SambaNova SYSTEMS

WHITE PAPER

Using deep learning models to conquer risk in the universal bank

Beyond data-driven, the bank of the future is signal-oriented

In "The signal-oriented bank of the future" paper, we detailed how data-driven organizations are evolving to become signal-oriented, where signal is an actionable insight generated from customer data by a predictive model. Immensely valuable, unstructured customer data in the form of speech and text from dialogue and customer behavior can inform business processes and drive beneficial economic outcomes.

The salient predictive models best suited to take advantage of this customer data are those in deep learning, which encompass advanced artificial neural network models in the domains of natural language processing, user content recommendations, and computer vision.

The impact that the adoption of deep learning models can have in supporting the broad lines of business within the universal bank is significant, especially when we consider domain-specific foundation models that are pre-trained for production ready deployments. We will trace the evolution of banking through the ways in which risk was successfully mitigated by the application of analytical techniques enabled by technology. It's an incredible story!

The story of banking is the story of conquering risk

Banking's modern origins can be traced back to Venice, where goldsmiths at their work table - or "banca" - loaned coins to merchants on the personal promise of repayment. Since the beginning, banking has always been focused on the assessment and management of risk.

Since the Renaissance, private banks have performed the classic financial intermediation function of lending the surplus funds held on deposit by one customer to another customer, at various maturities secured by various forms of collateral. The burden of liquidating debts with specie, or government-issued coins, evolved into a system where bank drafts became accepted as "currency" to make payments and settle debts.

The codification of fractional reserve banking in London allowed banks to provide the necessary credit for merchants to support commerce and international trade. When the Bank of England on Threadneedle Street made a market for government debt - or "gilts" - the security of gilts undergirded the development of the short-term money market on Lombard Street. The trading of the stock in corporations in the coffeehouses of the Merchants Exchange across Threadneedle Street evolved into the formalized London Stock exchange, with turnover enhanced by bank lending on stocks as collateral.

The 18th century boom in seaborne international commerce led to a demand for marine insurance against the peril of ships lost at sea, formalized by Lloyds of London. Both fire and life insurance were originally provided by mutual aid societies and the development of actuarial methods facilitated the development of hazard insurance by capitalists.

The development of financial capitalism in London in the 18th century illustrates that the majority of what we know today as financial services has had a long life. What is new is how these financial services are packaged, priced and delivered to an ever-wider audience. While human needs are constant, innovation in banking is driven by new technologies – especially those that allow an enhanced ability to dimension and manage risk. The story of banking is the story of conquering risk, whether it is risk born of credit repayment, illiquidity in times of crisis, mispriced or misallocated investments, fraudulent behavior or the natural hazards of disasters or premature death.

The breadth of risks mitigated and the reduction in the cost to insulate against them in banking, as expressed as rate of interest, goes hand-in-glove with the development of more accurate and reliable methods to assess and price these risks.

#1
Universal banking

The demand for financial services falls cleanly into two distinct sets of customers: commercial and retail. Commercial banking serves institutions such as governments and businesses who can issue securities such as bonds or equities that are easily traded in regulated markets. Retail banking is the domain of small and medium-sized enterprises as well as households and individual consumers.

Universal banking refers to the extent that a single financial institution provides a broad set of services, including deposit-taking, lending, investment management, capital markets, wealth management and insurance.

A key consideration for any financial institution is the degree to which the government is directly or indirectly involved in the control of the bank's decision-making and the degree of regulation regarding the privileges of the charter. There are clear benefits to a banking license - notably the availability of government-sponsored deposit insurance, a public good as it promotes confidence that payments will clear and bank runs will be eliminated. With the benefit of deposit insurance, however, comes the burden of government regulation. To ensure banking system "safety and soundness" and to promote other benefits to the public, such as crime reduction, banks are subject to a proliferating alphabet of regulations including KYC (know-your-customer), STM (suspicious transaction monitoring) and AML (anti-money laundering). Government regulation has introduced a new risk for a bank – the risk of sanctions or even charter suspension.

Historically, most banks have responded to the expansion of regulatory oversight with expensive manual processes or developed brittle rule-based systems to flag potential issues. With natural language processing, onboarding new customers and addressing KYC (know-your-customer) regulatory requirements can be made more efficient. Once NLP distills information from documentation, deep learning graph neural networks can then provide a deeper understanding of the entities involved and automatically identify and address potentially illicit transactions.

#2
Payments

Banks compete on rate, terms and, increasingly, customer experience. The vast majority of funds on deposit pay no explicit rate of interest yet banks compensate deposit-holders via the facilitation of payments and the ease of access to their accounts via banking channels.

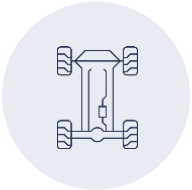
Banks are at the epicenter of the payments system and the benefits and risks therein. The medium of payment has evolved from promissory notes to bank drafts to real-time inter-bank funds transfers. The fundamental risk for the bank remains the same — are the payer and payee known and trustworthy entities? As the latency in inter-bank payments is reduced, the risk of fraudulent payments increases as does the necessity for sophisticated risk mitigation algorithms. The current decision tree learning approach to payments fraud risk and credit repayment risks are yielding to more effective deep learning modeling techniques such as recurrent neural networks (RNN), which allow a higher-order understanding of temporal payment patterns and cross-sectional payment features such as merchant type and payment instrument.

As articulated by Nobel prize-winning economist Douglas Diamond, the role of traditional banks in deposit taking and payments processing provides these banks a competitive advantage in credit underwriting through the "delegated monitoring" of customer funds inflows and outflows. The nexus of payer and payee relationships can be revealed from payments flow data leveraging a payments network graph and the hidden patterns revealed by graph neural networks (GNN) deep learning models.

#3
Loans

From the earliest days of financing trade or providing working capital or funds for expansion, banks have developed an expertise in evaluating the creditworthiness of potential borrowers through detailed knowledge of the people involved, complemented by sophisticated analysis of the potential borrower's account history and financial statements. Trade finance across international borders necessitated expertise in managing the risk of foreign currency depreciation as well as counterparty risk in areas beyond legal recourse. Today, asset-based lending requires enhanced analytical methods to understand the current and future value of the real assets that collateralize the loan. Due to the complexity and dynamic nature of international currency valuation, sophisticated deep learning models are on the frontier of enhanced predictive power.

Commercial banking has a very long history, while retail banking as we know it today only took shape in the early 20th century. In the 19th century, mortgages to purchase residential real estate were provided by extended family networks or were funded by non-profit mutual associations like savings banks. Today in the US, mortgages are originated by banks and sold to government-sponsored-entities (i.e. FNMA & FHMLC) which package the cash flows of the individual mortgages into mortgage-backed securities. Once again, the valuation of these securities requires sophisticated modeling of interest-rate and prepayment risks and traditional statistical models are being displaced by deep learning models, such as recurrent neural networks (RNN).



Commercial Banks first began to make direct loans to consumers at scale in the 1920s, stimulated by the necessity to finance automobile purchases through multi-year installment purchase plans. Trying to assess the creditworthiness of individual consumers was very difficult, even with the development of "credit bureaus" who compiled records of consumers creditworthiness which banks contributed to and drew upon.

By the end of the second world war, a bank's decision to make a loan to an individual was based on a scorecard which assigned points to information that the consumer provided on their application, including a character assessment by the banker. With the goal of reducing the cost and improving the reliability of credit decisions, two Stanford engineering professors developed a statistical algorithm to evaluate consumer loan applications and the Fair-Isaac company was born; the algorithm evolved to ingest credit bureau data via a logistic regression model and provided a binary scaled score we know as the "FICO score."

The current decision tree-based approaches to credit repayment risks are beginning to yield to deep learning modeling techniques such as recurrent neural networks (RNN) which allow a higher-order understanding of temporal payment patterns and cross-sectional features such as merchant and payment instrument. In addition, to assess the creditworthiness of a broader audience and to leverage novel payments data not captured by traditional credit bureaus, "alternative data" such as rental and utility payments is under consideration.

#4
Investments

During the US Civil War, the Federal government was unable to meet the costs of the war effort using tax revenues alone. Given the immaturity of the banking system, the Federal government was forced to issue debt directly to individuals to pay for war materiel and soldiers' wages with "greenbacks" which circulated as currency in the north as a supplement to bank notes and specie. The huge cost of the war led the US government to sell war bonds directly to the public for the first time and enlisted Jay Cooke and his army of commission sales agents spread across the country.

The huge requirements of capital to build the railroad networks in Europe, North America, and South America led to the widespread distribution of corporate debentures, or unsecured bonds. While joint stock banks were prevalent in England and America in the early 19th century, changes in corporation law led to the first widespread sale of corporate stocks directly to consumers in the 1870s. The excess capitalization of railroad stocks allowed market operators like Jay Gould to make the first Wall Street fortunes. The large flotation of corporate stocks led to formalization of stock jobbing via the New York Stock Exchange on Wall Street and the beginning of "mergers and acquisition" mania on a national scale. The invention of the corporate holding company, or Trust, led to the development of what we know today as Investment Banking, exemplified by J.P. Morgan's ability to roll up a dozen small foundries into the mammoth US Steel corporation in 1910.

The development of Investment Banking in order to underwrite bonds & stocks, as well as to develop and market structured financial products, such as mortgage-backed securities, was facilitated by innovations in computer technology and valuation models.

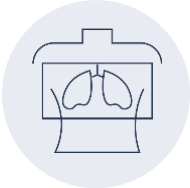
The development of broad and deep securities markets, notably the New York Stock Exchange, led to competition to identify investment and trading strategies that provide above market returns, as defined by the "efficient markets" hypothesis of Eugene Fama and Kenneth French.

Institutional money managers encounter a wide range of risks to maximize performance, they must determine the allocation of funds under management across asset types, positions within assets and consider the tax implications of asset location, while minimizing trading costs.

The search for yield has stimulated the pursuant of increasingly sophisticated asset pricing models, including those leveraging deep learning. While asset pricing models draw on the rich history of security trades, the search for yield has led to the pursuit of "alternative data" sources, such as interrogating published financial statements with natural language processing and even leveraging computer vision to evaluate satellite images of store parking lots. Increasingly, the search for investment value is moving beyond just the evaluation of security price histories and economic statistical data.

#5
Wealth management

Until the late nineteenth century, wealth meant land holdings, private partnerships, and gold coins. The development of government and corporate bond markets in the late nineteenth century and widespread corporate stock holding by households in the early twentieth century allowed wealth to be increasingly held as financial claims -- more liquid but with their value more sensitive to the state of the overall national economy. The failure of master promoter Jay Cooke to keep the Northwestern Pacific Railroad afloat in 1873 led to the first finance-driven economic depression in US history, the severity of which was only surpassed during the depression of the 1930s.



The development of institutional investment management was pioneered in the US in the early 20th century by trust companies for the affluent and life insurance companies such as New York Life for small investors. Stockbrokers advised wealthy families on how to maximize financial returns with the first crude notions of asset allocation: government bonds for safety and corporate stocks for return.

The collapse of the banking system during the depression and the 25-year bear market (US stocks returned to 1928 values only in 1953) led to a flight to the safety of "blue chip" stocks and government bonds.

By the late 1960s, "money managers" began to construct growth stock portfolios and ushered in the first econometric analysis of securities prices and the notion of the mean-variance tradeoff in the allocation of funds across assets and securities within asset classes, as pioneered by Harry Markowitz, to meet long-term financial goals. In the 1980s, the elimination of fixed-price commissions for stock trades and the rise of discount stockbrokers and the proliferation of mutual funds led to a more scientific approach to saving for retirement. Thus, "wealth management" was born.

Today, wealth management is not only concerned with constructing investment portfolios that generate excess "risk-adjusted returns" but also to integrate across multiple domains to preserve wealth, including insurance and tax. Wealth managers also need to effectively understand the goals and concerns of their customers and are increasingly leveraging techniques such as natural language processing to gauge the concerns and sentiment of their clients.

#6
Technology and customer service

The adoption of communications and information processing technology has transformed how banking services are delivered while core banking needs, in line with human nature, remain constant.

The telephone reduced the need for in-person communications at the bank building just as ATMs eliminated the need for a teller to disburse or accept funds. The deployment of internet banking has allowed fully remote banking service delivery for everything except currency. The adoption of new technologies allows banking services to be delivered more readily at a radically reduced cost and banks are no longer constrained by physical proximity to their customers.

The radical decline in the marginal cost of providing banking services and the surmounting of geographic barriers led to the rapid consolidation of banks in the US and Europe, increasing the size of the customer base and the scope of the services provided.

In a sense, money is information, as it is only currency when both parties agree to its value.

By the beginning of the 21st century, banks had transformed their ability to process information with a focus on technology adoption and deployment. An indirect result of the adoption of internet banking was the demand by consumers to export their banking transactional data into formats that they can review themselves, a process now largely accommodated by APIs via vendors such as Plaid.

Consider that speech and text data from customer service interactions is one of the only times a bank can hear exactly what a customer wants and needs, directly from the customer. Leveraging this unstructured data through deep learning and large language models offers a bank an unprecedented opportunity to understand customer intent and resolve issues more quickly, thus driving retention and expansion from well-serviced customers.

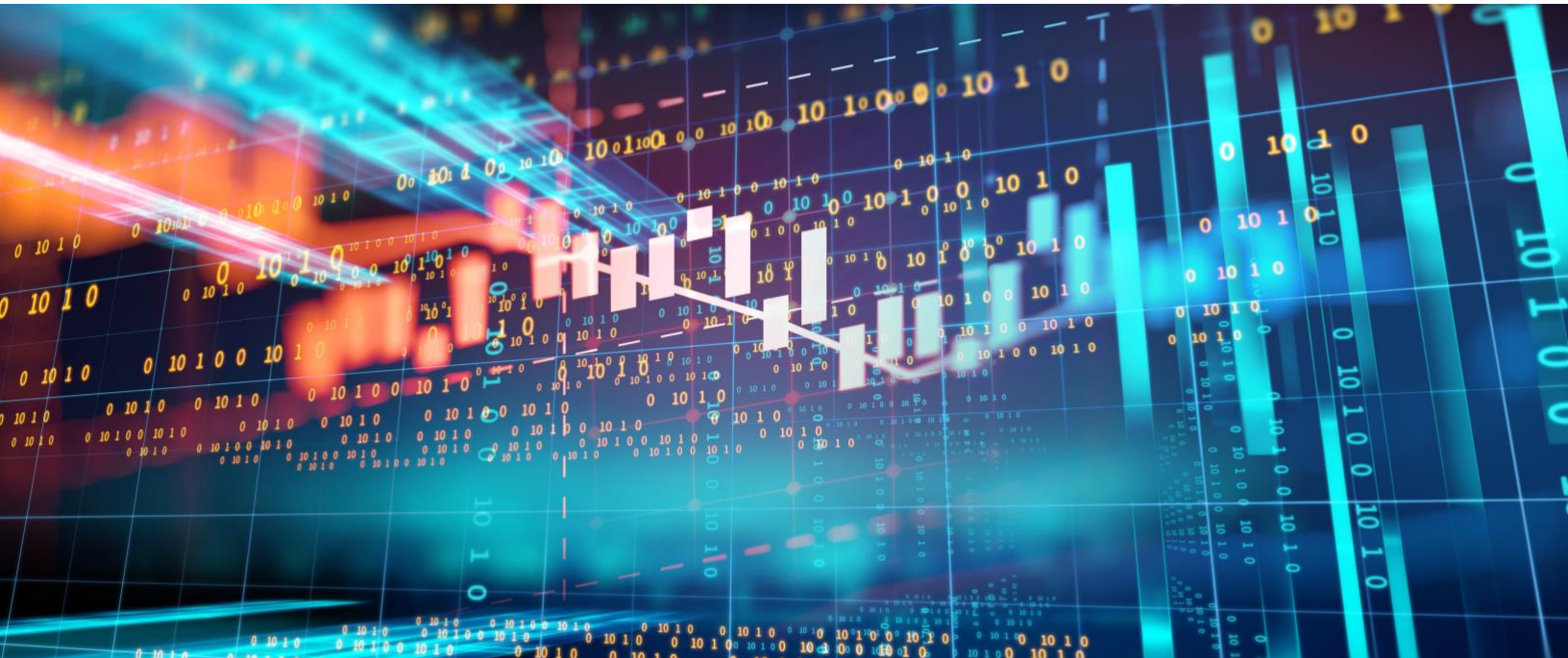
#7
Marketing

In the branch banking era, marketing meant advertising, and applications for new products were solicited and taken at the branch by the branch manager. In the 1960s, the development of the travel and entertainment charge card led Bank of America in California to develop the bank credit card, which morphed into VISA. Merchants were quick to accept the new bank charge card to reduce the necessity to handle currency and to deal with bad checks.

Moreover, merchants discovered that purchases with a bank credit card were for a higher dollar amount than cash, a quirk of consumer behavior. Bank of America developed a strategy to expand credit card holding within its large customer base and borrowed techniques for direct mail solicitations from book publishers. The mass solicitation of bank credit cards was widely successful - although new types of fraud surfaced via cards intercepted in the mail - and direct response marketing continued to evolve. By the 1990s, monoline banks such as Capital One were able to build very profitable operations through the innovative use of data and analytics to identify consumers who were prone to "revolve" credit card balances at high interest rates.

The development of the enterprise data warehouse in the 1980s enabled the first customer relationship management software and by the 1990s, banks developed product propensity models that were used to generate leads for branch bankers and call center agents, as well as to drive direct mail solicitations. At the turn of the 21st century, internet banking introduced the ability to market directly to bank customers during routine banking activity as well as the ability to originate new accounts via applications in the digital banking channel. The product propensity, service channel preference and sales channel response models developed by banks focused on identifying the "next best action" to increase customer engagement and value.

Inspired by the sophisticated approaches taken within social media platforms like Facebook, banks can now develop and deploy their own deep learning recommendation models. The ability to leverage a broader possible set of behavioral information about their customers allows banks to pursue "hyper-personalization" and to realize the long-held vision of "one-to-one marketing."



Speech & text

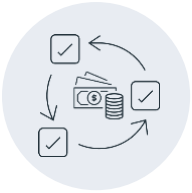
Throughout history, banking has always been primarily about credit - the reliability of a man's character where his "word is his bond." The deployment of the telegraph in the 1840s radically accelerated financial innovation and the first transatlantic cables in the 1870s resulted in "arbitrage" operations in New York and London to exploit information asymmetries. The realization of the financial returns to the disruption of banking by technology is not new; stock market operator Jay Gould acted quickly to consolidate telegraph companies into what is now Western Union and control the dissemination of securities prices on Wall Street, akin to the position of the Bloomberg terminal today.

Beginning at the end of the 20th century and accelerating in the first three decades of the 21st century, retail customers are no longer primarily served in the traditional branch channel but rather via self-service technologies such as inbound phone calls, email and SMS, and online banking, both desktop and mobile. Unlike in the past, customers don't share their concerns directly with branch bankers but rather identify their banking tasks, concerns and aspirations via phone calls, emails, and texts; this unstructured data is the most difficult for banks to process but contains the most valuable information – especially when conjoined with channel interactions data such as digital banking weblogs.

Automated speech recognition (ASR) automatically generates transcripts from inbound calls with astonishing validity. Natural language processing (NLP) can unlock the value of unstructured customer-generated speech and text. Recent innovations in deep learning large language models have radically improved the ability to generate actionable insights from speech and text. SambaNova is working with banking and financial services enterprises to support this type of 'language-as-a-service' approach that leverages today's most innovative deep learning capabilities to unlock previously unattainable value from the huge morasses of unstructured data that are stored within banking enterprises.

Conclusion

The evolution of banking is tied up in the development of novel methods to quantify and manage risk. Advances in communication and data processing technologies have been instrumental in surmounting the risks of banking and the need to develop novel methods to interact with customers and satisfy their banking needs. Today, we are witnessing the rapid evolution from statistical models that require hand-curation of data to pretrained, domain-specific foundation models that ingest a broad and deep set of behavioral data. These deep learning models more accurately identify the risks inherent in banking (fraud, credit, operational) and propagate these insights as signals that the bank can operationalize in downstream workflows such as credit risk assessment and pricing, fraud mitigation strategies, customer relationship management and every dimension of investment securities selection and trading.



The reality of banking in real-time across borders has changed how consumers understand and use their financial assets. It is incumbent on financial institutions to adopt and deploy modern technology solutions to keep pace with consumer expectations for speed and safety of digital transactions. By aligning with the expertise of subject matter experts and technology leaders, banks can demonstrate not only trustworthiness but insight and forward thinking as they employ deep learning foundation models and recommendation engines to deliver better experiences than ever before.

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Next steps

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