



Generative AI for Tabular and Time Series Data

eBook

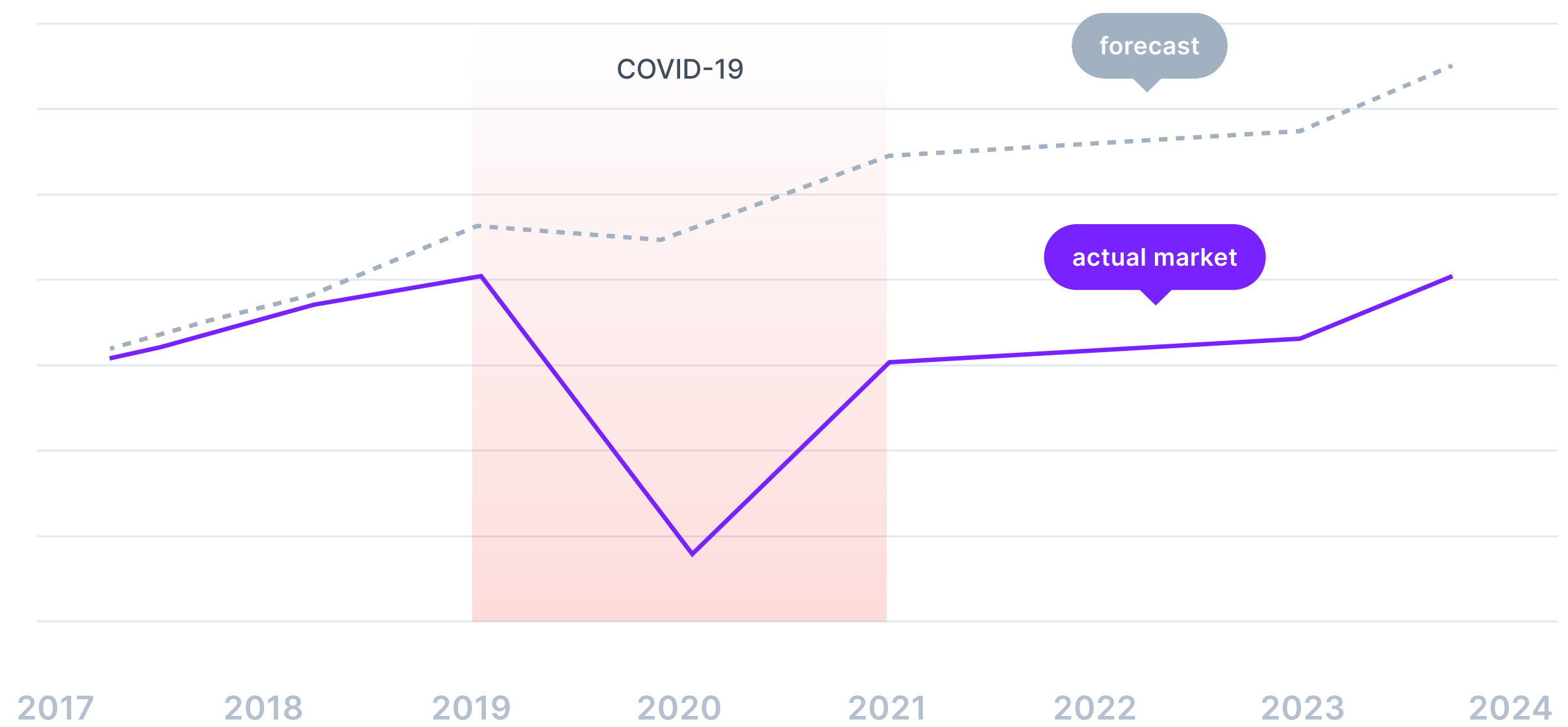
Embracing Uncertainty: How Probabilistic Forecasting Transforms Financial Strategies



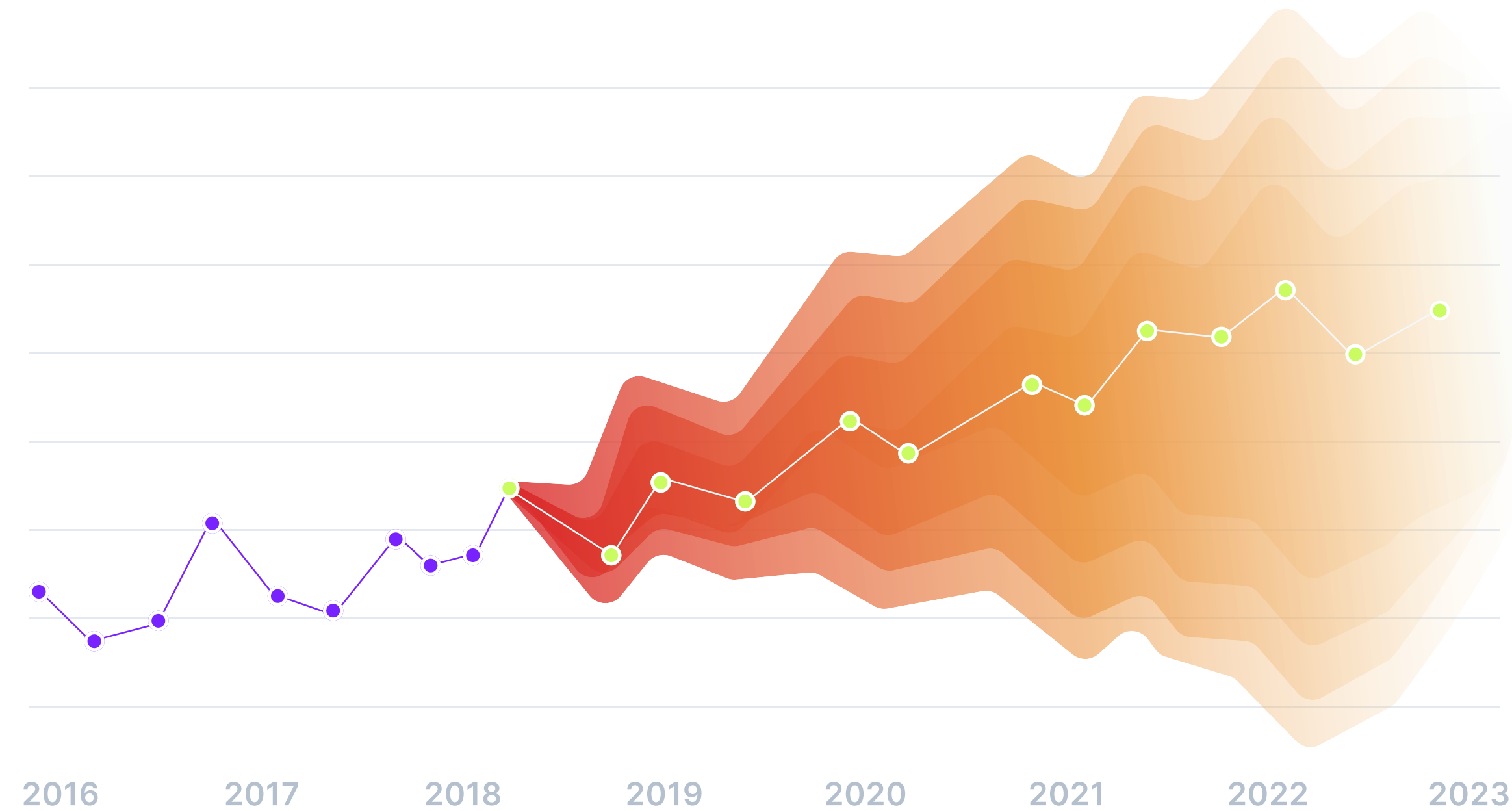
Overview:

Rule-based, deterministic systems have long been the standard for highly regulated financial services organizations. They provide predictable outcomes based on known inputs, are highly reliable, and make it easy to comply with regulations and demonstrate compliance to auditors and regulators.

Market Instability Presents in Many Ways



Probabilistic vs deterministic methods



However, in today's unstable business climate, traditional approaches have failed to keep pace with the rapid variability and change impacting financial services organizations.

Some pertinent challenges include:

- ✓ The introduction of new financial instruments and services
- ✓ Increased consumer expectations for personalized, real-time, and seamless experiences
- ✓ Increasing internal data complexity, with vast amounts of structured and unstructured data across a wide variety of sources
- ✓ Increasingly sophisticated bad actors such as hackers with rapidly changing techniques for exploiting vulnerabilities
- ✓ Increased competitive pressures from traditional players as well as fintech startups and tech giants

In the face of these changes, legacy systems — like Fiserv and SAS Fraud Detection – have struggled to adapt to heightened levels of complexity, leaving financial services stakeholders to deal with increased risks and missed revenue opportunities.

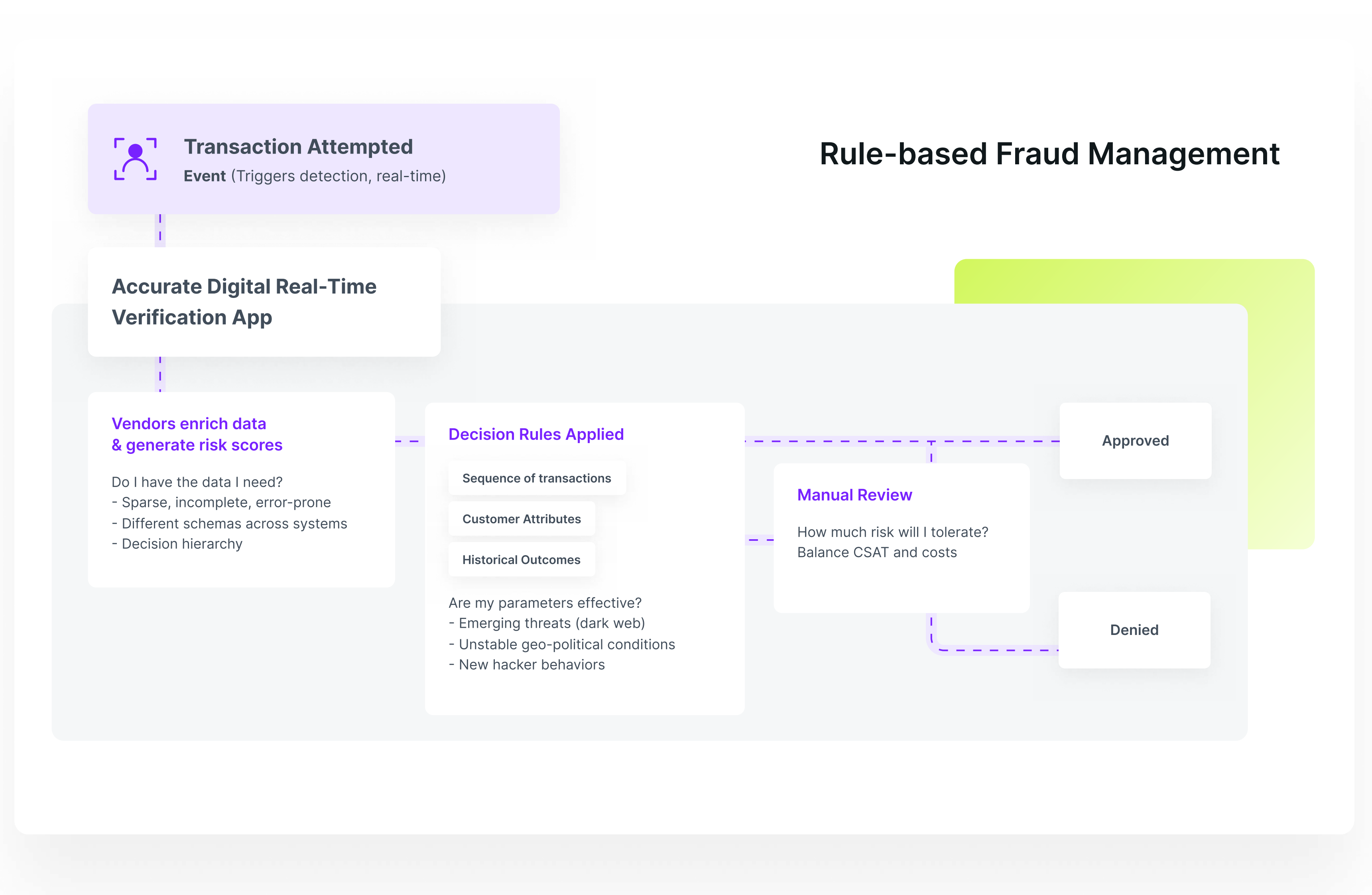
In this article, we will contrast the probabilistic approach with traditional rule-based and deterministic approaches, and delve into the advantage of incorporating probabilistic forecasting and planning methods into key business cases such as fraud prediction, risk management, portfolio optimization, and customer growth/retention strategies.

Rule-Based Systems Explained

Rule-based systems have been used for decades in the financial sector to automate decision-making processes, ensure compliance with regulations, and provide consistent and auditable results. They rely on predefined rules and conditions – generally created by domain experts — to make decisions or perform actions. In modern systems, rules can be complex, and may involve multiple conditions and exceptions. The most notable examples of rule-based systems include fraud detection systems, risk assessment engines, and trading systems that execute trades based on predefined criteria.

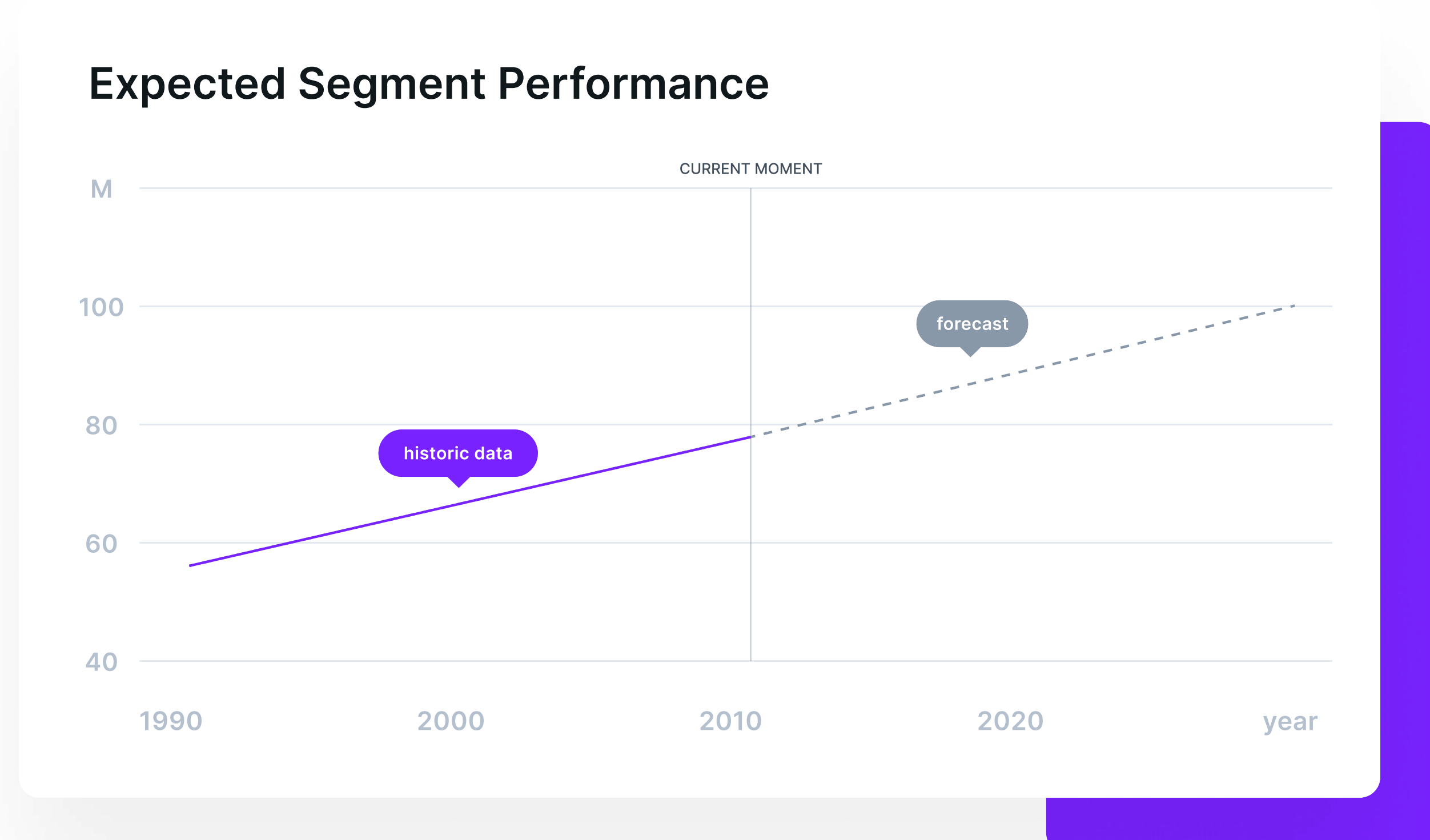
Because of the way they process input data and generate outputs based on predefined rules and conditions, rule-based systems are often associated with deterministic outcomes. This means, they strive to find a single, "most likely" outcome. **Examples of this include:**

- ✓ Generating a single "highest risk" score for each transaction, indicating the likelihood of it being fraudulent based on known fraud patterns and pre-determined rules
- ✓ Estimating a single "worst-case" value for potential losses under a given set of market conditions, based on historical data and statistical models
- ✓ Identifying a single "optimal" asset allocation that would maximize expected returns, based on assumptions about future market performance



A deterministic approach assumes future outcomes can be precisely determined based on known variables and rules. While deterministic and rule-based solutions have historically been considered the "safest" for compliance-driven industries, these solutions struggle to capture important risks and opportunities in rapidly changing and unstable environments

Example: Deterministic Forecasting for Customer Churn Prevention



Imagine a retail bank using a deterministic platform to forecast customer churn. In this scenario, the bank operates in a relatively stable market with a loyal customer base and a well-established brand.

To predict the likelihood of customer churn for the next quarter, the bank might use a combination of logistic regression and decision trees to analyze historical customer data, considering account activity, demographics, product usage, and customer interactions. Based on this analysis, the forecasting solution might predict a deterministic churn rate of 2% for the next quarter.

Limitations of Legacy Approaches in a Highly Variable Business Environment

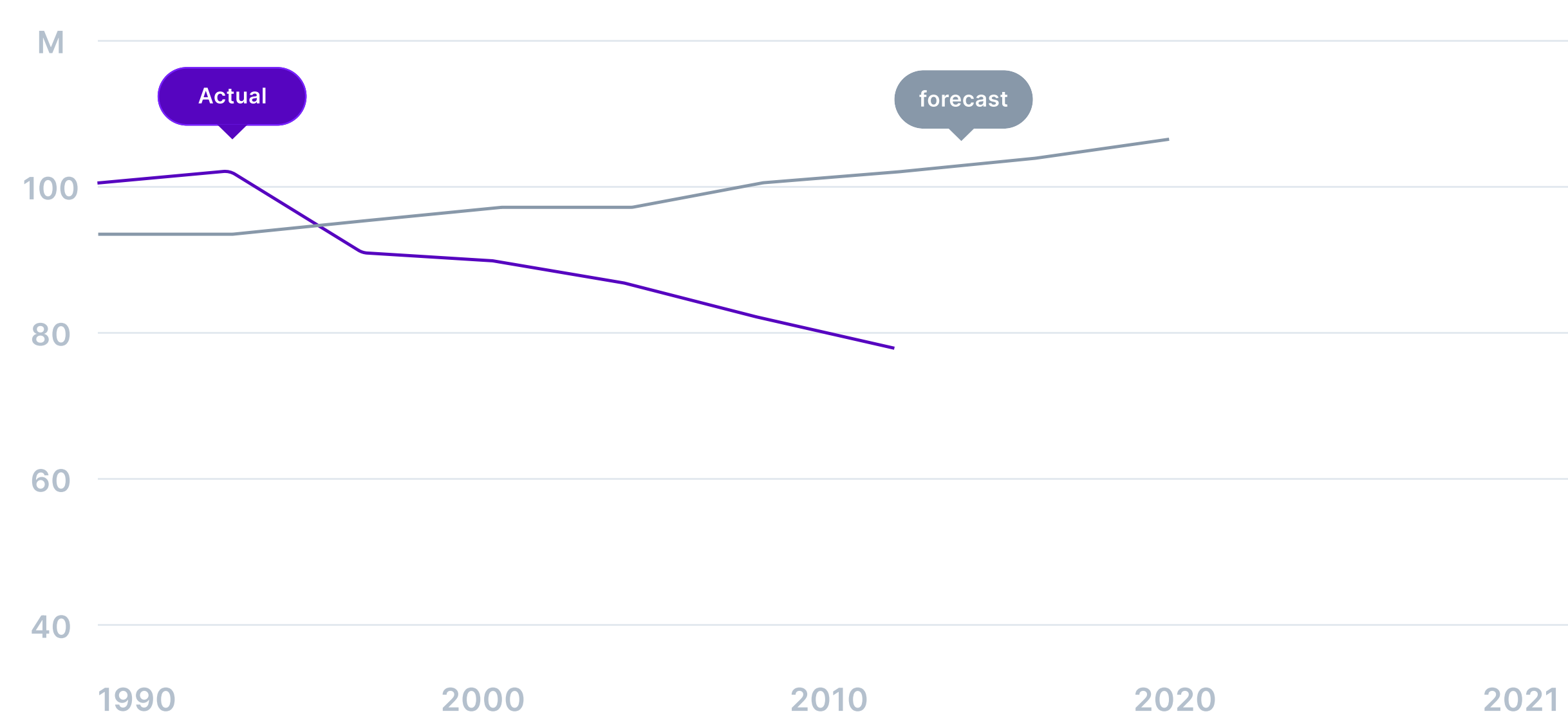
The success of the previous example depends largely on relatively high levels of business stability. Since most organizations today operate in an inherently unstable environment, the following conditions subvert the effectiveness of legacy approaches to problem-solving.

Business model or environment shifts:

Rule-based systems typically lack flexibility to adapt to significant or unexpected changes in customer behavior or market dynamics (e.g., new fintech competitors, changes in regulations, or shifts in customer preferences towards digital banking channels). This hinders their effectiveness in a constantly changing environment.

Rapid uncertainty in demand and supply:

The post-Covid world has seen higher levels of systemic variability in customer behavior and financial markets. Economic volatility, changes in interest rates, and evolving customer expectations have made it more challenging to predict churn accurately. Customers may become more price sensitive, open to switching banks for better offers, or more interested in up-and-coming, tech-forward brands. Legacy approaches are not suited to handle the inherent variability and struggle to assess the risks associated with different scenarios.



In a world of rapidly changing conditions, relying on a single point estimate or even range for forecasting creates a false sense of certainty. If market conditions deviate significantly from forecasts (either bullish or bearish), financial institutions may be unprepared to capitalize on opportunities or mitigate potential risks, leading to missed profits or alternatively unnecessary capital reserves.

Moving away from the customer churn example, let's consider the impact of these limitations on an activity like fraud detection:

- **When fraud detection systems are based on rigid, pre-defined rules or thresholds, they generate a high number of false positives.** This not only inconveniences customers but increases operational costs — according to JP Morgan, while actual fraud losses represent an estimated 7 percent of the total cost of fraud, false positive losses amount to 19 percent.
- **Similarly, relying on rule-based systems for fraud detection opens an organization up to risk,** as fraud tactics are rapidly evolving. As fraudsters adapt their strategies, it's hard for rule-based systems to catch new patterns and anomalies.
- **In both cases (false positives & unmitigated threats) the situation impacts the customer experience, whether through declined transactions or the need for additional authentication steps.** This results in a poor customer experience, reduced satisfaction, and potentially lost business, as Sapio Research found that 33% of customers who had a transaction falsely declined abandoned the purchase altogether.

Conclusion on Legacy Approaches

In conclusion, while rule-based, deterministic systems provide a strong foundation, persistent and growing challenges due to the changing landscape have led banks and other financial institutions to consider probabilistic approaches for growth and risk mitigation activities.

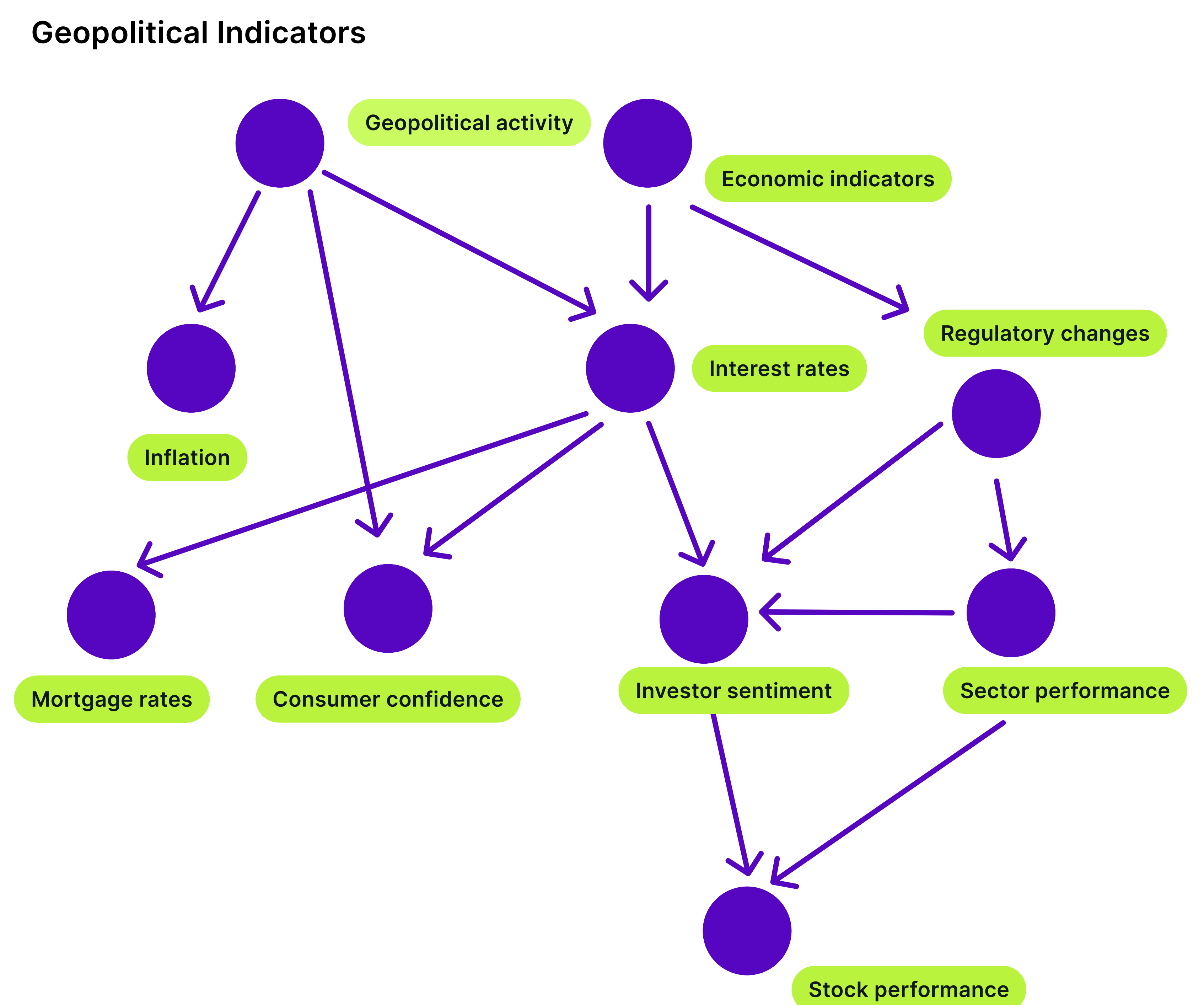
Probabilistic Forecasting Explained

Probabilistic forecasting acknowledges the inherent uncertainty in solving everyday challenges by generating a range of potential outcomes with their associated probabilities. In high-variability environments, the approach creates a more realistic picture, allowing for better decision-making while empowering proactive planning within the range of certainty or uncertainty posited by the forecast. Some common methodologies used in probabilistic forecasting include:

Monte Carlo Simulation: This method simulates many possible scenarios by randomly sampling from historical data and incorporating variability factors. The resulting distribution of outcomes provides a probabilistic forecast.

Bayesian Networks: These graphical models represent relationships between variables that influence outcomes. By updating the network with new data, Bayesian networks can generate probabilistic forecasts that reflect the changing dynamics of the market.

Probabilistic forecasting is best suited for dynamic and uncertain environments, medium- to long-term strategic forecasts, and data-rich industries. However, it can require more data and technical expertise and must be weighed in the context of the use case value.



BAYESIAN NETWORKS

A New Era for Probabilistic Methods in Financial Services

Finance professionals have been wary of adopting probabilistic systems. As a CFO once said, “probabilistic is fuzzy, and math is not.” Probabilistic methods, which rely on complex algorithms and large datasets, have historically been perceived as less transparent and harder to interpret. Probabilistic methods have also been associated with risks such as overfitting, bias, and instability, due to their complex natures. Finally, data quality and availability has long been an issue, as well as the lack of computational power, infrastructure and internal expertise to train and deploy models at scale.

However, both modeling and attendant advances in AI technology have changed conditions in the industry. A few conditions have coalesced to make banks more comfortable with adopting probabilistic methods, and integrating them into their existing risk management and decision-making processes:

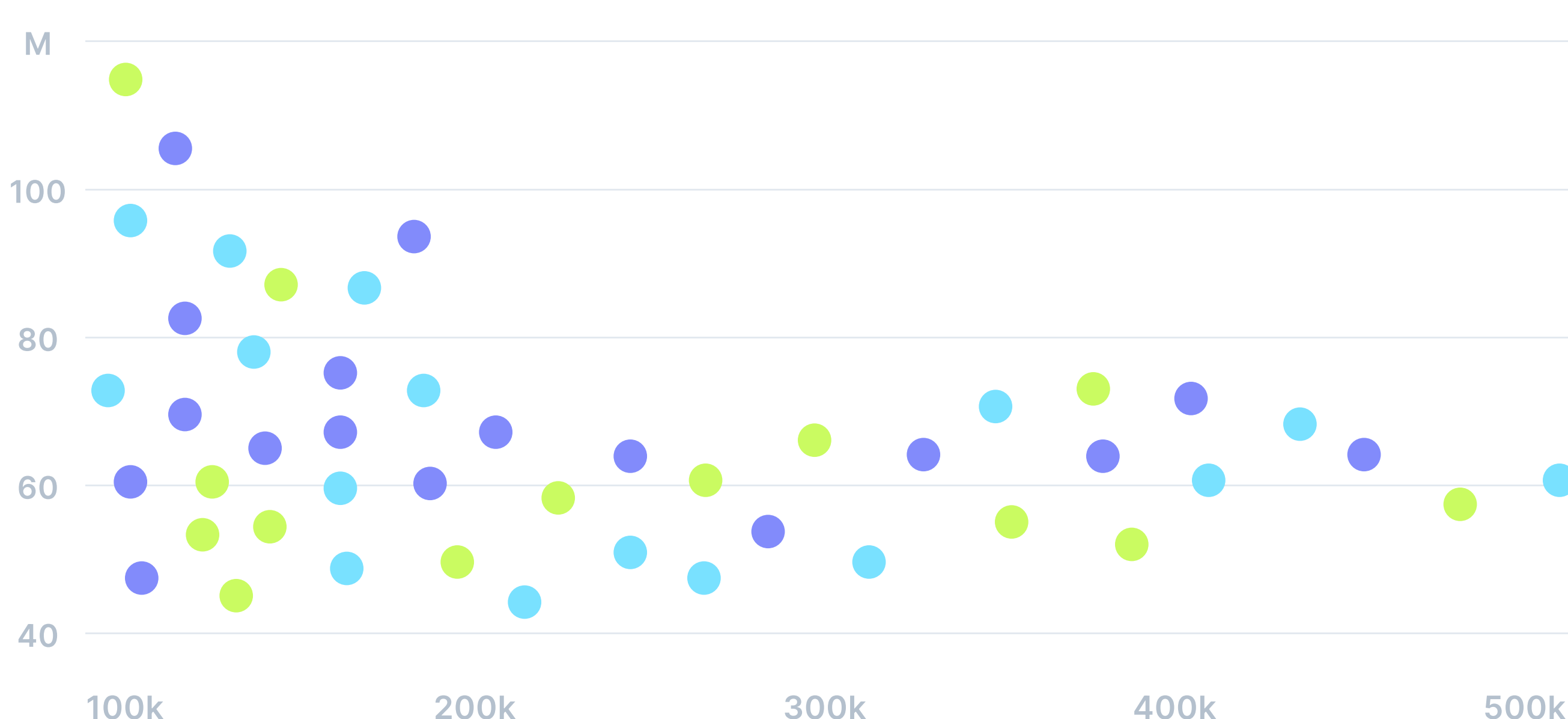
- ✓ The development of industry standards and best practices for model risk management (such as the SR 11-7 guidance from the federal reserve)
- ✓ The increasing adoption of data governance frameworks, data integration tools, and cloud-based platforms that de-risk probabilistic problem-solving
- ✓ The rise of innovative approaches such as large graphical models, which can deliver highly accurate probabilistic forecasts with large sets of sparse, disconnected datasets.
- ✓ A growing trend of collaboration and knowledge-sharing through industry consortia, research partnerships, and open-source initiatives

In an era of heightened uncertainty, no other method delivers the benefits of probabilistic approaches – such as **improved accuracy, adaptability, and risk quantification** – making probabilistic methods an attractive option for banks looking to navigate the complexities of the modern financial landscape.

The Power of Probabilistic Forecasting In Action

To see the power of probabilistic forecasting in action, let's consider the example of a large bank's treasury department utilizing probabilistic forecasting to predict interest rate movements and make informed decisions about managing the bank's assets and liabilities. The treasury may analyze historical interest rate data, as well as external inputs such as economic indicators, central bank policies, global market trends, and geopolitical events, to adjust the bank's liquidity position, adjust its investment portfolio, or set the price of loans and deposits.

See your plans here



Based on this analysis, the model might generate a probabilistic forecast indicating a 60% chance that the central bank would raise interest rates by 25 basis points in the next quarter, with a 30% chance of rates remaining unchanged, and a 10% chance of rates increasing by 50 basis points. Furthermore, the model may predict a 70% probability that the 10-year government bond yield will remain between 2.5% and 3% over the next six months, with a 20% chance of yields falling below 2.5%, and a 10% chance of yields rising about 3.0%.

In the previous example, a probabilistic approach to forecasting interest rates is particularly valuable due to the complex and dynamic nature of the factors influencing interest rate movements. Interest rates are affected by a wide range of variables, including economic growth, inflation, monetary policy, and global market sentiment, many of which are inherently uncertain and can change rapidly.

A probabilistic approach allows the bank's treasury to account for this uncertainty by assigning probabilities to different potential outcomes, rather than relying on a single point estimate. This enables the treasury to develop a more nuanced understanding of the risks and opportunities associated with different interest rate scenarios, and to make more informed decisions about how to allocate the bank's assets and manage its liabilities.

If the treasury believes there is a **high probability of interest rates rising in the near term**, it may choose to adjust the bank's asset mix to favor shorter-duration securities that are less sensitive to interest rate changes.

If the treasury assigns a higher probability to **rates remaining stable or falling**, it may opt to invest in longer duration assets to lock in higher yields.

Benefits of the Probabilistic Approach Explained

When organizations de-risk planning in an intrinsically variable world, results and benefits are manifold.

Increased forecast accuracy

By acknowledging variability, forecasts are more likely to reflect real-world patterns, leading to improved prediction accuracy.

Let's illustrate this benefit by considering the alternative.

With deterministic forecasting and planning, if actual results fall outside the anticipated "range" of outcomes, (i.e., something unexpected happens) you are in an unknown setting and risk a serious downstream impact.

Probabilistic forecasting anticipates a range of possibilities while probabilistic planning enables a range of contingency plans.

This tight interlock of forecasting and variability across any possible set of outcomes and constraints is the foundation for operating excellence in an uncertain environment.

Improved resource management

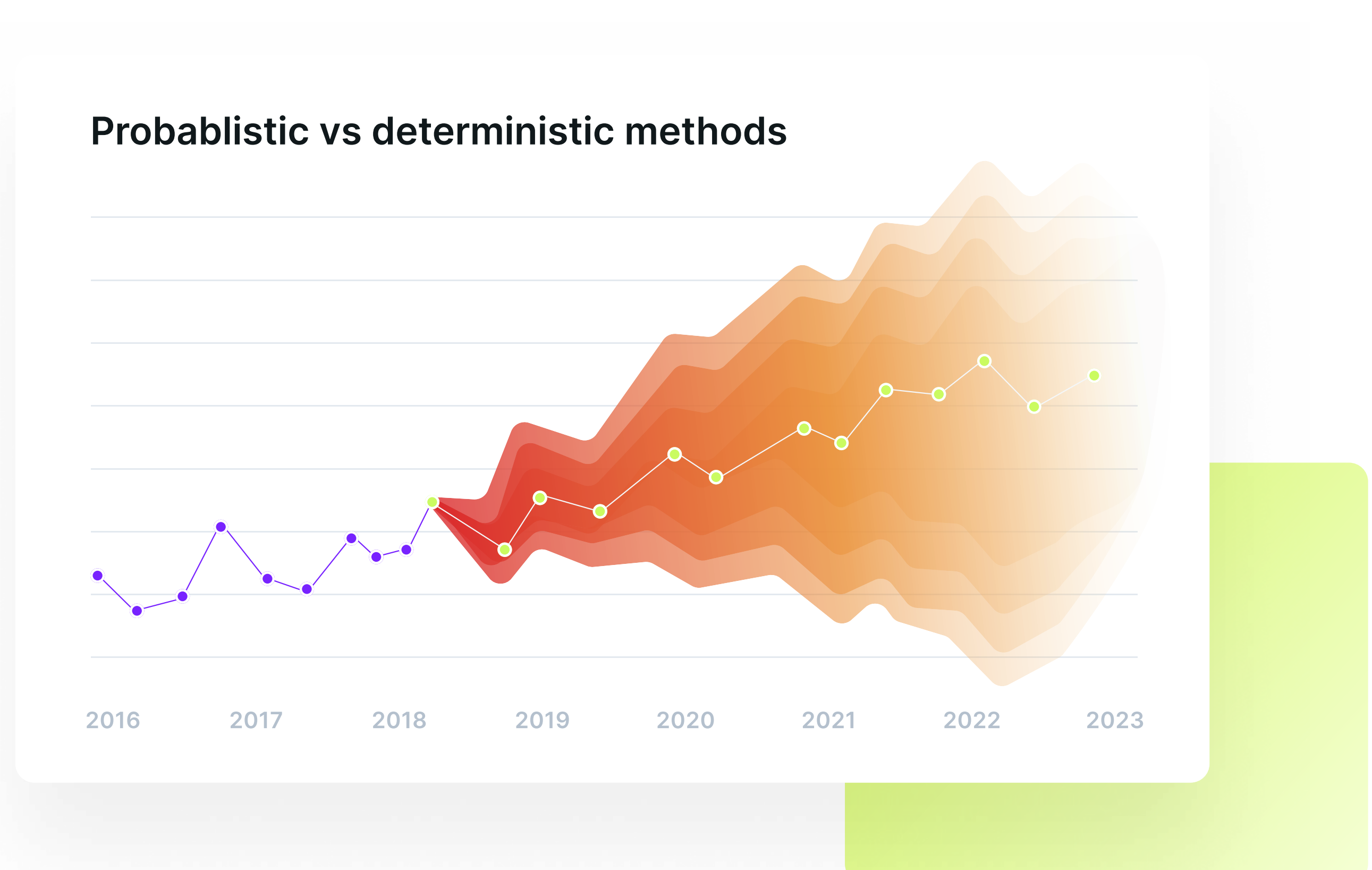
Probabilistic forecasts enable businesses to determine all feasible business risk vs reward scenarios for a given set of outcomes and constraints. For example, the treasury may invest more heavily in longer-duration, fixed-income securities to benefit from higher yields, but these investments increase the risk of capital losses if interest rates rise.

By understanding the plausible tradeoffs in play, probabilistic planning supports data-driven portfolio management decisions. In the previous example, a clear understanding of the probability of different interest rate levels would allow a bank's treasury to set optimal asset location and duration targets across a range of scenarios that maximize portfolio returns while minimizing the risk of capital losses.

Enhanced scenario planning

Exploring "what-if" scenarios is a powerful capability enabled by probability. In the above example, the treasury could use probabilistic forecasting to simulate the potential impact of an unexpected war that leads investors to flock to safe-haven assets like government bonds and drives down interest rates.

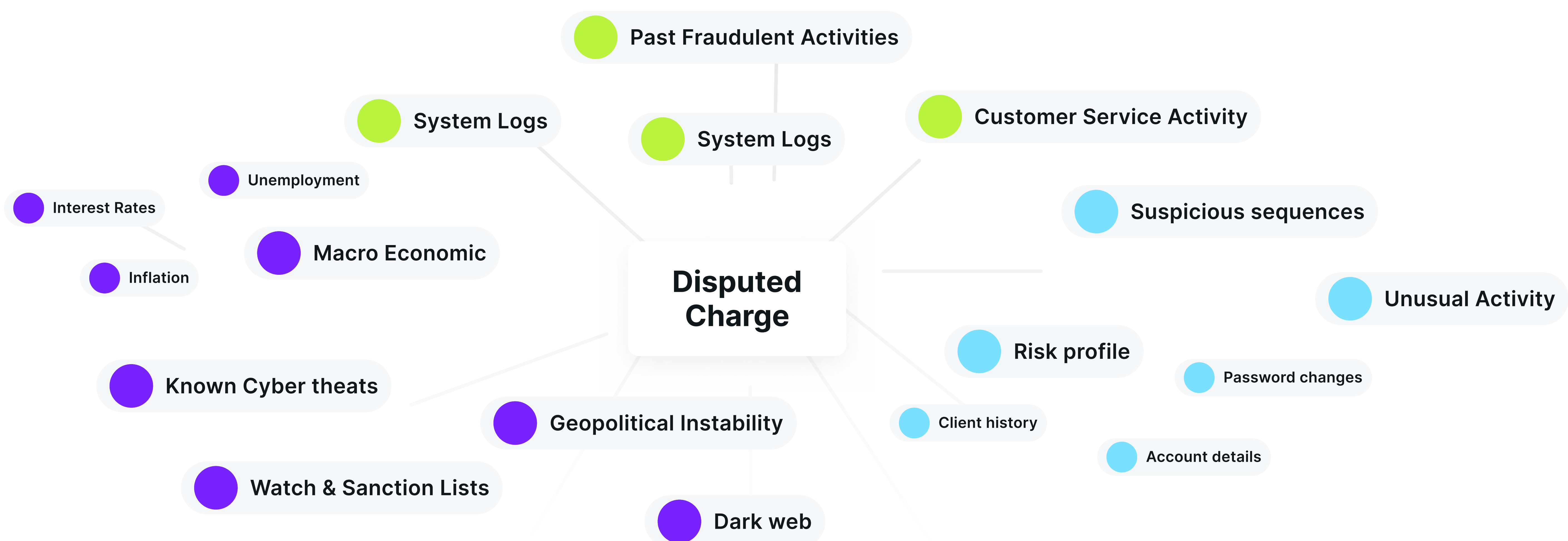
Based on this analysis, the business could proactively develop contingency plans to adjust the duration and composition of its investment portfolio, implementing hedging strategies to mitigate interest rate risk, or revise the bank's asset-liability management approach. This is a core aspect of business continuity planning in the face of unexpected events.



The Power of Probabilistic For Risk Management

For financial services organizations, the improved accuracy, stability, sensitivity, and resilience of a probabilistic approach takes on particular importance when it comes to risk management.

Consider a financial services company that is struggling to keep up with the changing tactics of fraudsters. While they have a deterministic system in place, they are unable to proactively identify emerging patterns, and their rigid rules yield high false positive rates. Here are four ways a probabilistic approach could support this company's successful fraud-detection or anti-money laundering strategy.



Transactional Frequency

Unlike deterministic systems that rely largely on static rules or expert intervention to incorporate ongoing changes, probabilistic systems account for daily, weekly, or even hourly variations in fraud patterns by incorporating probability distributions to deliver predictions at the highest desired level of business granularity. This enables a bank to detect and respond to emerging fraud schemes more quickly and effectively.

Fraud Detection and Prevention Frequency

Rule-based systems require frequent updates due to the above mentioned limitations, making administrative effort and cost a serious issue, as well as challenges related to versioning, reproducibility, and audibility with differing versions of rules and data. Probabilistic systems are built to learn from the data and reflect real time changes in their view of fraud patterns, reducing the need for manual updates and ensuring that the bank's fraud defenses remain up-to-date.

Enhanced scenario planning

Deterministic systems are challenged with reconciling uncertainties across various levels for the dimensions that drive fraud, including customer segments, transaction types, geographic regions, or product lines. Probabilistic models are based on the propagation of uncertainty through different levels of hierarchy. This enables both a top-down and bottoms-up approach to fraud management while also building confidence for business owners managing risks at every level.

Uncertainty in fraud patterns

Deterministic systems ignore dynamics such as changing fraudster behavior or the emergence of new fraud schemes. In contrast, probabilistic systems explicitly learn and implement learned distributions for these variables within a range of confidence. This enables proactive planning for various fraud scenarios and helps the bank stay ahead of evolving threats. By incorporating uncertainty into their fraud models, banks can adapt more quickly to new fraud patterns and minimize losses.

Not One or the Other: The Power of Complementary Approaches

In many cases, the most effective strategy leverages deterministic and probabilistic approaches in tandem, as each brings unique strengths. Here are a few ways a bank may optimize outcomes using both approaches:

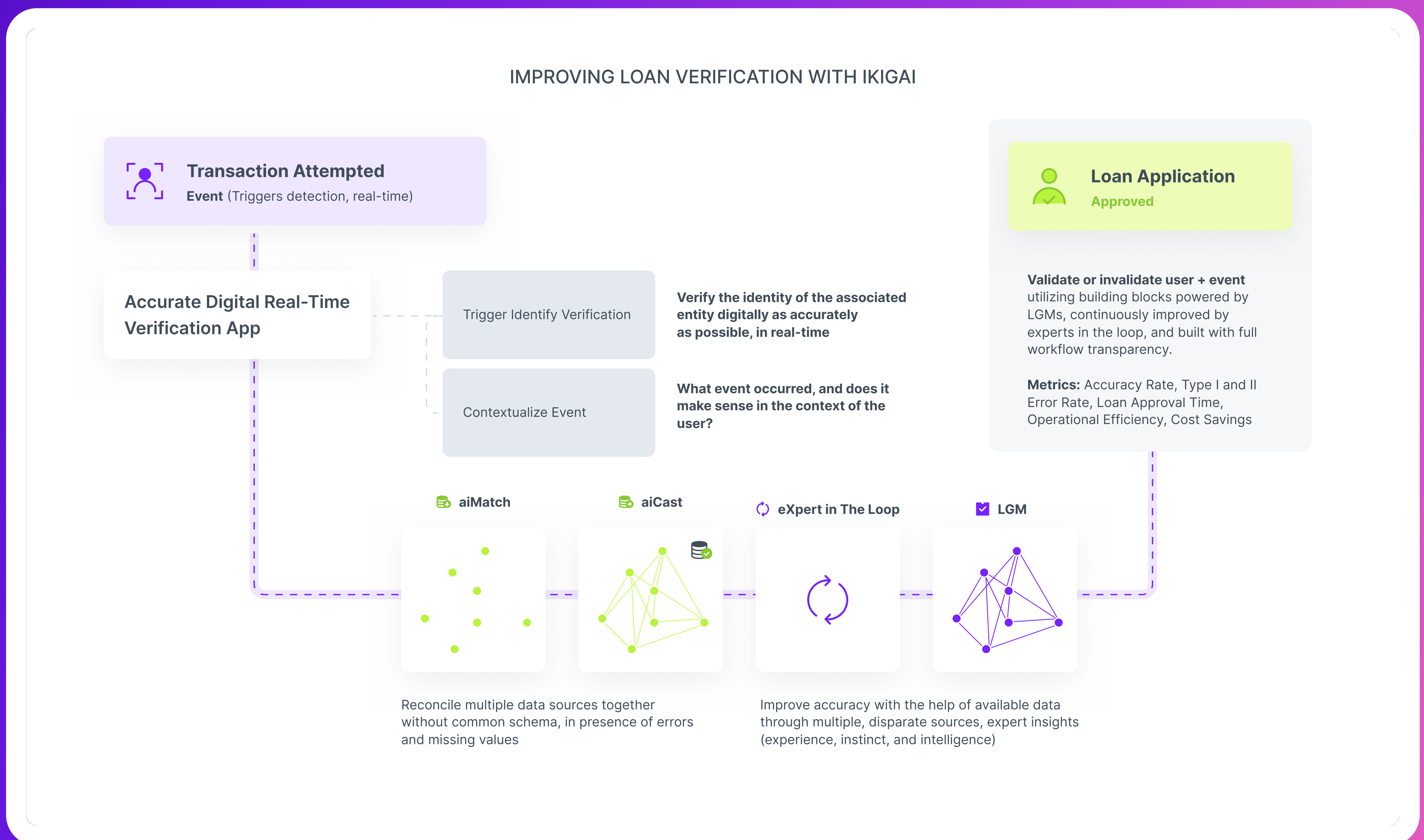
- **Identify emerging threats and guide long-term fraud prevention strategies with probabilistic methods, while using deterministic rules to flag known fraud patterns.**
- **Detect high-impact, high-variability risks (such as complex money-laundering schemes that involve multiple transactions and entities) with a probabilistic approach, while relying on deterministic systems to handle routine transactions with low fraud risk.**
- **Uncover the hidden patterns and relationships in customer data that inform the development of more targeted and effective fraud detection rules with a probabilistic method, then implement those rules within a deterministic system.**
- **Combine approaches for enhanced customer risk profiling and due diligence in anti-money laundering schemes, as deterministic rules can help banks meet regulatory requirements and screen customers against known watch-lists, while probabilistic models can provide a more nuanced assessment of customer risk based on behavior, transaction patterns, and network associations.**

In conclusion, probabilistic forecasting is a powerful approach that can help businesses navigate uncertainty, make better decisions, and drive real impact.

By leveraging the strengths of both probabilistic and deterministic methods in a strategic and targeted way, organizations can create more **accurate, adaptive, insightful, and actionable forecasts** that drive better outcomes in today's dynamic business environment

Introducing Ikigai: A Safe and Efficient Approach to Probabilistic Forecasting for Financial Services

As financial services institutions increasingly recognize the benefits of probabilistic forecasting to navigate uncertainty and make data-driven decisions, generative AI platforms like **Ikigai** have emerged with innovative approaches to probabilistic forecasting solutions that improve the performance of existing solutions.



Ikigai's generative AI for time-series data platform uses large graphical models (LGMs) to provide a powerful yet efficient approach to probabilistic forecasting. Benefits to financial services organizations include:

Superior accuracy: Ikigai's ability to identify relationships across all datasets enables it to spot correlations that may not be considered by other models. In recent benchmarking tests, Ikigai outperformed foundational models and open-source solutions, delivering an average of 30% better performance than Google's time-series forecasting solution in 12 out of 14 tests.

Transparency and interpretability: Ikigai provides a transparent approach that allows stakeholders to understand how the models arrive at their predictions and recommendations. The system shows what features are driving the forecast, presents results in an easily understandable format, and highlights potential errors or anomalies for expert review and resolution.

Flexibility with Data: Ikigai's [aiMatch](#) technology effectively handles messy, disparate data sources, connecting and reconciling data from various systems and filling in missing data to enable accurate forecasts even with limited historical data. The platform's autoML capabilities make it easy to prepare poorly formatted data quickly for analysis.

Efficient Deployment: Ikigai's domain-agnostic platform can service multiple use cases and sub-industries within financial services, allowing you to start with your most compelling use case and then leverage the solution across the entire enterprise. Unlike LLMs, Ikigai does not require internet-scale data or expensive GPU infrastructure to get up and running.

Data Security & Confidentiality: Ikigai ensures the security of your information through an explicit data governance system that authorizes each API call with user-specific credentials and provides users with access to logically separated data. Your data is never trained or cross-trained with data from other user accounts.

Safe Passage Approach to AI: For businesses looking to take a walk-crawl-run approach to probabilistic forecasting, Ikigai works well alongside deterministic solutions, improving performance of existing solutions.

To learn more about how probabilistic solutions are helping financial services organizations see better outcomes, visit [Ikigailabs.io](https://ikigailabs.io) or [schedule a call](#) with an Ikigai representative to see Ikigai in action.