PREDICTION OF TURBINE ENERGY YIELD

LINEAR REGRESSION WITH FEATURE SELECTION

Machine Learning Foundation

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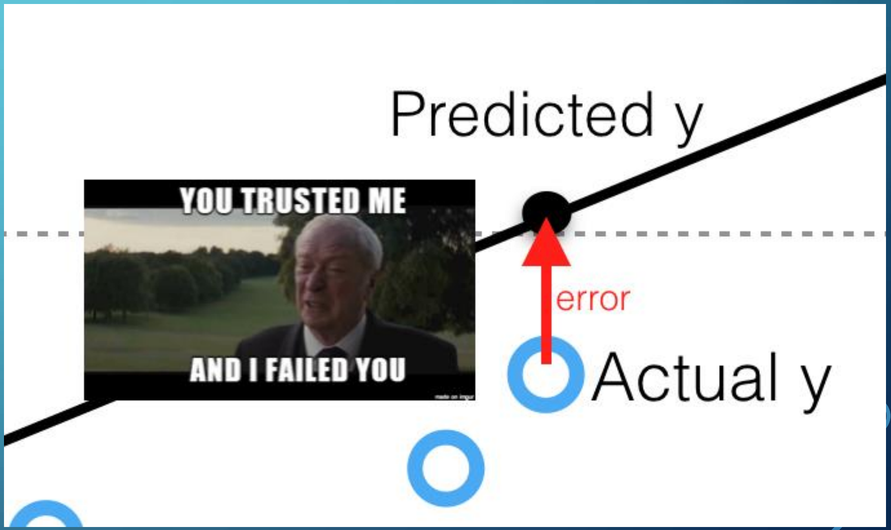
TURBINE ENERGY YIELD PREDICTION



PROBLEM STATEMENT

The goal is to predict Turbine Energy Yield (TEY) using ambient variables as features

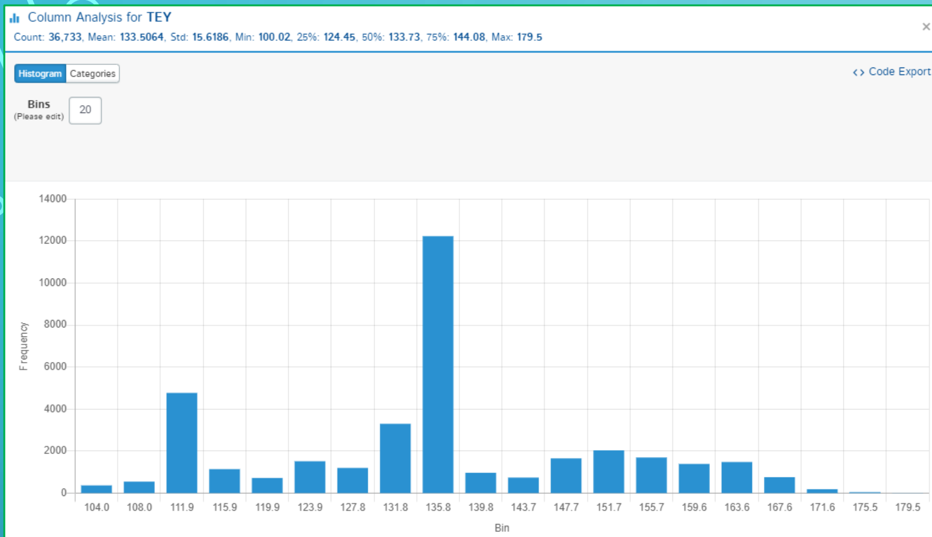
DATA LOADING AND DESCRIPTION

Data Source:
https://archive.ics.uci.edu/ml/datasets/Gas+Turbine+CO+and+NOx+Emission+Data+Set

Variable (Abbr.)	Unit	Min	Max	Mean
Ambient temperature (AT)	C	6.23	37.10	17.71
Ambient pressure (AP)	mbar	985.85	1036.56	1013.07
Ambient humidity (AH)	(%)	24.08	100.20	77.87
Air filter difference pressure (AFDP)	mbar	2.09	7.61	3.93
Gas turbine exhaust pressure (GTEP)	mbar	17.70	40.72	25.56
Turbine inlet temperature (TIT)	C	1000.85	1100.89	1081.43
Turbine after temperature (TAT)	C	511.04	550.61	546.16
Compressor discharge pressure (CDP)	mbar	9.85	15.16	12.06
Turbine energy yield (TEY)	MWH	100.02	179.50	133.51
Carbon monoxide (CO)	mg/m3	0.00	44.10	2.37
Nitrogen oxides (NOx)	mg/m3	25.90	119.91	65.29

The dataset comprises of **36733 instances of 11 sensor measures**. Above is a table showing names of all the columns and their description.

EXPLORATORY DATA ANALYSIS : TARGET

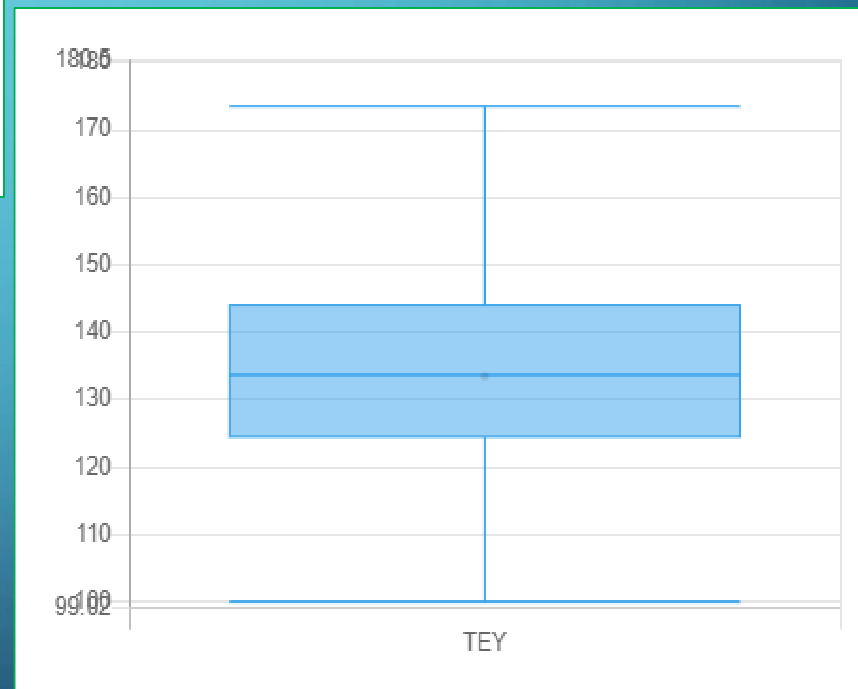


- Target is normally distributed ;
- No outliers

TEY (float64)

Describe | Histogram | Categories

- **Total Rows:** 36,733
  - **Count (non-nan):** 36,733
  - **Count (missing):** 0
  - **% Missing:** 0
- **top:** 133.78
  - **Frequency:** 185
- **25%:** 124.45
- **50%:** 133.73
- **75%:** 144.08
- **kurt:** -0.5 (platykurtic)
- **max:** 179.5
- **mean:** 133.5064
- **median:** 133.73



EXPLORATORY DATA ANALYSIS: FEATURES

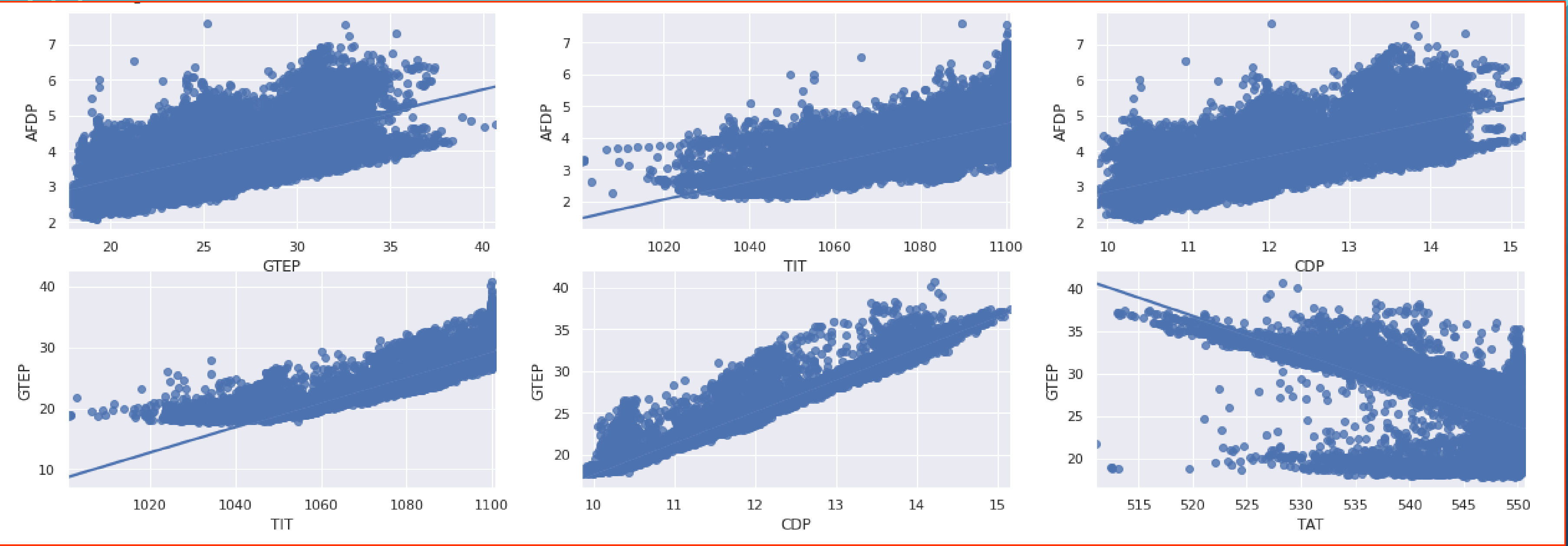
Overview

Overview | Warnings 4 | Reproduction

Warnings

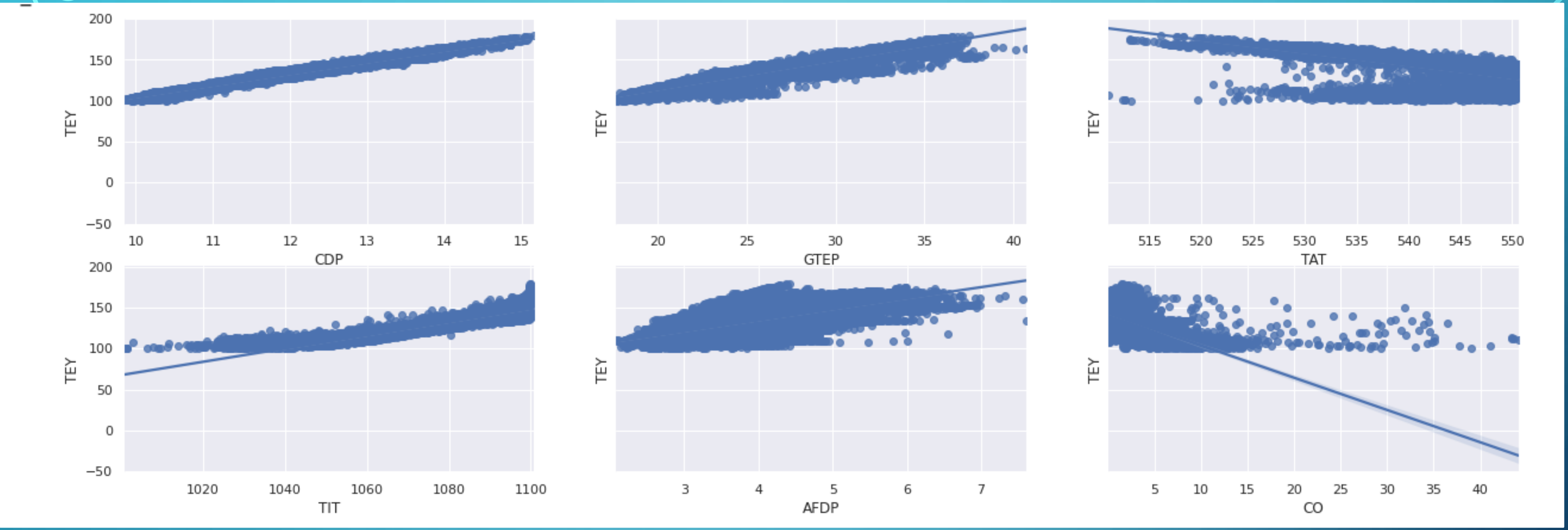
- TEY is highly correlated with GTEP and 2 other fields
- GTEP is highly correlated with TEY and 1 other fields
- TIT is highly correlated with TEY and 1 other fields
- CDP is highly correlated with GTEP and 2 other fields

EXPLORATORY DATA ANALYSIS: HIGH CORRELATION AMONG FEATURES



AFDP, GTEP, CDP, TAT, TIT are highly correlated among each others

EXPLORATORY DATA ANALYSIS: TARGET VS FEATURES

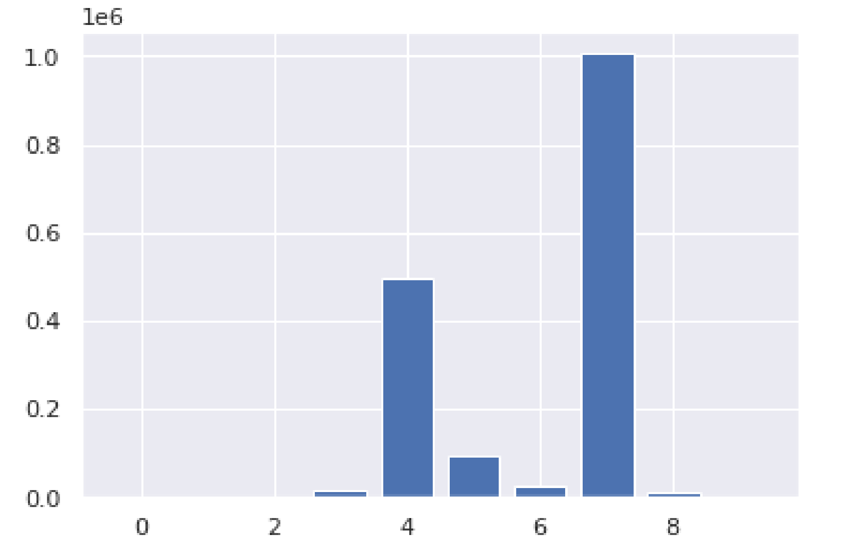


AFDP, GTEP, CDP, TIT, TAT are highly correlated with TEY

FEATURE SELECTION

FEATURE SELECTION:
USING CORRELATION STATISTICS

import SelectKBest and f_regression

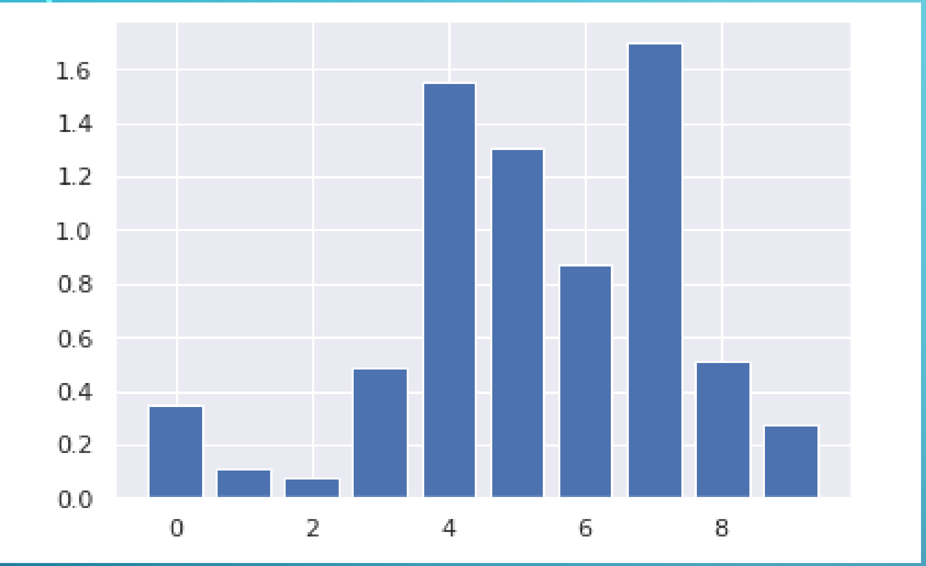



```
Feature 0: 860.624004
Feature 1: 718.013902
Feature 2: 293.925853
Feature 3: 15789.036161
Feature 4: 496027.685586
Feature 5: 95289.882724
Feature 6: 23891.083505
Feature 7: 1005912.467434
Feature 8: 11633.388290
Feature 9: 67.526325
```

So 3 to 4 features are having hi impact on the model

FEATURE SELECTION:
USING MUTUAL INFORMATION THEORY

import SelectKBest and mutual_info_regression

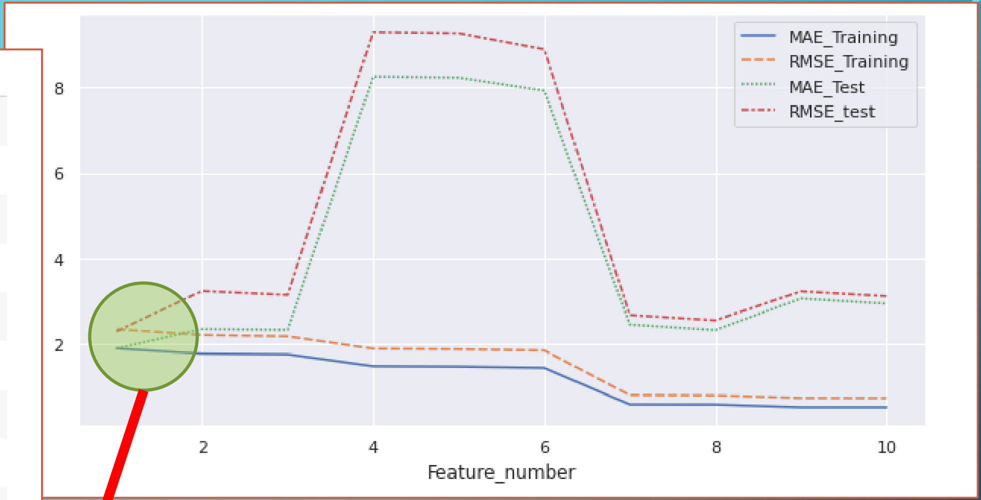



```
Feature 0: 0.350200
Feature 1: 0.109574
Feature 2: 0.073342
Feature 3: 0.484026
Feature 4: 1.552312
Feature 5: 1.304582
Feature 6: 0.874015
Feature 7: 1.699997
Feature 8: 0.510088
Feature 9: 0.272602
```

So 3 to 5 features are having hi impact on the model

FEATURE SELECTION: USING GRIDSEARCH WITH MUTUAL INFORMATION THEORY

	Feature_number	MAE_Training	RMSE_Training	MAE_Test	RMSE_test
0	1	1.905447	2.354340	1.903045	2.302691
1	2	1.782063	2.218478	2.356738	3.244547
2	3	1.765120	2.187249	2.338517	3.154224
3	4	1.490215	1.900632	8.242611	9.281714
4	5	1.480846	1.888095	8.220992	9.255912
5	6	1.451452	1.859275	7.916408	8.881514
6	7	0.597309	0.817165	2.461045	2.682705
7	8	0.595421	0.807878	2.333199	2.559623
8	9	0.531623	0.746790	3.070164	3.237879
9	10	0.531585	0.744256	2.951597	3.124839



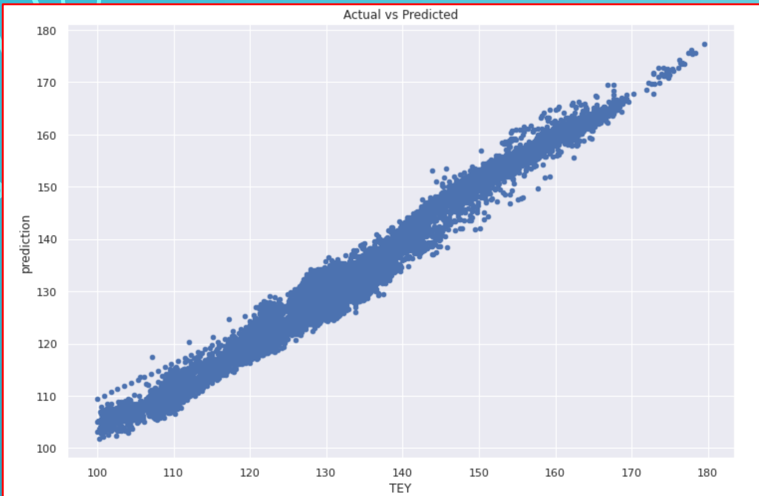
MAE/RMSE are in same level for both the Train & Test datasets together with a single feature

TEY = -38.03 + 14.227 * CDP

How do we interpret the coefficient (+14.227)

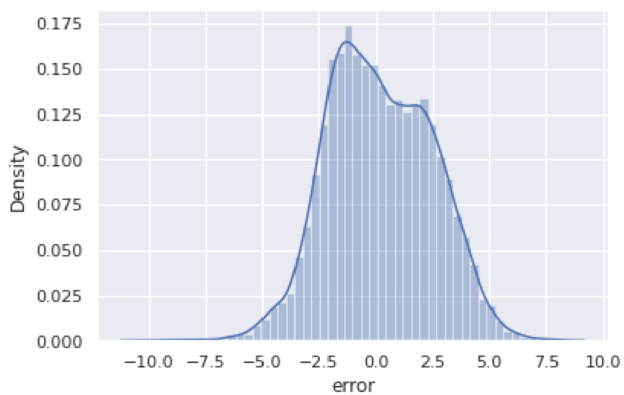
- A "unit" increase in **CDP** is **associated with** a **"14.227** unit" increase in **TEY**.

MODEL EVALUATION

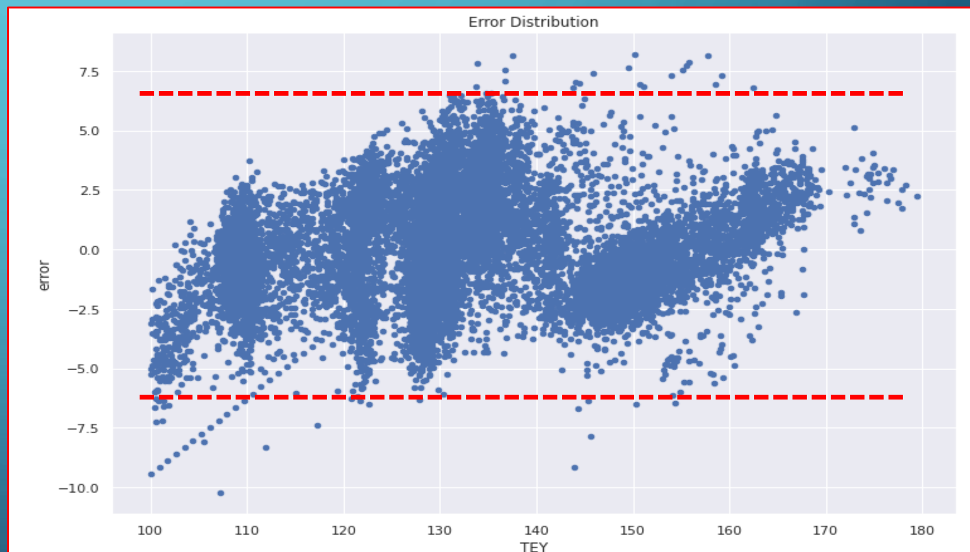



```
[ ]  sns.distplot(a['error'])
```

<matplotlib.axes._subplots.AxesSubplot at 0x7f0d4badbcf8>



Homoscedasticity has been observed.



CONCLUSION

- Feature selection is an important criterion when they are strongly correlated among each other.
- Search technique using RMSE and MAE for different number of features in train & test dataset is also an important factor while selecting a model.
- Homoscedasticity observed for the errors.
- This case study can also be referred for feature engineering having more number of features.

THANKS FOR READING

Lets collaborate and happy to receive any feedback/suggestion/comment at…….

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