements on fintech's use of data as part of risk analysis is correct?

A Stress testing requires precise inputs and excludes qualitative data.

B Machine learning ensures that traditional and alternative data are fully segregated.

C For real-time risk monitoring, data may be aggregated for reporting and used as model inputs.

7 A factor associated with the widespread adoption of algorithmic trading is increased:

A market efficiency.

B average trade sizes.

C trading destinations.

8 A benefit of distributed ledger technology (DLT) favoring its use by the investment industry is its:

A scalability of underlying systems.

B ease of integration with existing systems.

C streamlining of current post-trade processes.

9 What is a distributed ledger technology (DLT) application suited for physical assets?

A Tokenization

B Cryptocurrencies

C Permissioned networks

Answer

1 A is correct. Drivers of fintech include extremely rapid growth in data (includ-ing their quantity, types, sources, and quality) and technological advances enabling the capture and extraction of information from it.

2 B is correct. Big Data is collected from many different sources and is in a variety of formats, including structured data (e.g., SQL tables or CSV files), semi-structured data (e.g., HTML code), and unstructured data (e.g., video messages).

3 C is correct. Overfitting occurs when the ML model learns the input and target dataset too precisely. In this case, the model has been "over trained" on the data and is treating noise in the data as true parameters. An ML model that has been overfitted is not able to accurately predict outcomes using a different dataset and may be too complex

.4 A is correct. Through the Text Analytics application of natural language pro-cessing (NLP), models using NLP analysis may incorporate non-traditional information to evaluate what people are saying—via their preferences, opinions, likes, or dislikes—in the attempt to identify trends and short-term indicators about a company, a stock, or an economic event that might have a bearing on future performance.

5 B is correct. Research suggests that robo- advisers tend to offer fairly conser-vative advice, providing a cost- effective and easily accessible form of financial guidance to underserved populations, such as the mass affluent and mass mar-ket segments.

6 C is correct. There is increasing interest in monitoring risk in real-time. To do so, relevant data must be taken by a firm, mapped to known risks, and identi-fied while moving within the firm. Data may be aggregated for reporting pur-poses or used as inputs to risk models**.**

7 C is correct. Global financial markets have undergone substantial change as markets have fragmented into multiple trading destinations consisting of elec-tronic exchanges, alternative trading systems, and so- called dark pools. In such an environment, when markets are continuously reflecting real-time infor-mation and continuously changing conditions, algorithmic trading has been viewed as an important tool.

8 C is correct. DLT has the potential to streamline the existing, often complex and labor intensive post-trade processes in securities markets by providing close to real-time trade verification, reconciliation, and settlement, thereby reducing related complexity, time, and costs**.**
9 A is correct. Through tokenization—the process of representing ownership rights to physical assets on a blockchain or distributed ledger—DLT has the potential to streamline this rights process by creating a single, digital record of ownership with which to verify ownership title and authenticity, including all historical activity