Capstone Project

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Flight Delay Prediction

Abstract:

The project proposal is designed for creating a machine learning model for predicting flight delay. So that ground staff and network team can plan for aircraft scheduling and ground handling staff and even passenger also can plan their journey accordingly. It will help flight operation and ground staff for ground handling and network operation. For achieving this goal, we are going to use Supervised Machine Learning.

Data for the flight delay and cancellation problem was collected and published by the DOT’s Bureau of Transpiration Statistics. This project will be implemented with the help of Scikit-learn, Tensorflow and Python.

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Domain Background:

This project has been inherited from Airline Domain. In Airline, if you want travel or anyone who want to travel, he has to book the flight from one place to another.

There are number of factor, which can impact the flight journey like Weather, flight departure time, boarding gate time and actually departure time etc. Keeping these factor in mind, we can decide that particular aircraft can be landed or arrive on time or not or how much it will be delay.

Every airline has their flight history past journey, which can help them in predicting future flight delay. We can implement a machine learning model, which will help us in prediction of flight delay.

Motivation behind this project is to optimization of network operation, ground staff management and passenger.

Problem Statement:

This problem is related to flight operation department of Airline Industry. Flight is flying from source to destination, sometimes it’s reaching on time, sometime it reaching with some delay. This Delay in journey can impact many things like it can block airline’s resource and in Respect to passenger, they can miss their meetings etc.

Flight delay prediction mean, how much time was estimated for journey and how much time actually aircraft took to reach from Origin to Destination.

It’s a binary classification problem. We will classify that the upcoming flight will reach on time or will it be delay to reach at destination airport. For overcome this problem, we will drive a Supervised Classification Machine Learning.

Dataset and Inputs:

Data for this ML problem provided by DOT’s Bureau of Transpiration Statistics. It’s in CSV format. These CSV contains all the information related to airport, flight and airline, which is necessary to for it.

This corpus has 3 csv files.

* flights.csv
* airports.csv
* airline.csv

<https://www.kaggle.com/fabiendaniel/predicting-flight-delays-tutorial/data>

For model prediction we will use flights.csv. But for data insight we will use other two also.

## Flights.csv

This has all the data related to flight schedule from source to destination. It’s containing 31 features with 5819079 sample. We will use **arrival\_delay** to drive final target feature like **flight\_delay**.

|  |  |  |
| --- | --- | --- |
| Feature Name | Data Type | Description |
| YEAR | Integer | Year of travel |
| MONTH | Integer | Month of journey |
| DAY | Integer | Day of Journey |
| DAY\_OF\_WEEK | Integer | Day of week for given journey |
| AIRLINE | String | Name of Airline |
| FLIGHT\_NUMBER | String | Unique identifier of Flight |
| TAIL\_NUMBER | String | It Aircraft registration number. |
| ORIGIN\_AIRPORT | String | Source airport of journey |
| DESTINATION\_AIRPORT | String | Destination airport of journey |
| SCHEDULED\_DEPARTURE | Float | Schedule departure time of aircraft |
| DEPARTURE\_TIME | Float | Actual departure time of aircraft |
| DEPARTURE\_DELAY | Float | Actual Delay in departure of aircraft. |
| TAXI\_OUT | Float | Time to leave the gate |
| WHEELS\_OFF | Float | Wheels take off from runway. |
| SCHEDULED\_TIME | Float | Schedule take of time of wheels |
| ELAPSED\_TIME | Float |  |
| AIR\_TIME | Float | Arrival time on airport |
| DISTANCE | Integer | Distance between ORIGIN\_AIRPORT and DESTINATION\_AIRPORT |
| WHEELS\_ON | Float | Landing time on runway |
| TAXI\_IN | Float | Reached on gate |
| SCHEDULED\_ARRIVAL | Float | Schedule time to reach on gate |
| ARRIVAL\_TIME | Float | Actual arrival time |
| ARRIVAL\_DELAY | **Float** | **Arrival Delay of flight to reach the destination.** |
| DIVERTED | Boolean | Flight diverted in between journey to any other airport. |
| CANCELLED | Boolean | Particular flight got cancelled or not. |
| CANCELLATION\_REASON | String | What was the reason of cancellation of flight? |
| AIR\_SYSTEM\_DELAY | Boolean | Air system issue. |
| SECURITY\_DELAY | Boolean | Security issue |
| AIRLINE\_DELAY | Boolean | Airline started delay |
| LATE\_AIRCRAFT\_DELAY | Boolean | Connecting flight delay |
| WEATHER\_DELAY | Boolean | Weather issue |

## Airline.csv

This csv contains information related to airline. It has 2 feature with 15 sample.

|  |  |  |
| --- | --- | --- |
| Feature Name | Data Type | Description |
| IATA\_CODE | string | IATA Code for airline. It’s unique identifier of airline |
| Airline | string | Airline Name |

## Airport.csv

This csv contains information related to airport. It has 7 feature with 322 sample.

|  |  |  |
| --- | --- | --- |
| Feature Name | Data Type | Description |
| IATA\_CODE | String | IATA code for airport |
| AIRPORT | String | Airport name |
| CITY | String | Airport city |
| STATE | String | Airport belongs to which state. |
| COUNTRY | Sting | Country of airport |
| LATITUDE | Float | Geographical location of airport |
| LONGITUDE | Float | Geographical location of airport |

Solution Statement:

It’s a binary classification problem. So for solving it, we will use Supervised Classification algorithms. But before applying algorithms we have to do the data pre-Processing.

1. Visualization (for getting data insight )
2. Missing value handling
3. Feature selection
4. Categorical and continues feature processing
5. Driving new features
6. Normalization

After Data Pre-Processing, as per thumb rule we need to divide data into train and test for ML Model training and validation. There are several algorithms for classification, we will apply some of them for predicting aircraft delay.

1. Linear Classifiers: Logistic Regression, Naive Bayes Classifier
2. Support Vector Machines
3. Decision Trees
4. Boosted Trees
5. Random Forest
6. Neural Networks
7. Nearest Neighbour

I am planning to train my model on Logistic Regression, SVM, Decision Tree and neural Networks. At the end on the bases of evaluation matrix, I will selected one model which will perform best for our problem.

Benchmark Model:

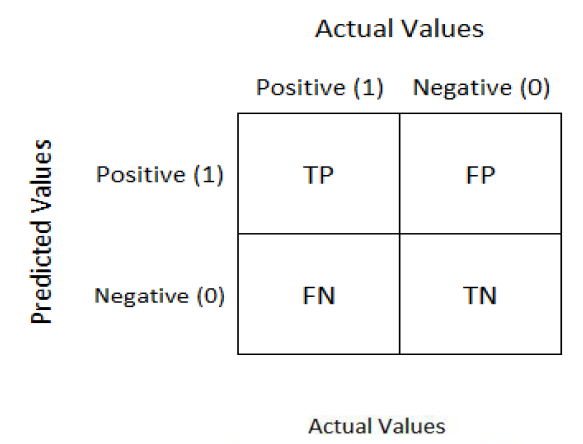
Planning to use Logistic Regression to train and test flight delay prediction. And the output of logistic Regression, I will use as my benchmark model.

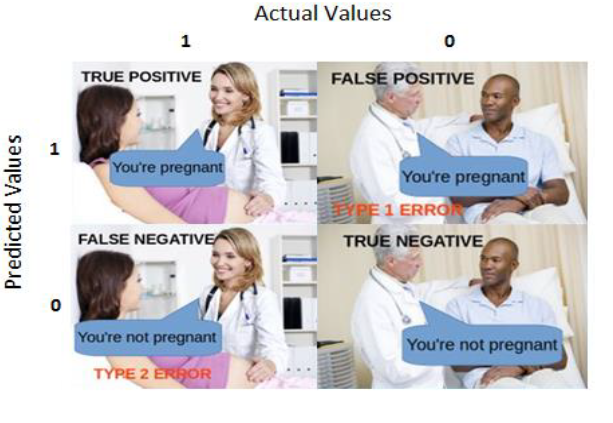
Evaluation Metrics:

Evaluation or performance matrices, after features selection, features engineer, and model training. We need to test the performance of our model, there are couple of matrices to test the model performance or evaluation.

## Confusion Matrix

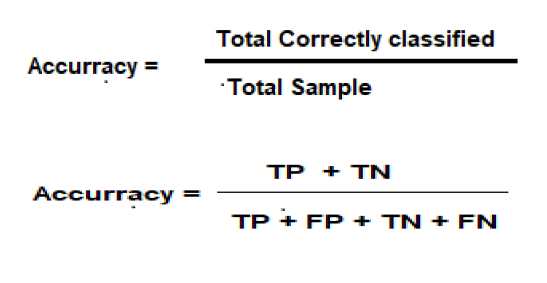
Confusion matrix is used for validating classification machine learning model. Its table representation of outcome.





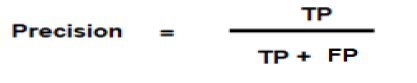
## Accuracy

Accuracy is the measure of calculating that how often Machine learning Model is predicting correct



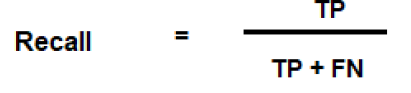
## Precision

Precision is a measure that tells us what proportion of patients that we diagnosed as having cancer, actually had cancer.



## Recall or Sensitivity

Proportion of correctly classified form the given positive sample.



Project Design:

Every Machine Learning Project have some steps to achieve the goal. Below the steps or action we need to perform for any ML project. I will follow the same for this project

## Language and Libraries

* Python 3.X
* Tensorflow
* Scikit-learn

## Data Collection

For implementing machine learning model, we need data. In this problem we will collect data in CSV format.

## Data Visualization

With the help of data visualization, we will try to get insight of data. In visualization, we can see the correlation in between features of dataset like HeatMap, Scatter plot.

## Feature Engineering

Feature engineering is a main step in ML model designing. In this we will do the feature analysis, which feature is more relevant and which are less impacting the outcome.

In feature Engineering, we will do feature normalization. So because of high magnitude one should not dominate another feature.

It very important step in machine learning model. It can drastically can impact model performance.

* <https://scikit-learn.org/stable/auto_examples/ensemble/plot_forest_importances.html>
* <https://machinelearningmastery.com/an-introduction-to-feature-selection/>
* <https://towardsdatascience.com/a-feature-selection-tool-for-machine-learning-in-python-b64dd23710f0>

## Train & Test Dataset

We will Split the dataset into train and test, Training set we will use for our training and testing set for model validation.

## Model Training

Training selected model on train dataset and validating on Training set.

## Model Testing

Testing is the process to test the model performance or accuracy on test data set.

(Validating overfitting and under fitting)

## Model Tuning

In tuning, we will try to tune our algorithms hyperparameter to get high accuracy and performance on test and train set with the help of GridSearch algorithm.

## Finalizing Model

Selecting best final model for production promote.

## Production Deployment

For production deployment we can use any Python framework, we will use Flask for your production deployment. We will create Rest Endpoint, So service will be available as rest API.

References:

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* <https://scikit-learn.org/stable/auto_examples/ensemble/plot_forest_importances.html>