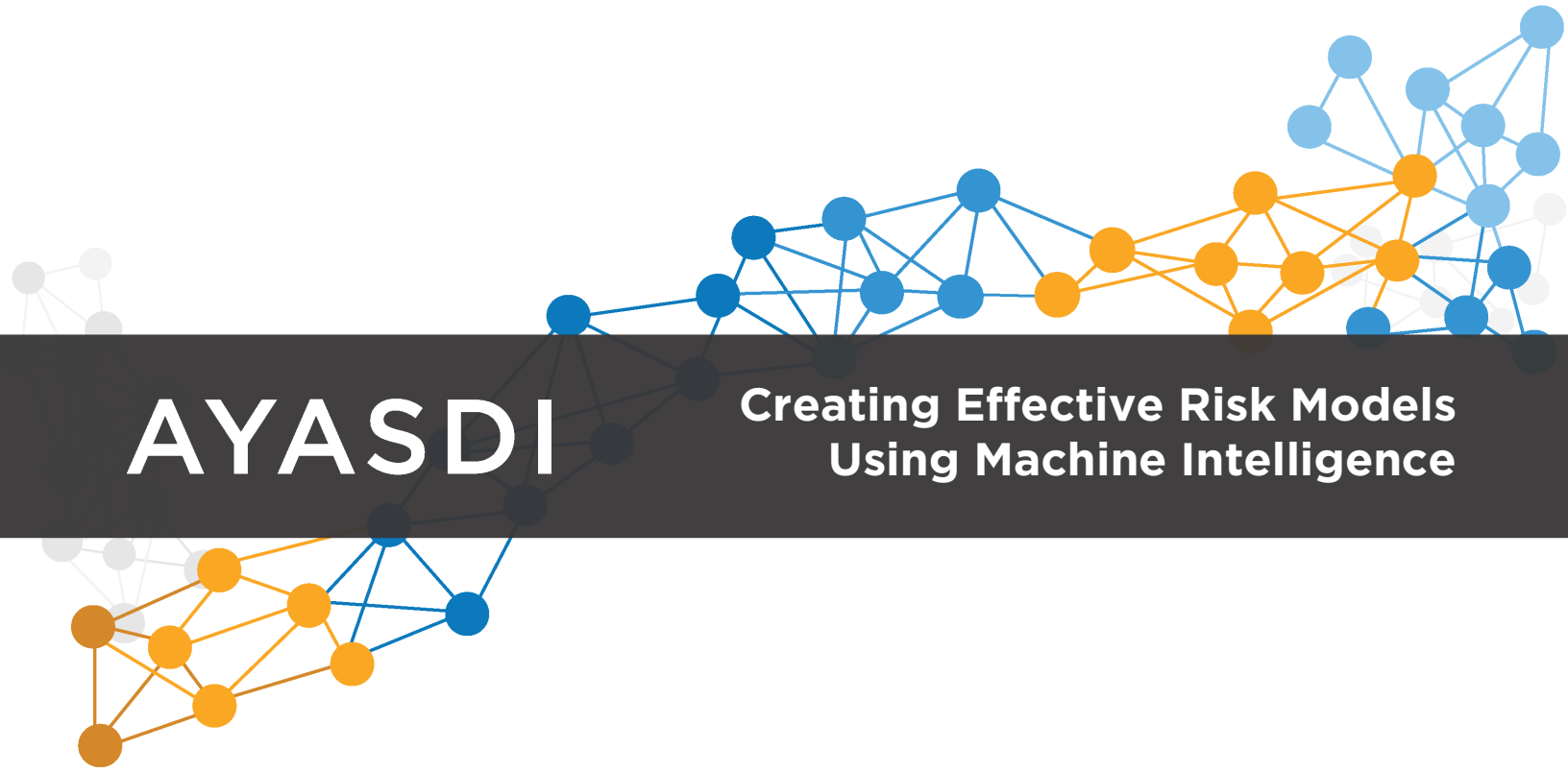

AYASDI

Creating Effective Risk Models Using Machine Intelligence

Why Effective Risk Models are Critical

There is a growing need for financial institutions to have sound models in place that can accurately measure and control risk, proactively detect and prevent fraud, and effectively evaluate capital reserve adequacy. Model failure can be catastrophic to a firm's financial condition.

The constraints imposed by annual regulatory reviews and huge financial losses as a result of decisions based off of inaccurate models are leading financial institutions to reassess how they develop, validate, and update the models they use to assess credit, market, and operational risk.

Accurately assessing a bank's risk exposure requires a deep understanding of the complex and dynamic interplay of a large number of variables and the ability to continuously incorporate these findings into its models. Conventional analytics solutions are overwhelmed by data complexity, and have reached their practical limits. There is a need for a new approach.

Ayasdi's machine intelligence software represents a revolutionary new way of rapidly analyzing highly complex data. It draws on the power of machine learning and topological data analysis (TDA) to speed the development of accurate and defensible models that encode business logic and that can be easily understood by the regulators.

Current Approaches to Risk Model Development, Validation and Improvement: The Pitfalls

A model is a means for applying statistical, mathematical, economic, or financial techniques to data to arrive at an idealized representation of the highly complex, actual relationships that exist between various events and variables. The key to defining effective risk models involves identifying and incorporating the right combinations of variables that accurately assess risk while maintaining model stability and reliability.

Creating effective risk models requires sound model development and validation techniques. However, current approaches using spreadsheets, statistical tools, and standard machine learning techniques can result in models that fail to account for important subtleties in the data. They also struggle to keep pace with evolving market conditions, customer behavior, products, and regulations.

MODEL DEVELOPMENT CHALLENGES

Most approaches to model development are dependent on scarce and expensive modeling resources, and can be extremely time-consuming. They are heavily reliant on subjective domain expertise, published research, and industry practices. Approximations of data inputs and assumptions can result in unstable models. In addition, if the underlying assumptions and methods are subjective, the models are likely to be called into question by regulators as well as the business managers that are impacted by the outcomes. These approaches struggle to produce reliable and defensible models. They are not adept at identifying and reflecting the complex relationships that exist between a bank's specific business activities and its risk exposures.

MODEL VALIDATION CHALLENGES

The "Supervisory Guidance on Model Risk Management" issued by Federal Banking regulators defines model validation as a set of processes and activities intended to verify that models perform as expected, in line with their design objectives and business uses. It involves rigorous testing using a myriad of actual market conditions. It assesses the impact on dependent models, and ensures that these models can hold up under extreme economic and business conditions. The challenge with model validation lies in being able to assess the potential impact of factors that are not immediately apparent. Uncovering combinations of features that represent stressed conditions, previously not considered, and then incorporating them into models to make them stress test-proof, for instance, often proves to be a difficult exercise.

MODEL MONITORING AND IMPROVEMENT CHALLENGES

Continuously monitoring and updating risk models to reflect environmental and structural changes can be challenging. However, a model's inability to keep pace with change will result in rapid model deterioration. Business decisions using flawed models will result in financial losses for a bank. Current model diagnostics and improvement techniques are resource intensive and expensive and hence limit the frequency at which models can be updated.

USING MACHINE INTELLIGENCE TO CREATE EFFECTIVE RISK MODELS

Ayasdi offers a new approach to constructing, validating, and updating risk models to reflect environmental and structural changes. Unlike conventional machine learning techniques, Ayasdi's machine intelligence software was designed from the ground up to help rapidly analyze highly complex data sets and uncover relationships that drive more accurate, defensible risk models.

Ayasdi's software draws on innovations in topological data analysis (TDA) and machine learning to analyze thousands of variables simultaneously. It uses the geometry of the data to create visual, topological summaries that reveal subtle patterns and relationships in highly complex data that signal risk. The software provides a simple visual way of finding and explaining the variables that characterize these uncovered patterns and relationships. For instance, it rapidly identifies combinations of factors that impact revenue streams or represent false positive regions in fraud detection models. By incorporating these variables, firms can create more accurate operational risk and fraud risk models.

> "Citi's unmatched multinational business footprint creates a complex data challenge. Ayasdi's big data technology simplifies and accelerates the analysis of thousands of discrete variables and delivers insights that enable Citi to tailor services to specific client needs, operate more efficiently, and mitigate risk."
>
> - *Deborah Hopkins, Chief Innovation Officer of Citi and CEO of Citi Ventures*

HOW MACHINE INTELLIGENCE IMPROVES MODEL DEVELOPMENT TECHNIQUES

Most firms use conventional machine learning techniques such as Dimensionality Reduction methods to analyze complex data and uncover variables to incorporate into their models. These powerful techniques reduce the number of attributes required to describe the data while still revealing some of the inherent patterns and relationships in that data. However, the compression of a large number of attributes down to a few can result in a firm missing out on subtle insights. For example, consider credit card transactions that have thousands of attributes. Visualizing the patterns and relationships in these transactions that signal fraud can be extremely difficult given that one cannot see more than three dimensions at a time.

Ayasdi's machine intelligence software eliminates issues typical of such machine learning techniques. It augments this approach by using innovations in TDA to visually identify and explain distinct segments and subsegments within the data that might have been missed using standard Dimensionality Reduction methods. As opposed to making global assumptions regarding all the underlying data, TDA effectively constructs an ensemble of models. Each model is responsible for a different segment of the data. This eliminates the need to create a single risk model that works well on all of the data. An ensemble of risk models can be much more accurate as they are each optimized for different segments of the data, thus reducing the possibility of systematic errors in the model output.

HOW MACHINE INTELLIGENCE IMPROVES MODEL VALIDATION AND IMPROVEMENT TECHNIQUES

Models for fraud detection, compliance, and regulatory risk management within organizations can range from simple rule-based systems to those that are the results of machine learning algorithms. One of the primary steps in validation or auditing exercises is the discovery of systematic errors or biases in a model.

Models created by standard machine learning techniques tend to "over-fit" as they attempt to describe all of the underlying data. Ayasdi's machine intelligence software uses TDA to uncover such errors in models. For instance, consider the process of validating models used to detect fraudulent credit card transactions. Ayasdi's software can identify errors in a model by comparing visual networks that represent the outcomes predicted by the existing model as well as the actual ground truth (i.e., were the transactions fraudulent or not). By comparing the model estimation with the ground truth, a firm can quickly focus on the subgroups of transactions in the network where the model made mistakes. The software automatically generates a list of the statistically significant variables associated with each subgroup. This helps the firm identify combinations of attributes that indicate fraud that had previously gone undetected and then incorporate them into models. Ayasdi's data-driven approach to model diagnostics and improvement also helps firms create models that can adjust as new data arrives, thereby curbing performance deterioration.

A Major Bank Passes CCAR with Effective Revenue Forecast Models

AYASDI CASE STUDY

THE BACKGROUND

The 2008-09 financial collapse led to a Federal Reserve directive that banks with consolidated assets over $50 billion have additional risk assessment frameworks and budgetary oversight in place. To assess a bank's financial foundation, the Federal Reserve oversees a number of scenarios (company-run stress tests). Referred to as the Comprehensive Capital Analysis and Review (CCAR) process, these tests are meant to measure the sources and use of capital under baseline as well as stressed economic and financial conditions to ensure capital adequacy in all market environments.

A Fortune 50 bank had previously struggled to pass its annual stress test. It was unable to demonstrate to the regulators that it could adequately forecast revenues across the many countries it serves and the lines of business it maintains. Failure to pass would have forced its board to explore restructuring measures. Passing the test would put the bank on the road to doubling its share price. The bank was in need of a way to create accurate, defensible models that would prove to the Federal Reserve that they could adequately forecast revenues and the capital reserve required to absorb losses under stressed economic conditions. The bank's previous approach using spreadsheets and conventional machine learning techniques for identifying the key variables that impact revenue streams to incorporate into its models was found to be inadequate. This "black box" approach left the business unit leads with little room and time to weigh in on the logic behind the choice of the variables selected – before they ran out the clock on the stress tests. It also meant that they were not in a position to confidently defend the models that they included in the filings they presented to the Federal Reserve.

HOW AYASDI HELPED

The bank decided to explore the use of Ayasdi's machine intelligence software to supplement its capital planning process. The process began with the leaders of all of the bank's business units reviewing the macroeconomic variables stipulated by the Federal Reserve. Ayasdi augmented these variables using several techniques (e.g., time series transforms such as lags, differences, and percent changes) and created over two thousand variables. The software was then used to correlate and analyze the impact of these variables on each business unit's monthly revenue performance over a six-year period. Ayasdi's software rapidly uncovered the statistically significant variables that were highly correlated with each business unit's performance.

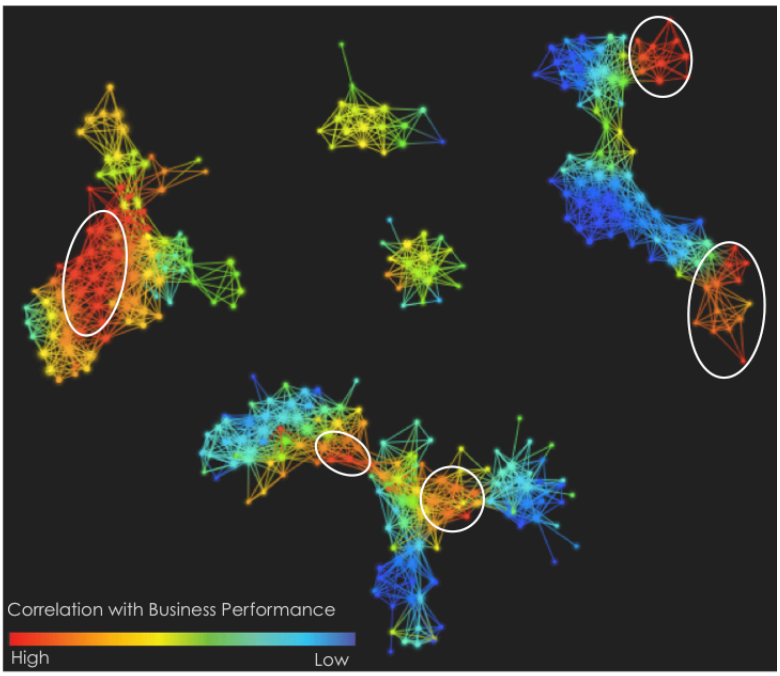

Figure 1:

Uncovered groups of variables highly correlated with business performance

A comprehensive business review was conducted to screen the identified variables prior to inclusion in the models for each business unit. Ayasdi then conducted exhaustive statistical tests (including stationarity and multicollinearity tests) to validate these models' ability to predict revenues for the business units. The business leads then selected the models that best represented their units. This new approach to identifying, validating and selecting the variables and models ensured that business logic was built into the process and that the bank had accurate, defensible revenue forecast models that stood up to the Federal Reserve's scrutiny.

THE BENEFITS OF THE NEW APPROACH

SPEED

Ayasdi's machine intelligence software helped shorten the variable selection process from three months to two weeks. The software helped rapidly analyze and uncover variables that were highly correlated with a business unit's performance from amongst thousands of transformed variables and six years of monthly revenue data.

DEFENSABILITY

The software produced statistically ranked variables that the business leads could evaluate and approve for inclusion in the model construction process. It automatically whittled down hundreds of combinations of models to a select group of statistically valid and empirically sound candidate models that the business leads could then select from and confidently include in their CCAR filing.

ACCURACY

The Ayasdi approach now helps the bank implement a regimented and statistically sound process for rapidly provisioning models that accurately forecast revenues under all the stress test scenarios stipulated by the Federal Reserve.

A Leading Payments Firm Creates More Accurate Fraud Detection Models

AYASDI CASE STUDY

THE BACKGROUND

According to the Nilson Report, payment card issuers, merchants, and their acquiring banks lose over $11 billion to fraud each year. These enormous losses are indicative of the challenges that risk departments face when it comes to creating and updating their fraud detection models. The ability to quickly identify clear correlations between transaction characteristics and patterns of fraud to keep pace with evolving fraud tactics is critical.

A credit and debit card-processing giant estimated that six cents out of every hundred dollars in transactions that it processed was fraudulent. In an increasingly competitive payments market, it could not afford to lose the trust of its customers.

Its existing statistical analysis tools did not afford its modelers the ability to objectively evaluate the data. The firm was looking for ways to improve the accuracy with which its models detected and predicted fraud.

HOW AYASDI HELPED

The firm decided to explore the use of Ayasdi's machine intelligence software to evaluate its existing fraud detection models. It used the software to ingest over a million credit card transactions and analyze over 600 variables that characterized these transactions.

The Ayasdi team was able to produce actionable results within six weeks. The software quickly visualized the regions with fraudulent transactions and produced a listing of the statistically ranked features that described these regions. The analysis also helped the firm visually compare the ground truth to the existing model's predictions and zero in on systematic model performance issues (both false positives and false negatives). It also helped the firm identify the statistically-significant features that characterize these regions of false positives and false negatives to improve their existing models and create new ones.

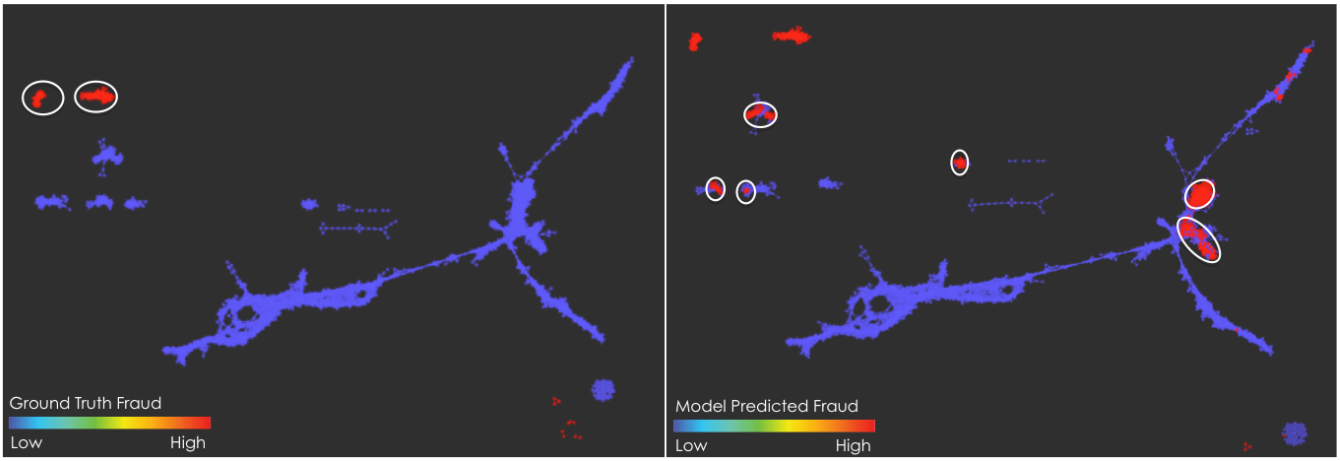

Figure 2: Compared ground truth with the model prediction. Identified characteristics of false positives

THE BENEFITS OF THE NEW APPROACH

SPEED

The firm was able to glean actionable results in six weeks. They were able to uncover systematic model issues – hard to uncover using any other approach.

SIMPLICITY

Unlike other approaches, Ayasdi's software provided the firm with a simple way of correlating and analyzing hundreds of variables to uncover combinations of variables that are more accurate predictors of fraud. The software lets them visually explore model shortcomings, when compared with the ground truth.

ACCURACY

The software helped the firm identify localized segments of transactions with high concentration of fraud. It produced statistically ranked features for specific segments that could then be used to build new, local models. It also helped the firm uncover the characteristics of false positives and false negatives and incorporate these features into their existing models. This increases fraud detection accuracy, reduces revenue losses, and improves customer satisfaction.

Summary

Flawed risk models can result in huge financial losses for a bank. It is imperative that financial institutions have sound models that can accurately measure and control risk, proactively detect and prevent fraud, and effectively evaluate capital reserve adequacy. Conventional analytical tools have hit an impasse. They are not equipped to handle the sheer complexity of the data on hand to create empirically sound and economically defensible models. Ayasdi's machine intelligence software combines innovations in machine learning and TDA to help firms analyze thousands of variables simultaneously. It leverages the shape of the data to surface meaningful relationships in highly complex data that signal risk, often hard to uncover using conventional analytical tools. Using Ayasdi's software, financial institutions are better equipped to speed the process of developing more accurate, defensible risk models.

ABOUT AYASDI

Ayasdi is on a mission to make the world's complex data useful by automating and accelerating insight discovery. The company's Machine Intelligence software employs Topological Data Analysis (TDA), to simplify the extraction of knowledge from even the most complex data sets confronting organizations today. Developed by Stanford computational mathematicians, Ayasdi's approach combines machine learning algorithms, abundant compute power and topological summaries to revolutionize the process for converting data into business impact. Ayasdi is funded by leading venture capitalists including Khosla Ventures, Institutional Venture Partners, FLOODGATE Kleiner Perkins, Citi Ventures, Centerview, and Draper Nexus. The company counts many of the Fortune 500 as clients.

AYASDI

CONTACT US

Ayasdi, Inc.
4400 Bohannon Drive
Suite #200
Menlo Park, CA 94025

sales@ayasdi.com
visit ayasdi.com

@ayasdi