Demand Forecasting for Materials to Improve Production Capability Planning in BASF

Team 6
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About BASF

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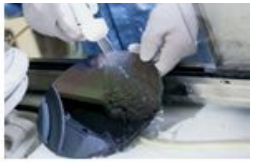
BASF is the world largest chemical company*. In 2017, BASF posted sales of € 64.5 billion and income from operations before special items of approximately € 8.3 billion. Our broad portfolio ranges from chemicals, plastics, performance products and crop protection products to oil and gas.

Agriculture



Electrical & electronics

Construction & housing

Health & nutrition

Energy & resources

Consumer goods

Transportation

https://www.statista.com/statistics/272704/top-10-chemical-companies-worldwide-based-on-revenue/

Business & Forecasting Goal

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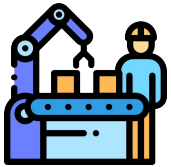
Stakeholder
Production Executive



Client
Business Analytics Team

Student team

Business Goal **Optimization on Production Capability Planning**

Problem

- Poor forecasting accuracy challenge demand planning and performance in inventory and delivery

Benefits

- lowers logistic costs
- maximises asset efficiency
- guarantees the desired service level

Forecast Goal **Forecast the demand of each materials for 2-months ahead**

Challenge

- no seasonality
- intermittent time series

Implication

- Over-forecast:
  Resource-wasted
- Under-forecast:
  Late delivery

Data Source

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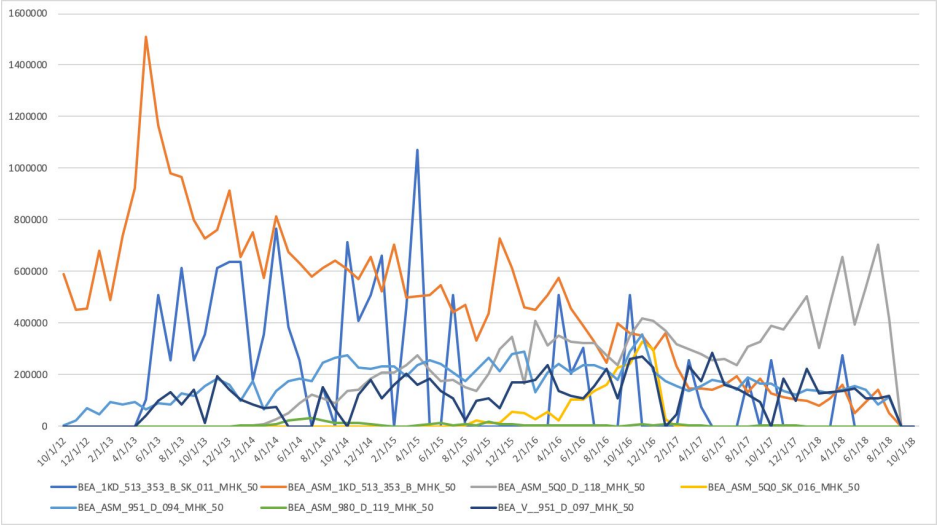
- **Source**: BASF Business Analytic Division
- **Time Period**: 2012/10/10 - 2018/08/31
- **Amount of row:**
  108,324 daily demands from 826 materials
- **Field Descriptions:**

date:	daily transactions
company:	BASF division
desc:	description of material
demand:	demand of material
ship2:	customer code
material2:	material masked code
capacity:	max production



date	company	desc	demand	ship2	material2	capacity
12/28/2012	BASF Polyurethane Sp	BUM-STO-1J0-512-131-SK-080-MHK-40	24000	79	332	784451.47
2/19/2013	BASF Polyurethane Sp	BUM-STO-1J0-512-131-SK-080-MHK-40	30240	79	332	784451.47
3/27/2013	BASF Polyurethane Sp	BUM-STO-1J0-512-131-SK-080-MHK-40	24000	79	332	784451.47
4/27/2013	BASF Polyurethane Sp	BUM-STO-1J0-512-131-SK-080-MHK-40	30240	79	332	784451.47
5/27/2013	BASF Polyurethane Sp	BUM-STO-1J0-512-131-SK-080-MHK-40	30240	79	332	784451.47
6/21/2013	BASF Polyurethane Sp	BUM-STO-1J0-512-131-SK-080-MHK-40	51360	79	332	784451.47

Forecasting Process

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- Business & Forecasting Goal

Define goal

- Tableau Exploration
Identify 1425 of “-” demand

Get & explore data

- Remove Negative Demand
- Monthly aggregation
- Graph exploration in R

Preprocess & Analysis

Apply forecasting method

- Naive
- Arima
- Exponential smooth (ETS)
- Neural Network (NN)
- Auto Model Selection
  - ETS / ARIMA
  - ETS / ARIMA / NN
- Ensemble

Evaluation & Choosing Method

- RMSE in validation period
- Graph Visualization

Implementation

- R Shiny Desktop apps

Forecasting Methods

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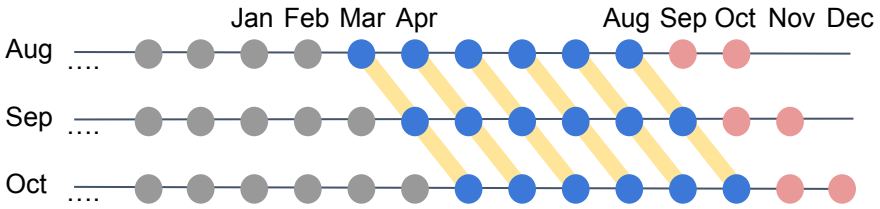
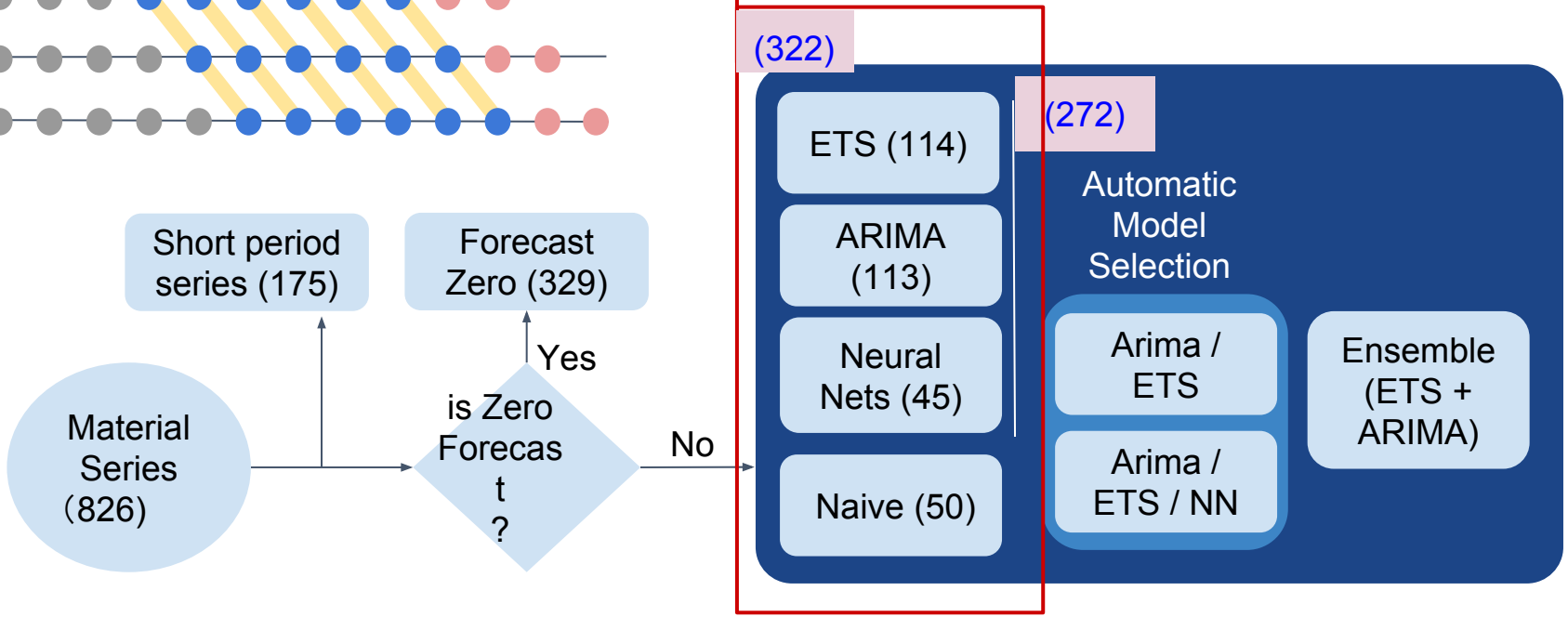
- **Roll-forward**



- **Compare RMSE**
  Validation Period: 2018 / 03 - 2018 / 08



Forecast Evaluations

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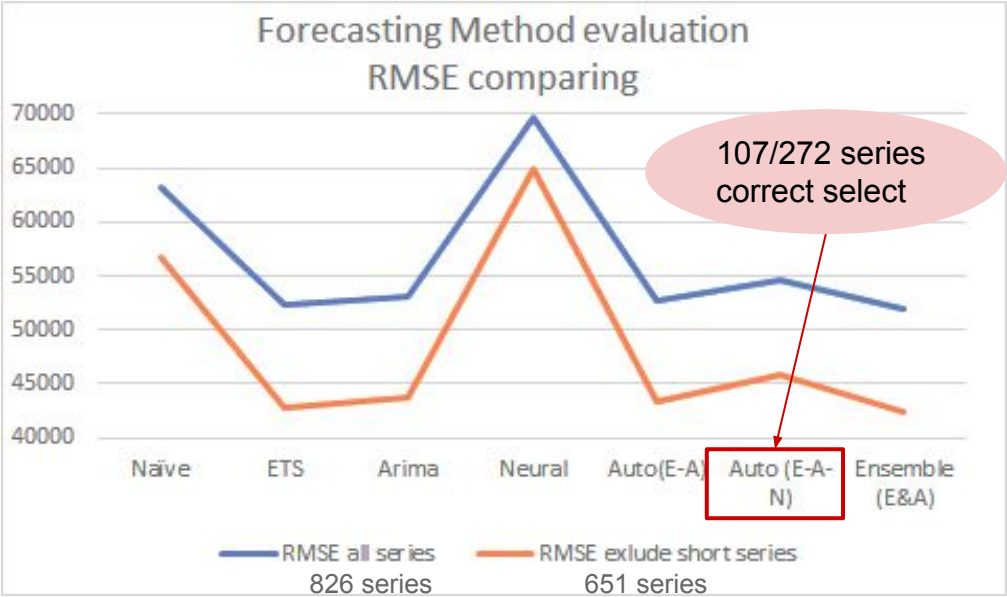

- High RMSE
- Short series issues
- Worst method:
  Neural Network
- Best method:
  Ensemble
- Auto Model selection
  No improvement

Auto model selection Validation	Method Validation
2017/09- 2018/02	2018/03- 2018/08

Chosen Forecast Methods

Naive	Zero forecast	Ensemble

Forecast Problem

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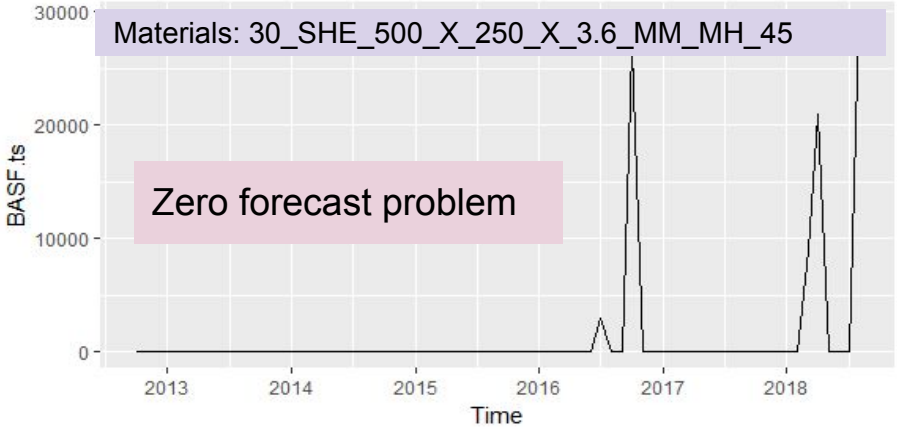

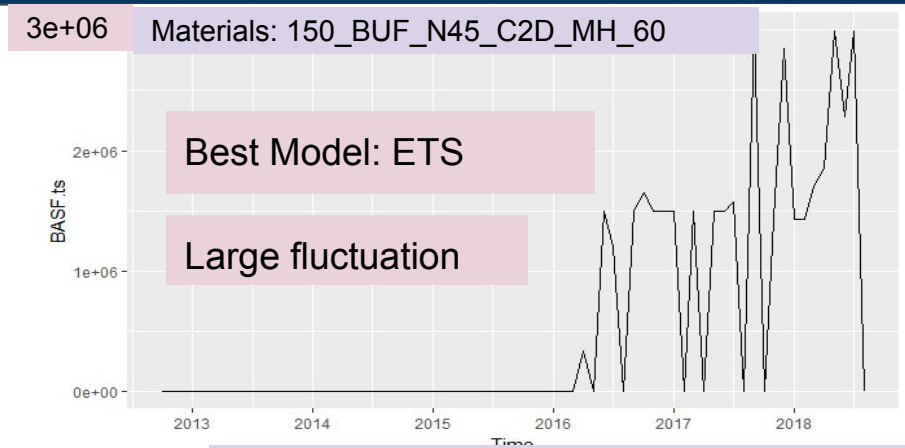

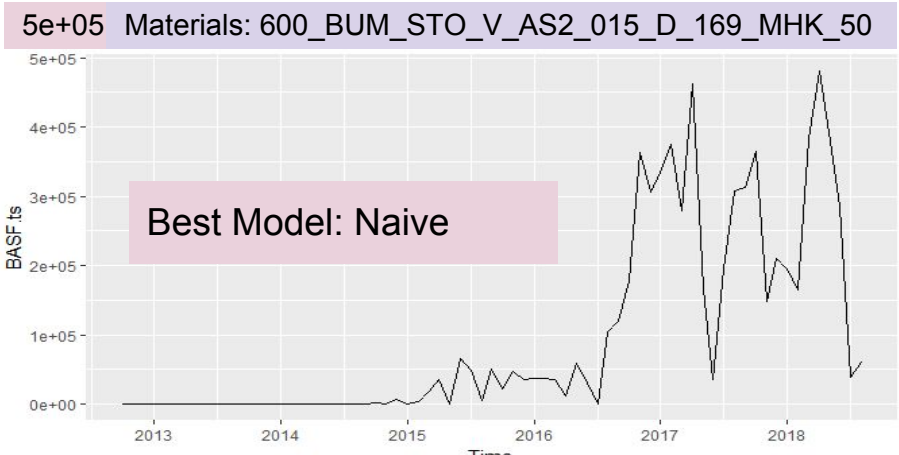

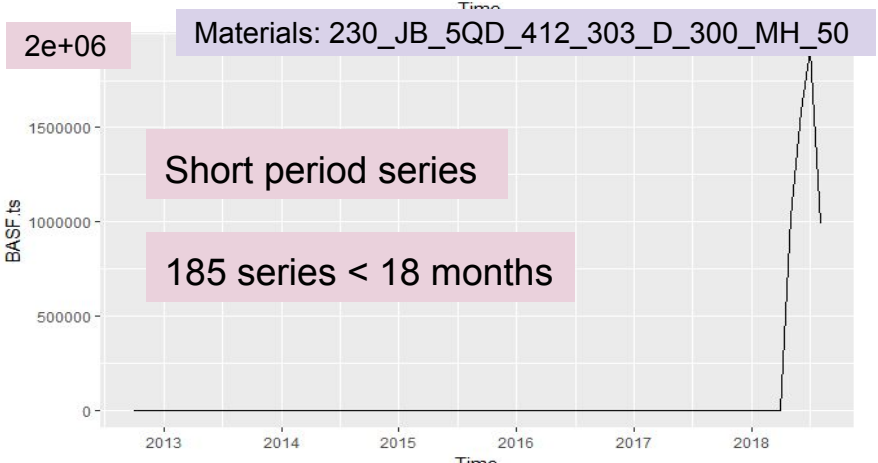

Implementation & Maintenance

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Business Analytics Team in BASF responsible to:

- Distribute the shiny applications to Productions Executive in Executable Desktop Applications.
- Regularly send them the newest data (daily / weekly).

Recommendations:

BA Team also can integrate the Shiny Applications with company database for better user experience, so the apps always consume latest data.

Limitations & Recommendations

Limitations:

1. We removed negative demand without looking at its context
2. Many time series have very short period, large fluctuation, hard to predict.

Recommendations

1. Negative demand should not be carelessly removed
2. Test the forecast model in different products categories
3. Use ensemble, don’t rely on automatic model selection methods
4. Categorization of the material (e.g. ABC-XYZ) might provide more insight
5. Including forecast price in the calculation of forecast error might provide better insight
6. Experiment with more advanced deep learning methods such as LSTM Keras in R
7. Direct integration Shiny Applications with company database for better user experience