# Mini Project: ETA Prediction

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#### **Overview**

#### **ETA Prediction**

Our goal is to minimize the error of ETA

Metric

$$MAPE = \frac{|ETA - ATA|}{ATA}$$

CurrentStatusAbout32.5%error

#### Tools

A second model (Regression) corrects the initial eta

#### Result

About 22.5% error

### Steps to go

#### **Data Insight**

- Data Schema
- Features' Insight
- Preprocessing
- Feature Selection
- Feature Engineering

#### **Data Modeling**

- Model Selection
- Optimization & Regularization
- Model Tuning
- Model Evaluation
- Model Explanation

#### Schema

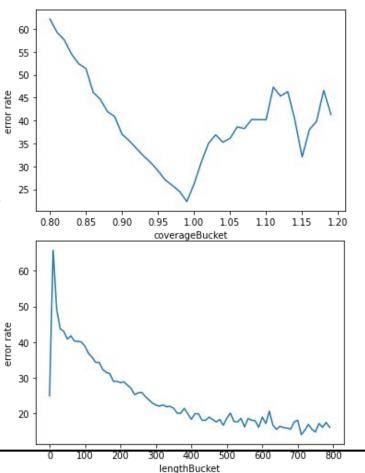
- Length
- ETA
- Coverage
- Lat
- Long
- Timestamp
- Way Segments Count
- Way Type
- isTunnel
- ATA (Target)

#### Overview

- Train: 160'000 rows
- Test: 70'000 rows
- Other Features:
  - Edge ID
  - Name
  - User Group

• **Coverage:** Coverage of about <u>10%</u> of data is lower than 0.85 and higher than 1.05. Not having a good enough coverage causes higher errors in the estimation of each road. Also, we can see a linear function for error rate and coverage (coverage < 1).

• **Length**: Average is 0.2 Km and we can see a linear function for error rate and length.



- Speed: I calculated each road's speed by dividing length on ATA and it is better to remove high speeds.
   Only about 1% of data has a speed more than 115 Km/hour.
- isTunnel: <u>0.02%</u> of roads are in tunnels
- Way Segments Count: Error rate didn't differ by any different segment count.

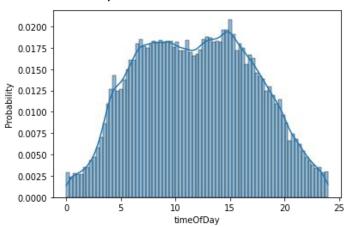
```
.withColumn('speed',F.col('length')
/F.col('ata')*3.6)
.filter(F.col('speed')<=150)
.filter(F.col('coverage').between(0.85,1.05))
.filter(F.col('is_tunnel')==0)
.filter(F.col('length')<=2500)</pre>
```

0.035 way\_type 0.030 0.025 Probability 0.020 0.010 0.005 0.000 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 0.00 target

**WayType**: Way-type of about <u>98.2%</u> of data is in [3,6,7,9]. We can see way type '6' creates overestimation but others have a random impact.

Way Type	Share	Error
7	42.3%	38%
3	28.3%	34%
6	14.9%	43%
9	12.7%	22%
Others	1.8%	-

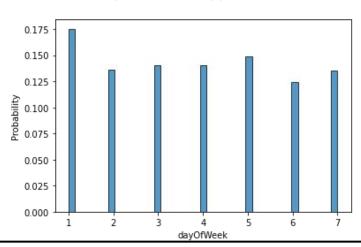
- Timestamp: I extracted two features from column 'time' to have a better knowledge more than unix timestamp:
  - Time of Day: Hour + (Minute/60)
  - Day of Week



```
.withColumn('createdAt',F.from_unix
time(F.col('timestamp')/1000))

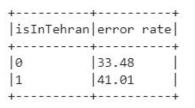
.withColumn('timeOfDay',F.hour('cre
atedAt')+F.round(F.minute('createdA
t')/60,2))

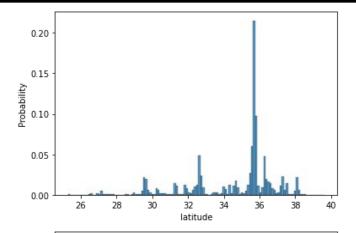
.withColumn('dayOfWeek',F.dayofweek
('createdAt'))
```

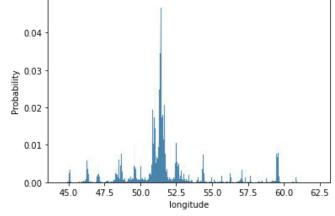


• Latitude and Longitude: As we can see, the roads are placed on different locations of Iran. So we can add a feature (zone or isTehran or isBigCity).

 25% of data are in Tehran. Error rate in Tehran is more than other locations in Iran. So the location may affect the estimation, but it's not necessary to label it, because we use trees for regression.







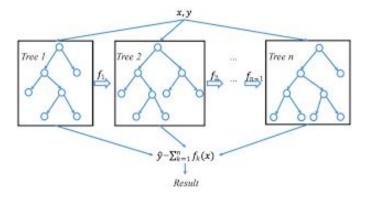
#### Questions

- What are the final features?
- How to evaluate the model? (loss function, validation data)
- What is the best metric for Target?
  - o | ETA ATA | / ATA
  - o | ATA ETA |
  - ATA
- What's the best regression model for estimating?
- Test and train have a same feature distribution?

#### **Model Selection**

- NonLinearity dependencies in features (such as time, location)
- The features are not completely independent.
- Our features are few, and, lasso and ridge will causes the weight shrinkage.
- We have enough data for training by random forests or same models.
- The table above, Shows that we have achieved a better loss compared to others. (SVM had a poor performance)
- I used the <u>XGBoost</u> Model for training. (other candidates: **Light GBM**, **CatBoost**)

XGBoost	22.5	ETA/ATA
Ridge	29	ATA
Lasso	33	ATA
SVM	-	-



```
.withColumn('target',F.col('eta')/F.co
l('ata'))

.withColumn('targetError',F.abs(100*((
F.col('eta')-F.col('ata'))/F.col('ata')))))
```

#### **Evaluation**

• I splitted data into two parts (10% and 90%) for training and validation in model training process. The model is evaluated by the **MAE of validation data**. I also used early stopping (**25 Rounds**) to prevent overfitting. I evaluated by MAE due to my experience as a customer, the relative error of a forecasting matters to me.

• The reported metric is:

$$MAPE = \frac{100*|ETA-ATA|}{ATA}$$

#### **Tuning**

- Parameters
  - Learning Rate: **0.2**
  - Estimator Count: 270
  - Maximum Depth: 8
  - Minimum Child Weight: 0
- Hyper Parametrization Space
  - Random space with 40 trials

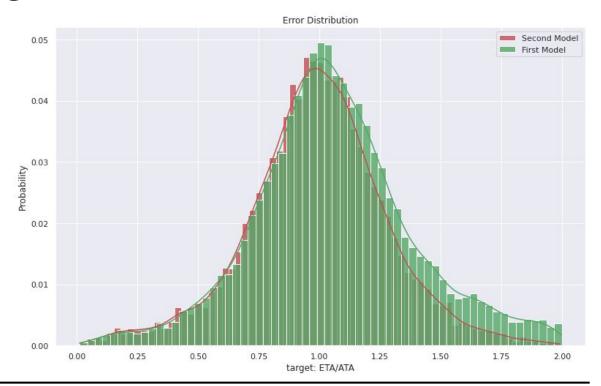
```
Stopping. Best iteration:
[77] validation 0-mae:0.250344
validation 1-mae:0.261973
XGBRegressor (eta=0.2,
eval metric='mae', max depth=8,
min child weight=0,
             n estimators=270)
```

mean

22.191274

#### Result

- MAPE: 22.2%
- First model is the eta of raw data, and second model is my estimator.
- The model reduced the overestimated cases and average is reduced.



#### **Model Explanation**

- I have scored the features by the SAHP value.
- As you can see, the most important features are **ETA**, **Length** and **Coverage**.
- High value of length and low value of eta decrease the output fraction by the model.
- Importance of the features are confirming our first insight from data.
- The least important feature is DayOfWeek.

