Forecasting Intermittent Demand for Aircraft Spare Parts Using Machine Learning

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Abstract

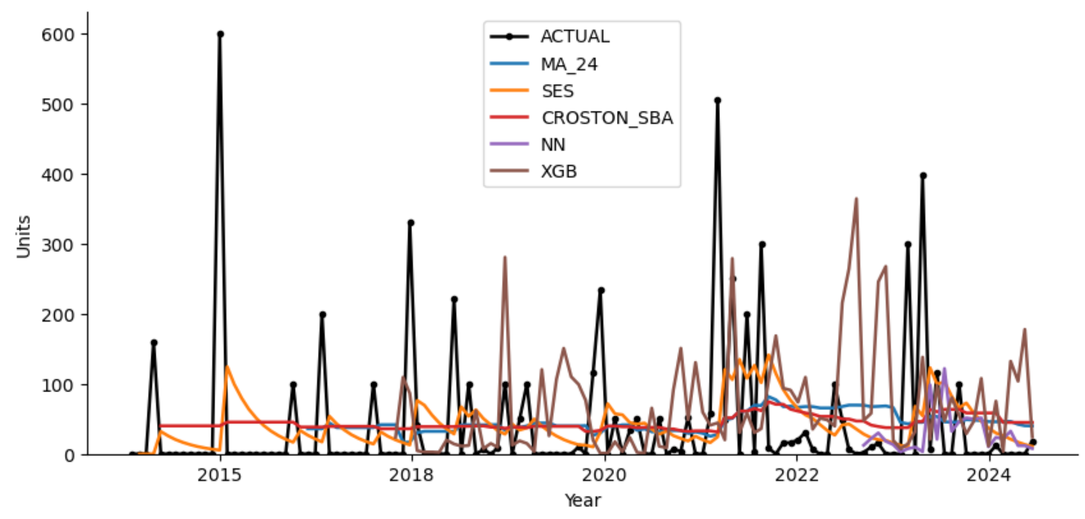
Intermittent demand poses a complex challenge for military aviation logistics due to long periods of zero consumption, followed by sudden peaks of demand, which makes traditional forecasting methods unreliable. This thesis develops and evaluates machine-learning approaches for forecasting intermittent aircraft demand for 2,428 Part Numbers within the Brazilian Air Force (FAB), with the goal of improving prediction accuracy and, consequently, enhancing readiness levels and reducing stockouts. Results demonstrate that machine learning models, particularly XGBoost combined with engineered features, achieve significant gains over classical methods in forecasting accuracy.

Methods

- 10 years of historical demand data from Brazilian Air Force's (FAB) T-27 TUCANO Fleet spare parts.
- Intermittent demand categorization and data cleaning.
- Traditional vs Machine Learning:
  - Simple Moving Average (SMA)
  - Simple exponential Smoothing(SES)
  - Croston-Syntetos-Boylan Approximation (Croston SBA)
  - Artificial Neural Network (NN)
  - Extreme Gradient Boost (XGBoost)
- Accuracy comparison – Mean Absolute Scaled Error (MASE)

Results & Impact

- XGBoost achieved the lowest global errors (MASE = 0.89),
- Outperformed traditional statistical models by roughly 11 %, and
- Provided the best forecast for 55.64 % of parts



Future Research

- Coupling machine-learning forecasts with inventory control policies.
- Estimating the economic impact of forecast errors through simulation of stockout costs, readiness rates, and flight-hour costs.
- Comparing feature-based boosting models with hybrid or deep-learning methods using larger datasets.

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