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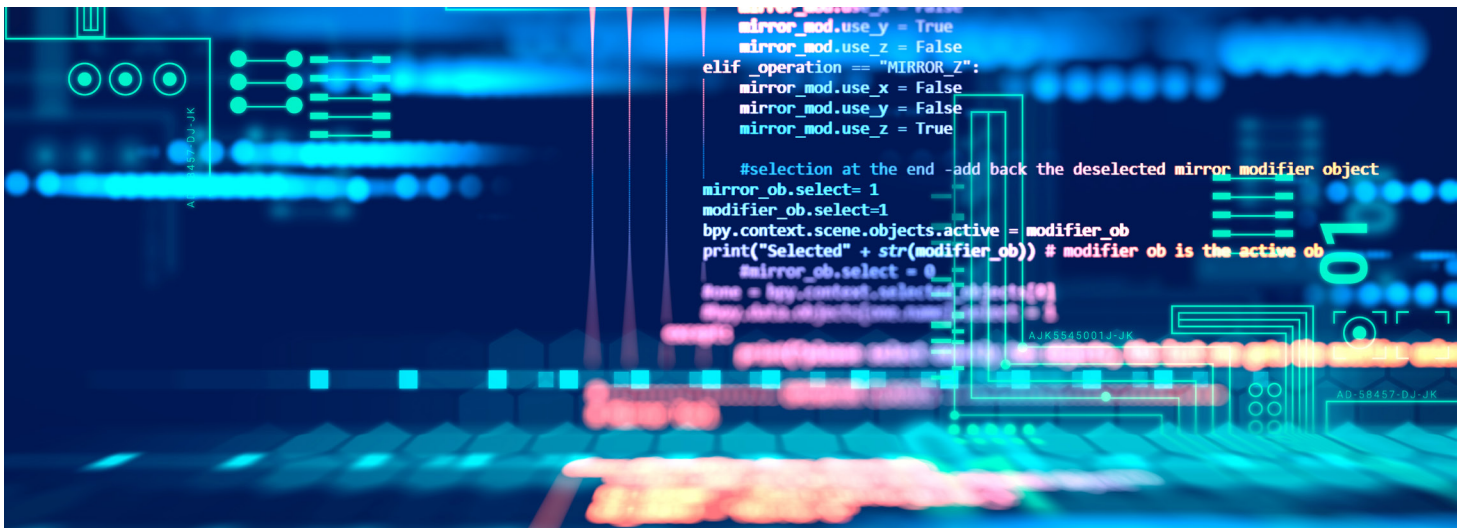
Datasheet

Machine Learning

Reduce demand volatility and risk with our self-tuning machine learning engine—built into ToolsGroup Service Optimizer 99+

Our probability forecasting and machine learning engines crunch multiple demand variables to automatically generate a reliable demand forecast. This self-tuning approach allows you to predict demand behavior much more accurately than considering demand history alone.



Machine Learning: A Perfect Fit for Supply Chain Planning

Supply chain professionals understand the importance of accurate demand forecasting. Yet this is a difficult task due to the extreme complexity of modern demand planning. Increasing forecasting complexity and rapidly shifting consumer demand are often exacerbated by seasonality, new product introductions, promotions and myriad causal factors like weather or social media. The high level of automation machine learning brings makes it an ideal application to improve forecast accuracy in supply chain planning.

Machine learning also supports the development of more resilient supply chain planning practices. Businesses that use machine learning-augmented supply chain platforms can harness real-time data for immediate action. This is the foundation businesses need to predict and sense demand changes and make smart pivots—which are essential for resiliency and survival amid disruptions.

What Is Machine Learning?

Machine learning is a subset of artificial intelligence that uses advanced statistical techniques to give a computer the ability to "learn" from data. There are different ways computers can "learn" from data: supervised, unsupervised and reinforcement learning.

Artificial Intelligence

The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, language translation and decision support systems.

Machine Learning

A branch of artificial intelligence that is concerned with the question of how to construct computer programs that automatically improve with experience.

	Supervised Learning	Unsupervised Learning	Reinforcement Learning
How does it work?	Learns from a labeled training dataset which already contains a known value for the target variable for each record. The algorithms "learn" how the rest of the features relate to the target.	Learns from training data that has not been labeled, classified, or categorized. Identifies commonalities in the data and reacts based on the presence or absence of such commonalities in each new piece of data.	Agent learns to take actions in an environment from episodes of experience to maximize long-term reward. The agent discovers which actions yield the most reward by trial and error, trading-off exploration and exploitation.
How is it applied?	**Classification:** predicting discrete classes (e.g. cat, dog) **Regression:** predicting continuous numerical values (e.g. house prices) **Algorithms:** Decision tree, random forest, neural networks, gradient boosting, support vector machines, etc.	**Clustering:** grouping objects such that members of each group are as similar as possible to each other… and as dissimilar as possible from other groups **Algorithms:** K-means, affinity propagation, hierarchical clustering, DBscan, etc.	**Prediction:** policy evaluation for unknown Markov Decision Processes **Control:** on or off-policy methods to learn optimal policies **Algorithms:** TD (Temporal Difference), Q-Learning, SARSA, DQN (Deep Q Network), etc.

At the highest level, machine learning enables a system to learn from experience (data), rather than being explicitly programmed to behave in a certain way. The typical machine learning process is highly iterative.

How Does Service Optimizer 99+ Utilize Machine Learning?

ToolsGroup's Service Optimizer 99+ (SO99+) supply chain planning software employs a phased approach, using probability forecasting and machine learning technologies, which seamlessly and automatically work together. We begin with SO99's self-adaptive model for probability forecasting using historical demand. We further improve this baseline probability forecast by applying ToolsGroup's machine learning technology to the existing historical data. This produces a more robust, reliable baseline forecast that accurately models the phenomena shaping the demand. We then layer on more sophisticated machine learning by leveraging external data sources. A reliable demand forecast is critical to business success with advanced machine learning and yields significant benefits on its own.

Machine learning engines are used in SO99+ to improve the calculation of the effects which affect sales (seasonality, promotions, etc.). An improvement in the coefficients calculation helps to better clean past demand and produces a most accurate future forecast. There are several advantages to ToolsGroup's approach:

- The machine learning results are combined with the statistical forecast
- The probabilistic forecasting algorithm remains the basis of the forecast and the machine learning results are layered on top of it, improving the accuracy
- The impacts of machine learning can be shown separately in SO99+, thus reducing the 'black box' effects typical of this kind of algorithm
- The overall solution is stable in the real world as an operationalized system (versus custom machine learning solutions)

Traditional Forecasting

- Point forecast (single value which is supposed to yield the minimum expected error)
- Simple, continuous probability distributions (mostly normal, sometimes lognormal, Poisson or exponential)
- Simple accuracy measurement (MAPE, wMAPE, MAD, etc.) to choose the "best" among a certain number of different forecasting models
- Time-series are analyzed only in terms of quantity, ignoring "demand granularity"
- Slow moving items are typically treated with some questionable algorithms (Croston's method or similar ones derived from it)

SO99+ Advanced Forecasting

- Probability forecasting (range of possible values with their probability of occurrence)
- Proprietary, discrete, probability distributions seamlessly adjusting to a wide variety of demand behaviors
- Single forecasting model, containing a variety of features and parameters that are automatically adjusted in a seamless way
- Time-series are analyzed in terms of customer order frequency and customer order size
- SO99+ unique "frequency based" algorithms, can seamlessly self-adjust to deal with very fast movers as well as intermittent demand series

Machine learning technology is packaged in specific engines that apply one or more machine learning techniques to analyze and predict the demand behavior in a specific application context.

ToolsGroup Machine Learning Models Various Demand Effects as Layers on Top of Baseline Probability Forecasts:

Seasonality: Create groups of products and groups of markets to model periodic, repetitive, and generally regular and predictable patterns. The groups are then used for the calculation of the seasonality.

ToolsGroup used machine learning (clustering and classification) to identify and track seasonality patterns and trends for a leading HVAC company. The system recognizes more than 200 "micro-climates" within the United States and their seasonal timing variations. Machine learning sifted through the SKU-Locations to identify "clusters" with similar seasonality profiles. They improved service levels by 16 percent while simultaneously increasing inventory turns by 25 percent.

Point-of-Sale Demand Sensing: Advanced techniques to improve sell-in forecasting using sell-out demand data.

ToolsGroup used its probabilistic forecast combined with machine learning to help a global cosmetics company apply daily point-of-sale demand sensing data to improve their forecast accuracy. Integrating their sell-out demand patterns with their sell-in forecast quickly improved their WMAPE (weighted mean absolute percent error).

Promotions: All similar promotions in the past are grouped together in order to reduce the noise and promotion attributes are correlated with the promotional behavior. This provides a way to assign a complete profile to any promotion in the future.

ToolsGroup used machine learning for promotions to help a multinational food company lower forecast error 20 percent and lost sales by 30 percent. They increased their service level to 98.6 percent, and realized a 30 percent reduction in product obsolescence.

New Product Introduction and Launch Profiles: New product introductions calculate a baseline forecast for the new items where only few demand months, or none, are available. Launch profiles create groups of

product/market combinations with similar launch profiles in the past and use the correlation with launch attributes to assign launch profiles to new items. New Production Introduction and Launch profiles work together to provide a complete forecast for new product launches in the future.

ToolsGroup used machine learning (new product introduction and launch profiles) to help a global leader in eyewear cluster the behaviors of past launches, select the most probable performance for the new product, then "learn" common demand behaviors in the first launch period through detailed demand profiles. They improved global WMAPE by 10 percent and reduced the forecast baseline on new launches by about 30 percent.

Daily Sales Profiles: Create groups of products and groups of markets to model periodic, repetitive and generally regular and predictable patterns at the daily level. The groups are then used for the calculation of the daily sales profiles.

External Demand Causals: How to use weather, social media, IoT, market trends, indicators and other external data to improve the forecast.

Product Life Cycles: Creates the Life Cycle groups. A Life Cycle Profile is calculated for each Life Cycle Group.

How Can ToolsGroup Help You Leverage Machine Learning?

Advances in machine learning are driving significant benefits in supply chain planning. However, adopting machine learning is a journey and ToolsGroup has designed service offerings to help customers at any stage of that journey.

Advisory Services

ToolsGroup will assess customers' current maturity levels, identify opportunities and develop a roadmap to achieve short-, medium- and long-term objectives. Services can be tailored depending on need.

Training: While embarking on the machine learning journey, it is important that all stakeholders have a high-level understanding of what machine learning is, how it can be applied and what the strongest use cases and critical success factors are.

Readiness Assessment: Data availability is the single biggest reason machine learning journeys get derailed. ToolsGroup will assess data availability, quality and granularity to support priority use cases. Existing systems, processes, teams and priorities are also evaluated to understand overall business readiness.

Roadmap Development: Assess current performance, understand gaps to targets and industry benchmarks and quantify value propositions. Discover business dynamics (e.g. seasonality, promotions, rate of new product introduction, etc.) and current pain points to identify opportunities. Prioritize opportunities based on complexity versus benefit. Construct a roadmap to demonstrate initial value quickly, while closing any gaps to support longer term and more complex use cases (typically data governance).

Exploratory Data Analysis: Data availability alone doesn't guarantee success with machine learning. Finding the relationship between sell-out and sell-in demand, for example, is often considered the 'holy grail' but can be influenced by external factors not directly related to demand, e.g. erratic purchasing behaviors, stocking policies, seasonal buy-in, etc. In this case, EDA aims to analyze the available data to determine the feasibility for Demand Sensing, prior to committing fully to an initiative.

Proof of Concept: Build an SO99+ model (or extend an existing model) with customer data to demonstrate the value for targeted machine learning use cases.

Expansion Services

Implement SO99+ Machine Learning Capabilities: ToolsGroup's proven methodology for accelerated implementation of machine learning capabilities.

Ongoing Calibration of SO99+ Machine Learning Models: Machine learning in SO99+ automates processes, with models learning and adjusting to changes over time. It is, however, important to recalibrate models on a period basis. These subscription services allocate a number of consulting hours per quarter to this, as part of our broader Premium Care offering.

Data Engineering Services

The primary objective of these services is to remove data as an obstacle to adopting machine learning. ToolsGroup's Data Engineering team can develop and manage data pipelines to extract, prepare and transform data from existing data sources. These services can also accelerate access to external data sources for causal factor analysis, e.g. weather, social media, Google search, socio-economic indicators, point-of-sale retail data, seasonal trends like flu and allergies, etc. These can be done on a one-off basis, and as a managed service to maintain and continuously improve over time.

Data Science Services

Some use cases are more complex and require a higher degree of expertise to implement. ToolsGroup has deep data science expertise and is open to exploring these requirements as mutually beneficial co-development opportunities. Improved capabilities are subsequently merged into the core SO99+ product to continue to provide the high degree of stability, support, and abstraction of complexity our customers expect from an operationalized platform—instead of bespoke custom solutions that are difficult and expensive to maintain.