Aurubis Coil Analysis

PRESENTATION

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Agenda

PART 01 Project Overview - Designs
Jiangcheng Lin

PART 02 DA - Key Findings
Kaili Tan

PART 03 Yield Pattern & Dashboard
Sifeng Zhu

PART 04 PA - Key Findings
Xuanhe Xu

PART 05 Model Prediction
Ze Long

PART 06 Interface and Recommendation
Runhe Zheng

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Project Design

Project Mandate

Yield Improvement

Improving **accuracy** of standard yield.

Analytic Need

Descriptive Analytics
Yield Pattern across Key Features

Predictive Analytics
yield pattern, Main drivers

Data Design

Data Capture
Order Detail
Operational Coil History

Data Preparation
EDA, FEA

Analysis

Tableau Dashboard Creation

ML - Model Building
Random Forest, Ridge
Lasso

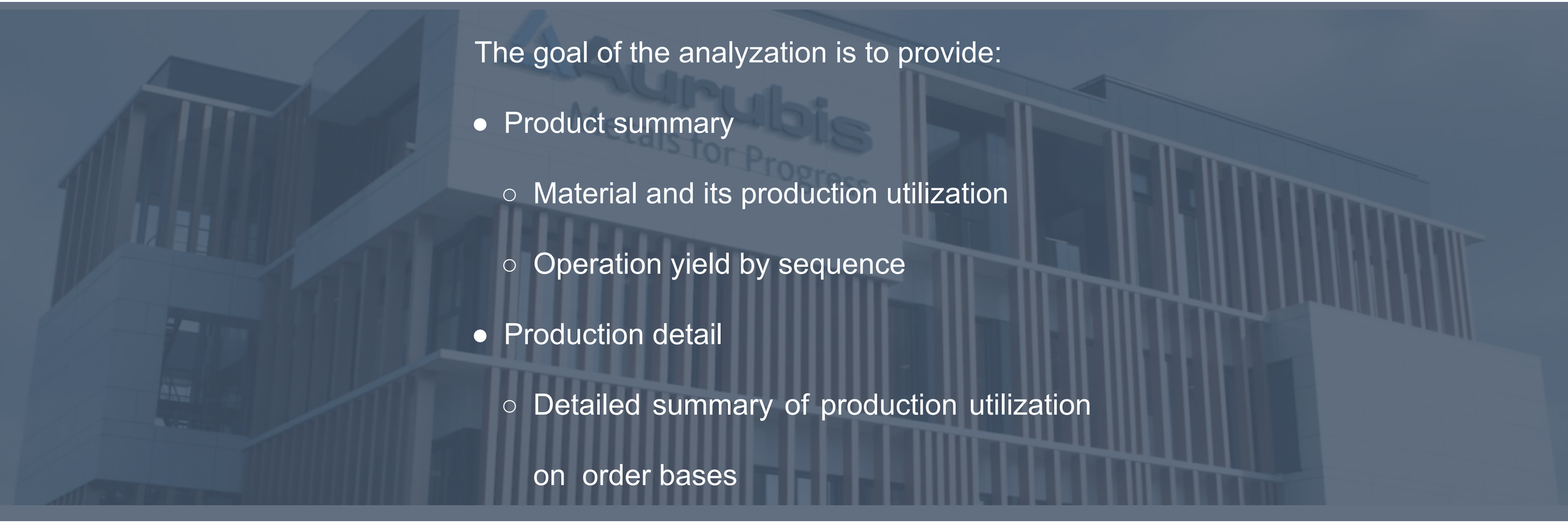
Action

Data Warehouse

Operation Simplification

Yield Control

Descriptive Analysis



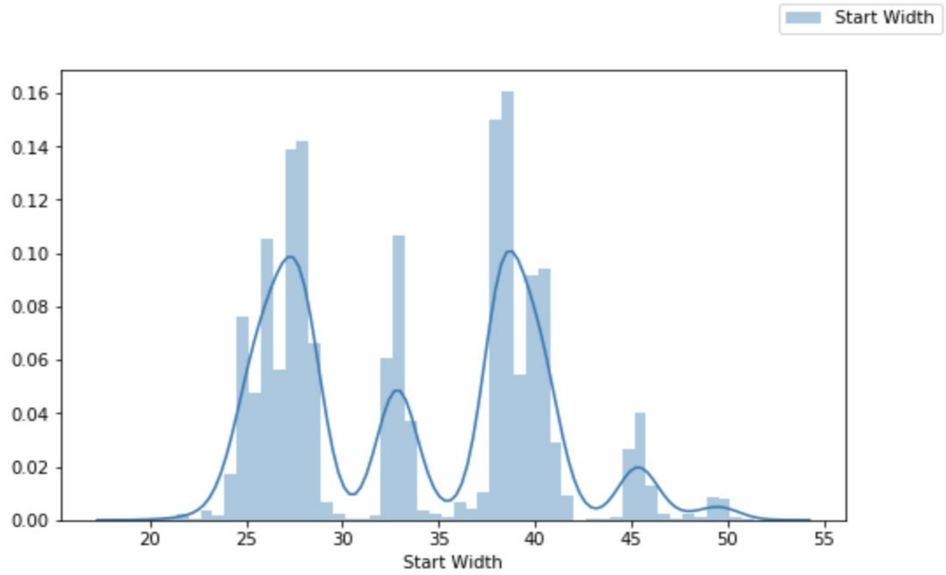
The goal of the analyzation is to provide:

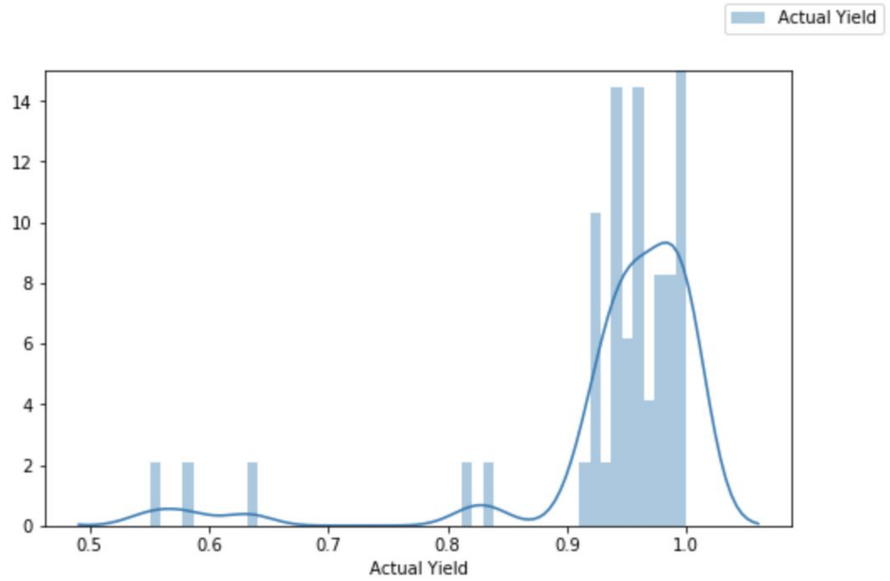
- Product summary
  - Material and its production utilization
  - Operation yield by sequence
- Production detail
  - Detailed summary of production utilization on order bases

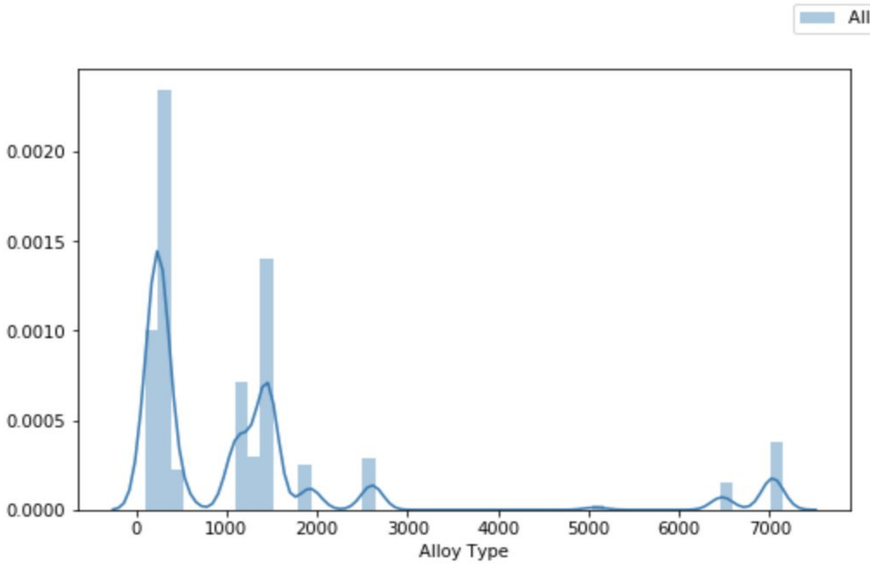
Key Findings for DA

- Product
  - Width in **25-30**, Alloy **260** : **11,333** ½ of total
  - Yield Range : 90% - 100%
  - Top 5 Operation Use: **50, 60, 30, 40, 70**
  - Most Efficiency Performance: **60, 70, 80, 90, 100**
- Production Detail
  - Machine 27, 46, 47, 77 are performing close to standards
  - Machine 133, 134, 147, 148, 36, 613 are constantly under performance
  - The average value of actual yield is around **90%**.

Product & Yield







- Coil Start Width has most high frequency in **25 - 30** inches, 35 - 40 is the next.
- Coil production tend to use low number type of alloy (**0 - 1000**).
- The common yield range : **90% - 100 %**
- Highest output product: width 25-30 inches, alloy 260. ½ of total production

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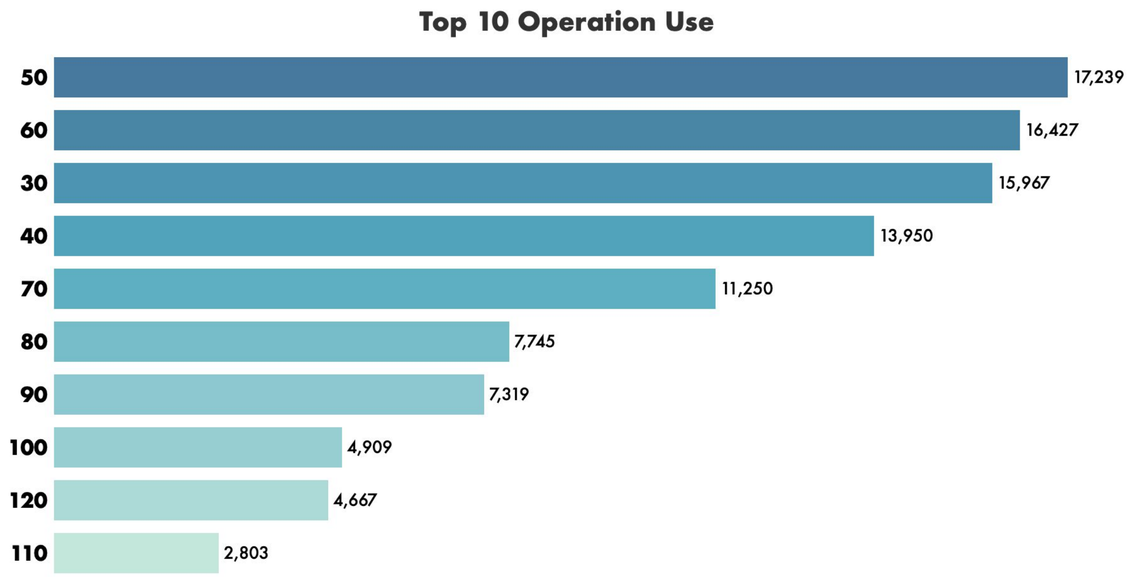
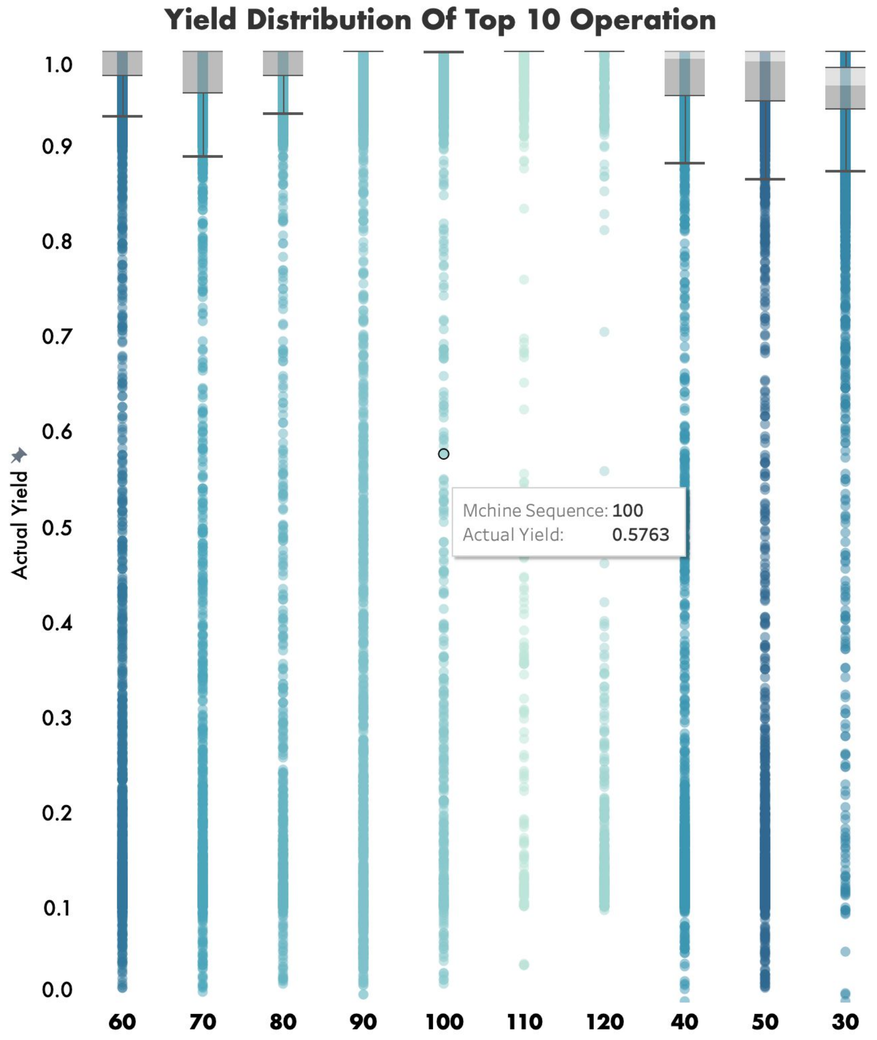
Operation & Yield





- Operation 50, 60 - operated by 20 machines, main procedure - IN, CR, AN, SL
- Operation 30 - operated by 10 machines, main procedure - IN, CR
- Operation 60, 70, 80 tend to have best yield efficiency

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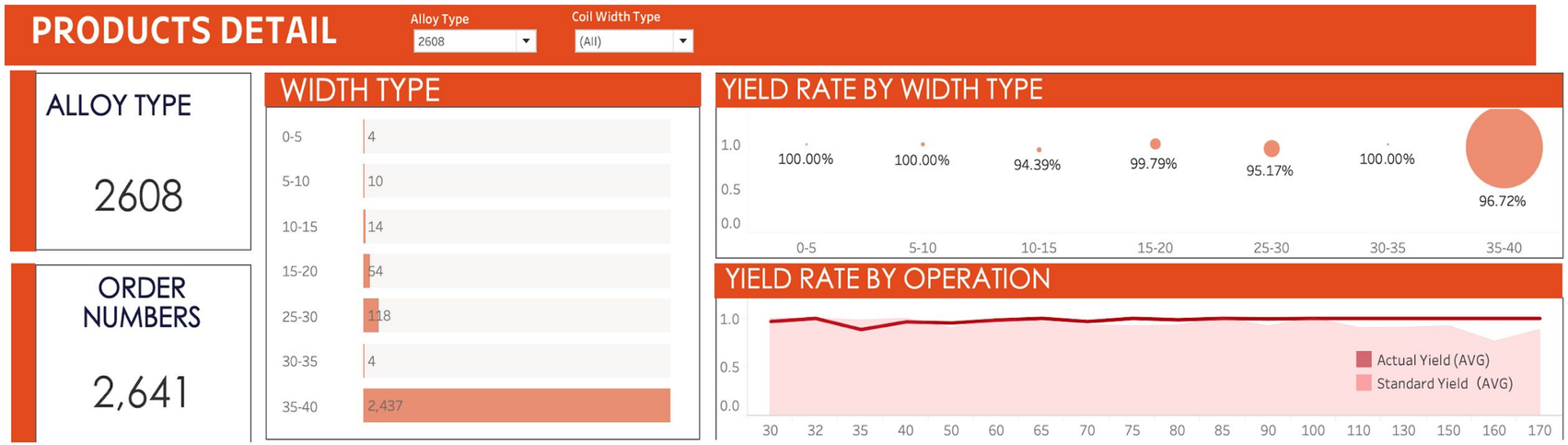
Product Description

Granularity: Identify the frequency and production efficiency of product applied within orders.

Area and trend: The production yield of the production sequence within the alloy type.

Bars: The frequency of different width type applied within the order.

Bubbles: The combination of production yield and width frequency applied.



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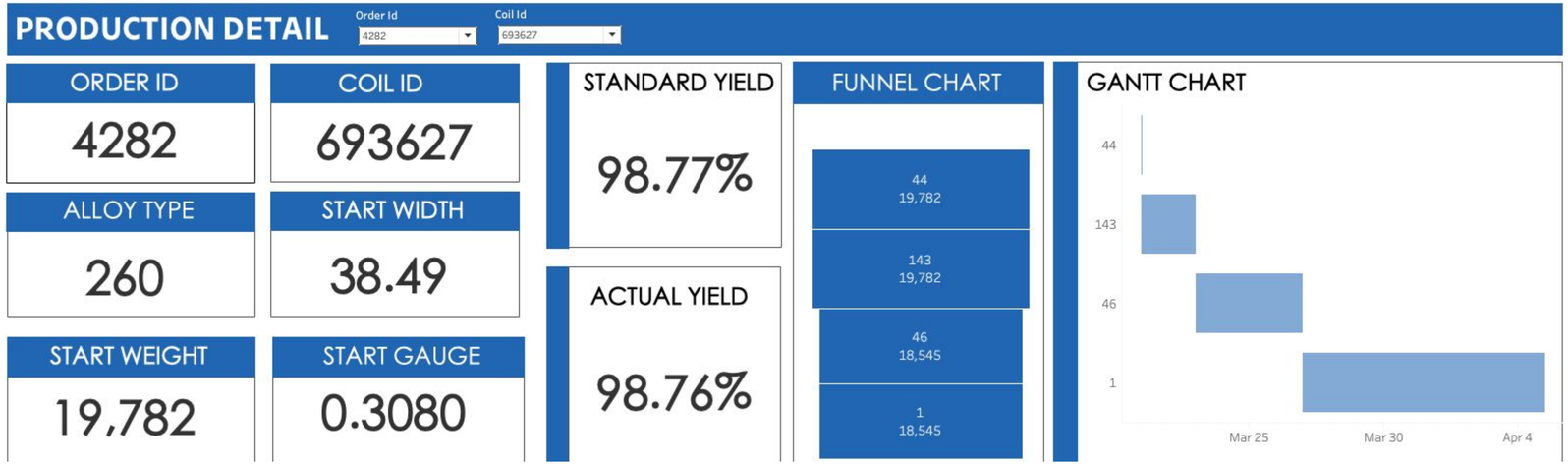
Order Detail

Granularity: In our data warehouse, we decided to present the data for each machine.

Funnel Chart: We also want to figure out how the weight loss for each manchine.

Gantt Chart: We also want to figure out how the machine planing for each coil.

Yield Pattern: We also compared the actual yield with the standard yield.



Some examples about how to use our dashboard

Predictive Analysis

- Predictive Goal:
  - Predict the yield, by the combination of alloy, density, cast width, gauge, weight and specific time
  - Picked main drivers by checking the feature importance.
- Predictive Tools:
  - Random Forest
  - Ridge
  - Lasso

Key Findings for PA

Feature importance

Important Variables: start weight, start gauge, start width, start Date_Day, start Date_Week.

Start weight is the most important.

Model Selection

Ridge regression is the optimal model.

Less around 40% more MSE than the MSE between standard yield and actual yield.

Width the best evaluating estimator alpha = 0.01155 from using the Cross Validation.

There's no significant difference in performance of the regression models we used.

Feature Engineering

preparation for predictive analysis

Date Variable:
Create new features including year, month, week, day, day of week, isWeekend

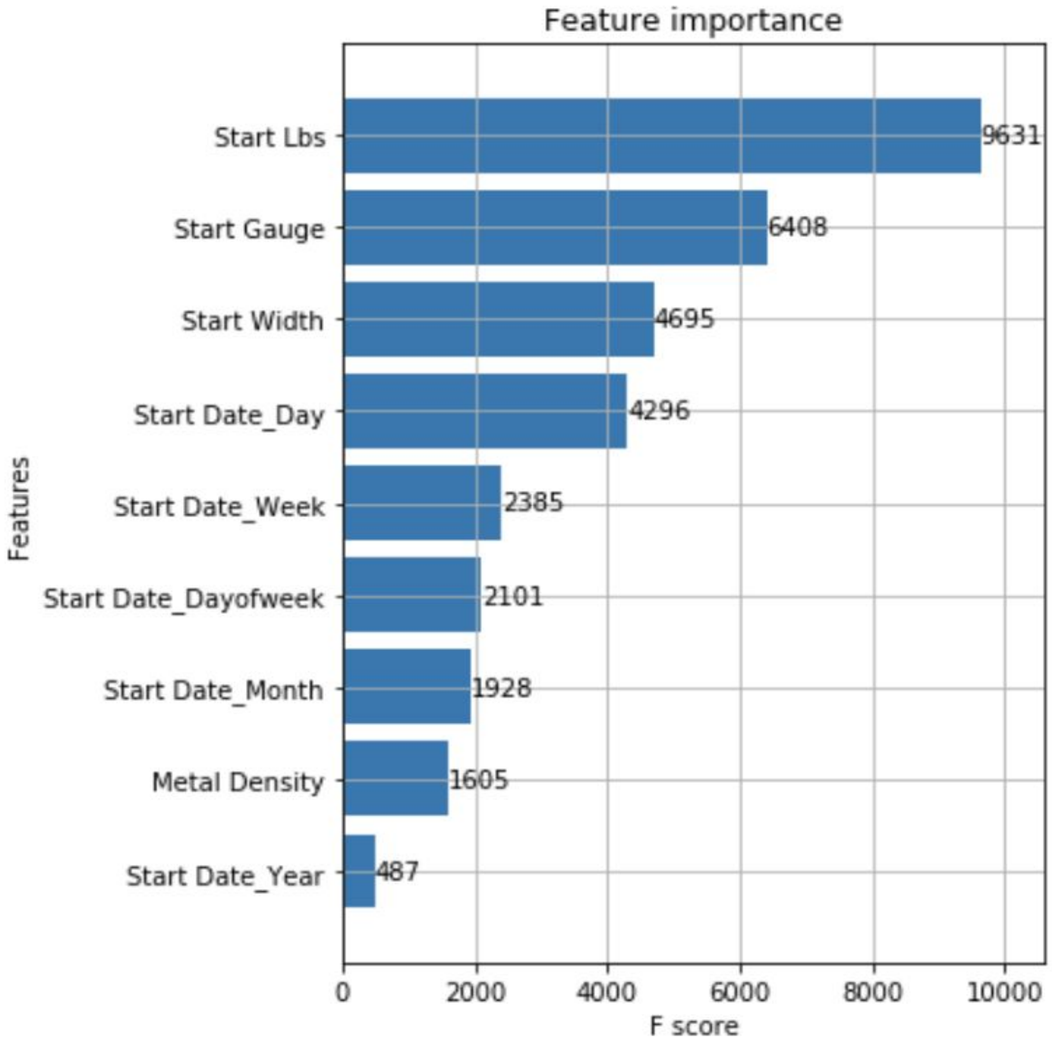
Null Values:
Drop row containing NA

Outliers:
Limit the standard yield to no more than 1

Categorical variable:
get dummies of the categorical variables

Feature Importance

Select important features



Top 3 Important features:

- Start Weight (LBS)
- Start Gauge
- Start Width

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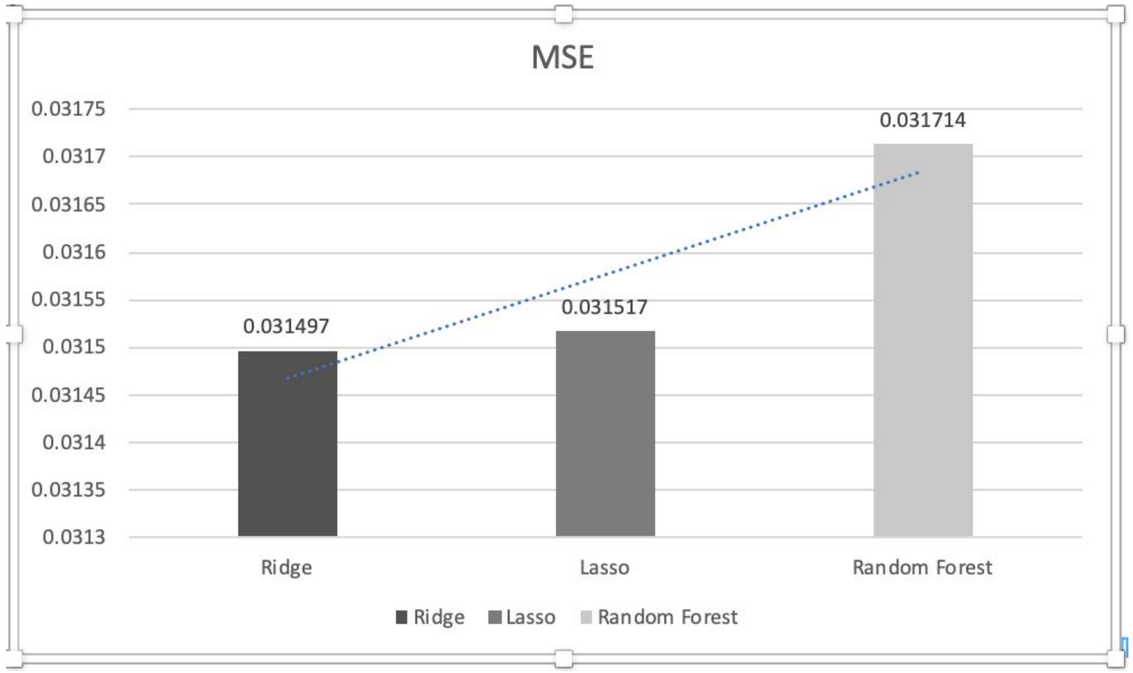
Model Selection

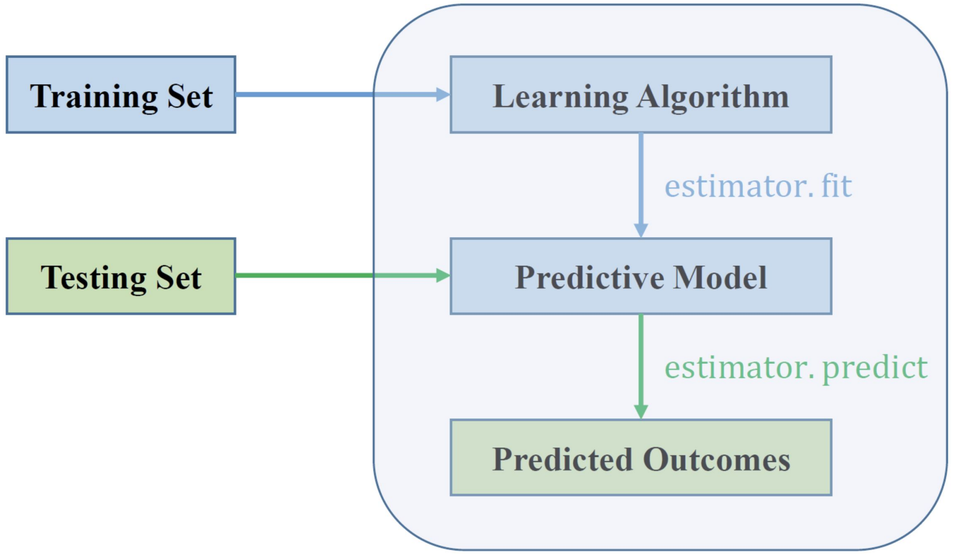
Models & MSE

- Ridge Regression: 0.031497
- Lasso Regression: 0.031517
- Random Forest: 0.031714



Finding the Best Evaluation Estimator:

- Cross Validation
- Model Hyperparameter Tuning



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Metal Density
0.31
0.00 1.00

Start Gauge
0.09
0.00 1.00

Start Width
38.43
0.00 60.00

Start Lbs
19590
0 33000

Start Date_Year
2019
2000 2100

Start Date_Month
3
1 12

Start Date_Day
28
1 31

Aurubis Yield Prediction Model

Show dataframe

	Gauge	Start Width	Start Lbs	Actual Yield	Standard Yield	Start Date
0	.2500	38.4100	20989	0.9628	0.9957	Mar 27, 2019
1	.0905	38.4100	20209	1	0.9949	Mar 27, 2019
2	.0905	38.4100	20209	1	0.8384	Mar 28, 2019
3	.0905	38.4300	19590	1	0.9949	Mar 27, 2019
4	.0905	38.4300	19590	1	0.8384	Mar 28, 2019
5	.0905	38.4500	20564	1	0.9949	Mar 27, 2019
6	.0905	38.4500	20564	1	0.8384	Mar 28, 2019
7	.2500	38.7300	21476	0.9394	0.9969	Mar 23, 2019
8	.0643	38.7300	20175	1	1	Mar 23, 2019
9	.0643	38.7300	20175	1	0.8512	Mar 25, 2019
10	.2500	38.8300	21163	0.9357	0.9969	Apr 11, 2019

Choose a row of information in the dataset (0~90652):

4

Which algorithm?

Ridge

Yield Prediction: 0.9567

Average Yield Prediction: 0.9542

Mean Squared Error: 0.03503

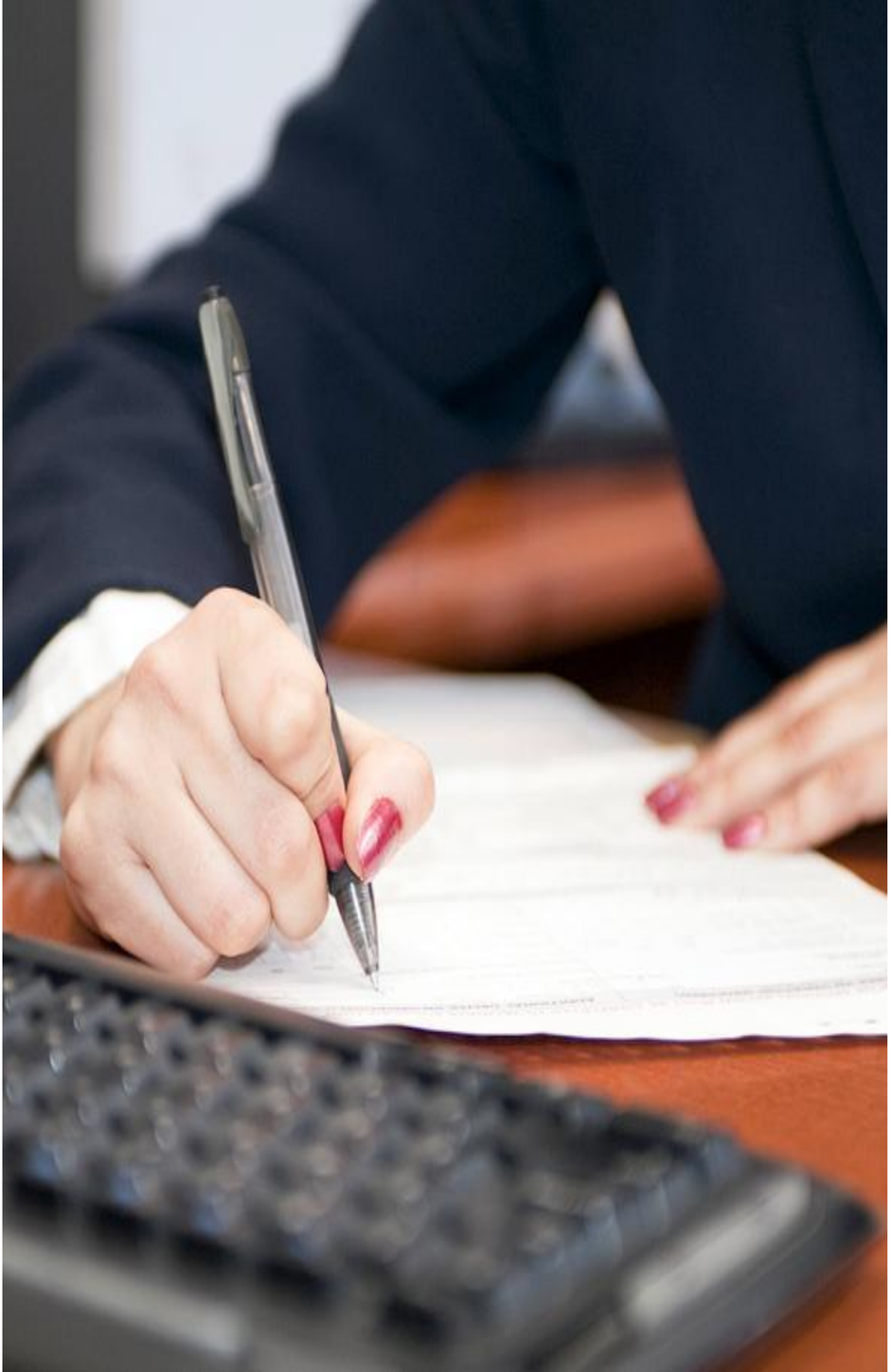
Yield Prediction

Over Time Performances

Used historical data to construct machine-learning models and built a user-friendly interface.

Using slide bars on the left panel to input values.

Choosing a model and making a prediction.



Recommendation

Improve and Grow

General Data:

- **Inconsistent data recording**
- **Duplicated data**
- **Outliers**

Suggestion

- **Restructure the data into a data warehouse to increase the usage efficiency**

Descriptive:

- **Detail overview of historical production**
  - **Order detail, performance, & machine historical production**
  - **Regular maintenance for underperformed machines**

Predictive:

- **Customized production predictive model**
  - **Less MSE to achieve more sufficient yield estimation**
  - **Recommend to use our model with a higher accuracy**

THANK YOU

Our Copper for Your Life