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Intelligent Technologies for Modern Financial Ecosystems: Transforming Housing Finance, Risk Management, and Advisory Services Through Advanced Analytics and Secure Cloud Solutions

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Abstract

The financial industry is transforming multiple business processes by leveraging intelligent technologies for modern digital platforms delivered through secure and compliant cloud solutions. Emerging technologies based on machine learning, robotic process automation, and artificial intelligence facilitate new opportunities for privacy-preserving analytics and scalable processing engines to optimize mortgage transactions with superhuman capabilities and control potential risks for investors with potential trillion-dollar financial impacts. In these situations, recommendations must be provided in real-time to enable secure management of the complete financial ecosystem. Based on an interactive chatbot, technology can facilitate comprehensive enterprise workflows, including document preparation, collaboration, approval, and signing. For advisory services, disruptive insights for smart usage of natural resource-based assets can be derived with high precision through spatial intelligence and intuitive visualization tools for financial professionals.

Intelligent technologies are assisting customers in the entire financial service foundation area to manage their specialized topics more independently, enable the deployment of personalized customer service, and improve opinion formation quickly by providing verifiable information with requestable proof of concepts. This text focuses on intelligent, enterprise-grade, integrated solutions from one of the leading financial software providers. The content is organized into three main parts. The first part will introduce innovative housing finance concepts. The second part will focus on the modern risk management of portfolio investments. The third part will emphasize transformative services to benefit from an intelligent, digitalized world. All proposed tools and services are regularly and securely maintained by trusted cloud experts to become an integral part of the modular Enterprise Support service offering.

Keywords: Intelligent Technologies, Digital Platforms, Cloud Solutions, Machine Learning, Robotic Process Automation, Artificial Intelligence, Privacy-Preserving Analytics, Scalable Processing, Mortgage Transactions, Risk Management, Financial Ecosystem, Interactive Chatbot, Enterprise Workflows, Spatial Intelligence, Visualization Tools, Personalized Customer Service, Opinion Formation, Housing Finance, Portfolio Investments, Transformative Services.

1. Introduction

Solving key business challenges in a financial ecosystem in a timely, economical, and secure fashion is critical for cost savings and for increasing customer satisfaction. In the context of an established financial ecosystem, we have targeted three key business use cases: retail banking operations, consumer finance, and advisory services for bank services. Not only have we integrated current technology trends to handle these complex challenges, but we have also ingested a variety of new and emerging data sources and employed advanced analytics well ahead of industry practices.

Mitigating risk and reaching optimal housing finance solutions that substantially benefit both banks and customers is a scientific and quantifiable problem. We have also nullified several analytic technology barriers in the process. Regulatory red flags and problem-solving skills concerning housing finance are other joint deliverables of this partnership, which we have actively pursued. Another unique component of the proposed smart cognitive computing solution includes end-to-end data security, secure

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data sharing among the banking ecosystem, technology down the path of driverless AI, and measurement of its value. Topics of interest also include a comparison of value when these large analytic pipelines are in action and a comparative study of the influence of success over other alternative tools.

1.1. Fundamental Framework

Many feel that the global housing finance market has finally shifted out of its doldrums. Recent forecasts on the continued uptick in U.S. housing prices bring added measures of enthusiasm for faster advances to various pieces of the credit links in the housing finance value chain, including the secondary market. House price increases are a positive but still modest portent that the extensive, and in many cases hard-fought gains from the multiple housing finance reform initiatives will not only be preserved but will be advanced as well. With the end of the Federal Reserve Board's intervention in the mortgage finance market, the future for different parts of the market pursuing a responsible and profitable growth trajectory should be underpinned by employing intelligent analytics, particularly the latest advances in the field of very large scale, high-frequency analytics, as well as adaptive systems that are designed to continuously analyze, revalidate, and optimize the spectrum of risk dynamics of house price movements, the composition of housing finance portfolios, and their underlying, and at times slowly changing, paradigm. At the most fundamental level, the world of finance is a story of transforming potential energy that lies embedded in logic and rational self-interest into dynamism and actions that produce a cornucopia of goods and services, as well as the ancillary enhancements of social charity, justice, and rights protection. Financial engineering using all manner of technology, both human and electronic, has enabled the design of incredibly complex financial instruments, making possible ideas that not only satisfy the goals of traditional economic and political thought but also the aspirations of human beings, including the current and future generations, who will never have the opportunity for a say at any of the tables where financial solutions are crafted. What has gotten lost from the discipline of finance, especially the more mature and highly specialized pillars of real estate finance, housing finance, asset-backed securities, portfolio management, performance optimization, or mortgage risk assessment, is the value-added contribution of forward logic and insight versus the enormous amount of backward-looking judgment and experience that is employed to balance interests.

Fig 1 : The Evolution of IT in Financial Services

2. Overview of Intelligent Technologies

In recent years, the explosion of digital customer data has created a significant opportunity for analytics-based business transformation in financial services. These large data troves are an undervalued asset, as sophisticated business analytics, smart alerts, intuitive visualizations, and informed actions can be derived directly from the data to support business decision-making. Advanced analytics solutions for financial institutions deliver real-time actionable insights to help marketing executives maximize the world's most critical resource – the customers. As our business becomes increasingly digitized, it turns out that customers create a lot of valuable data, and we are now in a position to access, analyze, and interpret that data to better understand and serve our customers.

Cloud computing in today's business climate has radically transformed the way new businesses are conceived, validated, built, and brought to market, and has a powerful impact as well on fast-changing business operations and processes. Financial services are undergoing significant disruption with the advent of cloud platforms. Technologies such as data warehousing and analytics, rich customer relationship management, mobile payments, direct digital transactions, secured document delivery, as well as a host of other services, are vastly improving the financial services experience as a result. To effectively transform their

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businesses, financial firms will need to find the advantaged economics provided by shared cloud services, as they strive to drive once unimaginable organizational productivity levels. The advanced analytics solutions for financial institutions offer business patterns empowered by this cloud revolution to sift through high-value customer data. These solutions surface customer preferences and behavioral patterns that would have previously gone unknown or unrecognized, and play a central role in providing business leaders guidance to take action based on those insights.

Equation 1 : Housing Finance Optimization

$$H = \frac{L \cdot C}{R + I}$$

Where:

H = Housing finance efficiency

L = Loan approval speed via automation

C = Creditworthiness assessment accuracy

R = Risk exposure

I = Interest rate fluctuations

2.1. Definition and Scope

The combination of cost-efficient data management, adjustable elastic analytics technology, and intelligent algorithms with self-updating models, along with decision systems hosted on a well-protected cloud, enables the development of a new generation of AI-driven, scalable financial services that facilitate infrequent transactions without depleting scarce and costly human expertise. By combining AI and cloud computing through these principles, Modern Financial Ecosystems (MFE) are transforming existing financial services through precise predictions, affordable and effective risk management, rational behavior recommendation services, and continuous and scalable advisory for complex public and private weather-affected markets and other financial ecosystems. On the road to converting human financial judgment into replicable and explainable solutions for scalable financial analysis and advocacy, it is the intellectual process itself that emerges. Creating a scalable MFE is also a transformational educational process for human capital, as lessons from effective risk management suggest better story-driven human actions in the chain of custom, contract, and real economy management. Practical decision rules, devoid of unnecessary complexity, also improve sector feasibility, allow a seamless transition to the current system for real estate finance, introduce robust corporate benefit technology that reduces the current cost for benefits in development protection, and establish decision consistency at different levels of government and insurance. For this type of ecosystem, fields such as sustainable activities are not only financially possible but also technically and legally feasible methods are available. Our decision infrastructure suggests using anonymized algorithms only in cases of asymmetry or wider interpersonal imbalance, and hand-tailored face-to-face consultation by a human. Scoring methods are used when necessary for better legal and ethical goals. Providing infrequent and complex transactions without incurring prohibitive search costs was practiced in government services well before the internet era, and tailored, face-to-face rules or scoring tests supported by evidence documents as proof of financial background or need to collect private information were perceived as protection of public resources. Small transactions require limited guarantees not only because they support efficient operations in the financial ecosystem, but also because, in general, ethical individuals are aware that they should receive something for this reciprocal transaction.

2.2. Historical Context

Historical records from Babylon—the first urban society in history—provide evidence of a system of housing finance to promote private ownership of dwellings. Over time, interest rates were institutionalized, not only as compensation for the postponement of current consumption but also as a reward for the financial risk incurred by individuals providing finance for housing and other investment projects, such as managing a crop in return for a share of the profit or loss. Over time, the repugnance related to the charging of interest was prohibited by religions, and—providing a solution to the erosion of lending standards—a form of joint liability lending was introduced to achieve positive expected returns on accumulated savings. Although the development of economic theory and practice laid the foundations for the concepts of fair investment instrument testing for the presence of inflationary price pressures and protecting people's living standards, the source and intertemporal use of data was limited and tended to favor the interests of the ruling elite, or the urban houses of those with surplus resources towards when the accounting period was translated to mean a 12-month risk cycle.

Using their privileges to create nontraditional guarantees denoted as money, the Medici family transacted decentralized book entries called giro credit, which were linked to a cash fund account. This centered arrangement also involved transactions between third parties in the form of unsecured letters of advice which, although not guaranteed by the Central Bank, were transacted as a decentralized means of payment. These techniques spread all over Europe by allowing individuals to participate. Another mobile case of mortgage finance due to skirting local laws was generally regarded as excessive usury during Moorish Spain when contractual equity partnerships (also used in

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trade) included the sharing of earnings of the partners according to the percentage of capital invested and the corresponding projected expected earnings. Unlike modern monetary policies controlled by lenders of last resorts in sovereign states, the introduction of city-states increased the availability of matching savings investment finance, most notably with the contribution of the banking system in the financing of redevelopment for the city of Augsburg, Germany from and in shifts in the geopolitical balance of power with sovereign debt and partial loan guarantees of small Canary Island countries.

3. Housing Finance Transformation

In this chapter, we delve deeply into the transformative potential of intelligent technologies within, and in the peripherals of, housing finance, accomplished via modern, secure, and well-structured cloud solutions. In particular, we begin with an overview of several structural challenges that have impeded the increased flow of funds to the housing sector. These challenges range from complex, interconnected regulatory burdens that have increased the costs of matching funds to borrowers, to market information that does not relate to the true underlying risk. Given their structural underpinnings, these impediments translate into a high degree of market instability surrounding what could be considered normal economic conditions. Rather than simply absorbing and transferring risk as happens in the securitization process, a modern housing finance system needs to perform several key roles with differing dimensions of risk tolerance.

One of the most positive impacts that cloud solutions offer is making these and other important government mortgage functions more transparent to the policymakers that oversee them. Transparency strengthens accountability—the internal checks and balances within an institution—because leadership and managers act under a greater degree of public scrutiny. Comparative stakeholder benchmarking also drives qualitative improvements as well. At the same time, sophisticated cloud service offerings can deliver quantitative benefits that enhance the enterprise analytics capabilities of these same functions. Platforms can help to change management decisions in various ways, such as aligning more resources to material operations, reducing resource spending on redundant operations, fundamentally shifting an operational focus due to the deployment of emerging intelligent technologies, or quantifying the opportunity costs associated with different options.

3.1. Current Challenges in Housing Finance

In essence, it is very important to have a holistic view of a customer's behavior by tracking potential distress early and most effectively by reducing costs, minimizing risks, and improving speed. Housing finance for self-employed, informal workers is a high-growth segment with underserved credit due to limited credit and product understanding. As these segments earn in cash, verification is more challenging, mainly relying on information from bank statements. The process requires multi-party approval, which must be comprehensive and binding, often difficult for developers and customers due to a lack of trust in housing funding. Unequal governance of builders presents the financial community with a high perceived potential risk in affordable housing projects using technological business geolocation combined with AI and ML.

Relocation for under $30,000, a potential customer group in underserved rural and semi-urban areas, has limited credit and product understanding. We use naturally spoken information to better identify the need, credit, and repayment capacity of the customer through daily conversations with advisors. Suitable governance structures and agreements between the various stakeholders must be in place to encourage all stakeholders to return income from liens. Alternatively, incentives and rigorous monitoring may assist the financial community in investing in affordable housing. FinTech should also respond to this need by introducing products to the market that can be adapted to liquidity, allowing for seasonal payments. This can be checked through consultation with tech, for example, via a single window, and includes small funding valuation offices and reducing the complexity of reporting the income produced in the corresponding upper market jurisdictions.

3.2. Role of AI and Machine Learning

Consequently, though the consequences of excessive use of algorithm-based technologies in the field of financial services can have serious implications if they are used without strict compliance with ethical standards, the use of AI has unleashed great potential in the field of finance, as evidenced by the cautious but also enthusiastic interventions of regulators. The potential positive effects of AI and other innovative technologies can improve the quality, accessibility, and reliability of available and innovative financial services. The uncertain impact of the authorization of AI and machine learning means that the authorization to use self-learning algorithms for forecasting cannot rely on a mere registry of variations. Therefore, AI and other innovative technologies raise questions concerning responsibility in the occurrence of damage caused by an act or omission. In other words, it is essential to consider the way the operator utilizes the algorithms and, if necessary, the moral weight of the algorithm in producing the damage. The regulatory approach to the various issues related to the use of AI in finance must seek, in general, to ensure the achievement of the objectives of efficiency, inclusion, and adaptation of the different functions of interest to the financial operator and counterparties in response to the speed of innovation, ensuring that the actions of stakeholders are

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consistent with the assumption of responsibility in the face of possible damage.

3.3. Case Studies: Successful Implementations

The experiences of the organizations behind this book reflect the patterns presented in the previous case studies. These successful implementations on the cloud demonstrate how accurate and believable results can be presented throughout the organization. Benefits realized include no infrastructure costs and low operational costs, flexible data connections, improved data access, and real-time value and instant ROI. Building an agile organization with data-driven enterprise decision-making is achievable.

Case 1: Government of Caldas. The government started a practice offering a mobile app and website with intelligent search capabilities that use machine learning for automatic categorization and scoring of each proponent and investment option. The public still answers a simple question: if they agree with each project, involving citizens and making them part of government decisions.

Case 2: Interzap. Interzap helps a Brazilian bank better understand shops' level of revenue at each street corner of a city with no need for credit history or help from third parties. Using cloud technology, the bank can perform real-time validation of information consistently and make quick loan offerings, which is revolutionary in Brazil.

4. Risk Management Innovations

The faster you can access and analyze all types of data, the better you can steer your risk protections and governance with powerful, insightful analytics that help to identify exposures and concentrations, assess portfolio model properties, and track risk-capital allocation trends. But effective risk management today is about more than numbers. Risk data you can aggregate and synthesize information of many kinds, a range of data types and formats, including structured tables, raw text, videos, and music. High-end analytics can support all types of simulation and decision-making processes, offering comprehensive assessments and explorations tailored for individual roles. What-if analysis, optimization, and robust understanding of systemic events leverage a wide variety of risk assessment and management methodologies. Analyze as many scenarios as possible in a reasonable amount of time. Explore a variety of different possibilities, using search capabilities to complete risk management data additions such as inspection and financial statement data. Construct many different models, assessments, and calculations per portfolio or counterparty. Calculate aggregated risk measures more quickly, including tail VaR and expected shortfall. Measure the potential exposure to counterparty default by simulating the yield curve and spreads in scenarios that are tailored specifically for modeling counterparty-specific market variables. Benefit from secure, scalable, rules-based risk data processing, which is capable of identifying, cleaning, and validating complex multi-source data. Effective administration of model workflows, with audit trails. Quantification of operational and legal risks, along with economic capital assessment. Permit output aggregation across thousands of models.

Fig 2 : AI is Transforming Financial Risk Management

4.1. Understanding Financial Risks

Advances in technology, automation, and real-time computing have improved financial risk management. Identifying, assessing, and evaluating the risk's maturity and impact have become dynamic practices in response to the volume, velocity, and variety of financial data processing. Model risk management is the key component to validate all financial risk management practices. Multiple types of models are developed to evaluate these types of risk, including valuation, performance, risk rating, forecasting, budgeting, stress testing, and economic scenario generation. The economic scenario generator is used for strategic planning to ensure comprehensive stress testing and capital assessment. The development and validation of all models are essential activities forming the governance of model risk management.

For the last couple of years, there has been renewed interest focused on interpreting various aspects of financial risk, such as asymmetry, tail dependency, the discrepancy between forecasted and actual portfolio value, and especially black swan high-impact, low-probability events, by leveraging rapidly developing theories surrounding entropic windowing, homeomorphism preserving mapping, and homomorphic entropy. While advancing the frontiers of financial risk, the prior technologies mainly address assets and liabilities risk. Derived from physical-biological processes, some of the recent innovations have been able to relatively tame the pathologic factor structures and make the concepts of risk consistent and flexible, leading to advanced options pricing models. These advanced pricing models strongly support the arguments that two out of the four fundamental effects form the universal economic derivative laws. This new research direction, with the aid of modern

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emerging mathematical toolboxes, may lead to solutions for some grand challenges in financial risk.

4.2. Advanced Analytics in Risk Assessment

Mortgage providers, institutional investors, and government and multilateral credit agencies share the objective of reaching creditworthy borrowers with mortgage loans at the lowest possible risk. They face several challenges when assessing risks: identifying the most suitable economic indicators and tools for the domestic housing and mortgage finance markets in which they participate; relying on models developed in other countries, which might not be useful because they do not incorporate local factors; and paying too much for these models. In this context, design thinking, rapid prototyping, and implementation of quick incremental functionality improvements provide important lessons. Advanced analytics models are also important, as the mortgage lending industry today is increasingly moving toward the analysis of larger data sources. This chapter describes some solutions successfully applied in several emerging markets in support of housing microfinance development, where providing affordable housing for low-income families is of particular relevance.

This competency enables: cutting-edge statistical models and machine learning algorithms developed by expert data scientists; proof of concept or testing activities of these algorithms, in case custom modeling is being considered, to understand the effectiveness of the models; pricing grade validation of custom models and/or consulting on strategies for their implementation; modeling specific advisory services to define which pre-existing models can successfully meet the customer's needs; building predictive models on customer-provided datasets while assuring the most effective and most appropriate output; and building flexible modular solutions, applicable to different sectors and easily adaptable to the contexts.

Equation 2 : Cloud-Based Financial Advisory Optimization

$$U_{client} = \sum_{i=1}^{n} w_i \cdot A_i$$

where

U_{client} = Utility function of financial advice,

w_i = Weight assigned to financial preference i,

A_i = AI-advised action for investment i,

n = Number of financial instruments analyzed.

4.3. Predictive Modeling Techniques

In the context of this research, the term "predictive modeling" represents a statistical framework to forecast outcomes. The most popular example of a predictive model is the credit scoring system, in which the credit score is used as a statistical model to indicate the creditworthiness of the applicant and the corresponding interest rate. There are various classes of predictive models. The most popular ones among them are the generalized linear model, decision trees, neural networks, support vector machines, and recursive partitioning techniques.

Generally, the predictive modeling process can be broken down into separate steps. The first step in the model-building process involves data preparation and model construction. This step usually takes about 70% of the time allocated to constructing models. The second step is model validation. In this step, we assess the validity of the model. At this point, some of the developing or building processes might backtrack if they have gone far from their targets. Nonetheless, in the final step of the process, the predictive model is applied to the current information to generate the prediction results. After discussing the building and validation processes of the predictive model, several examples are presented to provide practical implementation strategies for the reader.

4.4. Integration of Cloud Solutions

The intelligent financial ecosystem is an interconnected network of financial institutions and fintech partners supported by secured cloud solutions to enable seamless and instant support of the customer journey within a trusted platform, from product origination to fulfillment, while leveraging open APIs for unbeatable agility and innovation. Modern secure cloud solutions support lenders to perform a wide variety of tasks as part of the loan lifecycle, from managing the technology requirements of selling and servicing mortgage loans to analyzing loan risk or obtaining access to capital markets, among other services. The loan mortgage lifecycle is streamlined through an integrated, full-stack suite of services to procure automated underwriting, condition management, eClose, and funding requests.

The cloud-based architecture simplifies and enforces data consistency, reduces data latency through flexible data update schedules, reduces exchange overhead with data sequencing and transaction validation, provides a golden copy for audit and reporting, provides a modern API architecture, and delivers platform services and monitoring tools to extend lender configuration management. The platform ecosystems are developed and distributed by modern secure cloud solution providers that offer end-to-end security, reliability, performance, and scale. These platforms have a shared responsibility model that minimizes customer risk exposure and supports a wide array of partner integrations.

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5. Advisory Services Enhancement

Financial institutions need to analyze a customer's financial status before providing financial advice. Advanced analytics based on intelligent technologies can be used to better understand a customer's financial needs, which may be difficult to collect only via face-to-face consultation. While a traditional questionnaire has to be filled out by the customer and explained by financial consultants, the developed system offers functionalities like visualizing the financial status of the customer by extracting information from chat, email, etc., and gathering social data via methods on social networking services or online communities. Next, the financial needs are classified according to the job group of the customer. The personalized products or services are then generated and offered by the company or platform.

For this problem, the integrated system for B2B2C was developed. Fast infrastructure, including the big data platform and AI models, using high-quality security control, process, and pattern analysis services, is designed to enable firms to more expeditiously share attractive service content and benefit the customer base via the B2B2C model, to activate alliances and language services among firms. The initial training to classify the customer groups or representative texts and to generate the sequential ideal text is done using transfer learning. The validated results obtained in various languages improve the model's ability to figure out the nuances in each language. The industry solution includes financial services to enterprises offering benefits to encourage customers to become members of the enterprise's mobile app or e-commerce platform.

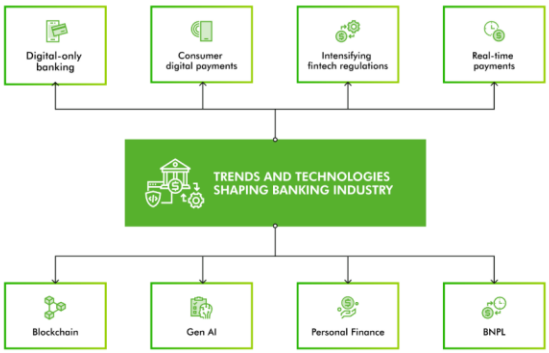

Fig 3 : Redefining Financial Services

5.1. Traditional vs. Modern Advisory Services

Typically, traditional advisory services are mostly financial advisers, institutional fund managers, analytical departments at investment houses, financial experts on television and in the press, or researchers at university departments. These people and structures are typically underpinned by sophisticated and proprietary forecasting models that use significant amounts of the most up-to-date data and best modeling techniques. While often very knowledgeable, these traditional experts are sometimes subject to significant conflicts of interest and are focused on high net-worth individuals and institutions that can afford to pay high fees or salaries, or on near-term results. Unfortunately, not everyone can afford the services of the best experts, which has been a growing issue. Consequently, modern advisory services have been evolving to provide scalable and accessible options for everyone.

Many can argue that innovations in technology and the internet have made the financial environment more democratic and transparent and that access to sophisticated advisory services has considerably improved. However, these are early days for modern financial advisory services; the best is still in the process of being built. While the technology and the supporting cloud infrastructure are continually improving, access to the best proprietary data and the best modeling capabilities is still a bottleneck for the more universal development of advanced high-quality analytics. Decentralization and tokenization efforts should mitigate data accessibility bottlenecks, but the regulatory environment is still uncertain.

5.2. Data-Driven Decision Making

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By making better data-driven decisions, housing finance, and other financial institutions can improve the strength and sustainability of their business and potentially promote market stability. Blockchain, artificial intelligence, machine learning, augmented reality, the Internet of Things, and other current technologies are increasingly available to analyze increasing volumes of both traditional and nontraditional data sources, responding to the challenges of the rapidly expanding digital era. Optimizing the potential of these advanced analytics and integrations with secure cloud offerings requires accessing high levels of computing power, storage capabilities, and tools that run on a single computer, networked servers, and distributed cluster architectures to accommodate evolving and increasing sizes and types of data.

Implementing secure cloud solutions can also diminish the escalating costs associated with ongoing maintenance, modernizing existing infrastructures, and protecting against widespread and evolving cyber threats. Research capabilities make continuous adaptations, reconfigurations, and acquisitions possible, as well. Critical to its ongoing and evolving digital learning strategy, training and workshops, practicing tailored coaching, communicate to a wide range of learners the many possibilities available through secure cloud technologies. Real-world experience, directly from

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these secure cloud technologies, can empower learners to support the distinctive requirements and constraints under which each of their housing finance or other financial institutions operates. Such an enterprise security and compliance strategy thoughtfully addresses three dimensions of a secure cloud: the architecture, data management, and application capabilities. The cloud provides varied deployment choices as well for the diverse range of workloads and objectives in existing or prototyped hybrid-multi-cloud scenarios, relying on sophisticated encryption and deduplication technologies to protect the confidentiality and integrity of the data. By doing so, energetic and ambitious financial services managers can derive significant value from the solution opportunities for deploying secure, scalable, and innovative intelligent technologies that embed into the existing business operations a set of sophisticated advanced analytics capabilities.

5.3. Personalization of Financial Advice

A fundamental question in financial advisory services is how to tailor investment advice to individual investors to maximize return. This paper links an innovative aspect of supported decision-making in financial advice to an influential strand of work on social transformation in finance. It is observed that technology played no role with the possible exception of computer technology, suggesting that decision-making was largely a human activity that could not be mechanized. It is noted that today's technology – including big data, cyber-physical systems, and artificial intelligence (AI) – opens a range of opportunities to help individual investors benefit from very manual investment, automated investment, and even beyond automated investment to create investment strategies based on fast, transparent, and tailored advice. In the present study, we develop empirically driven and proprietary machine learning algorithms to classify housing finance decisions and derive product-specific advice tailored to each housing loan applicant.

The importance of financial stability for economic development and growth is well established. Policymakers across the globe have always worked on ways to increase and sustain the level of financial independence for households and businesses. It is well-recognized that having access to housing loans allows people to build a more secure and better future for themselves and their families. Programs in India have brought many first-time homebuyers closer to their dreams of having a home, be it economically weaker sections, low-income groups, middle-income groups, or people buying their first homes. The formula for calculating eligibility or affordability for a housing loan is well-known and available across any bank or online. What has, however, remained obscure has been the optimality of crafting, based on real income inflows and credit standing linked to the borrower's signature, the right home loan or finance combination, which also captures other borrower-specific liabilities. We empirically demonstrate to the industry that for administrator-assessed risks, housing loans custom-tailored to the needs and specific circumstances of the borrowers can achieve better risk-adjusted economic utility than a one-size-fits-all housing loan from an industry-leading bank design. The present approach facilitates not only financing calculation rationing but also productive loan securitization by developing personalized business rules for the cards.

6. Advanced Analytics Applications

The advent of big data, computing capabilities, and advances in mathematical algorithms, together with the globalization of financial markets, has prompted forward-looking organizations to focus on advanced analytics applications for institutional effectiveness, efficiency, and overall business performance, and to achieve their business objectives. Different sources of data like the web, data from sensors, customers, partners, audits, and internal transaction data, just to name a few, are used to make connections between process events or objects and spot hidden patterns, correlations, trends, and more, bustling with new and untapped insights that can trigger better business decisions and, if released, extract incremental value for better performance and increased efficiency that can translate into better financial results. The potential benefits of advanced analytics have been recognized and, especially in the financial sector, countless applications have been developed, using the latest available technology like advanced interactive dashboards or big data technologies. Moreover, the reality is that advanced analytics applications are part of the broader category of business intelligence applications and can transform software into decision support solutions that can be applied to business challenges across the entire business ecosystem, helping any company to tackle strategic decisions, developing and evaluating conservation strategies and business models, identifying acquisition targets with favorable performance and business risk metrics, or designing and benchmarking effective loyalty programs for both employees and clients. Ongoing developments in basic technology and access to third-party databases leading to the selection of relevant algorithms for specific use cases will make it easier and more economical for organizations, both within and outside the financial sector, to benefit from analytics applications.

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Fig 4 : Cloud Analytics

6.1. Big Data in Finance

Effective risk management, compliance, and customer relationship management are foundational to an effective, stable, and innovative financial ecosystem. They share in common the need to harness and manage large and complex data from a wide spectrum of public and proprietary sources in a way that provides meaningful and actionable insights for humans and decision systems. New analytic, visualization, and cloud solutions first developed for other economic sectors are transforming these financial fields, provoking new business opportunities and impacting both jobs and daily operations. Cloud-based and in-memory technologies can handle large analytic tasks and support real-time decision systems that span the globe. These technologies are being used to enhance performance and effectiveness in financial research, residential and commercial mortgage finance, payment systems, risk management, compliance, operational oversight, and structured products such as asset-backed securities, collateralized mortgage obligations, and mutual funds. Specific examples and case studies are presented.

6.2. Real-time Data Processing

Real-time data processing. Sophisticated algorithms for prediction and classification leverage features based on real-time hydrological data, nearby stations' data, and spatial estimation techniques. For in situ data, feature transformation methods are employed to better capture the complex seasonality of the data. Multi-sensor fusion approaches aggregate information across several measures. In some cases, the prediction framework adapts steadily by injecting dynamic data directly into the model, reflecting the most recent events as they occur, and effectively acting as an early warning system. It also incorporates knowledge-based rule sets to integrate predictive and mechanistic modeling techniques, remove outliers based on the distribution of measurement errors, and mitigate data discrepancies, including smoothing, interpolation, and data reconciliation. All continuous data processing, with online retraining of the models, is carried out at the cloud level to ensure that the real-time engine operates continuously 24/7.

6.3. Visualization Tools and Techniques

In the age of multiple sensors, devices, service enterprises, the Internet of Things, open data, big data, and cloud and grid computing, an analyst might easily get overwhelmed. The key is to be able to make sense of all data streams and, at the same time, do this promptly. It is imperative to use interactive visualization for meaningful data exploration. Nowadays, analysts are not data miners in the traditional sense of the word. Their roles are far more complex and varied. Thus, flexible visualization techniques can greatly aid analysts in understanding patterns, correlations, and anomalies. We are now entering the era of visual analytics. Today's tools provide an intuitive and flexible environment, allowing users to make real-time but informed decisions. There is a need to use the right tools and techniques to obtain insights from the voluminous content of today's multimedia information systems. Techniques should aid in easy data access, extraction, and management, while at the same time offering powerful means for data representation and analytics. Key challenges include the need to seamlessly combine rich and diverse data sources while being able to provide performance guarantees. A system should provide flexibility in various data streams and live content representations, feature encoding, feature construction models, and visualization algorithm design. Just as financial analysts strategically assess intricate, complex financial, risk, and compliance aspects of structured securities, economists need similarly powerful tools for evaluating country fundamentals, global economic risk, and vulnerabilities. There is a need to build technologies that capture nontraditional signs. Novel data types provide real-time insights into innovations occurring within a country's industries. However, the primary challenges involved in the capture and analysis of such data are fourfold: 1) data volume and heterogeneity; 2) difficulty in performing broad content screening and mining; 3) effective data translation and organization in a structured format well suited for comparison; 4) integration and use with traditional statistical data. Access to various types of data services can greatly aid and simplify these tasks. By providing an integrated interface with a range of available data tools, we can allow and encourage analysts to easily access interesting data, determine its value, and begin to answer fundamental questions through early data exploration.

7. Secure Cloud Solutions

As financial firms migrate from legacy to cloud architectures, they provide customers with more flexible and lower-cost consumption experiences. However, customers have unique data security, privacy, and compliance requirements that are not fully met by most cloud service providers. We discuss a set of research results that show the

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goals of advancing the state-of-the-art use of big data within financial services through the application of deep analytics and advances in artificial intelligence and machine learning can all be met via secure applications of cloud computing. These results show that the same business case that prompts the move of advanced compute architectures from on-premises to various cloud providers can also be used to support hybrid cloud deployment in which an enterprise's most sensitive and valuable data and models remain on-premises, while more widely accessible data can remain within a private cloud or be accessible to the hyperscalers after dynamic and secure access and computation on them. Broader commercial deployment of high-end cloud computing with a manageable security upgrade is exactly what needs to be developed to extend the work done by financial services to a broader class of enterprises. Our perspective, developed on a journey to support commercial cloud adoption in which the cloud providers had both technical talent that could do better than what was currently available and business cases to build the subset of technical solutions that could be broadly adopted by financial services into the commercial offerings that all customers, not just those in financial services regions, are demanding.

7.1. Cloud Computing Fundamentals

We compare cloud computing with the state-of-the-art data center facilities deployed by some of the world's largest cloud providers. We define cloud computing and discuss precision data center and cloud building design, energy, maintenance, virtualization, and engineering best practices. Clouds allow for efficient resource utilization through multi-tenancy and are usually equipped with a variety of information and communications technology equipment that is powered and networked in a way that allows workload and data movement to be orchestrated and managed in an energy-efficient manner. Cloud computing is a natural direction in the development of recent trends in data center technologies, and today's largest technology service providers are indeed the principal developers and users of clouds. Provider clouds offer advanced energy and information technology resource management, and they often deploy base-of-the-pyramid concepts to realize efficiencies in power and cooling. Although provider cloud efficiency may thus be difficult for smaller-scale enterprises to replicate, there is much that may be learned from cloud best practices and made use of closer to the typical scale of computing. We therefore focus on design and operational practices that are common in cloud data centers and can benefit both in-house data centers and smaller-scale cloud infrastructure.

7.2. Security Challenges and Solutions

In the age of mobility, customers are seeking to obtain information on products and services at the consumer's convenience anytime and anywhere. A recent study discloses that to increase the use of online banking services, financial institutions need to provide more security-related information to build consumer confidence in engaging in online interactions. The increasing use of online banking services also raises the risk of security threats. Many consumers are reluctant to use web-based banking services. Bringing the consumer back to your financial webpage time and time again and slowly growing their confidence takes intelligent technology deployment. A typical consumer's primary level of security is to initiate a service through a playlist of entry points scattered throughout other vendors. Security is an increasing scale into the financial webpage up to the point where the consumer's use of functions is initiated within your banking infrastructure.

When the consumer feels financially comfortable, the majority of data will be managed within the bank's infrastructure. These issues allow a financial market opportunity that could recapture finite consumer webpage time to result in increased transactions. The best opportunity to nudge the financially confident user shifts documents or information flow that come to knowledge workers' authority outside of a popular bank's web infrastructure. Specifically, understanding this movement of data and the appeal in influencing the change to remain internal through using this movement of data that is sent via other means requires third parties to provide equivalent security features found in other customer-proposed structures. Thus, ensuring financial stability for a bank involves monitoring what types of unique activities are outside of the created infrastructure.

7.3. Compliance and Regulatory Considerations

Financial institutions want to benefit from the cost-effectiveness and scalability of advanced analytics-based AI/ML technologies. Institutions using AI/ML technologies for assessing consumer applications should be cautious about explicit and implicit biases. They should also conduct ongoing automated assessments of outcomes and fair lending risks. Institutions need to assure customers about the development and remediation of the models, the interpretation and explanation of model decisions, and the evaluation processes and analyses done for complex models. The use of AI/ML technologies often raises new and complex questions about compliance with consumer protection laws. The use of "alternative data" outside the traditional sources supervised by financial regulators in credit decisions is a new challenge for institutions.

Adding intelligence to advice in banking, payments, and wealth management is a big opportunity. The application of AI/ML technologies in personal and corporate wealth, asset

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management, and the pensions industry must be ethical. Insurance AI solutions target three priority areas: fraud detection and accelerated resolution, intelligent chatbots and natural language applications, and climate risk modeling and portfolio management. The validation of AI models for compliance should be executed through the calibration of models and systems, backtesting to determine the effectiveness of the models, periodic validations considering the performance of models with new data, and ongoing monitoring of the output and processes of the models and systems. Business and financial services are a target area of investment in AI, and global spending will total $450 million by 2028. The biggest budgets will center on reconciliations and confirmations, followed by compliance management, trade finance, fraud and risk control, credit scoring, and claims processing.

8. Interoperability and Integration

Interoperability throughout the end-to-end financial ecosystem, including financial advisors, banks, housing finance agencies, and mortgage programs, is a key requirement of next-generation solutions like VICAM (Visual Intelligent Consumer Advisory and Management System). This ecosystem spans organizations with mission goals, regulators, property record databases, software VARs for services related to home maintenance, and other IT service providers. Intelligent technology solutions that support interoperability run across a wide range of architecture, software, and network infrastructure services.

An idealized future state envisions prequalified service providers sharing financial incentive goals with selling owners. The speed and cost of new home services are substantially improved. Homeowners and service providers benefit by value from selling new homeowners using subscriber lists from housing financial services. Current and future interoperability solutions rely not only on services provided by truly modern, agile, and secure cloud solutions but also on global architecture standards, reference models, and architecture building blocks. The Internet of Things (IoT), Hypercat, semantically controlled APIs, and microbiomes, including everything from drug mixing software services to baked bean bakers' production service software, are speeding the integration of complex services.

Fig 5 : Integrating Technology Business Management and Enterprise Architecture

8.1. System Compatibility Issues

Tech-savvy companies face system compatibility issues when they want to move towards a new model of software-based business. This is very often the case for banks and insurance companies with their aging mainframes. The program developer is a solution to this problem. Over time, software gets old-fashioned and requires updates. This is also the case for six program libraries we have maintained throughout time to enhance an algebraic high-level gate description program to generate very large-scale ASIC designs. These designs have been widely used and have recently been enabled for check-ups by making use of a supercomputer.

Developers' solutions often require that they work for different foreseeable scenarios to provide a minimum common platform approach. Extended solutions, which also operate in unforeseeable scenarios to provide partnership models, exist in the form of prediction libraries or code generators. Libraries and code generators have to account for several constraints to generate scalable programs capable of solving today's business-critical problems while guaranteeing that they will be able to solve tomorrow's issues. Software tools, methods, design, and program models to address these problems are also required. Examples are provided for banks and insurance companies in their endeavor to provide IT applications with better data availability and faster and more reliable software products.

8.2. API Development for Financial Services

Intelligent software delivered as web services offers brokerages, mortgage lenders, and real estate organizations unparalleled decision support capabilities that are at the core of "drive-by Internet" solutions characterized by a newly empowered and increasingly technically sophisticated customer base. Insight-rich analytics services feature accessible explanations of performance drivers and key characteristics of value offerings and can bring executive-level insight to the desktop via a highly flexible and scalable platform. Advanced analytics can be utilized in internal and external website technology to draw customers into the

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process of tracking property values and mortgage performance. A new generation of secure, integrated cloud applications, embracing commodity computing and advances with new infrastructure as service capabilities and leveraging advanced analytics to ensure best practice decision-making for professionals and customers, will augment and significantly restructure professional services and open up a new era of informed home-based decision making for the real estate consumer.

Financial services ecosystems today include space for cutting-edge scientific, analytical, software, web service development, data integration, and open communications and compatible software platforms that are needed to make sure that these advances are applied both appropriately and securely. Financial services ecosystem web services need to prove their reliability and robustness to the levels required in the demanding service level agreements that are required in mission-critical financial applications widely; high levels of usage and widespread adoption will ultimately validate this position and confirm that there is a financial industry consensus on the use of web services today that is similar to that achieved by the finance industry data standards consortium that widely use services standards.

9. Ethical Considerations

Any tool created by humans, especially if powered by the latest advances in IT and AI technologies, carries potential implications for everyone involved. The design and deployment of advanced solutions should thus be done under the principles of transparency, fairness, interpretability, accountability, inclusiveness, privacy, and user experience. As technological humanists, the authors feel especially compelled to pay close attention to these guiding principles. To wit, we must emphasize that our current and future work is under the most explicit human oversight at the interface level, since the very goal of advanced AIs, systems capable of self-learning, is to offer previously unseen levels of effort-saving or problem-solving through expert problem-solving. However, superfast and successful problem-solving techniques would also require the capability to learn, re-learn, and execute simulative processes of self-extension limited, in turn, only by the speed of creativity of the humans standing in the smooth self-extension path.

These advanced AIs have the explicit purpose of simulating and solving classifiable human-level decisions involving, for instance, complex risk pricing strategies, social preferences ranking, or investment allocation decisions by account of – and in care of – themselves, not only with human-interfacing advice. Critical inspection of these and all impending applications of self-learning support systems should sufficiently inhibit this transition to unbridled, unchaperoned creativity out of control. Ethical principles should be able to guarantee safety for both creators and users of these new open-world environments, exactly as intricate mathematics and mechanisms of partnership had to evolve to ensure a working plane traveling fast at 20,000 feet in the sky can turn into a real flying commercial success, safely landing 800 persons at once, in comfort and security.

Equation 3 : Risk Management Through Predictive Analytics

$$V_{risk} = \sigma_P \cdot \sqrt{T}$$

where

V_{risk} = Expected portfolio value at risk,

σ_P = Portfolio standard deviation,

T = Investment time horizon in years.

9.1. Data Privacy Concerns

Today, private and public organizations increasingly leverage data analytics to unlock the value of data in a fully digital world. The various applications of analytics based on machine learning, cognitive computing, data visualization, and other artificial intelligence-driven techniques are transforming finance. Analytical models, algorithms, and artificial intelligence systems can forecast future events, behaviors, or opportunities with a higher level of confidence. Leveraging such capabilities can, in turn, provide better insights to support decision-making and risk management, improve operational efficiency, and create a basis for new services and business models. Financial institutions are banking on analytics capabilities to source relevant data, detect patterns and a variety of signals, and ultimately generate better insights to support community development, credit risk management, the provision of affordable housing opportunities, the valuation of environmental assets, and much more. Notwithstanding their adoption, the latest technology companies must navigate headwinds that have damaged the reputations of larger technology companies over time-related to open banking, privacy, data ownership, and data usage.

Big data and its analysis remain a market that is still in its infancy. The exponential increase in digital data generated worldwide requires data privacy and data ownership protections. The ability to combine data between different systems or databases is of great value to the users of data. As a consequence, it is important to reimagine how analytics should adhere to privacy requirements by leading with security and by ensuring that data is provider-controlled. Financial institutions are also identifying the concept of a data lake, among others, wherein different categories of data might be stored until needed for analysis. The increased use of the internet, social media, and the capabilities derived

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from AI have also resulted in record levels of data breaches and fines across the industry. Data privacy and intellectual property in the digital age then become an increasingly important and sensitive area, which risks under investigation by financial regulatory authorities. With new regulations and data privacy laws surfacing, analytics has business implications that should therefore be well understood. There is an increasing need for assurance and disclosure in cyberspace. The latest interest in zero-knowledge proof, lightweight cryptography, secure multi-party computation, fully homomorphic encryption, and trusted execution environments using hardware such as trusted platform modules are therefore discussed. This can also provide an understanding of how these technologies advance a business's goals while also determining the risk that such advanced technology poses to the business. Furthermore, without engaging in significant due diligence, a corporation's entire data lake may be throttled into many rivers.

9.2. Bias in Algorithms

Progress in machine learning, deep learning, and predictive and prescriptive analytics is creating new models for decision-making and changing decision-making in significant ways in both government and industry. However, to reach their full potential, modern data and models must be accessed and pre-processed in ways that minimize risk and bias. These modern analytics can improve decision-making in basic government models such as stimuli, and housing affordability through enhanced mortgage underwriting criteria, and climate change assessment and management. They are bringing about new models for industry in areas such as risk assessment, reputation monitoring and stewardship, and market innovation. This chapter covers both government and industry impacts of using such advanced algorithms. Algorithm-based business models and user interactions have increasingly taken on roles with the expectation of treating users equitably, even across diverse user groups. However, data and algorithms have been found to reflect and perpetuate inequalities. Gender and racial bias, among other types of bias, have emerged and are continuing to emerge in a plethora of systems including search engines, natural language processing, resume ranking systems, voice recognition systems, crime prediction systems, coding tools, equity tools, jury prediction, socioeconomic background prediction, hiring and advertising targeting algorithms. Such biases can manifest themselves in various stages of decision-making: data bias, which reflects a bias in the data; extraction bias, where the features are biased; evaluation bias, where the performance metric is skewed; and random bias which occurs during the development, deployment, or utilization of the model. These types of bias have been found not only in datasets with discriminatory content but also in datasets that are devoid of such bias.

10. Future Trends in Financial Technologies

The transaction banking and retail services landscape, as well as the funding mix, would see major evolution through intelligent and contextual APIs. Universal banks will evolve into cloud-based multi-sided platforms for various verticals and ecosystems, providing (1) batch and continuous advisory to consumers on wealth and housing; (2) tagging of contextual models for simple products; (3) security, risk, and compliance ecosystem services; (4) wealth, mortgage, insurance, payment, savings deposits, and gift services for consumers, corporates, and retailers. The privacy-safe monetization of big data would allow an increase in net interest income of up to 3%.

The real estate securitization and whole loan sale would extend from RMBS and CMBS to SFBS and CFBS. Secure, income-generating real estate tokens and intelligent APIs would match interested local and international communities of investors and issuers. Open banking and eco-based insurance complement risk capital. The speed at which new services will reach the economic scale will be record-breaking. While financial service firms' roles will evolve in a new environment, the banks, especially the ones that are customer-centric and ecosystem-anchored, will still have a key role to play. What truly differentiates banking services from FinTech firms is the cost of funding. FinTech firms rely on the existing banking infrastructure for their funding needs, and it is those FinTech firms that will benefit from the banks' sustainability.

10.1. Emerging Technologies

Some of the emerging technologies like hybrid cloud, enterprise mobility, big data/advanced analytics, and social media integrated with economic models are revolutionizing banking and capital markets businesses by developing and distributing products and services that can be accessed on demand. This trend should continue with intelligent technologies for modern financial ecosystems, like integrated inside-out apps developed for Windows 10 with the Internet of Things, business process as a service platform combined with robotic process automation, video as default leveraged both as a service, and more as the initiative with blockchain allowing secured sharing of services, data, and financial engines to increase encryption and storage data security, privacy, consumer trust, reducing vulnerability, and enhancing oversight and compliance.

With growing regulatory and consumer demand for transparency, trust, and access, cloud and solutions should aim to become key foundations of tomorrow's financial and

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information housing infrastructures and be the undisputed foundation of the modern financial and information services ecosystems, to enable innovation breakthroughs and competitive advantage. By integrating the key capabilities in the core offering—social, mobile, analytics, and cloud—and leveraging the power inherent in using the key technologies and services of today and the future, and offering intelligent technologies for modern financial ecosystems, key financial institutions can stay ahead and maintain focus on running the core tenant operations much more effectively.

The core software-as-a-service, platforms-as-a-service, infrastructure-as-a-service, big data, advanced analytics, predictive data mining, CRM, campaign management, and security software come together to form the major intelligence quotient, which is the financial intelligence quotient. Moreover, the services provided like data-as-a-service, and analytics-as-a-service with both self-service business intelligence and self-service reporting, as well as business activity monitoring to business process as a service specific to both industry verticals and line-of-business users. Platforms and solutions for employees, clients, and partners, together with prebuilt industry accelerators and strategic business consulting, should lead to serious bottom-line implications. Finally, proponents will derive maximum big data insights by establishing and integrating numbers that encompass and are part of their pillar business model for industry solutions.

10.2. Impact of Blockchain

At its core, blockchain technology is the continuous, decentralized, and consensus-based digital ledger of all transactions that execute in a network. Utilized to store, manage, and execute transactions, this ledger can be written multiple times. Participants within the network validate and authenticate the transactions. Once authenticated, transactions immediately propagate to all participants in the network and are stored within blocks of information that are written to the blockchain. The level of security associated with the blockchain is obtained through digital signatures, chains of custody, cryptographic hashing, and distributed consensus.

What has occurred as a result of blockchain technology is the acceleration of distributed structure concepts, cryptography, and digital signatures to a level that can protect and secure transactions. Much of the complexity behind the blockchain structure is hidden from the individuals utilizing blockchain-based services. The complexities and details of the security are managed transparently, providing a level of security not yet understood by most individuals. Because blockchain technology ensures immutability and transparency of all activities, the IoT can be effectively incorporated to securely execute smart contracts, which are then automatically recorded or used within broader enterprise resource planning systems such as enterprise risk management or property finance and farm management software, to ensure compliance with relevant activity-triggered auditor-tested internal controls and international standards. With the blockchain, a proof of concept for a multi-cloud backup service that allows confidential information to be stored in multiple clouds while integrated secure deduplication ensures confidentiality.

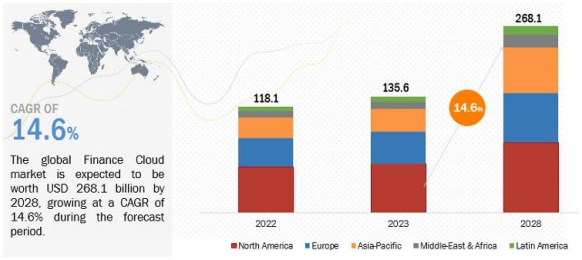

Fig 6 : Finance Cloud Market Size

11. Conclusion

This book explores how intelligent technologies are reengineering the housing finance and risk management landscape by transforming the three important and interconnected financial control processes: valuation, risk management, and advisory services offered by the key financial players. We focused on several intelligent technologies, such as cognitive computing, advanced analytics, sensor technology, secure cloud solutions, and mobile computing, as well as the key algorithms and models for each of these advanced technologies. All our critical academic insights are developed based on a well-proven, profitable, cutting-edge intelligent technology platform, which has domain-specific cognitive cloud solutions developed over a series of international consulting projects with several pioneering financial institutions and has demonstrated positive financial impacts on the players in the housing finance industry. We will conclude our chapter by suggesting a few business and technical research opportunities for academics, financial players, and technology vendors who are interested in leveraging intelligent technologies to foster business innovation and catalyze growth for the financial ecosystem. First, researchers interested in valuation and risk modeling of innovative financial products or the new financing scheme are encouraged to develop joint accounting, actuarial, and econometric models that integrate sources of information to gauge better the key housing attributes and player attributes, as well as novel visualization and cognitive computing applications catered for the new segments in the portfolio.

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