

**Flight Delay Predictor**

**Spark Application**

Big Data

M.Sc. Data Analytics

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1. Introduction

This report presents the development of a Spark application consisting in a flight delay predictor based on machine learning techniques. The goal of the application is to develop a model that, given a set of data available at takeoff, can estimate the arrival delay time of a commercial flight. Publicly accessible data from commercial domestic flights in the USA is used to accomplish that. This data can be found in the Harvard Dataverse [1]. Concretely, the subset of data from year 2000 has been selected in order to work with a dataset with a reasonable size.

In the following sections, the whole application development process is explained, starting with a first general exploratory data analysis, which will enlighten the variable selection criteria. Hereafter, the application main code where the model is created is explained step by step. Finally, a brief summary of the performance results is presented, followed by the instructions for the user in order to run the application.

1. Exploratory Data Analysis

In order to gain a general overview of the dataset, a first general analysis is performed, obtaining the number of rows and columns contained in the dataset and a statistical summary of the numerical variables, as well as the different datatypes. A brief explanation of the dataset is exposed in Table 1.

Table 1: Variable Description

|  |  |
| --- | --- |
| Variable | Description |
| Year | Year of the flight |
| Month | Month Of the flight 1-12 |
| DayOfMonth | Day of the month 1-31 |
| DayOfWeek | Day of the Week 1-7 |
| DepTime | Actual Departure Time (local, hhm m) |
| CRSDepTime | Scheduled departure time (local, hhmm) |
| ArrTime | Actual arrival time (local, hhmm) |
| CRSArrTime | Scheduled arrival time (local, hhmm) |
| UniqueCarrier | Unique carrier code |
| FlightNum | Flight number |
| TailNum | Plane tail number |
| ActualElapsedTime | Actual elapsed time (min) |
| CRSElapsedTime | Scheduled elapsed time (min) |
| AirTime | Air time (min) |
| ArrDelay | Arrival Delay (min), target variable |
| DepDelay | Departure delay (min) |
| Origin | Origin IATA airport code |
| Dest | Destination IATA airport code |
| Distance | Distance (miles) |
| TaxiIn | Taxi in time (min) |
| TaxiOut | Taxi out time (min) |
| Cancelled | Cancelled flight (1 = yes, 0 = no) |
| CancellationCode | Reason for cancellation (A = carrier, B = weather, C = NAS, D = security) |
| Diverted | Diverted (1 = yes, 0 = no) |
| CarrierDelay | Carrier delay (min) |
| WheatherDelay | Weather delay (min) |
| NASDelay | NAS delay (min) |
| SecurityDelay | Security delay (min) |
| LateAircraftDelay | Late aircraft delay (min) |

After analyzing the structure of the dataset and the meaning of the variables, a brief preprocessing process is carried out to eliminate rows with missing values and rows corresponding to cancelled flights, which do not provide any useful information. Moreover, variables that contain information that is unknown at the time the plane takes off are removed as they cannot be used in the prediction model, because it could not be implemented in a real situation. These “forbidden” variables are: ArrTime, ActualElapsedTime, AirTime, TaxiIn, Diverted, CarrierDelay, WeatherDelay, NASDelay, SecurityDelay and LateAircraftDelay. Finally, the categorical variables are encoded. Also, we consider other non-informative variables, that will not be used in the model, which are UniqueCarrier, FlightNum, TailNum, Distance, Origin, Dest, Cancelled, and CancellationCode.

Once the data was clean, a brief analysis based on the correlation matrix for the numerical variables was performed. The goal is to observe which variables are more correlated with the target variable ArrDelay. The results are shown in Figure 1. It can be seen that seasonal data such as the year, month, day of month/week, etc are not relevant variables, as they have very low correlation values regarding ArrDelay. The same happens with the distance variable. On the other hand, the most correlated variables to ArrDelay are DepDelay (0.9), TaxiOut (0.31), DepTime (0.17), CRSDepTime (0.13) and CRSArrTime (0.12).

From these results we can conclude that, for the linear regression model, the best variable selection might be DepDelay, TaxiOut and CRSArrTime. Note that DepDelay is the result of the difference between CRSDepTime and DepTime, so these two variables can also be removed to avoid linear relationships between the predictor variables.

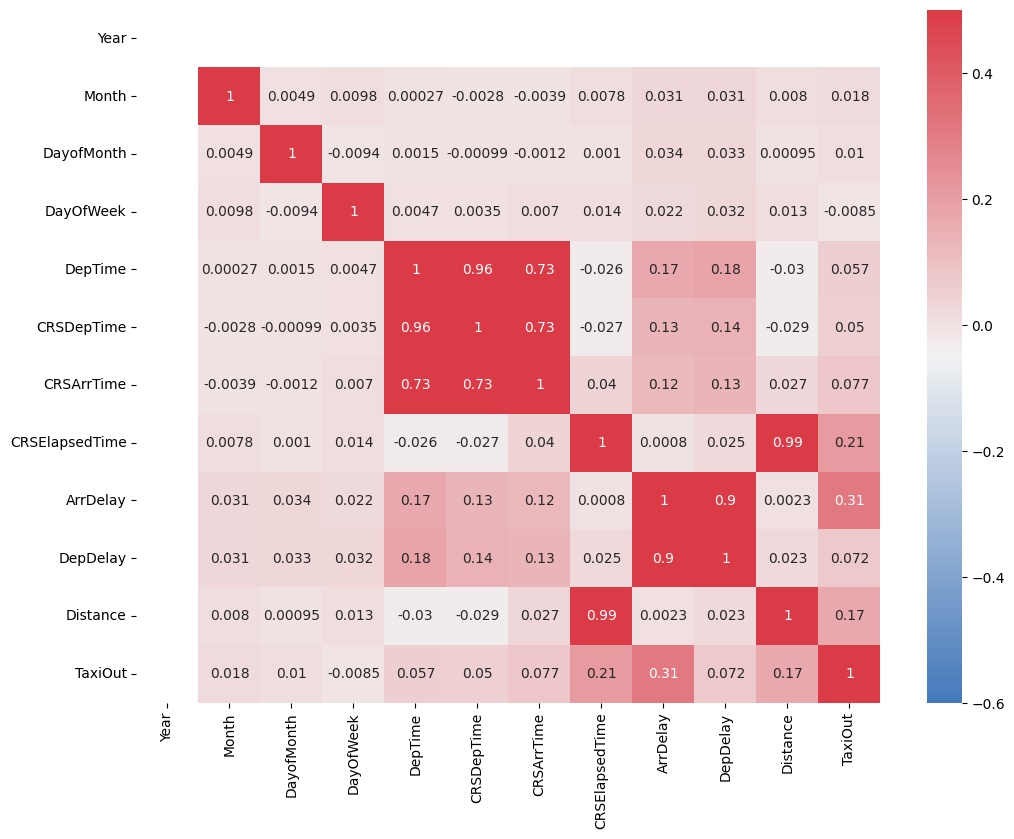


Figure 1: Correlation matrix for the numerical variables

1. Application Development
   1. Loading the Data
   2. Processing the Data
   3. Model Generation
   4. Model Validation
2. Results

* Performance measures

1. Running the Application

* Instructions

1. References

[1] 2008, "Data Expo 2009: Airline on time data", https://doi.org/10.7910/DVN/HG7NV7, Harvard Dataverse, V1