Emerging Technologies

ISTM 643 Section II

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Table of Contents

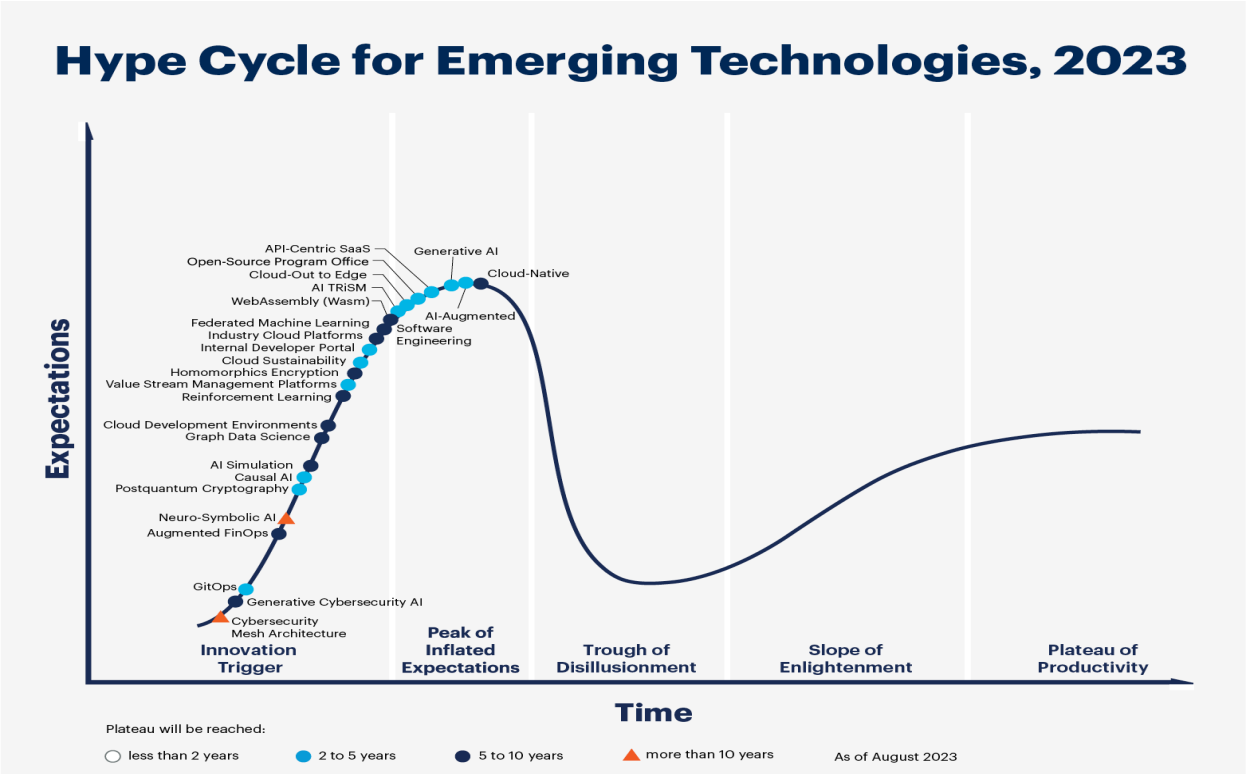
Contents

Abstract

The finance and insurance sectors pertain to organizations that are involved in financial transactions. A financial transaction may be defined as creation, liquidation or change of ownership of financial assets. These are the very institutions that lay the foundations of a nation and safeguard its security. Right from 2000 BCE when banking as concept was initiated, the industry has seen innumerable changes. The way people perceive and use money has shifted. From worrying about financial security people have pushed themselves to a position where they are now worried about their financial future. Bad loans and poor financial decisions have led to the decline of some of the major banks in the world. In the face of such a tough market condition, taking support of advanced technology will surely help in the sustainable growth of financial institutions. Promoting and implementing information technology initiatives that utilize advanced technology while empowering the customers will help build a large customer base thereby ensuring the safety of these institutions.

Introduction

The hype cycle for emerging technologies is a succinct way to look at technologies based on their maturity, adoption, and social implications. In this report we have identified four main technologies which we believe will help in advancing the finance and insurance industry. Below depicted is the “Hype Cycle for Emerging Technologies”:



Each chapter is dedicated towards a technology chosen to be implemented in the industry. The report will provide complete information regarding the IT Objectives pertaining to the technology, the IT initiatives, their associated risks and describe a realistic timeline for the implementation of the technology.

Chapter Summaries

Chapter 1: Federated Machine Learning

In today's rapidly evolving landscape of finance and insurance, the pursuit of innovative solutions that enhance operational efficiency, mitigate risks, and elevate customer experiences is paramount. One such solution gaining prominence is Federated Machine Learning (FML) technology. This decentralized approach to model training holds the promise of revolutionizing how financial institutions and insurance companies leverage data without compromising privacy or security. By allowing model training to occur on local devices or servers holding data samples, FML avoids the pitfalls of centralized data aggregation while offering scalability, privacy preservation, and decentralized control.

Chapter 2: Reinforcement Learning

The finance and insurance industry are very dynamic and generates a lot of data which can be leveraged to reform the operations, to transform the decision-making process and to manage risk. Reinforcement learning is a method used to give the optimal solution to maximize benefit. The algorithms used in reinforcement learning, learn from their own experiences or in technical detail. It can be used in systems where numerous decisions must be made without human touch. It is an algorithm which uses the ‘learning by doing’ method. This method can be used in the finance and insurance industry to achieve pricing strategy optimization, stock trading optimization, credit risk prediction, portfolio optimization and other initiatives. The reinforcement learning chapter focusses on these four initiatives in detail.

Chapter 3: Cloud Native

As companies scale out their data and begin to increasingly need greater resiliency as well as availability, cloud native applications have progressively become a more desirable approach for software applications. Cloud Native refers to tactics utilized to build, deploy, and run software on cloud stacks. Through a Cloud Native approach, the finance and insurance industries can achieve great improvements through the following IT initiatives.

Chapter 4: Graph Data Science

Graph data science is defined as a science-driven approach to understand the context of the data. By associating customers as entities and their respective transactions as their relationships will help understand and establish hierarchies among these customers. Utilizing such approaches will help understand the user behavior and cater better to their needs. The IT initiatives under this technology are to strengthen the cyber-security layer, improving the condition of the labor markets and consumer behavior by studying the context-based graph databases and finally to educate and empower the customer. There are already institutions in the financial domain that have adopted graph databases like Neo4j and have shown tremendous improvement in their results. Learning from the previous examples, other institutions can follow the same to ensure their longevity and relevance. Lastly, integrating such technology will work in two ways since not only will this add more customers, but it will also help the institution budge away from the unwanted fines and risks they are exposed to.

Chapter 1: Federated Machine Learning

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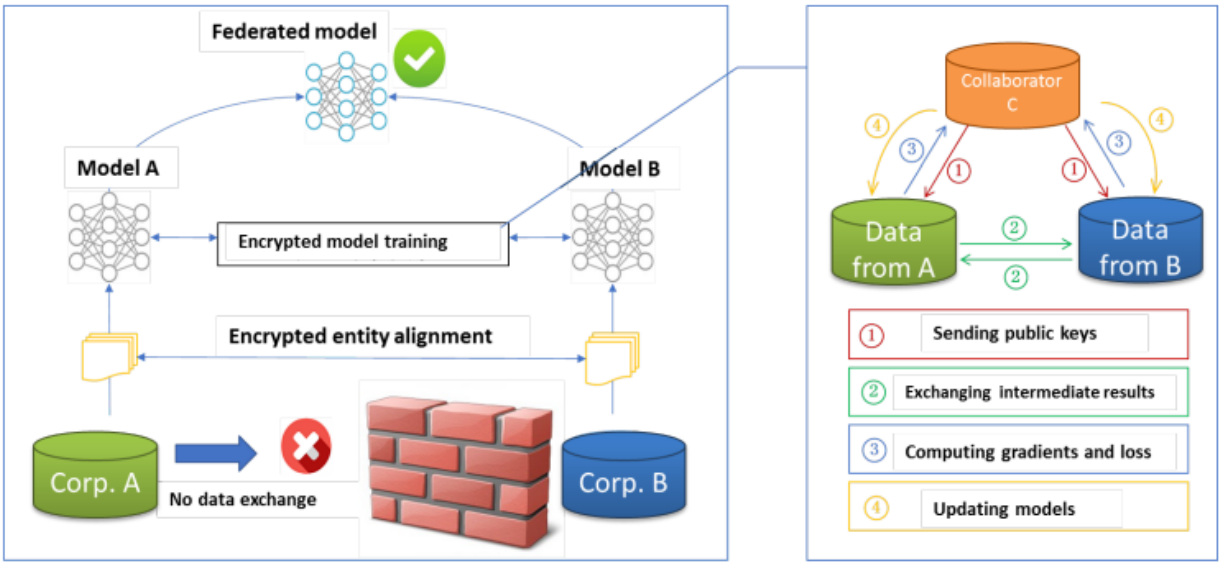
Federated Machine Learning (FML):

Federated Machine Learning (FML) is a decentralized approach where model training occurs on local devices or servers holding data samples, avoiding centralized data aggregation. Each device trains a local model on its data, periodically sending updates to a central server. The server aggregates these updates to create a global model, which is then sent back to the devices for further training. FML offers privacy preservation, reducing communication overhead, scalability, and decentralized control. It is suitable for scenarios with privacy concerns or limited network connectivity (George F. Fragulis, 2023). Let us look at the IT initiatives that can be taken up in the finance and insurance industry by making use of the Federated Machine Learning technology.



Federated ML Model in Finance and Insurance Industry

IT Objectives:

The primary objective of implementing Federated Machine Learning (FML) technology in the finance and insurance sectors is to enhance operational efficiency, mitigate risks, and improve customer experiences while aligning with overarching business strategies. Specifically, FML initiatives aim to achieve the following:

1. By leveraging decentralized models trained on local transaction data, financial institutions aim to swiftly identify fraudulent activities without compromising sensitive customer information. This aligns directly with the business strategy of safeguarding financial assets, enhancing brand reputation, and ensuring competitiveness in the market.
2. Through FML-powered recommendation algorithms, banks and insurance companies seek to deliver tailored financial advice, fostering increased customer engagement and loyalty. This strategic approach supports the business strategy of enhancing customer satisfaction, driving revenue generation, and cultivating long-term customer relationships for sustained profitability.
3. By enhancing risk assessment models with FML technology, insurers aim to achieve more accurate pricing of insurance products and optimized underwriting decisions. This directly contributes to the business strategy of improving risk management practices, reducing claim losses, and ensuring compliance with regulatory standards, thereby maintaining market competitiveness and profitability.

IT initiatives using the Federated Machine Learning technology in the finance and insurance industry:

Fraud Detection: Financial institutions can collaborate through FML to enhance fraud detection capabilities while preserving customer privacy. Each institution can train local models on their transaction data, identifying suspicious patterns indicative of fraudulent activities. These decentralized models contribute insights to a central server, where aggregated information is analyzed to detect fraud across multiple institutions. By leveraging FML, the finance industry can effectively combat sophisticated fraudulent schemes without compromising sensitive customer data, enhancing security and trust. For Instance, credit card fraud detection without sharing the customer personal and credit history details to other organizations (Wensi Yang, 2019). Similarly, E-banking fraud account identification etc. (Boliang Lv, 2022).

Personalized Financial Recommendations: FML enables banks and insurance companies to provide personalized financial recommendations to customers while maintaining data privacy. Individual companies can train models on their customer data to understand their financial behaviors, preferences, and risk profiles. These decentralized models contribute insights to a central server, where aggregated information is used to generate tailored recommendations for each customer. By leveraging FML, financial institutions can offer personalized advice on savings, investments, insurance coverage, and retirement planning, enhancing customer satisfaction and engagement. A federated learning-empowered recommendation model (FLRM) is an effective recommendation model that can be used to reduce data transfer costs, personalize recommendations, and enhance user privacy (Pushpita Chatterjee, 2023).

Risk Assessment Enhancement: Insurers can collaborate through FML to improve risk assessment models while safeguarding policyholder privacy. Each insurer trains a model on its own policyholder data, capturing unique risk factors and behaviors. These models contribute insights to a centralized server, where aggregated information informs more accurate risk assessments without compromising individual privacy. By leveraging FML, insurers can tailor coverage options and premiums to individual policyholders' risk profiles, promoting fairness and compliance with data protection regulations. This approach uses several methods to assess risk, including financial and medical assessments, category classification based on client information, and other considerations like clinical history, prior insurance information, and financial data (Vijayakumar Varadarajan, 2024).

IT initiatives and stakeholders, importance, and shared value of initiatives:

Initiative	Stakeholders - Importance and shared value of initiatives across stakeholders
Fraud Detection	Financial Institutions (Banks, Credit Unions, etc.) - Enhancing fraud detection capabilities is crucial for mitigating financial losses and maintaining customer trust. The shared value of this initiative is that Financial Institutions can benefit from reduced fraud losses and increased customer trust.

	Regulatory Bodies and Compliance Agencies – Ensuring compliance with data protection regulations and ethical use of technology is essential for protecting consumer rights. The shared value of this initiative is that Regulatory Bodies can ensure consumer protection and uphold ethical standards in financial transactions. Customers (Individuals and Businesses) - Improved fraud detection leads to increased security and trust in financial institutions, safeguarding their financial assets. The shared value of this initiative is that Customers can gain enhanced security and confidence in their financial transactions.
Personalized Financial Recommendations	Financial Institutions (Banks, Credit Unions, etc.) - Providing personalized financial recommendations improves customer engagement and loyalty, leading to increased revenue. Financial Institutions benefit from increased customer engagement and loyalty, leading to higher revenue generation. Customers (Individuals and Businesses) - Tailored financial advice helps individuals make informed decisions about savings, investments, and insurance, enhancing their financial well-being. Customers gain access to personalized financial advice that meets their unique needs and preferences. Technology Providers and Developers - Developing effective recommendation algorithms contributes to customer satisfaction and fosters innovation in financial services. Technology Providers contribute to industry innovation by developing advanced recommendation algorithms that enhance customer experiences.
Risk Assessment Enhancement	Insurance Companies - Improving risk assessment models leads to more accurate pricing and underwriting decisions, reducing claim losses and enhancing customer satisfaction. Shared value is that insurance companies can benefit from reduced claim losses, improved customer satisfaction, and compliance with regulatory standards.

	Regulatory Bodies and Compliance Agencies - Ensuring compliance with data protection regulations and fair pricing practices is essential for consumer protection and market integrity. Shared value is that regulatory bodies can ensure consumer protection and market integrity through oversight and regulation of risk assessment practices. Customers (Individuals and Businesses) - Fairer premiums and personalized coverage options based on accurate risk assessment improve customer satisfaction and trust in insurance providers. Shared value is that customers can gain access to fairer premiums and personalized coverage options tailored to their risk profiles, enhancing their financial security.

IT Initiatives and Associated Risks:

Initiative	Associated Risk
Fraud Detection	• **Algorithm Accuracy:** Ensuring new fraud detection models effectively identify fraudulent activities. • **Data Security:** Protecting sensitive financial information during data gathering and analysis. • **Regulatory Compliance:** Adhering to financial regulations to avoid legal implications.
Personalized Financial Recommendations	• **Algorithm Accuracy:** Ensuring personalized recommendations align with user financial goals and preferences. • **User Privacy:** Balancing personalized recommendations with user privacy concerns. • **Technical Challenges:** Potential disruptions during algorithm implementation and system upgrades.

Risk Assessment Enhancement	• **Data Quality Risks:** Ensuring accurate and reliable data integration from diverse sources. • **Model Accuracy Risks:** Ensuring machine learning algorithms provide accurate risk assessments. • I**mplementation Risks:** Potential challenges during system integration and deployment.

IT Activities Life Cycle and Phases

Initiative	Lifecycle	Phase
Fraud Detection	**Research and Planning Phase:** 6 months	Phase 1: Research and Planning Stage 1: Market Analysis Stage 2: Ideation and Conceptualization
	Development Phase: 12 months	Phase 2: Development Stage 1: Algorithm Design and Development Stage 2: Implementation of Fraud Detection Models
	Testing and Optimization Phase: 6 months	Phase 3: Testing and Optimization Stage 1: Comprehensive Testing Stage 2: Optimization Based on Feedback

Personalized Financial Recommendations	**Research and Planning Phase:** 6 months **Development Phase:** 14 months **Testing and Optimization Phase:** 8 months	Phase 1: Research and Planning Stage 1: Market Analysis Stage2: Ideation and Conceptualization Phase 2: Development Stage 1: Algorithm Design and Development Stage 2: Implementation of Recommendation Features Phase 3: Testing and Optimization Stage 1: Comprehensive Testing Stage 2: Optimization Based on User Feedback
Risk Assessment Enhancement	**Research and Planning Phase:** 8 months **Development Phase:** 16 months **Testing and Optimization Phase:** 6 months	Phase 1: Research and Planning Stage 1: Market Analysis and Requirements Gathering Stage 2: Evaluation of Existing Systems and Technology Phase 2: Development Stage 1: Design and Development of Data Integration Tools Stage 2: Implementation of Machine Learning Algorithms with respect to Risk Assessment. Phase 3: Testing and Optimization Stage 1: Comprehensive Testing (UAT) of Integrated Systems Stage 2: Fine-Tuning and Optimization of Algorithms

Fraud Detection

Costs	Priorities	Change Management Requirements
Data Gathering and Preparation: Range: $3 million - $6 million **Model Development and Training:** Range: $15 million - $25 million **Deployment and Integration:** Range: $8 million - $12 million **Monitoring and Maintenance:** Range: $5 million - $8 million per year	**High Priority:** Model Development and Training to enhance fraud detection accuracy. **Medium Priority:** Deployment and Integration to ensure seamless implementation into existing systems. **Ongoing Priority:** Monitoring and Maintenance for continuous fraud detection efficacy.	**User Education:** Communicating changes in fraud detection methods to stakeholders. **Training for Support Teams:** Equipping support teams with the skills to handle inquiries related to fraud detection. **Feedback Mechanism:** Establishing a system for stakeholders to provide feedback on fraud detection effectiveness and user experience.
Personalized Financial Recommendations		
Costs	**Priorities**	**Change Management Requirements**
Algorithm Development: Range: **$**15 million – $25 million **Data Acquisition and Processing:** Range: **$**10 million – $20 million **Monitoring and Maintenance:** Range: $5 million - $8 million per year	**High Priority:** Algorithm Development to ensure accurate and effective personalized recommendations. **Medium Priority:** Data Acquisition and Processing for acquiring and processing diverse financial data. **Ongoing Priority:** Testing and Optimization for continuous refinement based on user feedback.	**User Education:** Communicating the benefits of personalized financial recommendations to users. **Training for Support Teams:** Equipping support teams with necessary training to address user queries related to personalized recommendations. **Feedback Mechanism:** Establishing a system for users to

		provide feedback on recommended financial products and services.
Risk Assessment Enhancement		
Costs	**Priorities**	**Change Management Requirements**
Data Integration and Analysis Tools: Range: $8 million - $12 million **Machine Learning and Predictive Analytics Algorithms:** Range: $15 million - $20 million	**High Priority:** Development of Machine Learning Algorithms for accurate risk assessment. **Medium Priority:** Design and Development of Data Integration Tools for seamless data processing. **Ongoing Priority:** Testing and Optimization for continuous improvement of risk assessment accuracy.	**Stakeholder Engagement:** Involving key stakeholders throughout the project to ensure alignment with business objectives. **User Training:** Providing training to underwriters and risk managers on using new risk assessment tools and algorithms. **Communication Strategy:** Communicating changes and enhancements to risk assessment processes to all relevant stakeholders.

Appendix:

1. **FML**: Federated Machine Learning
2. **FLRM**: Federated learning-empowered recommendation model
3. **UAT**: User Acceptance Testing

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1. A survey on federated learning applications in healthcare, finance, and data privacy/data security (George F. Fragulis, 2023)

2. FFD: A Federated Learning Based Method for Credit Card Fraud Detection (Wensi Yang, 2019)
3. Research on Modeling of E-banking Fraud Account Identification Based on Federated Learning (Boliang Lv, 2022)
4. Federated Learning Empowered Recommendation Model for Financial Consumer Services (Pushpita Chatterjee, 2023)
5. Evaluation of risk level assessment strategies in life Insurance: A review of the literature (Vijayakumar Varadarajan, 2024)

Chapter 2: Reinforcement Learning

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Reinforcement learning:

Reinforcement learning refers to the method by which autonomous systems learn from their own experiences and actions as feedback. Essentially, reinforcement learning enables the machine to learn from its mistakes (Bhat, 2018). Let us look at the IT initiatives that can be taken up in the finance and insurance industry by making use of the reinforcement learning technology.

IT initiatives using the reinforcement learning technology in the finance and insurance industry:

Pricing strategy optimization

Pricing is a major problem with it being related to products like credit scoring or insurance. Consider the insurance industry for example, it will face difficulty in adjusting the insurance renewal price. They will face two contradictory situations, one being to increase customer retention and the other would be to increase revenue. If they increase prices to increase revenue, they might end up losing customers and hence the revenue. Thus, they must prioritize retaining customers. The prices must be optimized in a way to strike a balance between revenue growth and customer retention (Krasheninnikova, García, Maestre, Fernández, 2019)

Stock trading optimization

To maximize revenue, stock companies need to optimize stock trading in a dynamic environment. Xinyi et al. has designed a new framework that will help in the same using deep deterministic reinforcement learning. It comprises of optimistic and pessimistic deep reinforcement learning and can gain better portfolio profit. It can be tried to implement such a system to enable stock trading optimization on a mass level (Mosavi, Faghan, Ghamisi, Duan, Ardabili, 2020).

Credit risk prediction

Risk assessment is one of the most studied and researched areas of Reinforcement learning. There are different areas of study like credit rating, credit risk scoring, bankruptcy prediction, mortgage decision, prediction of business failure and so on. Identifying the risk status is crucial as asset pricing depends on the risk assessment results. The major focus of the studies in risk assessment in the financial industry is on credit scoring (Singh, Chen, Singhania, Nanavati, kumar kar, Gupta, 2022).

Portfolio optimization

Portfolio optimization refers to the trader selecting and trading the best portfolio of assets that he can to get the expected return and to keep risk to a threshold. This enables the trader to diversify his portfolio and maximize the returns per unit of risk. The methods that are currently being used to solve this problem are value-based methods like Q-Learning, SARSA, DQN and policy-based algorithms such as DPG and DDPG (Singh, Chen, Singhania, Nanavati, kumar kar, Gupta, 2022).

IT initiatives and stakeholders, importance, and shared value of initiatives:

Initiative	Stakeholders - Importance and shared value of initiatives across stakeholders
Pricing strategy optimization	• Executives – This initiative will be important for maximizing profit, it will reduce the risk of losing customers • Insurance managers – This initiative will help the insurance managers to achieve customer satisfaction and can give the company a competitive advantage. The shared value that it contributes to is improved market positioning and improving customer experience. • Customer service department - It will help the customer service representatives to improve customer retention thereby increasing customer loyalty

Stock trading optimization	• Traders – The initiative will be important to traders as they will be the ones using the system to realize greater profits and minimize risk • Finance and Insurance organizations – This initiative will be important for the finance and insurance companies as it will help their clients realize greater profits and minimize risk, thereby giving the companies a competitive advantage and increase profit realization • Regulators – making sure that the stock trading optimization system is not manipulating the market and adheres to the fair-trading rules • IT and project team - The IT team, the developers, data analysts and scientists and support personnel will be responsible for making sure the system is reliable and produces accurate results thereby benefitting the business
Credit risk prediction	• Customers – Credit risk prediction will be an important initiative for customers as they will benefit from better credit terms and lending decisions. • Finance and Insurance organizations – The finance and insurance organizations will benefit from it as it will result in reduction in the defaulter rate, increase profits and reduce risks • IT and project team – They will be responsible for ensuring the DBN model works as desired thereby contributing to business growth • Regulatory bodies – Making sure that the organizations comply with the lending norms
Portfolio optimization	• Investors – this initiative will be important for investors as it will enable them to have diversified portfolios and better returns per unit of risk • Portfolio managers – It will help portfolio managers to improve customer satisfaction by providing better investing recommendations leading to increased customer retention

	• Executives – This initiative will be important as it will help them increase the customer base of the organization and improve the market positioning of the organization

IT Initiatives and Associated Risks

Initiative	Associated Risk
Pricing strategy optimization	• The model might work well on training data, but it might produce inaccurate results on real-world data • Non-compliance with regulations related to pricing of insurance renewal • Resistance from employees to shift from the traditional method of pricing
Stock trading optimization	• The deep RL model might give inaccurate results leading to financial losses for investors and organizations • Market manipulation risk • Risk of sensitive financial information being compromised
Credit risk prediction	• Risk of getting inaccurate prediction can lead to unfair lending of money • Risk of model overfitting
Portfolio optimization	• Model inaccuracies can result in financial losses from poor investment decisions • Risk of customer sensitive data being compromised or frauds happening

IT Activities Life Cycle and Phases

Initiative	Lifecycle	Phase

Pricing strategy optimization	**Planning, Development, and testing phase** 9 months **Implementation Phase** 1 month **Optimization and Continuous Improvement Phase** Lifelong	**Phase 1: Planning, development, and testing phase:** Stage 1: Defining project scope and KPIs to measure success Stage 2: Research and finalize the appropriate algorithms and system data architecture Stage 3: To clean and process historical pricing data Stage 4: Training the model using RL techniques Stage 5: Testing the model to ensure near accurate price optimization is performed **Phase 2: Implementation phase:** Stage 1: Integrating the model with the present system/s Stage 2: Conduct UAT and training activities **Phase 3: Optimization and continuous improvement phase:** Stage 1: Perform real-time monitoring of the model and its effect on the rest of the system, if any Stage 2: Log the results obtained from the continuous monitoring efforts Stage 3: Tweak the models based on the continuous monitoring results and stakeholder feedback
Stock trading optimization	**Planning, Development, and testing phase** 9 months **Implementation Phase** 1.5 months	**Phase 1: Planning, development, and testing phase:** Stage 1: Defining project scope and Key Performance Indicators (KPIs) to measure success Stage 2: Research about deep RL models and their feasibility and come up with a system architecture Stage 3: Building the deep RL model and using the historical data to train the model

	Optimization and Continuous Improvement Phase Lifelong	Stage 4: Testing the model to ensure reliability and accuracy **Phase 2: Implementation phase:** Stage 1: Integrating the model with the trading platform Stage 2: Conduct training sessions to ensure the stakeholders know how to use the system **Phase 3: Optimization and continuous improvement phase:** Stage 1: Perform real-time monitoring of the model and log the results Stage 2: Gather feedback from stakeholders about system performance and usability Stage 3: Tweak the model and the system based on the outputs of Stage 1 and 2
Credit risk prediction	**Planning, Development, and testing phase** 11 months **Implementation Phase** 2 months **Optimization and Continuous Improvement Phase** Lifelong	**Phase 1: Planning, development, testing phase:** Stage 1: Requirements analysis and definition of project scope, objectives, stakeholders, and risk Stage 2: Feasibility analysis of the DBN model and finalizing the model and data architecture Stage 3: Cleaning and keeping the historical data ready Stage 3: To develop the model and testing it with historical data **Phase 2: Implementation phase:** Stage 1: Integrating the model with the current system Stage 2: Training the relevant stakeholders on the system Stage 3: Conducting UAT

		Phase 3: Optimization and continuous improvement phase: Stage 1: real-time monitoring of the model and logging all the necessary observations Stage 2: Gathering feedback from stakeholders Stage 3: Tweaking the model based on the outputs from Stage 2 and 3
Portfolio optimization	**Planning, Development, and testing phase** 10 months **Implementation Phase** 2 months **Optimization and Continuous Improvement Phase** Lifelong	**Phase 1: Planning, development, testing phase:** Stage 1: Requirements analysis and defining project scope, stakeholders, and risks Stage 2: Feasibility analysis of policy-based algorithms like DPG and DDPG, finalizing the model and data architecture Stage 3: Cleaning and keeping the historical data ready Stage 3: Developing models and the underlying framework Stage 4: Training the models with historical data and testing for accuracy and reliability **Phase 2: Implementation phase:** Stage 1: Integrating the model with the current system Stage 2: Training the portfolio managers on the new system Stage 3: Conducting UAT and recording stakeholder feedback **Phase 3: Optimization and continuous improvement phase:** Stage 1: real-time monitoring of the model and logging all the necessary observations, Gathering feedback from stakeholders Stage 2: Tweaking the model based on the outputs from Stage 1

IT initiatives, Associated costs, Priorities and Change Management Requirements:

Pricing strategy optimization		
Costs	**Priorities**	**Change Management Requirements**
Initial Investment These will include data acquisition costs, storage costs, development costs, model testing costs, implementation, and training costs. **Ongoing Operational Costs** It will include real-time monitoring costs and model optimization costs	**High:** Compliance with pricing strategy regulations, build reliable models to help optimize price in a dynamic environment, data security **Medium:** near-real time adjustments to pricing models	Any new changes required in the models must follow integrated change development and the changes must be implemented after approval from the stakeholders. The changes must be prioritized in order of their value addition to the business. Training programs must be conducted in case of a major change to the model and thereby the system.
Stock trading optimization		
Costs	**Priorities**	**Change Management Requirements**
Initial Investment These will include historical data collection and storage costs, setting-up costs, personnel, and model training costs **Ongoing Operational Costs** These will include model optimization costs, real-time	**High:** Ensuring the deep RL model produces reliable results, data security, compliance with regulations	The relevant stakeholders should be kept in the loop regarding any changes to the system. Training sessions must be conducted to ensure the stakeholders adjust well to any new major changes. Feedback mechanisms must be established to gather feedback from the traders as any model discrepancy can financially affect them.

monitoring costs, costs to host the system and infrastructure costs, personnel costs like salaries of data scientists, developers		
Credit risk prediction		
Costs	**Priorities**	**Change Management Requirements**
Initial Investment It includes data acquisition costs, DBN model development costs, infrastructure costs and training costs **Ongoing Operational Costs** It will include real-time monitoring and model refinement costs, change management costs, data storage and system hosting infrastructure costs, and personnel salary costs	**High:** Ensuring that the DBN model predicts credit risk accurately, protecting customer data, compliance with fair lending practices **Medium:** near-real time adjustment to the credit risk prediction model	The stakeholders must be aware of any major changes being made to the credit risk prediction model and how the changes will affect them and their role in the system. Appropriate training needs to be conducted to educate stakeholders about the system. An 'Integrated change control' approach must be adopted to move the system from the older version to the newer one.
Portfolio optimization		
Costs	**Priorities**	**Change Management Requirements**
Initial Investment It involves historical data acquisition costs, data storage and infrastructure	**High:** Ensuring accurate portfolio suggestions and recommendations, protecting	It is important that the portfolio managers are informed about any major changes that might affect the usability of the portfolio optimization system for them. Training must

costs, model development and testing costs, compliance training and system training costs **Ongoing Operational Costs** It involves model optimization costs, change management costs, auditing and reporting costs, and personnel costs	sensitive financial data, compliance with government regulations **Medium:** Ensuring a smooth user experience for portfolio managers	be conducted to ensure they can use the system smoothly. They must be informed about the benefits and limitations of the system so that they can create the best portfolios for the clients. All changes must be subjected to approval from the stakeholders and must be prioritized based on the value that they will add to the business.

Appendix:

1. **DPG:** It stands for Deterministic Policy Gradient. For additional Information, refer to Introduction to Deterministic Policy Gradient (DPG) | by Cheng Xi Tsou | Geek Culture | Medium
2. **DDPG:** Deep Deterministic Policy Gradient. For additional information, refer to Deep Deterministic Policy Gradient (DDPG): Theory and Implementation | by Sunny Guha | Towards Data Science
3. **DBN:** It stands for Deep Belief Network and is a class of deep neural networks. Detailed Information can be found here: Deep belief network - Wikipedia
4. **RL:** Reinforcement Learning
5. **UAT:** User Acceptance Testing

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Chapter 3: Cloud Native

Author: Jacob Foster

Cloud Native Computing

As companies scale out their data and begin to increasingly need greater resiliency as well as availability, cloud native applications have progressively become a more desirable approach for software applications. Cloud Native refers to tactics utilized to build, deploy, and run software on cloud stacks. (McCarthy, 2022). Through a Cloud Native approach, the finance and insurance industries can achieve great improvements through the following IT initiatives.

IT initiatives using cloud native technology in the finance and insurance industry:

Managed Services

Finance and insurance industries often rely on many platforms and systems to complete the complex tasks involved in the industry. Cloud managed services provide a solution to these issues by allowing cloud platforms such as cloud managed databases to handle tasks such as patching, backups, and increased availability to help the companies deal with the copious amount of data. Moreover, studies show that companies can save up to 30% on IT expenses by leveraging cloud solutions (Logista, 2023). Through cost savings by using cloud managed services, financial institutions and insurance companies can now allocate resources towards other process improvements and revenue streams.

Improved Regulatory Compliance

Adhering to compliance rules and regulations is imperative to finance and insurance companies due to the sensitive nature of the data and information that flows within their business operations. Many cloud native architectures promote the use of immutable infrastructure in addition to declarative configurations – both of which aid in audit and logging for stronger regulatory compliance. Cloud providers can engage with compliance teams to help with their understanding of specific regulatory requirements to ensure greater aligning of the features that can be adopted to ensure that the company remains in complete compliance (Trigyn, 2023).

Scalability and Elasticity

As many services within financial and insurance business processes can have unpredictable workloads and business demands, having cloud native services that are both scalable and elastic is crucial to adapting fluctuations throughout the day. For example, financial institutions see spikes at various times within the year as trades may see a surge in trading at any given period – cloud native platforms provide companies the opportunity to increase and decrease computing capacity automatically as demand fluctuates (Flaherty, 2023).

IT initiatives and stakeholders, importance, and shared value of initiatives:

Initiative	Stakeholders - Importance and shared value of initiatives across stakeholders
Managed Services	Chief Information Officer - Decreases infrastructure overhead and costs in addition to improved agility. Chief Financial Officer – Improved operational efficiency and resource utilization. Development Teams – Access to more managed platforms and services for faster application development.
Improved Regulatory Compliance	Compliance team – Greater data protection measures and audit procedures can enable stricter compliance. Regulators – this initiative allows for easier auditing and greater transparency between compliance teams and regulators.
Scalability and Elasticity	DevOps team – This initiative enables scalable architectures to support operations and business procedures. Data Analytics team – This initiative allows for a greater and more flexible data load to facilitate data analysis.

IT Initiatives and Associated Risks

Initiative	Associated Risk

Managed Services	• Organizations may become over reliant on cloud services for critical business operations – which could open them up to risk in the event a disruption to the service occurs. • Security and privacy risks may arise as now there are external parties involved in handling sensitive financial and personal data.
Improved Regulatory Compliance	• New laws require cloud services to stay keen and up to date on any newly passed regulation or legal changes. • Industry specific standards may cause steep learning curves for compliance aiding platforms.
Scalability and Elasticity	• Vendor lock in can limit flexibility and induce high switching costs in the event a new platform is desired. • If done improperly, poor scaling mechanisms can lead to performance degradation as the load on the system spikes.

IT Activities Life Cycle and Phases

Initiative	Lifecycle	Phase

Managed Services	**Planning, Development, and testing phase:** **6 months** **Implementation Phase** 1 month **Optimization and Continuous Improvement Phase** Lifelong	**Phase 1: Planning, development, and testing phase:** Stage 1: Identifying business needs that can be enhanced by managed services. Stage 2: Researching and negotiating with desired cloud platforms, ensuring that they are compatible and fit business needs. **Phase 2: Implementation phase:** Stage 1: Installation and data transfer Stage 2: Documentation of newly installed service. Stage 3: Employee training sessions **Phase 3: Optimization and continuous improvement phase:** Monitoring and tracking tools for each service to ensure that any potential areas ripe for improvement are addressed.
Improved Regulatory Compliance	**Planning, Development, and testing phase** 9 months **Implementation Phase** 1 month **Optimization and Continuous Improvement Phase** Lifelong	**Phase 1: Planning, development, and testing phase:** Stage 1: Identification of relevant standards Stage 2: Evaluation of compliance tools. **Phase 2: Implementation phase:** Stage 1: Installation and customization of compliance assisting systems and applications. Stage 2: Employee training **Phase 3: Optimization and continuous improvement phase:** Stage 1: Regular compliance reviews and evaluations to ensure that proper protocols are being adhered to. Stage 2: The addition of features to address newly created compliance regulations.

Scalability and Elasticity	**Planning, Development, and testing phase** 12 months **Implementation Phase** 2 months **Optimization and Continuous Improvement Phase** Lifelong	**Phase 1: Planning, development, testing phase:** Stage 1: Assessing current infrastructure scalability limitations, performance bottlenecks, and company resource utilization. Conducting of the defining of scalability goals and metrics will also be required. **Phase 2: Implementation phase:** Stage 1: Deploying cloud infrastructure and auto scaling configurations Stage 2: Migration of applications to the new architecture. **Phase 3: Optimization and continuous improvement phase:** Stage 1: Testing and Optimization Stage 2: Tweaking databases-based data needs.

IT initiatives, Associated costs, Priorities and Change Management Requirements:

Managed Services		
Costs	**Priorities**	**Change Management Requirements**
Initial Investment: Migration, training, onboarding, licensing fees **Ongoing Operational Costs:** Subscription for services and applications.	**High:** High Service availability, strong performance, and adept security. **Medium:**	Communication: Regular updates to relevant stakeholders and users. Support: Necessary training to users who will now be using cloud-

	Increased operational efficiency and optimized resource utilization.	based services and application to ensure a smooth transition.
Improved Regulatory Compliance		
Costs	**Priorities**	**Change Management Requirements**
Initial Investment: Compliance tools and auditing software. **Ongoing Operational Costs:** Monitoring, auditing, and compliance assessments.	**High:** Complete and strict compliance with regulations and standards.	Support and Training: Equipping implementation support teams with necessary training to address user questions related to regulatory compliance. Communication Strategy: Transparent communication about the potential benefits and impact of new features on the Regulatory Compliance software and tools.
Scalability and Elasticity		
Costs	**Priorities**	**Change Management Requirements**
Initial Investment Cloud infrastructure services **Ongoing Operational Costs:** Usage based costs for scaling to userbase.	**High:** Increased performance and efficiency of applications and services. **Medium:** Ensuring that the application is resilient to potential failure, while	Communication: Regular updates to relevant stakeholders and users. Support and Training: Training to address any potential concerns and to explain the benefits of cloud-based data storage in relation to scalability.

	maintaining availability during disruptions.	

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Chapter 4: Graph Data Science

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Introduction

In the 21st century, modern financial institutions are a hub for hacks, data leaks and money laundering. Government regulations, economic theories, and technological advancements have changed yet banks as an institution still stand tall. The finance and industry must leverage the new age tech which ensures safety and trust which will in turn increase the number of customers they are able to attract. Graph data science is one such domain that can help solve both these issues. The base theory of graph data science is that to understand or gain knowledge about the key entities, their relationships and context is necessary. Existing banks such as JP Morgan Chase, Citi, and UBS use Neo4j to track data lineage, but we see the implications of Graph databases and data science to be far wider.

Information Technology (I.T.) Objectives:

The finance and insurance industry are just recovering from a dreadful pandemic and a gut-wrenching recession. Analysts suggests that the United States (U.S.) revenue will only grow by 1.4% in the coming year, as compared to the staggering 6.4% of the developing countries. The information technology objective should be focused on extracting the maximum out of the historical and present user data. They will have to aim at strengthening the stopgaps. The following should be the I.T. Objectives of the banking and finance industry:

6. Graph data science will be leveraged towards strengthening the cyber-security norms in the banking industry. In 2023, Bank of America fell victim to a cyber-attack which exposed personal information of 57000 employees. The industry will leverage the contextual information gained using graph data science to combat this threat.
7. The International Monetary Funds (I.M.F) suggest that the U.S. finance and insurance industry is in a state of turmoil. The newer I.T. objectives will be aimed at improving the labor markets and consumer behavior.
8. To ensure efficient understanding of regulatory and compliance requirements, I.T. objectives which help track these regulations and compliance issues will be formed. Previous data related to such incidents will be studied with context to prevent the future occurrences of these events.
9. To ensure trust and foster more customers, the industry will reform the way it empowers them. New regulations and products will be released as a part of this objective. A social media like outlook to banking and finance will surely help the users learn more and learn better.

Information Technology initiatives using Graph Data Science in the Finance and Insurance industry:

Fraud Detection Strategy

It has become increasingly difficult to ensure user safety due to the innovative technology at the intruder's disposal. Among reported frauds, credit card scams held the first position with more than 100,000 cases reported. [1] Advocates the usage of graph neural networks (GNNs), which are adept at recognizing fine intricacies among graph patterns. Introducing a model where the customers are considered as the nodes and the transaction they make as the relationship they share, will help identify patterns. Pattern recognition coupled with GNNs will help solve an impending problem of scams and will instill confidence in their customers.

Regulatory Compliance Databases

The problem with using traditional databases to enlist their regulatory requirements is that it can blindside the organization and run them into regulatory compliance issues. [2] suggests that close to 47 billion US dollars were paid as fines and dues. Using graph databases to visualize the regulatory compliances, will help them mainly by highlighting the pitfalls and loopholes, internal flagging if any operation is running against the industry compliance

and finally help them in recognizing pattern in the previous mistake/error committed.[3] advocates the usage of graph databases which help us in maintain better data lineages and help study bigger networks in a swift manner.

Risk Assessment and Prediction

Risk assessment is one of the major areas that can be implemented using graph data science. Using models where we can gain more context will help us recognize patterns easier. Moreover, the historical data around these incidents once re-established in the above discussed models will help the major players in the industry to build models based on graph neural networks. Assessing these risks, assigning a score to them, and monitoring them regularly will lead to risk management.

Gamified/Knowledge Based Applications

Once the databases of customers are transformed to a more unstructured form of database management (Graphs), it becomes easier to relate customers of same geography same purchasing habits or same financial behavior. Strong community builds a loyal customer base. Studying the user behavior based on their financial choice played out in a branch format visualization will help understand user behavior and provide automated sound common financial judgements which help them play safe in this.

Information Technology Initiatives and Associated Risks

Initiative	Associated Risk
Fraud Detection Strategy	• GNNs are extremely complex to set up and require heavy computing. • Inaccurate results due to ineffective parameter setting. • High set-up cost with long pay off time.
Regulatory Compliance Databases	• Studying the regulation and remodeling the data can lead to be complex. • Ineffective Knowledge Transfers can lead to poor usage of resources. • Ineffective GNN Models will lead to poor regulatory control.
Risk Assessment and Prediction	• The risk of getting inaccurate predictions can lead to unfair lending of money. • Inaccurate Risk Assessment Score calculations can lead to ineffective models. • Ineffective Knowledge Transfers can lead to poor usage of resources.

Gamified/Knowledge Based Applications	• Creating a space for a new application in the current market scenario may be tough. • Since the application will be directly being released by a financial institution, the regulatory compliance risk is an impending one.

IT Activities Life Cycle and Phases

Initiative	Lifecycle	Phase
Fraud Detection Strategy	**Planning, Development, and Testing phase** 7 Months (28 Weeks) **Implementation Phase** 1 Month (4 weeks) **Optimization and Continuous Improvement Phase** Continuous Activity (Back up team)	**Phase 1: Planning, development, and testing phase:** Stage 1: Study existing data Stage 2: Remodel the existing databases using Neo4j Graph Databases. Stage 3: Train the Graph Neural Network using training datasets. Stage 4: Testing and finalizing the network parameters. **Phase 2: Implementation phase:** Stage 1: Integrate the new system while the current system is up and running. Stage 2: Deploy and monitor the network parameter thresholds. Stage 3: Keep testing on historic data for better parameter setting for the final 3 months of this stage. **Phase 3: Optimization and continuous improvement phase:** Stage 1: Study the transaction logs to study networks and patterns. Stage 2: Keep monitoring on the network parameters.

		Stage 3: Tweak the parameters based on the outputs of Stage 1 and 2.
Regulatory Compliance Databases	**Planning, Development, and testing phase** 4 Month (16 Weeks) **Implementation Phase** 1 Month (4 weeks) **Optimization and Continuous Improvement Phase** Continuous Activity (Back up team)	**Phase 1: Planning, development, and testing phase:** Stage 1: Remodeling the existing databases. Stage 2: Setting up hierarchy and connections among the existing regulations. Stage 3: Test against traditional systems. **Phase 2: Implementation phase:** Stage 1: Integrating the model along with the existing regulatory databases. Stage 2: Create Live Dashboards to keep track of regulatory compliance. **Phase 3: Optimization and continuous improvement phase:** Stage 1: Run GNNs on the Regulatory databases to recognize patterns.

		Stage 2: Set-up teams to study the patterns and help with Knowledge transfers.
Risk Assessment and Prediction	**Planning, Development, and testing phase** 6 Months (24 Weeks) **Implementation Phase** 2 months (8 Weeks) **Optimization and Continuous Improvement Phase** Continuous Activity (Back up team)	**Phase 1: Planning, development, testing phase:** Stage 1: Remodeling the existing databases. Stage 2: Setting up hierarchy and connections among the historical events recorded that were a threat to the company. Stage 3: Training GNNs on this dataset. **Phase 2: Implementation phase:** Stage 1: Get the Risk Assessment scores churned out by the model. Stage 2: Create a Graph database to store the existing results. Stage 3: Deploy the model to live scenarios. **Phase 3: Optimization and continuous improvement phase:** Stage 1: Identification of common risks and creating visualizations for the same. Stage 2: Knowledge Transfers.
Gamified/Knowledge Based Applications	**Planning, Development, and testing phase** 3 Months (12 Weeks) **Implementation Phase**	**Phase 1: Planning, development, testing phase:** Stage 1: Impact analysis and Feasibility Study for A mobile application. Stage 2: Wireframing and Mockups Stage 3: Remodeling customer data to generate buzz in targeted locations. **Phase 2: Implementation phase:** Stage 1: Integrating the model with the current application.

	1 Month (4 Weeks) **Optimization and Continuous Improvement Phase** Continuous Activity (Back up team)	Stage 2: Deploying the (beta-version) application backed on Graph Databases. Stage 3: Monitoring application traffic **Phase 3: Optimization and continuous improvement phase:** Stage 1: Release the Application on iOS and Android. Stage 2: Releasing successive versions with improvements.

IT initiatives, Associated costs, Priorities and Change Management Requirements:

Fraud Detection Strategy		
Costs	**Priorities**	**Change Management Requirements**
Initial Investment • Graph Databases - $50,000 - $100,000 • Cloud Storage – $1,000 - $8,000 • GPUs – $ 600-$1000 per unit **Ongoing Operational Costs** • Resources to monitor– $55,000 Cloud model subscription - $1,000 - $8,000 (Annual) • Setting up Virtual Machines - $ 400	**High:** • Model Accuracy to better prevent fraudulent events. • Highly Efficient Graph Database nodes. • Setting up network parameters. **Medium:** • Alternative Cloud based solution to minimize costs.	• Change Management documents to catalog the new graph databases. • Knowledge Transfers to the employees. • Setting up access controls to restrict access. • Employee feedback will be monitored to improve the efficiency of the system.
Regulatory Compliance Databases		
Costs	**Priorities**	**Change Management Requirements**

Initial Investment • Graph Databases - $50,000 - $100,000 • Cloud Storage – $1,000 - $8,000 • GPUs – $ 600-$1000 per unit • Testing – $50,000-$60,000 • Legal Personnel – $120,000-$140,000 **Ongoing Operational Costs** • Cloud model subscription - $1,000 - $8,000 (Annual) • Salaries of Data Analyst Data Scientists - $1,200,000-$1,400,000	**High:** • Modeling hierarchical graph databases. • Integrating the database with the GNN models • Pattern Recognition **Medium:** • Live Dashboards • Automated Monthly Reports	• Change Management documents to catalog the new graph databases with regulatory specifications. • Knowledge Transfers to the employees. • Setting up access controls to restrict access. • Publishing the Live dashboards along with the data catalogs with automated refreshes. • Employee feedback will be monitored to improve the efficiency of the system.
Risk Assessment and Prediction		
Costs	**Priorities**	**Change Management Requirements**
Initial Investment • Graph Databases - $50,000 - $100,000 • Cloud Storage – $1,000 - $8,000 **Ongoing Operational Costs** • Model Monitoring - $50,000 - $60,000 • Salaries of Personnel - $5,000,000-$10,000,000	**High:** • Modeling hierarchical graph databases. • Integrating the database with the GNN models • adherence Regulatory Compliance • Data Management and Security **Medium:**	• Change Management documents to catalog the risks. • Change Management Documents to explain the analysis for Risk Assessment Scores • Knowledge transfers to help make use of the live dashboards. • Publishing the Live dashboards along with the data catalogs with automated refreshes.

	• Live Dashboards	• Employee feedback will be monitored to improve the efficiency of the system.
Gamified/Knowledge Based Applications		
Costs	**Priorities**	**Change Management Requirements**
Initial Investment • Impact Analysis - $5,000 - $10,000 • $50,000 - $100,000 • Cloud Storage – $1,000 - $8,000 • Wireframes and mockups – $25,000 - $30,000 **Ongoing Operational Costs** • Application Maintenance - $1,000,000 • Salary for the development team - $3,000,000 - $4,000,000 • Database Management - $3,000,000 - $4,000,000	**High:** • Data Remodeling • Data Security • Application deployment on multiple operating systems • Marketing • Smooth user experience **Medium:** • Continuous improvement • Scalability	• Stakeholders will be made aware of each release. • Release Notes with each version upgrade will be created. • User Manual for better usage of the application by the users.

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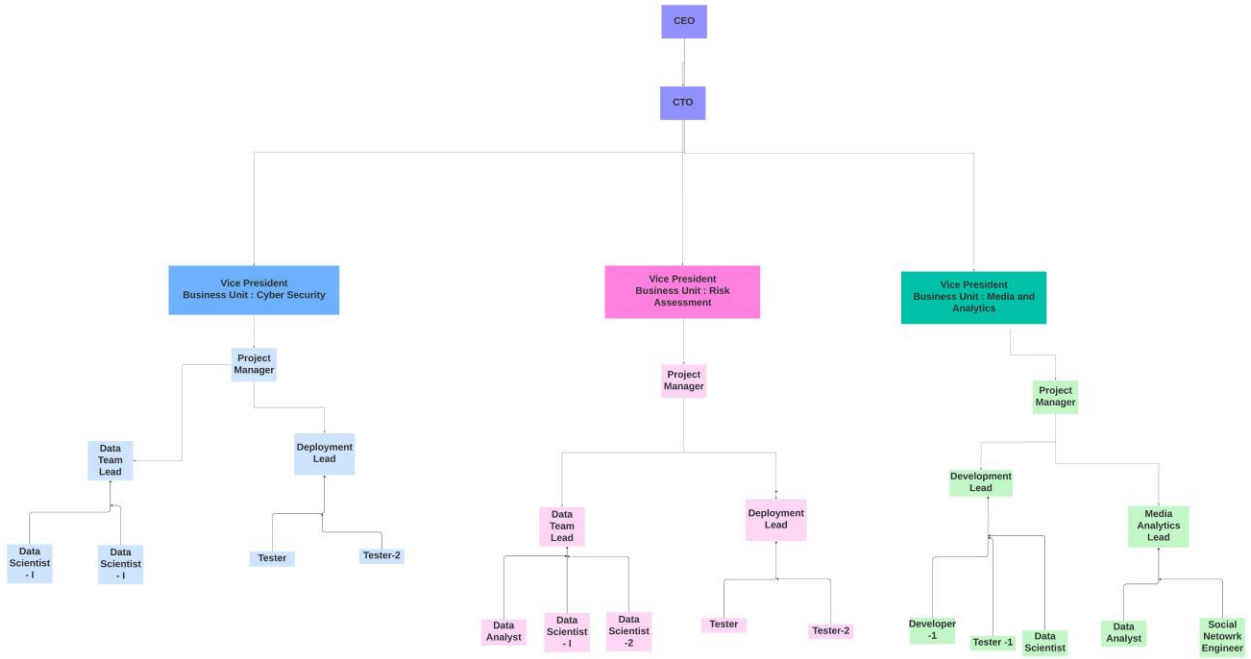
Conclusion

Proposed IT Organization

The proposed IT organization for the finance and insurance industries encompasses a skilled team spanning data scientists, software engineers, data analysts, IT architects, project managers, quality assurance specialists, and support and operations staff. These professionals will operate across specialized centers dedicated to data science, technology, and operations, under the guidance of experienced leadership including the Chief Technology Officer (CTO), Head of Data Science, IT Director, and Operations Manager.

Significant technologies such as federated machine learning (FML), machine learning, big data analytics, cloud computing, and data integration platforms will be leveraged to develop innovative solutions for fraud detection, personalized financial recommendations, and risk assessment enhancement. Additionally, strategic commercial relationships with technology partners, consulting firms, data providers, and software vendors will be established to access specialized expertise and cutting-edge tools.

Integration plans will ensure seamless coordination between different IT teams and centers, with agile methodologies facilitating iterative development and continuous integration of IT solutions. Robust change management processes will be in place to manage transitions effectively, while training and knowledge sharing sessions will ensure alignment and readiness among all stakeholders. Through these efforts, the proposed IT organization aims to deliver effective solutions that enhance security, trust, customer satisfaction, and compliance with data protection regulations across the finance and insurance industries.



Utilizing the reinforcement learning technology to drive our IT initiatives can help in increasing efficiency, reducing or better managing risk and to increase profitability. It will help us in making data-driven decisions to optimize insurance pricing, improve portfolio performance, improving the credit risk prediction capability of organizations and building optimized investment portfolios to maximize profits and minimize risks.

Cloud native computing is essential to the success of financial and insurance companies moving forward. While it may currently fall under the peak of inflated expectations regarding the Hype Cycle for Emerging Technologies, cloud native computing has indubitable allowed for greater efficiency and resource allocation for companies that seek to lead the way in information technology advances. From the top of the organization with the chief officers all the way down to the IT teams manning development – native cloud applications help to drive the initiatives of managed services, improved regulatory compliance, and scalability of a business's data centers.