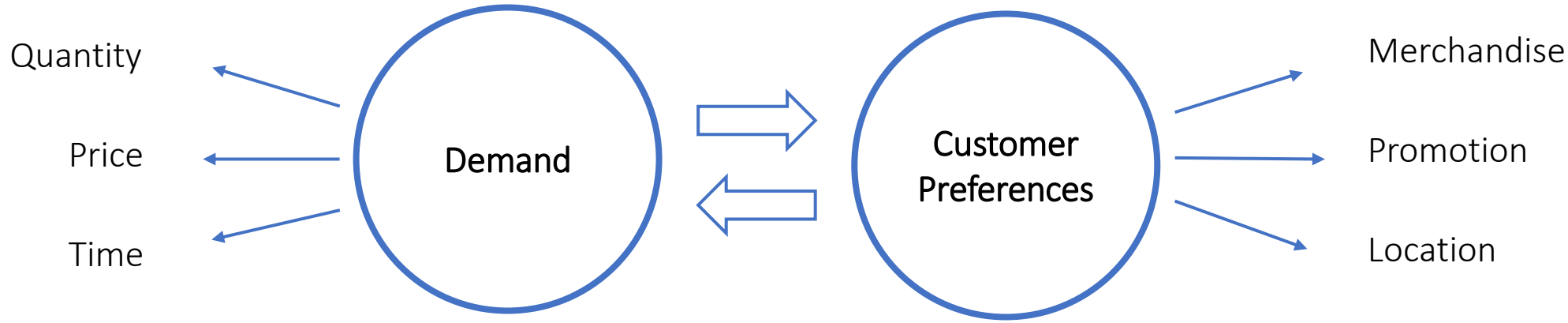
Novel Solutions
to Existential Retail Problems

The Problem Statement

To be successful, retailers must solve the existential problem:

What are the right quantities of the right merchandise with the right price and the right promotion to be delivered at the right time to the right location.



Retailers need to know demand
to deal with quantities, price, and time

Retailers need to know customer preferences
to deal with merchandise, promotion and location

How to “Know” Demand

Redefining Demand Forecasting

Shift in Demand Forecasting Paradigm

Traditional

Generally accepted, but incorrect and misleading, view on demand forecast and forecast error:

forecast = expected value of demand

forecast error = error in expected value

Accuracy: Difference Between Forecast Value and Actual Value

Precision: Dispersion of Forecast Residuals

Probabilistic

The complete and correct view on demand forecast and forecast error:

forecast = distribution of possible demand values

forecast error = error in distribution

Accuracy: Difference Between Forecast Distribution and Actual Distribution

Precision: Dispersion of Forecast Distribution

Advantages of Probabilistic Paradigm [1]

The methodology helps retailers to recognize that traditional view on demand forecast and forecast error are causing real problems in the business and are hurting competitiveness.

- Demand and out-of-stock:

  Is out-of-stock has an equal risk as overstock?

  Or… does each have its own probability and its own mitigation plan?

- Intermittent demand

(characterized by having several sporadic or highly varying periods of demand, 60%-75% of merchandise have intermittent demand):

Do you sell 0.1 units each week?

Or… 0.1 probability to sell 1 unit each week?

Advantages of Probabilistic Paradigm [2]

The methodology helps to recognize that to make a change, the demand forecast error needs to be measured correctly.

All traditional metrics only measure error of a single central point per period (MAPE, WMAPE, MASE, MAD, MAE, MSE, RMSE, FVA, ….)

Total Percentile Error, a new metric, measures error in distribution of possible demand values:

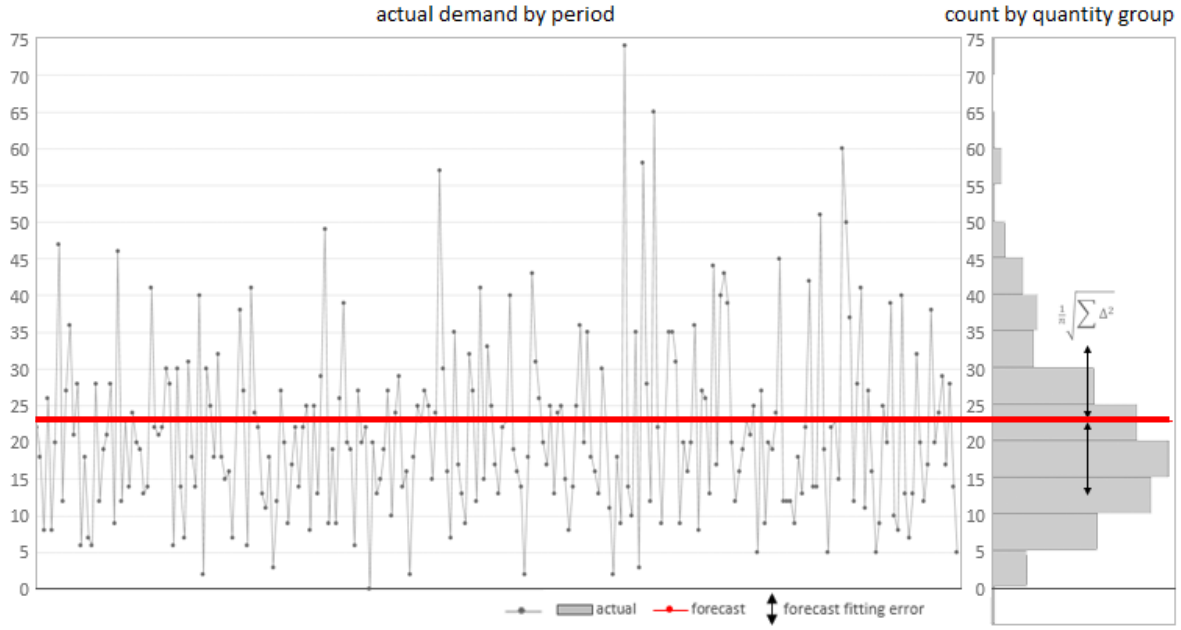
$$\varepsilon_{general} = \frac{\sum_{b=1}^{B} w_b \left| \sum_{i=1}^{n} \mu_i \left(l_b - \lambda_{b,i} \right) \right|}{\sum_{b=1}^{B} w_b \sum_{i=1}^{n} \mu_i}$$

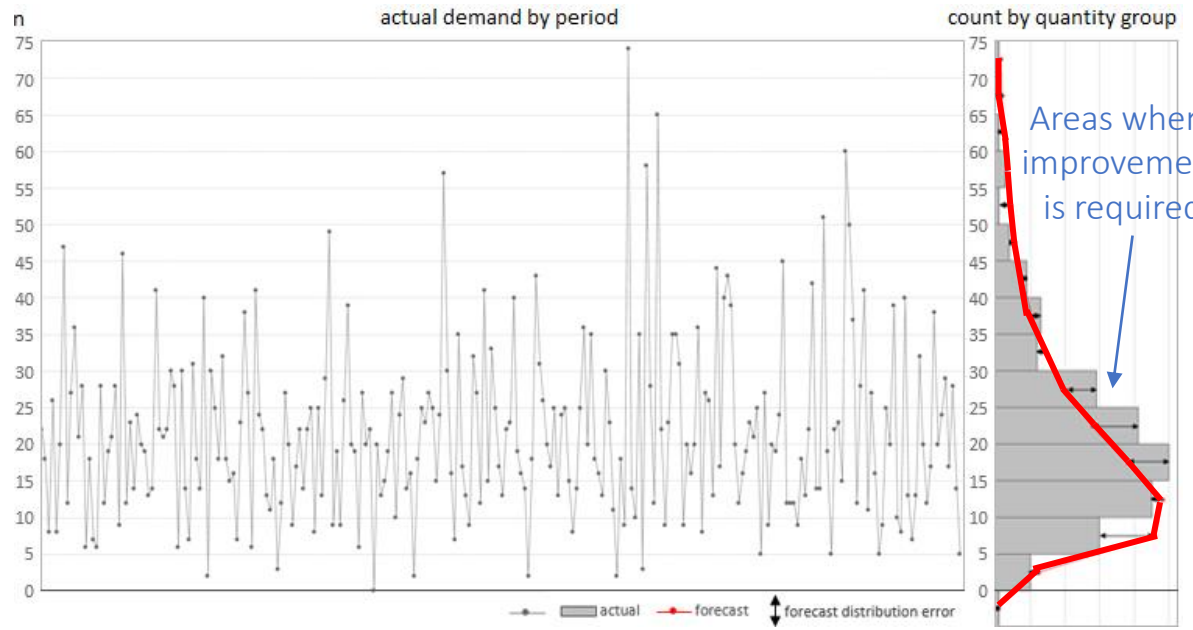
n is the number of observations
B is the number of percentile bins
w_b is the weight for percentile bin b
l_b is the size of the percentile bin b
μ_i is a weight assigned to the i-th actual
$\lambda_{b,I}$ is the spreading factor

Advantages of Probabilistic Paradigm [3]

The probabilistic forecasting and the new metric of forecast error are the eye-openers to why all the efforts never worked before:

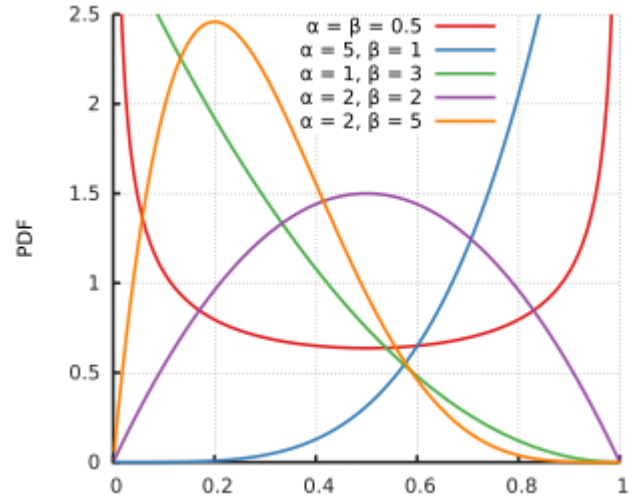
- Probabilistic forecast explains magnitude of demand variability.
- New metric of forecast error properly measures uncertainty in forecasts, providing directions where the forecast should be improved.





Probabilistic Methodology

1. Demand is decomposed by sources of demand (e.g., type of customers, channels of sales, etc.)
2. Empirical probabilistic distributions over levels of demand are the basis for demand forecasting. The empirical distributions are modeled using Beta distribution and demand forecasts are presented as the demand levels multiplied by their probability.
3. Forecast quality is measured using Total Percentile Error which:
   - Measures complete value of a forecast, not just the average expected value per period.
   - Is robust to intermittency, outliers, trends, seasonality, promos, etc.



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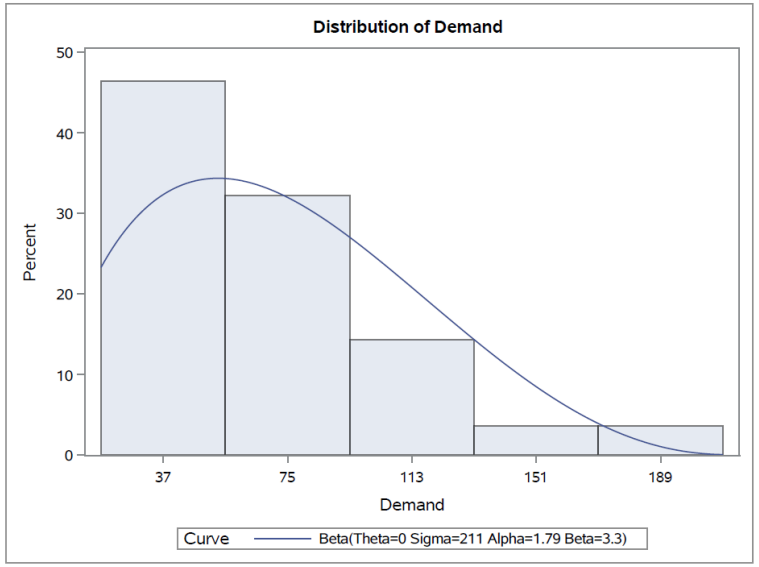


Business Value

- An error metric is based on the entire demand distribution, thus any error reduction efforts will target that entire distribution and have a massive immediate ***impact on inventory quality***. In practice, probabilistic forecasts lead to inventory reductions while at the same time satisfy customer demand.
- With probabilistic view on forecast and forecast error, there is ***no difference between slow-moving and fast-moving products, between seasonal and non-seasonal, trended and non-trended, promoted and non-promoted***. They all have different distributions, and these are almost equally easy or difficult to predict. Retailers can objectively know when and where to spend improvement efforts.
- Probabilistic view on forecast and forecast error delivers more ***relevant information that leads to better business decisions***. In planning capacity, purchasing, production, distribution, inventory, or budget, knowing the probabilities of demand ***allows retailers to mitigate the risks and leverage opportunities***.

How to “Know” Customer Preferences

Redefining Customer Analytics :: Customer & Product Success Profile

Shift in Customer Analytics Paradigm

Surveys are everywhere, as they are a never-ending dialog with customers about opinions on new or existing products, brand awareness, customer needs, and more.

Traditional

Survey data is often inappropriately analyzed, and it leads to incorrect conclusions about customer preferences:

- Survey responses are considered and analyzed as numbers, while they are not: responses are measured on ordinal scale and represent data without values.
- Different difficulties of survey items (survey questions) and dependencies among them are ignored.
- Different abilities of respondents are ignored.

Novel

Survey data is appropriately analyzed, and it leads to correct conclusions about customer preferences when:

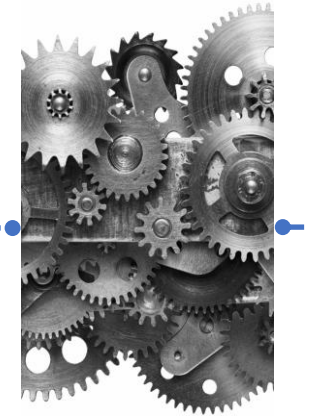
- Responses that are measured on ordinal scale converted to probability scale.
- Difficulty of survey items (survey questions) and ability of respondents are taken into the analysis.
- Dependencies among items are used to reveal foundational survey items.

AI/ML Customer Analytics Methodology

Modified Polytomous Rasch Measurement Model (mPRMM)

$$P\{X_{ni} = x\} = \frac{exp\sum_{k=0}^{x}(\beta_n - (\delta_i - \tau_k))}{\sum_{j=0}^{m} exp\sum_{k=0}^{j}(\beta_n - (\delta_i - \tau_k))}$$

Relational Bayesian Network



Proprietary algorithms

- Identifies malfunctioning survey items and untrustworthy responses
- Identifies difficulty of survey items and ability of respondents
- Establishes causal relations among survey items
- Produces actionable outcomes for the respondents as a whole and for individual respondent

Through *series of short consecutive surveys*, that eliminate bias of sample under-representation, the system identifies customer preferences and product strength and weaknesses, and creates Customer & Product Success Profile that quantifies impact of foundational items on consumer preferences.

Business Value

Customer & Product Success Profile (or Model) brings the following values to a business:

- ***Optimizes demand forecasting*** by integrating it with customer preferences
- Helps to ***generate demand*** for products
- Reveals the true and realistic situation with ***customer opinions on products attributes*** and their promotions
- Identifies ***critical attributes of a product*** and their alignments with customer preferences
- Provides ***actionable recommendations on the improvement of the product and its promotions***
- Helps ***avoiding erroneous decisions*** about a product and promotions, that can be extremely costly for the business.

Thank you!

Q&A