Prediction of Animal Strike on US Commercial Flights

Final Paper for the CEU MSc in Business Analytics program

Gábor Horváth

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CEU CENTRAL EUROPEAN UNIVERSITY

1 Introduction

The structure of the document follows the Cross Industry Standard Process for Data Mining (CRISP-DM) process model, which is a non-proprietary, documented, and freely available data mining model (Shearer 2000). Whenever the model sections can be matched to (and can fulfill) the requirements stated by CEU for the Final Paper I'm using the appropriate section identified by the CRIPS-DM model. Please keep in mind that the model supports the full end-to-end process of a data mining project, but the project does not require the use of all the model elements.

2 Business Understanding

2.1 Determine Business Objectives

2.1.1 Business Objectives

There are two main objectives what the project is aiming to complete.

1. Create a statistical analysis to identify those reasons (based on the data available), which are determining the the risk of an animal strike for an airport.
2. Create a prediction model, which can be used to predict the risk of an animal strike for a given flight.

The result of the statistical analysis could be used in the completion of the model building and evaluation the recommended order of the completion is the order of the objectives stated above.

2.1.2 Business Success Criteria

- Identification of features determining the risk potential of an airport
- Working model for animal strike prediction

2.2 Assess Situation

2.2.1 Inventory of resources

- Flight Data
- Animal Strike Data
- R
- Buckets

2.2.2 Requirements, Assumptions, and Constraints

- Additional requirements:
  - No additional requirements identified on top of the requirements already stated in this document.
- Assumptions
  - No initial assumptions made.
- Constraints
  - No initial hard constraints identified.

2.2.3 Risks and Contingencies

- Risks
  - No initial risks identified
- Contingencies
  - No initial contingencies identified

2.2.4 Terminology

The project is using different terminologies from the different domains. The terms/definitions used will not be marked or explained in details, if based on the context the reader can easily identify the domain of the particular term. In case there are uncertainties about a term (and it's not explained in the paper), the following sources can be used for the definitions:

- Aviation:
  - Aviation Terms / Directory: http://www.aviation-terms.com/index2.php
  - Aviation Glossary: http://www.aerofiles.com/glossary.html
  - Aviation Glossaries: https://www.flightsimaviation.com/_glossaries.html?s=aviation_terms
- Data Mining
  - Data Mining Glossary: http://www.thearling.com/glossary.htm
  - Data Mining - Terminologies: https://www.tutorialspoint.com/data_mining/dm_terminologies.htm
  - Data Mining and Predictive Analytics Glossary: http://www.kdnuggets.com/2015/06/data-mining-predictive-analytics-glossary.html
- Data Science / Big Data
  - Data Science Glossary: http://www.datascienceglossary.org/
  - Analytics and Big Data Glossary: http://data-informed.com/glossary-of-big-data-terms/
  - Data Science Glossary: http://www.kdnuggets.com/2015/09/data-science-glossary.html

2.2.5 Costs and Benefits

This is a one-man project, no significant cost is expected. Main benefit is to put to and almost end-to-end scenario the topics covered during the courses and discovering bits and bolts of the techniques for creating the project.

2.3 Determine Data Mining Goals

2.3.1 Data Mining Goals

- Understand, Analyse, Clean and Merge the source data correctly
- Create the required attributes
- Generate the required records (if applicable)

2.3.2 Data Mining Success Criteria

- Identification of featured determining the risk potential of an airport
- Working model for animal strike prediction

2.4 Produce Project Plan

2.4.1 Project Plan

The project is managed in an agile way, where all the tasks, requirements, issues, solutions, and ideas are kept in a project at buckets.

2.4.2 Initial Assessment of Tools and Techniques

- Programming language:
  - R: https://www.r-project.org/
- IDE for the programming language:
  - RStudio: https://www.rstudio.com/
- Documentation is created using:
  - knitr: https://yihui.name/knitr/
  - MiKTeX: https://miktex.org/
  - ReporteRs: https://cran.r-project.org/web/packages/ReporteRs/index.html
- Data visualization:

    - ggplot2: http://ggplot2.org/
- Data manipulation:
    - access2csv: https://github.com/AccelerationNet/access2csv
    - dtplyr: https://cran.r-project.org/web/packages/dtplyr/index.html
- Project plan / task management:
    - Buckets: https://www.buckets.co/
- Source code repository:
    - GitHub: https://github.com/

Note: The list above do not contain the list of all the tools and packages used to create the project, but the full list will be provided in the source code.

3 Data Understanding

3.1 Collect Initial Data

3.1.1 Initial Data Collection Report

There have been two data sources acquired in the initial phase of the project. These sources are the following:

3.1.1.1 Federal Aviation Administration

- Data source: Wildlife Strike Database
- The FAA provides the database as a compressed Microsoft Access file.
- The database version used is Version 2016.4-P (as of 24-10-2016).
- The database contains 180,177 Strike Reports from 1-1-1990 through 30-4-2016.
- The compressed file size is 44,730,852 bytes.
- The uncompressed Microsoft Access database file size is 193,495,040 bytes.
- The extracted tables are:
  - STRIKE_REPORTS (1990-1999) - 30082 rows - CSV size is 21,523,668 bytes
  - STRIKE_REPORTS (2000-2009) - 69960 rows - CSV size is 51,833,820 bytes.
  - STRIKE_REPORTS (2010-Current) - 70577 rows - CSV size is 53,973,874 bytes.
  - STRIKE_REPORTS_BASH (1990-Current).csv - 8046 rows - CSV size is 5,412,394 bytes.

3.1.1.2 United States Department of Transportation

- Data source: Bureau of Transportation Statistics
- The BTS provides the database as separate compressed CSV files. One file contains data of one month.
- The datestamp of the first CSV file available is 1-1-1987.
- The datestamp of the first data available is 1-10-1987.
- The datestamp of the last data acquired from BTS in the project is 31-12-2016.
- The number of files is 360.
  - Compressed size of the files is 6,196,385,360 bytes.
  - Uncompressed size of the files is 71,146,030,010 bytes.
- The download speed of the public access to these files seems to be limited, which needs to be taken into account in case of reproducing the results.

3.2 Describe Data

3.2.1 Data Description Report

The two main data sources have the following column explanations, which is attached to the downloaded files as well, by the data provider agencies.

3.2.1.1 Animal strike data

Column name	Explanation of Column Name and Codes
INDEX NR	Individual record number
OPID	Airline operator code
OPERATOR	A three letter International Civil Aviation Organization code for aircraft operators. (BUS = business, PVT = private aircraft other than business, GOV = government aircraft, MIL - military aircraft.)
ATYPE	Aircraft

Column name	Explanation of Column Name and Codes
AMA	International Civil Aviation Organization code for Aircraft Make
AMO	International Civil Aviation Organization code for Aircraft Model
EMA	Engine Make Code (see Engine Codes tab below)
EMO	Engine Model Code (see Engine Codes tab below)
AC_CLASS	Type of aircraft (see Aircraft Type tab below)
AC_MASS	1 = 2,250 kg or less: 2 = ,2251-5700 kg: 3 = 5,701-27,000 kg: 4 = 27,001-272,000 kg: 5 = above 272,000 kg
NUM_ENGS	Number of engines
TYPE_ENG	Type of power A = reciprocating engine (piston): B = Turbojet: C = Turboprop: D = Turbofan: E = None (glider): F = Turboshaft (helicopter): Y = Other
ENG_1_POS	Where engine # 1 is mounted on aircraft (see Engine Position tab below)
ENG_2_POS	Where engine # 2 is mounted on aircraft (see Engine Position tab below)
ENG_3_POS	Where engine # 3 is mounted on aircraft (see Engine Position tab below)
ENG_4_POS	Where engine # 4 is mounted on aircraft (see Engine Position tab below)
REG	Aircraft registration
FLT	Flight number
REMAINS_COLLECTED	Indicates if bird or wildlife remains were found and collected
REMAINS_SENT	Indicates if remains were sent to the Smithsonian Institution for identification
INCIDENT_DATE	Date strike occurred
INCIDENT_MONTH	Month strike occurred
INCIDENT_YEAR	Year strike occurred
TIME_OF_DAY	Light conditions
TIME	Hour and minute in local time
AIRPORT_ID	International Civil Aviation Organization airport identifier for location of strike whether it was on or off airport
AIRPORT	Name of airport
STATE	State
FAAREGION	FAA Region where airport is located
ENROUTE	If strike did not occur on approach, climb, landing roll, taxi or take-off, aircraft was enroute. This shows location.
RUNWAY	Runway
LOCATION	Various information about aircraft location if enroute or airport where strike evidence was found. Some locations show the two airports for the flight departure and arrival if pilot was unaware of the strike.
HEIGHT	Feet Above Ground Level
SPEED	Knots (indicated air speed)
DISTANCE	Miles from airport
PHASE_OF_FLT	Phase of flight during which strike occurred
DAMAGE	
Blank	Unknown
M = minor	When the aircraft can be rendered airworthy by simple repairs or replacements and an extensive inspection is not necessary.
M? = uncertain level	The aircraft was damaged, but details as to the extent of the damage are lacking.
S = substantial	When the aircraft incurs damage or structural failure which adversely affects the structure strength, performance or flight characteristics of the aircraft and which would normally require major repair or replacement of the affected component.
D = Destroyed	When the damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Column name	Explanation of Column Name and Codes
STR_RAD	Struck radome
DAM_RAD	Damaged radome
STR_WINDSHLD	Struck windshield
DAM_WINDSHLD	Damaged windshield
STR_NOSE	Struck nose
DAM_NOSE	Damaged nose
STR_ENG1	Struck Engine 1
DAM_ENG1	Damaged Engine 1
STR_ENG2	Struck Engine 2
DAM_ENG2	Damaged Engine 2
STR_ENG3	Struck Engine 3
DAM_ENG3	Damaged Engine 3
STR_ENG4	Struck Engine 4
DAM_ENG4	Damaged Engine 4
INGESTED	Engine ingested the bird/ animal
STR_PROP	Struck Propeller
DAM_PROP	Damaged Propeller
STR_WING_ROT	Struck Wing or Rotor
DAM_WING_ROT	Damaged Wing or Rotor
STR_FUSE	Struck Fuselage
DAM_FUSE	Damaged Fuselage
STR_LG	Struck Landing Gear
DAM_LG	Damaged Landing Gear
STR_TAIL	Struck Tail
DAM_TAIL	Damaged Tail
STR_LGHTS	Struck Lights
DAM_LGHTS	Damaged Lights
STR_OTHER	Struck Other than parts shown above
DAM_OTHER	Damaged Other than parts shown above
OTHER_SPECIFY	What part was struck other than those listed above
EFFECT	Effect on flight
EFFECT_OTHER	Effect on flight other than those listed on the form
SKY	Type of cloud cover, if any
PRECIP	Precipitation
SPECIES_ID	International Civil Aviation Organization code for type of bird or other wildlife
SPECIES	Common name for bird or other wildlife
BIRDS_SEEN	Number of birds/wildlife seen by pilot
BIRDS_STRUCK	Number of birds/wildlife struck
SIZE	Size of bird as reported by pilot is a relative scale. Entry should reflect the perceived size as opposed to a scientifically determined value. If more than one species was struck, larger bird is entered.
WARNED	Pilot warned of birds/wildlife
COMMENTS	As entered by database manager. Can include name of aircraft owner, types of reports received, updates, etc.
REMARKS	Most of remarks are from the form but some are data entry notes and are usually in parentheses.
AOS	Time aircraft was out of service in hours. If unknown, it is blank.
COST_REPAIRS	Estimated cost of repairs of replacement in dollars (USD)
COST_OTHER	Estimated other costs, other than those in previous field in dollars (USD). May include loss of revenue, hotel expenses due to flight cancellation, costs of fuel dumped, etc.

Column name	Explanation of Column Name and Codes
COST_REPAIRS_INFL_ADJ	Costs adjusted for inflation
COST_OTHER_INFL_ADJ	Other cost adjusted for inflation
REPORTED_NAME	Name(s) of person(s) filing report
REPORTED_TITLE	Title(s) of person(s) filing report
REPORTED_DATE	Date report was written
SOURCE	Type of report. Note: for multiple types of reports this will be indicated as Multiple. See "Comments" field for details
PERSON	Only one selection allowed. For multiple reports, see field "Reported Title"
NR_INJURIES	Number of people injured
NR_FATALITIES	Number of human fatalities
LUPDATE	Last time record was updated
TRANSFER	Unused field at this time
INDICATED_DAMAGE	Indicates whether or not aircraft was damaged

3.2.1.2 Flight data

Column name	Explanation of Column Name and Codes
Year	Year
Quarter	Quarter (1-4)
Month	Month
DayofMonth	Day of Month
DayOfWeek	Day of Week
FlightDate	Flight Date (yyyymmdd)
UniqueCarrier	Unique Carrier Code. When the same code has been used by multiple carriers, a numeric suffix is used for earlier users, for example, PA, PA(1), PA(2). Use this field for analysis across a range of years.
AirlineID	An identification number assigned by US DOT to identify a unique airline (carrier). A unique airline (carrier) is defined as one holding and reporting under the same DOT certificate regardless of its Code, Name, or holding company/corporation.
Carrier	Code assigned by IATA and commonly used to identify a carrier. As the same code may have been assigned to different carriers over time, the code is not always unique. For analysis, use the Unique Carrier Code.
TailNum	Tail Number
FlightNum	Flight Number
OriginAirportID	Origin Airport, Airport ID. An identification number assigned by US DOT to identify a unique airport. Use this field for airport analysis across a range of years because an airport can change its airport code and airport codes can be reused.
OriginAirportSeqID	Origin Airport, Airport Sequence ID. An identification number assigned by US DOT to identify a unique airport at a given point of time. Airport attributes, such as airport name or coordinates, may change over time.
OriginCityMarketID	Origin Airport, City Market ID. City Market ID is an identification number assigned by US DOT to identify a city market. Use this field to consolidate airports serving the same city market.
Origin	Origin Airport
OriginCityName	Origin Airport, City Name
OriginState	Origin Airport, State Code
OriginStateFips	Origin Airport, State Fips
OriginStateName	Origin Airport, State Name
OriginWac	Origin Airport, World Area Code

Column name	Explanation of Column Name and Codes
DestAirportID	Destination Airport, Airport ID. An identification number assigned by US DOT to identify a unique airport. Use this field for airport analysis across a range of years because an airport can change its airport code and airport codes can be reused.
DestAirportSeqID	Destination Airport, Airport Sequence ID. An identification number assigned by US DOT to identify a unique airport at a given point of time. Airport attributes, such as airport name or coordinates, may change over time.
DestCityMarketID	Destination Airport, City Market ID. City Market ID is an identification number assigned by US DOT to identify a city market. Use this field to consolidate airports serving the same city market.
Dest	Destination Airport
DestCityName	Destination Airport, City Name
DestState	Destination Airport, State Code
DestStateFips	Destination Airport, State Fips
DestStateName	Destination Airport, State Name
DestWac	Destination Airport, World Area Code
CRSDepTime	CRS Departure Time (local time: hhmm)
DepTime	Actual Departure Time (local time: hhmm)
DepDelay	Difference in minutes between scheduled and actual departure time. Early departures show negative numbers.
DepDelayMinutes	Difference in minutes between scheduled and actual departure time. Early departures set to 0.
DepDel15	Departure Delay Indicator, 15 Minutes or More (1=Yes)
DepartureDelayGroups	Departure Delay intervals, every (15 minutes from <-15 to >180)
DepTimeBlk	CRS Departure Time Block, Hourly Intervals
TaxiOut	Taxi Out Time, in Minutes
WheelsOff	Wheels Off Time (local time: hhmm)
WheelsOn	Wheels On Time (local time: hhmm)
TaxiIn	Taxi In Time, in Minutes
CRSArrTime	CRS Arrival Time (local time: hhmm)
ArrTime	Actual Arrival Time (local time: hhmm)
ArrDelay	Difference in minutes between scheduled and actual arrival time. Early arrivals show negative numbers.
ArrDelayMinutes	Difference in minutes between scheduled and actual arrival time. Early arrivals set to 0.
ArrDel15	Arrival Delay Indicator, 15 Minutes or More (1=Yes)
ArrivalDelayGroups	Arrival Delay intervals, every (15-minutes from <-15 to >180)
ArrTimeBlk	CRS Arrival Time Block, Hourly Intervals
Cancelled	Cancelled Flight Indicator (1=Yes)
CancellationCode	Specifies The Reason For Cancellation
Diverted	Diverted Flight Indicator (1=Yes)
CRSElapsedTime	CRS Elapsed Time of Flight, in Minutes
ActualElapsedTime	Elapsed Time of Flight, in Minutes
AirTime	Flight Time, in Minutes
Flights	Number of Flights
Distance	Distance between airports (miles)
DistanceGroup	Distance Intervals, every 250 Miles, for Flight Segment
CarrierDelay	Carrier Delay, in Minutes
WeatherDelay	Weather Delay, in Minutes
NASDelay	National Air System Delay, in Minutes
SecurityDelay	Security Delay, in Minutes
LateAircraftDelay	Late Aircraft Delay, in Minutes
FirstDepTime	First Gate Departure Time at Origin Airport

Column name	Explanation of Column Name and Codes
TotalAddGTime	Total Ground Time Away from Gate for Gate Return or Cancelled Flight
LongestAddGTime	Longest Time Away from Gate for Gate Return or Cancelled Flight
DivAirportLandings	Number of Diverted Airport Landings
DivReachedDest	Diverted Flight Reaching Scheduled Destination Indicator (1=Yes)
DivActualElapsedTime	Elapsed Time of Diverted Flight Reaching Scheduled Destination, in Minutes. The ActualElapsedTime column remains NULL for all diverted flights.
DivArrDelay	Difference in minutes between scheduled and actual arrival time for a diverted flight reaching scheduled destination. The ArrDelay column remains NULL for all diverted flights.
DivDistance	Distance between scheduled destination and final diverted airport (miles). Value will be 0 for diverted flight reaching scheduled destination.
Div1Airport	Diverted Airport Code1
Div1AirportID	Airport ID of Diverted Airport 1. Airport ID is a Unique Key for an Airport
Div1AirportSeqID	Airport Sequence ID of Diverted Airport 1. Unique Key for Time Specific Information for an Airport
Div1WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code1
Div1TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code1
Div1LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code1
Div1WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code1
Div1TailNum	Aircraft Tail Number for Diverted Airport Code1
Div2Airport	Diverted Airport Code2
Div2AirportID	Airport ID of Diverted Airport 2. Airport ID is a Unique Key for an Airport
Div2AirportSeqID	Airport Sequence ID of Diverted Airport 2. Unique Key for Time Specific Information for an Airport
Div2WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code2
Div2TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code2
Div2LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code2
Div2WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code2
Div2TailNum	Aircraft Tail Number for Diverted Airport Code2
Div3Airport	Diverted Airport Code3
Div3AirportID	Airport ID of Diverted Airport 3. Airport ID is a Unique Key for an Airport
Div3AirportSeqID	Airport Sequence ID of Diverted Airport 3. Unique Key for Time Specific Information for an Airport
Div3WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code3
Div3TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code3
Div3LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code3
Div3WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code3
Div3TailNum	Aircraft Tail Number for Diverted Airport Code3
Div4Airport	Diverted Airport Code4
Div4AirportID	Airport ID of Diverted Airport 4. Airport ID is a Unique Key for an Airport
Div4AirportSeqID	Airport Sequence ID of Diverted Airport 4. Unique Key for Time Specific Information for an Airport
Div4WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code4
Div4TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code4
Div4LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code4
Div4WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code4
Div4TailNum	Aircraft Tail Number for Diverted Airport Code4
Div5Airport	Diverted Airport Code5
Div5AirportID	Airport ID of Diverted Airport 5. Airport ID is a Unique Key for an Airport
Div5AirportSeqID	Airport Sequence ID of Diverted Airport 5. Unique Key for Time Specific Information for an Airport
Div5WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code5

Column name	Explanation of Column Name and Codes
Div5TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code5
Div5LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code5
Div5WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code5
Div5TailNum	Aircraft Tail Number for Diverted Airport Code5

3.3 Explore Data

3.3.1 Data Exploration Report

Keeping the length of this section reasonable, the exploration report shown here contains the data from 1990. The report for the rest of the data is in the appendix of the final document.

3.3.1.1 Animal Strike Data

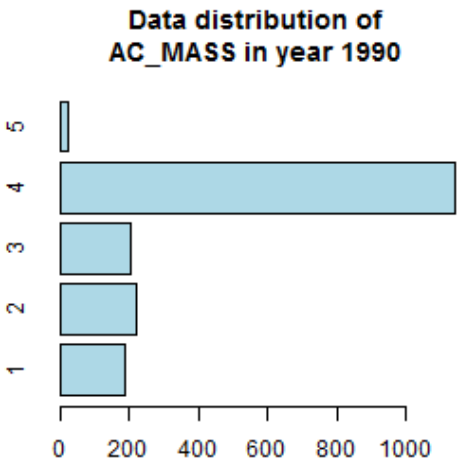
The first summary table shows the number of distinct items for each year regarding the Airline operators, Aircraft, Aircraft types, Aircraft mass types, and Engine types, which have been reported as being affected in an animal strike.

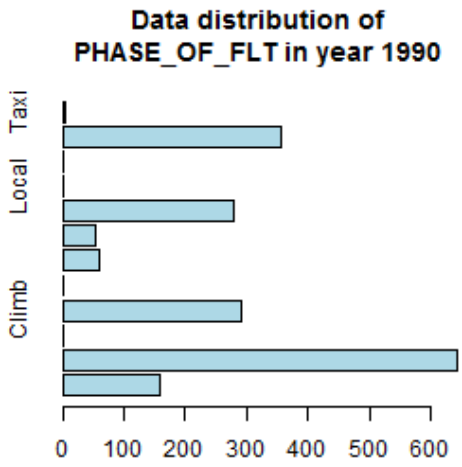
Year	# of reports	Operators	Aircraft	Aircraft type	Aircraft mass type	Engine type
1990	1847	316	329	4	5	9

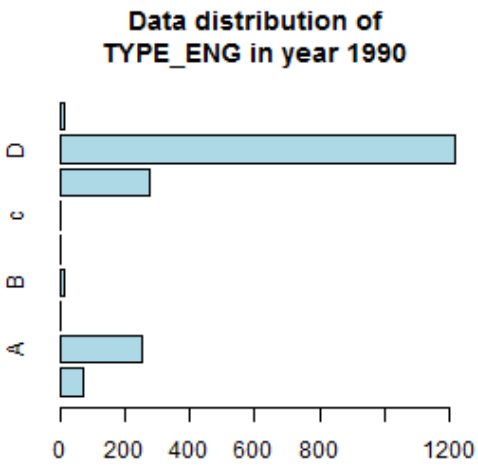
The second summary table shows the number of distinct items for each year regarding the Time of day, Airports, States, Phase of flight, weather conditions (Sky and Precipitation), and the flag for showing if the pilot has been warned or not about birds / wildlife in the reports.

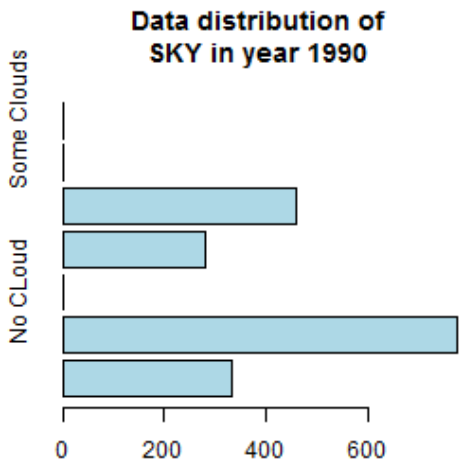
Year	Time of day	Airports	States	Phase of flight	Sky	Precipitation	Warned
1990	5	1175	61	12	7	8	4

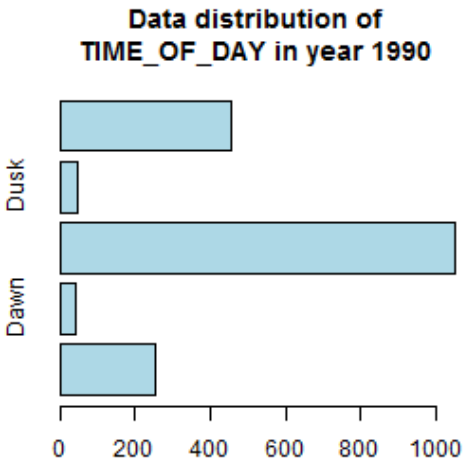
The following graphs show the distributions of some of the selected distinct items summarized in the tables above.

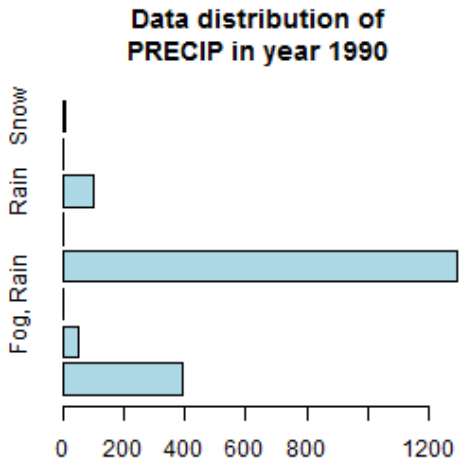

Data distribution of
AC_MASS in year 1990
5
4
3
2
1
0
200
400
600
800
1000


Data distribution of
PHASE_OF_FLT in year 1990
Taxi
Local
Climb
0
100
200
300
400
500
600


Data distribution of
TYPE_ENG in year 1990
D
c
B
A
0
200
400
600
800
1200


Data distribution of
SKY in year 1990
Some Clouds
No CLoud
0
200
400
600


Data distribution of
TIME_OF_DAY in year 1990
Dusk
Dawn
0
200
400
600
800
1000


Data distribution of
PRECIP in year 1990
Snow
Rain
Fog, Rain
0
200
400
600
800
1200

3.3.1.2 Flight Data

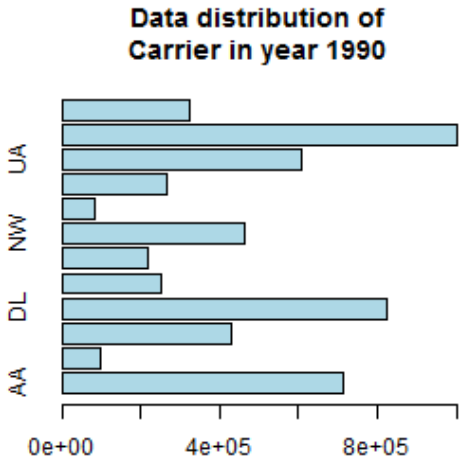
The first summary table shows the number of distinct items for each year regarding the number of records, the carriers, and the origin and the destination airports.

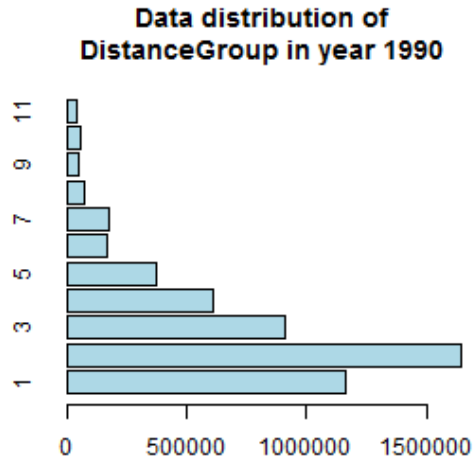
Year	# of flights	# of carriers	Origin airports	Origin states	Destination airports	Destination states
1990	5270893	12	235	53	236	53

The second summary table shows the number of distinct items for each year the departure time group and distance between the airports.

Year	Departure time block	Distance group
1990	19	11

The following graphs show the distributions of some of the selected distinct items summarized in the tables above.





3.4 Verify Data Quality

3.4.1 Data Quality Report

3.4.1.1 Animal strike data

The data set provided by the Federal Aviation Administration is a data set based on voluntary strike reporting from airlines, airports, pilots, and other sources. Therefore the quality of the data enormously depends on the goodwill of the reporting source and even with the best intentions there are several quality issues which needs to be addressed later in the project.

- Mixed use of uppercase and lowercase letters/codes
- Mixed use of codes (e.g.: engine type is defined as “A/C”)
- Number of States in the data set is above the actual number of states of the U.S.

The Federal Aviation Administration provides code books for some of the data details in the strike reports. Based on these code books the records with the following values can be removed from the data set, as they are not relevant for the goals of the project.

Column name	Value	Reason for removal
OPID	“PVT”	Record is related of a strike to a privately owned aircraft, not to an aircraft operated by a commercial airline.
OPID	“BUS”	Record is related of a strike to a business aircraft, not to an aircraft operated by a commercial airline.
OPID	“GOV”	Record is related of a strike to a government aircraft, not to an aircraft operated by a commercial airline.
OPID	“MIL”	Record is related of a strike to a military aircraft, not to an aircraft operated by a commercial airline.
OPID	“UNKC”	Record is related of a strike to an aircraft of an unknown commercial operator. Without this information identification of the flight can’t be done correctly.
OPID	“UNK”	Record is related of a strike to an aircraft of an unknown operator. Without this information identification of the flight can’t be done correctly.
AC_CLASS	“B”	Value stands for helicopter.
AC_CLASS	“C”	Value stands for glider.
AC_CLASS	“D”	Value stands for balloon.
AC_CLASS	“F”	Value stands for dirigible.
AC_CLASS	“I”	Value stands for gyroplane.
AC_CLASS	“J”	Value stands for ultralight.
AC_CLASS	“Y”	Value stands for other.
AC_CLASS	“Z”	Value stands for unknown.
AC_CLASS	“”	Value is empty.
TYPE_ENG	“E”	Value stands for none (glider).
TYPE_ENG	“F”	Value stands for turboshaft (helicopter).
TYPE_ENG	“”	Value is empty.

The strike report itself contains a great deal of details, which can be used in different projects, but for our purposes the following details have to be removed to concentrate on those information, which we expect to be the cause and not the effect of the strike. The following details needs to be removed from the data set in a later stage.

Column name	Explanation of Column Name and Codes
AMA	International Civil Aviation Organization code for Aircraft Make
AMO	International Civil Aviation Organization code for Aircraft Model
EMA	Engine Make Code
EMO	Engine Model Code

Column name	Explanation of Column Name and Codes
NUM_ENGS	Number of engines
ENG_1_POS	Where engine # 1 is mounted on aircraft
ENG_2_POS	Where engine # 2 is mounted on aircraft
ENG_3_POS	Where engine # 3 is mounted on aircraft
ENG_4_POS	Where engine # 4 is mounted on aircraft
REMAINS_COLLECTED	Indicates if bird or wildlife remains were found and collected
REMAINS_SENT	Indicates if remains were sent to the Smithsonian Institution for identification
LOCATION	Various information about aircraft location if enroute or airport where strike evidence was found. Some locations show the two airports for the flight departure and arrival if pilot was unaware of the strike.
DAMAGE	Amount of the damage.
STR_RAD	Struck radome
DAM_RAD	Damaged radome
STR_WINDSHLD	Struck windshield
DAM_WINDSHLD	Damaged windshield
STR_NOSE	Struck nose
DAM_NOSE	Damaged nose
STR_ENG1	Struck Engine 1
DAM_ENG1	Damaged Engine 1
STR_ENG2	Struck Engine 2
DAM_ENG2	Damaged Engine 2
STR_ENG3	Struck Engine 3
DAM_ENG3	Damaged Engine 3
STR_ENG4	Struck Engine 4
DAM_ENG4	Damaged Engine 4
INGESTED	Engine ingested the bird/ animal
STR_PROP	Struck Propeller
DAM_PROP	Damaged Propeller
STR_WING_ROT	Struck Wing or Rotor
DAM_WING_ROT	Damaged Wing or Rotor
STR_FUSE	Struck Fuselage
DAM_FUSE	Damaged Fuselage
STR_LG	Struck Landing Gear
DAM_LG	Damaged Landing Gear
STR_TAIL	Struck Tail
DAM_TAIL	Damaged Tail
STR_LGHTS	Struck Lights
DAM_LGHTS	Damaged Lights
STR_OTHER	Struck Other than parts shown above
DAM_OTHER	Damaged Other than parts shown above
OTHER_SPECIFY	What part was struck other than those listed above
EFFECT	Effect on flight
EFFECT_OTHER	Effect on flight other than those listed on the form
SPECIES_ID	International Civil Aviation Organization code for type of bird or other wildlife
SPECIES	Common name for bird or other wildlife
BIRDS_SEEN	Number of birds/wildlife seen by pilot
BIRDS_STRUCK	Number of birds/wildlife struck
SIZE	Size of bird as reported by pilot is a relative scale. Entry should reflect the perceived size as opposed to a scientifically determined value. If more than one species was struck, larger bird is entered.

Column name	Explanation of Column Name and Codes
COMMENTS	As entered by database manager. Can include name of aircraft owner, types of reports received, updates, etc.
REMARKS	Most of remarks are from the form but some are data entry notes and are usually in parentheses.
AOS	Time aircraft was out of service in hours. If unknown, it is blank.
COST_REPAIRS	Estimated cost of repairs of replacement in dollars (USD)
COST_OTHER	Estimated other costs, other than those in previous field in dollars (USD). May include loss of revenue, hotel expenses due to flight cancellation, costs of fuel dumped, etc.
COST_REPAIRS_INFL_ADJ	Costs adjusted for inflation
COST_OTHER_INFL_ADJ	Other cost adjusted for inflation
REPORTED_NAME	Name(s) of person(s) filing report
REPORTED_TITLE	Title(s) of person(s) filing report
REPORTED_DATE	Date report was written
SOURCE	Type of report. Note: for multiple types of reports this will be indicated as Multiple. See “Comments” field for details
PERSON	Only one selection allowed. For multiple reports, see field “Reported Title”
NR_INJURIES	Number of people injured
NR_FATALITIES	Number of human fatalities
LUPDATE	Last time record was updated
TRANSFER	Unused field at this time
INDICATED_DAMAGE	Indicates whether or not aircraft was damaged

3.4.1.2 Flight data

The data set provided by the United States Department of Transportation is a data set based on the timetable and the actual flight information collected by various systems. Therefore the quality of the data is significantly better than the data from the Federal Aviation Administration Animal Strike Database, but there are still some possible quality issues which needs to be addressed later in the project after further investigation. These issues include:

- Number of States in the data set is above the actual number of states of the U.S.

The data in the Federal Aviation Administration Animal Strike Database is available only until 30-4-2016, so the flight data needs to be adjusted accordingly.

Similarly to the Federal Aviation Administration Animal Strike Database, the flight performance data set contains a great deal of details as well, which can be used in different projects, but for our purposes the following details have to be removed to concentrate on those information, which we expect to be the cause and not the effect of the strike. The following details needs to be removed from the data set in a later stage.

Column name	Explanation of Column Name and Codes
UniqueCarrier	Unique Carrier Code. When the same code has been used by multiple carriers, a numeric suffix is used for earlier users, for example, PA, PA(1), PA(2). Use this field for analysis across a range of years.
AirlineID	An identification number assigned by US DOT to identify a unique airline (carrier). A unique airline (carrier) is defined as one holding and reporting under the same DOT certificate regardless of its Code, Name, or holding company/corporation.
TailNum	Tail Number
OriginAirportID	Origin Airport, Airport ID. An identification number assigned by US DOT to identify a unique airport. Use this field for airport analysis across a range of years because an airport can change its airport code and airport codes can be reused.

Column name	Explanation of Column Name and Codes
OriginAirportSeqID	Origin Airport, Airport Sequence ID. An identification number assigned by US DOT to identify a unique airport at a given point of time. Airport attributes, such as airport name or coordinates, may change over time.
OriginCityMarketID	Origin Airport, City Market ID. City Market ID is an identification number assigned by US DOT to identify a city market. Use this field to consolidate airports serving the same city market.
OriginStateFips	Origin Airport, State Fips
OriginWac	Origin Airport, World Area Code
DestAirportID	Destination Airport, Airport ID. An identification number assigned by US DOT to identify a unique airport. Use this field for airport analysis across a range of years because an airport can change its airport code and airport codes can be reused.
DestAirportSeqID	Destination Airport, Airport Sequence ID. An identification number assigned by US DOT to identify a unique airport at a given point of time. Airport attributes, such as airport name or coordinates, may change over time.
DestCityMarketID	Destination Airport, City Market ID. City Market ID is an identification number assigned by US DOT to identify a city market. Use this field to consolidate airports serving the same city market.
DestStateFips	Destination Airport, State Fips
DestWac	Destination Airport, World Area Code
CRSDepTime	CRS Departure Time (local time: hhmm)
DepTime	Actual Departure Time (local time: hhmm)
DepDelay	Difference in minutes between scheduled and actual departure time. Early departures show negative numbers.
DepDelayMinutes	Difference in minutes between scheduled and actual departure time. Early departures set to 0.
DepDel15	Departure Delay Indicator, 15 Minutes or More (1=Yes)
DepartureDelayGroups	Departure Delay intervals, every (15 minutes from <-15 to >180)
TaxiOut	Taxi Out Time, in Minutes
WheelsOff	Wheels Off Time (local time: hhmm)
WheelsOn	Wheels On Time (local time: hhmm)
TaxiIn	Taxi In Time, in Minutes
ArrTime	Actual Arrival Time (local time: hhmm)
ArrDelay	Difference in minutes between scheduled and actual arrival time. Early arrivals show negative numbers.
ArrDelayMinutes	Difference in minutes between scheduled and actual arrival time. Early arrivals set to 0.
ArrDel15	Arrival Delay Indicator, 15 Minutes or More (1=Yes)
ArrivalDelayGroups	Arrival Delay intervals, every (15-minutes from <-15 to >180)
Cancelled	Cancelled Flight Indicator (1=Yes)
CancellationCode	Specifies The Reason For Cancellation
Diverted	Diverted Flight Indicator (1=Yes)
ActualElapsedTime	Elapsed Time of Flight, in Minutes
AirTime	Flight Time, in Minutes
Flights	Number of Flights
CarrierDelay	Carrier Delay, in Minutes
WeatherDelay	Weather Delay, in Minutes
NASDelay	National Air System Delay, in Minutes
SecurityDelay	Security Delay, in Minutes
LateAircraftDelay	Late Aircraft Delay, in Minutes
FirstDepTime	First Gate Departure Time at Origin Airport
TotalAddGTime	Total Ground Time Away from Gate for Gate Return or Cancelled Flight
LongestAddGTime	Longest Time Away from Gate for Gate Return or Cancelled Flight

Column name	Explanation of Column Name and Codes
DivAirportLandings	Number of Diverted Airport Landings
DivReachedDest	Diverted Flight Reaching Scheduled Destination Indicator (1=Yes)
DivActualElapsedTime	Elapsed Time of Diverted Flight Reaching Scheduled Destination, in Minutes. The ActualElapsedTime column remains NULL for all diverted flights.
DivArrDelay	Difference in minutes between scheduled and actual arrival time for a diverted flight reaching scheduled destination. The ArrDelay column remains NULL for all diverted flights.
DivDistance	Distance between scheduled destination and final diverted airport (miles). Value will be 0 for diverted flight reaching scheduled destination.
Div1Airport	Diverted Airport Code1
Div1AirportID	Airport ID of Diverted Airport 1. Airport ID is a Unique Key for an Airport
Div1AirportSeqID	Airport Sequence ID of Diverted Airport 1. Unique Key for Time Specific Information for an Airport
Div1WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code1
Div1TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code1
Div1LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code1
Div1WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code1
Div1TailNum	Aircraft Tail Number for Diverted Airport Code1
Div2Airport	Diverted Airport Code2
Div2AirportID	Airport ID of Diverted Airport 2. Airport ID is a Unique Key for an Airport
Div2AirportSeqID	Airport Sequence ID of Diverted Airport 2. Unique Key for Time Specific Information for an Airport
Div2WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code2
Div2TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code2
Div2LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code2
Div2WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code2
Div2TailNum	Aircraft Tail Number for Diverted Airport Code2
Div3Airport	Diverted Airport Code3
Div3AirportID	Airport ID of Diverted Airport 3. Airport ID is a Unique Key for an Airport
Div3AirportSeqID	Airport Sequence ID of Diverted Airport 3. Unique Key for Time Specific Information for an Airport
Div3WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code3
Div3TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code3
Div3LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code3
Div3WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code3
Div3TailNum	Aircraft Tail Number for Diverted Airport Code3
Div4Airport	Diverted Airport Code4
Div4AirportID	Airport ID of Diverted Airport 4. Airport ID is a Unique Key for an Airport
Div4AirportSeqID	Airport Sequence ID of Diverted Airport 4. Unique Key for Time Specific Information for an Airport
Div4WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code4
Div4TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code4
Div4LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code4
Div4WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code4
Div4TailNum	Aircraft Tail Number for Diverted Airport Code4
Div5Airport	Diverted Airport Code5
Div5AirportID	Airport ID of Diverted Airport 5. Airport ID is a Unique Key for an Airport
Div5AirportSeqID	Airport Sequence ID of Diverted Airport 5. Unique Key for Time Specific Information for an Airport
Div5WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code5
Div5TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code5
Div5LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code5

Column name	Explanation of Column Name and Codes
Div5WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code5
Div5TailNum	Aircraft Tail Number for Diverted Airport Code5

4 Data Preparation

4.1 Data Set

4.1.1 Data Set Description

The resolution of the issues found during the data quality verification includes the reducing of several details originally provided by the Federal Aviation Administration and the United States Department of Transportation agencies. This section describes the resulted data sets.

4.1.1.1 Animal strike data

Column name	Explanation of Column Name and Codes
INDEX NR	Individual record number
OPID	Airline operator code
OPERATOR	A three letter International Civil Aviation Organization code for aircraft operators. (BUS = business, PVT = private aircraft other than business, GOV = government aircraft, MIL - military aircraft.)
ATYPE	Aircraft
AC_CLASS	Type of aircraft (see Aircraft Type tab below)
AC_MASS	1 = 2,250 kg or less: 2 = ,2251-5700 kg: 3 = 5,701-27,000 kg: 4 = 27,001-272,000 kg: 5 = above 272,000 kg
TYPE_ENG	Type of power A = reciprocating engine (piston): B = Turbojet: C = Turboprop: D = Turbofan: E = None (glider): F = Turboshaft (helicopter): Y = Other
REG	Aircraft registration
FLT	Flight number
INCIDENT_DATE	Date strike occurred
INCIDENT_MONTH	Month strike occurred
INCIDENT_YEAR	Year strike occurred
TIME_OF_DAY	Light conditions
TIME	Hour and minute in local time
AIRPORT_ID	International Civil Aviation Organization airport identifier for location of strike whether it was on or off airport
AIRPORT	Name of airport
STATE	State
FAAREGION	FAA Region where airport is located
ENROUTE	If strike did not occur on approach, climb, landing roll, taxi or take-off, aircraft was enroute. This shows location.
RUNWAY	Runway
HEIGHT	Feet Above Ground Level
SPEED	Knots (indicated air speed)
DISTANCE	Miles from airport
PHASE_OF_FLT	Phase of flight during which strike occurred
SKY	Type of cloud cover, if any
PRECIP	Precipitation
WARNED	Pilot warned of birds/wildlife

The number of details (columns) for each strike report has been reduces from 94 to 27.

4.1.1.2 Flight data

Column name	Explanation of Column Name and Codes
Year	Year
Quarter	Quarter (1-4)
Month	Month
DayofMonth	Day of Month
DayOfWeek	Day of Week
FlightDate	Flight Date (yyyymmdd)
Carrier	Code assigned by IATA and commonly used to identify a carrier. As the same code may have been assigned to different carriers over time, the code is not always unique. For analysis, use the Unique Carrier Code.
FlightNum	Flight Number
Origin	Origin Airport
OriginCityName	Origin Airport, City Name
OriginState	Origin Airport, State Code
OriginStateName	Origin Airport, State Name
Dest	Destination Airport
DestCityName	Destination Airport, City Name
DestState	Destination Airport, State Code
DestStateName	Destination Airport, State Name
CRSDepTime	CRS Departure Time (local time: hhmm)
DepTimeBlk	CRS Departure Time Block, Hourly Intervals
CRSArrTime	CRS Arrival Time (local time: hhmm)
CRSElapsedTime	CRS Elapsed Time of Flight, in Minutes
Distance	Distance between airports (miles)
DistanceGroup	Distance Intervals, every 250 Miles, for Flight Segment

The number of details (columns) for each flight performance record has been reduces from 110 to 23.

4.2 Select Data

4.2.1 Rationale for Inclusion / Exclusion

The resolution of the issues found during the data quality verification includes the exclusion of certain records from the data sets originally provided by the Federal Aviation Administration and the United States Department of Transportation agencies. This section provides the summary of the changes on the data sets.

4.2.1.1 Animal strike data

The following columns are impacted by the selection criteria described in the data quality verification section:

- OPID
- AC_CLASS
- TYPE_ENG

4.2.1.2 Flight data

The data in the Federal Aviation Administration Animal Strike Database is available only until 30-4-2016, so the flight data needs to be adjusted accordingly.

4.3 Clean Data

4.3.1 Data Cleaning Report

TODO

4.4 Construct Data

4.4.1 Derived Attributes

TODO

4.4.2 Generated Records

TODO

4.5 Integrate Data

4.5.1 Merged Data

TODO

4.6 Format Data

4.6.1 Reformatted Data

TODO

5 Modeling

TODO

5.1 Select Modeling Technique for Model 1

5.1.1 Modeling Technique

TODO

5.1.2 Modeling Assumptions

TODO

5.2 Generate Test Design for Model 1

5.2.1 Test Design

TODO

5.3 Build Model for Model 1

5.3.1 Parameter Settings

TODO

5.3.2 Models

TODO

5.3.3 Model Description

TODO

5.4 Assess Model for Model 1

5.4.1 Model Assessment

TODO

5.4.2 Revised Parameter Settings

TODO

5.5 Select Modeling Technique for Model 2

5.5.1 Modeling Technique

TODO

5.5.2 Modeling Assumptions

TODO

5.6 Generate Test Design for Model 2

5.6.1 Test Design

TODO

5.7 Build Model for Model 2

5.7.1 Parameter Settings

TODO

5.7.2 Models

TODO

5.7.3 Model Description

TODO

5.8 Assess Model for Model 2

5.8.1 Model Assessment

TODO

5.8.2 Revised Parameter Settings

TODO

6 Evaluation

6.1 Evaluate Results

6.1.1 Assessment of Data Mining Result with Business Success Criteria

TODO

6.1.2 Approved Models

TODO

6.2 Review Process

6.2.1 Review of Process

TODO

6.3 Determine Next Steps

6.3.1 List of Possible Actions

TODO

6.3.2 Decision

TODO

7 Deployment

7.1 Plan Deployment

7.1.1 Deployment Plan

TODO

7.2 Plan Monitoring and Maintenance

7.2.1 Monitoring and Maintenance Plan

TODO

7.3 Produce Final Report

7.3.1 Final Report

TODO

7.3.2 Final Presentation

TODO

7.4 Review Project

7.4.1 Experience Documentation

TODO

8 Contributors

Student: Gábor Horváth
Mentor: Gergely Daróczi

9 Environment

The following language, tool and library versions have been used to create the project:

R Studio version 1.0.143

R version 3.4.0 (2017-04-21) 72570

Package versions:
- RODBC version 1.3.15
- knitr version 1.16
- data.table version 1.10.4
- dplyr version 0.5.0
- dtplyr version 0.0.2
- ReporteRs version 0.8.8
- ReporteRsjars version 0.0.2
- installr version 0.19.0
- stringr version 1.2.0
- ggplot2 version 2.2.1
- yaml version 2.1.14
- png version 0.1.7
- grid version 3.4.0
- pander version 0.6.0

Base package versions:
- stats version 3.4.0
- graphics version 3.4.0
- grDevices version 3.4.0
- utils version 3.4.0
- datasets version 3.4.0
- methods version 3.4.0
- base version 3.4.0

MiKTeX Package Manager 2.9.6200 (MiKTeX 2.9.6210 64-bit)

Contents

10 Appendix 1 - Final project requirements

The following pages contain the Final project requirements received from the CEU Business School.

Final project

The goal of the final project is to expose the students in Business Analytics to a complete analytics workflow with a variety of tasks. They will use the full spectrum of skills acquired in the program, challenge themselves and learn something useful in the process and create value for the partner company. Throughout the project, students will interact with clients in the host company, analysts, IT engineers, and vendors of analytics solutions.

Examples

Insurance Ltd. sells many insurance products through a variety of channels. Customer data are stored in separate data silos for each market segment (e.g., life, home, car, travel), and there are often duplicates across sales channels (e.g., brokers do not check for existing customers but enter everyone as a new customer). In order to analyze customer behavior (e.g. churn) in all segments jointly, senior analysts need to merge all data by the same user. This requires entity resolution and unique user ID in all data silos. The student will study the various datasets, research entity resolution tools, conduct some tests with one or more prototype, and propose a solution to senior management.

Webstore Kft. is an online store of sporting goods. They want to evaluate the effectiveness of past social marketing campaigns. The management would like to know the average spending of new customers. Clickthrough rates are measured, but Webstore does not have information on conversion: if and what the newly acquired customers bought. Discussing with the person responsible for social campaigns, and the person running the website and maintaining the log, the student helps approximately identify new customers in the log and estimate their spending. She presents the results under alternative assumptions to the management. Together, they also propose a method for tracking conversion better.

Banking Ltd. is a financial company issuing credit cards. They have an existing model for predicting credit card non-payments which they want to improve. They have just launched a Hadoop project so they require a student with Hadoop expertise. Student meets with clients and analysts to understand current model and the need for improvement. Research current dataset and other data that can potentially be used to help predict default. Working as part of the analytics team, builds a prototype of a new machine learning model and tests its performance. Presents results to clients.

Deliverables

- Project plan. Describe the project and the resource needs in one page. Any special need in training, tools or any restrictions (e.g., non-disclosure agreement) should be specified here. Signed by student, host and mentor. Due April 3, 2017.
- Business needs. Student documents business needs as gathered from clients. User stories, scope of the project. Due April 30.
- Estimate of resource needs. Students estimates the resource needs of the project. Who needs to be involved? What time do they need to devote to the project? Any new software or data needs to purchased? Due April 30.
- Preliminary report. This contains the description of the business needs and the scope of the project, results of the analysis with exhibits, and recommendations for management. Due to host and mentor by June 30.

Resource needs

Each student has a **mentor** appointed by CEU and a **host** in their host company. The host company provides access to the necessary **space**, **people**, computer, software **tools** and **data**. The precise resource needs depend on the project and are negotiated in advance with the help of the mentor.

Benefits to host company

- Temporary staff with high technical skills and sensitive to the business environment; more dependable than entry-level interns.
- Consultations with CEU mentor.
- Access to latest technologies and trends.
- New perspective on a particular analytics problem or the analytics workflow.

Responsibilities

Student

- Select a host company and a project.
- Meet with mentor early on to discuss plans.
- Meet with mentor biweekly during the implementation of the project.
- Identify and understand business needs of host company clients.
- Select appropriate tools and provide best effort to address those needs.
- Complete deliverables by deadlines below.
- Maintain code of academic ethics, workplace rules of host company, and nondisclosure as agreed in project plan.
- Immediately raise concerns about project with mentor.

Mentor

- Help select a topic.
- Meet biweekly with the student to monitor progress and provide feedback.
- Verify project is feasible within the time frame.
- Discuss with host in case of concerns and problems.
- Verify successful project delivery at all stages.

Host

1. Propose analytics topics relevant to the host company.
2. Together with the mentor, identify the special needs in training, skills and tools.
3. Discuss with mentor and student the proposed project and agree on a plan.
4. Provide access for student to space, people, tools and data needed for successful completion of project.
5. Introduce student to other stakeholders at the company.

11 Appendix 2 - Project Plan

The following pages contain the Project Plan, which is the first deliverable described as the “Describe the project and the resource needs in one page. Any special need in training, tools or any restrictions (e.g., non-disclosure agreement) should be specified here.” in the final project requirements.

Project Plan of the Final Paper

for the CEU MSc in Business Analytics program

Gábor Horváth

2017

CEU CENTRAL EUROPEAN UNIVERSITY

1 High level description

The goal of the project is to show - creating a risk evaluation of wildlife strikes of flights in the US - the techniques, methods, interpretations and understanding of the data analytic. The project is based on the Cross Industry Standard Process for Data Mining (CRISP-DM) process model, which is widely used worldwide for various scientific and business related data analytic projects. The use of the CRISP-DM process model will enable to for the project to cover all those areas (i.e. Business Understanding, Data understanding, Modelling, Evaluation, etc.), which are crucial of managing and delivering a successful data analytic project.

2 Resource needs

2.1 Training requirements

No additional organized / official training requirements are required above the trainings received during the courses in the program. There are tools and techniques used to fulfill the project which have not been described in the program at CEU, but there are several useful user manuals available on the webpages of the tool's creators, which would enable the use of these tools and resources for any student who have been part of the program.

2.2 Tools & resources used

Fulfilling the completion need for the project the following tools are planned to be used:

- Programming language:
  - R: https://www.r-project.org/
- IDE for the programming language:
  - RStudio: https://www.rstudio.com/
- Documentation is created using:
  - knitr: https://yihui.name/knitr/
  - MiKTeX: https://miktex.org/
  - ReporteRs: https://cran.r-project.org/web/packages/ReporteRs/index.html
- Data visualization:
  - ggplot2: http://ggplot2.org/
- Data manipulation:
  - access2csv: https://github.com/AccelerationNet/access2csv
  - dtplyr: https://cran.r-project.org/web/packages/dtplyr/index.html
- Project plan / task management:
  - Buckets: https://www.buckets.co/
- Source code repository:
  - GitHub: https://github.com/

Note: The list above do not contain the list of all the tools and packages used to create the project, but the full list will be provided in the source code.

2.3 Data sources

The project will use the following data provided by multiple US government agencies:

- Federal Aviation Administration: Wildlife Strike Database
- United States Department of Transportation: Bureau of Transportation Statistics

Note: In case data enrichment would be required for the successful risk modelling, additional data sources might be used as well. These possible additional data sources will be listed in the Final Paper.

2.4 Restrictions

Restrictions apply as per the restrictions set by the tools, data providers and owners of additional resources used. No additional restrictions have been identified and set regarding the use of the results of this project.

2.5 Contributors

Student: Gábor Horváth
Mentor: Gergely Daróczi

12 Appendix 3 - Business Needs

The following pages contain the Business Needs, which is the second deliverable described as the “Student documents business needs as gathered from clients. User stories, scope of the project.” in the final project requirements.

Business needs of the Final Paper

for the CEU MSc in Business Analytics program

Gábor Horváth

2017

CEU CENTRAL EUROPEAN UNIVERSITY

1 Introduction

The structure of the document follows the Cross Industry Standard Process for Data Mining (CRISP-DM) process model, which is a non-proprietary, documented, and freely available data mining model (Shearer 2000). Whenever the model sections can be matched to (and can fulfill) the requirements stated by CEU for the Final Paper I'm using the appropriate section identified by the CRIPS-DM model. Please keep in mind that the model supports the full end-to-end process of a data mining project, but the project does not require the use of all the model elements.

2 Business understanding

2.1 Determine Business Objectives

2.1.1 Business Objectives

There are two main objectives what the project is aiming to complete.

1. Create a statistical analysis to identify those reasons (based on the data available), which are determining the the risk of an animal strike for an airport.
2. Create a prediction model, which can be used to predict the risk of an animal strike for a given flight.

The result of the statistical analysis could be used in the completion of the model building and evaluation the recommended order of the completion is the order of the objectives stated above.

2.1.2 Business Success Criteria

- Identification of features determining the risk potential of an airport
- Working model for animal strike prediction

2.2 Assess Situation

2.2.1 Inventory of resources

- Flight Data
- Animal Strike Data
- R
- Buckets

2.2.2 Requirements, Assumptions, and Constraints

- Additional requirements:
  - No additional requirements identified on top of the requirements already stated in this document.
- Assumptions
  - No initial assumptions made.
- Constraints
  - No initial hard constraints identified.

2.2.3 Risks and Contingencies

- Risks
  - No initial risks identified
- Contingencies
  - No initial contingencies identified

2.2.4 Terminology

The project is using different terminologies from the different domains. The terms/definitions used will not be marked or explained in details, if based on the context the reader can easily identify the domain of the particular term. In case there are uncertainties about a term (and it's not explained in the paper), the following sources can be used for the definitions:

- Aviation:
  - Aviation Terms / Directory: http://www.aviation-terms.com/index2.php
  - Aviation Glossary: http://www.aerofiles.com/glossary.html
  - Aviation Glossaries: https://www.flightsimaviation.com/_glossaries.html?s=aviation_terms
- Data Mining
  - Data Mining Glossary: http://www.thearling.com/glossary.htm
  - Data Mining - Terminologies: https://www.tutorialspoint.com/data_mining/dm_terminologies.htm
  - Data Mining and Predictive Analytics Glossary: http://www.kdnuggets.com/2015/06/data-mining-predictive-analytics-glossary.html
- Data Science / Big Data
  - Data Science Glossary: http://www.datascienceglossary.org/
  - Analytics and Big Data Glossary: http://data-informed.com/glossary-of-big-data-terms/
  - Data Science Glossary: http://www.kdnuggets.com/2015/09/data-science-glossary.html

2.2.5 Costs and Benefits

This is a one-man project, no significant cost is expected. Main benefit is to put to and almost end-to-end scenario the topics covered during the courses and discovering bits and bolts of the techniques for creating the project.

2.3 Determine Data Mining Goals

2.3.1 Data Mining Goals

- Understand, Analyse, Clean and Merge the source data correctly
- Create the required attributes
- Generate the required records (if applicable)

2.3.2 Data Mining Success Criteria

- Identification of featured determining the risk potential of an airport
- Working model for animal strike prediction

2.4 Produce Project Plan

2.4.1 Project Plan

The project is managed in an agile way, where all the tasks, requirements, issues, solutions, and ideas are kept in a project at buckets.

2.4.2 Initial Assessment of Tools and Techniques

- Programming language:
  - R: https://www.r-project.org/
- IDE for the programming language:
  - RStudio: https://www.rstudio.com/
- Documentation is created using:
  - knitr: https://yihui.name/knitr/
  - MiKTeX: https://miktex.org/
  - ReporteRs: https://cran.r-project.org/web/packages/ReporteRs/index.html
- Data visualization:

  - ggplot2: http://ggplot2.org/
- Data manipulation:
  - access2csv: https://github.com/AccelerationNet/access2csv
  - dtplyr: https://cran.r-project.org/web/packages/dtplyr/index.html
- Project plan / task management:
  - Buckets: https://www.buckets.co/
- Source code repository:
  - GitHub: https://github.com/

Note: The list above do not contain the list of all the tools and packages used to create the project, but the full list will be provided in the source code.

3 Data Understanding

3.1 Collect Initial Data

3.1.1 Initial Data Collection Report

This report will be part of the following documents:

- Preliminary Report
- Final Paper

3.2 Describe Data

3.2.1 Data Description Report

The two main data sources have the following column explanations, which is attached to the downloaded files as well, by the data provider agencies.

3.2.1.1 Animal strike data

Column name	Explanation of Column Name and Codes
INDEX NR	Individual record number
OPID	Airline operator code
OPERATOR	A three letter International Civil Aviation Organization code for aircraft operators. (BUS = business, PVT = private aircraft other than business, GOV = government aircraft, MIL - military aircraft.)
ATYPE	Aircraft
AMA	International Civil Aviation Organization code for Aircraft Make
AMO	International Civil Aviation Organization code for Aircraft Model
EMA	Engine Make Code (see Engine Codes tab below)
EMO	Engine Model Code (see Engine Codes tab below)
AC_CLASS	Type of aircraft (see Aircraft Type tab below)
AC_MASS	1 = 2,250 kg or less: 2 = ,2251-5700 kg: 3 = 5,701-27,000 kg: 4 = 27,001-272,000 kg: 5 = above 272,000 kg
NUM_ENGS	Number of engines
TYPE_ENG	Type of power A = reciprocating engine (piston): B = Turbojet: C = Turboprop: D = Turbofan: E = None (glider): F = Turboshaft (helicopter): Y = Other
ENG_1_POS	Where engine # 1 is mounted on aircraft (see Engine Position tab below)
ENG_2_POS	Where engine # 2 is mounted on aircraft (see Engine Position tab below)
ENG_3_POS	Where engine # 3 is mounted on aircraft (see Engine Position tab below)
ENG_4_POS	Where engine # 4 is mounted on aircraft (see Engine Position tab below)
REG	Aircraft registration
FLT	Flight number
REMAINS_COLLECTED	Indicates if bird or wildlife remains were found and collected
REMAINS_SENT	Indicates if remains were sent to the Smithsonian Institution for identification
INCIDENT_DATE	Date strike occurred
INCIDENT_MONTH	Month strike occurred
INCIDENT_YEAR	Year strike occurred
TIME_OF_DAY	Light conditions
TIME	Hour and minute in local time

Column name	Explanation of Column Name and Codes
AIRPORT_ID	International Civil Aviation Organization airport identifier for location of strike whether it was on or off airport
AIRPORT	Name of airport
STATE	State
FAAREGION	FAA Region where airport is located
ENROUTE	If strike did not occur on approach, climb, landing roll, taxi or take-off, aircraft was enroute. This shows location.
RUNWAY	Runway
LOCATION	Various information about aircraft location if enroute or airport where strike evidence was found. Some locations show the two airports for the flight departure and arrival if pilot was unaware of the strike.
HEIGHT	Feet Above Ground Level
SPEED	Knots (indicated air speed)
DISTANCE	Miles from airport
PHASE_OF_FLT	Phase of flight during which strike occurred
DAMAGE	
Blank	Unknown
M = minor	When the aircraft can be rendered airworthy by simple repairs or replacements and an extensive inspection is not necessary.
M? = uncertain level	The aircraft was damaged, but details as to the extent of the damage are lacking.
S = substantial	When the aircraft incurs damage or structural failure which adversely affects the structure strength, performance or flight characteristics of the aircraft and which would normally require major repair or replacement of the affected component.
D = Destroyed	When the damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.
STR_RAD	Struck radome
DAM_RAD	Damaged radome
STR_WINDSHLD	Struck windshield
DAM_WINDSHLD	Damaged windshield
STR_NOSE	Struck nose
DAM_NOSE	Damaged nose
STR_ENG1	Struck Engine 1
DAM_ENG1	Damaged Engine 1
STR_ENG2	Struck Engine 2
DAM_ENG2	Damaged Engine 2
STR_ENG3	Struck Engine 3
DAM_ENG3	Damaged Engine 3
STR_ENG4	Struck Engine 4
DAM_ENG4	Damaged Engine 4
INGESTED	Engine ingested the bird/ animal
STR_PROP	Struck Propeller
DAM_PROP	Damaged Propeller
STR_WING_ROT	Struck Wing or Rotor
DAM_WING_ROT	Damaged Wing or Rotor
STR_FUSE	Struck Fuselage
DAM_FUSE	Damaged Fuselage
STR_LG	Struck Landing Gear
DAM_LG	Damaged Landing Gear
STR_TAIL	Struck Tail
DAM_TAIL	Damaged Tail

Column name	Explanation of Column Name and Codes
STR_LGHTS	Struck Lights
DAM_LGHTS	Damaged Lights
STR_OTHER	Struck Other than parts shown above
DAM_OTHER	Damaged Other than parts shown above
OTHER_SPECIFY	What part was struck other than those listed above
EFFECT	Effect on flight
EFFECT_OTHER	Effect on flight other than those listed on the form
SKY	Type of cloud cover, if any
PRECIP	Precipitation
SPECIES_ID	International Civil Aviation Organization code for type of bird or other wildlife
SPECIES	Common name for bird or other wildlife
BIRDS_SEEN	Number of birds/wildlife seen by pilot
BIRDS_STRUCK	Number of birds/wildlife struck
SIZE	Size of bird as reported by pilot is a relative scale. Entry should reflect the perceived size as opposed to a scientifically determined value. If more than one species was struck, larger bird is entered.
WARNED	Pilot warned of birds/wildlife
COMMENTS	As entered by database manager. Can include name of aircraft owner, types of reports received, updates, etc.
REMARKS	Most of remarks are from the form but some are data entry notes and are usually in parentheses.
AOS	Time aircraft was out of service in hours. If unknown, it is blank.
COST_REPAIRS	Estimated cost of repairs of replacement in dollars (USD)
COST_OTHER	Estimated other costs, other than those in previous field in dollars (USD). May include loss of revenue, hotel expenses due to flight cancellation, costs of fuel dumped, etc.
COST_REPAIRS_INFL_ADJ	Costs adjusted for inflation
COST_OTHER_INFL_ADJ	Other cost adjusted for inflation
REPORTED_NAME	Name(s) of person(s) filing report
REPORTED_TITLE	Title(s) of person(s) filing report
REPORTED_DATE	Date report was written
SOURCE	Type of report. Note: for multiple types of reports this will be indicated as Multiple. See “Comments” field for details
PERSON	Only one selection allowed. For multiple reports, see field “Reported Title”
NR_INJURIES	Number of people injured
NR_FATALITIES	Number of human fatalities
LUPDATE	Last time record was updated
TRANSFER	Unused field at this time
INDICATED_DAMAGE	Indicates whether or not aircraft was damaged

3.2.1.2 Flight data

Column name	Explanation of Column Name and Codes
Year	Year
Quarter	Quarter (1-4)
Month	Month
DayofMonth	Day of Month
DayOfWeek	Day of Week
FlightDate	Flight Date (yyyymmdd)

Column name	Explanation of Column Name and Codes
UniqueCarrier	Unique Carrier Code. When the same code has been used by multiple carriers, a numeric suffix is used for earlier users, for example, PA, PA(1), PA(2). Use this field for analysis across a range of years.
AirlineID	An identification number assigned by US DOT to identify a unique airline (carrier). A unique airline (carrier) is defined as one holding and reporting under the same DOT certificate regardless of its Code, Name, or holding company/corporation.
Carrier	Code assigned by IATA and commonly used to identify a carrier. As the same code may have been assigned to different carriers over time, the code is not always unique. For analysis, use the Unique Carrier Code.
TailNum	Tail Number
FlightNum	Flight Number
OriginAirportID	Origin Airport, Airport ID. An identification number assigned by US DOT to identify a unique airport. Use this field for airport analysis across a range of years because an airport can change its airport code and airport codes can be reused.
OriginAirportSeqID	Origin Airport, Airport Sequence ID. An identification number assigned by US DOT to identify a unique airport at a given point of time. Airport attributes, such as airport name or coordinates, may change over time.
OriginCityMarketID	Origin Airport, City Market ID. City Market ID is an identification number assigned by US DOT to identify a city market. Use this field to consolidate airports serving the same city market.
Origin	Origin Airport
OriginCityName	Origin Airport, City Name
OriginState	Origin Airport, State Code
OriginStateFips	Origin Airport, State Fips
OriginStateName	Origin Airport, State Name
OriginWac	Origin Airport, World Area Code
DestAirportID	Destination Airport, Airport ID. An identification number assigned by US DOT to identify a unique airport. Use this field for airport analysis across a range of years because an airport can change its airport code and airport codes can be reused.
DestAirportSeqID	Destination Airport, Airport Sequence ID. An identification number assigned by US DOT to identify a unique airport at a given point of time. Airport attributes, such as airport name or coordinates, may change over time.
DestCityMarketID	Destination Airport, City Market ID. City Market ID is an identification number assigned by US DOT to identify a city market. Use this field to consolidate airports serving the same city market.
Dest	Destination Airport
DestCityName	Destination Airport, City Name
DestState	Destination Airport, State Code
DestStateFips	Destination Airport, State Fips
DestStateName	Destination Airport, State Name
DestWac	Destination Airport, World Area Code
CRSDepTime	CRS Departure Time (local time: hhmm)
DepTime	Actual Departure Time (local time: hhmm)
DepDelay	Difference in minutes between scheduled and actual departure time. Early departures show negative numbers.
DepDelayMinutes	Difference in minutes between scheduled and actual departure time. Early departures set to 0.
DepDel15	Departure Delay Indicator, 15 Minutes or More (1=Yes)
DepartureDelayGroups	Departure Delay intervals, every (15 minutes from <-15 to >180)
DepTimeBlk	CRS Departure Time Block, Hourly Intervals
TaxiOut	Taxi Out Time, in Minutes
WheelsOff	Wheels Off Time (local time: hhmm)

Column name	Explanation of Column Name and Codes
WheelsOn	Wheels On Time (local time: hhmm)
TaxiIn	Taxi In Time, in Minutes
CRSArrTime	CRS Arrival Time (local time: hhmm)
ArrTime	Actual Arrival Time (local time: hhmm)
ArrDelay	Difference in minutes between scheduled and actual arrival time. Early arrivals show negative numbers.
ArrDelayMinutes	Difference in minutes between scheduled and actual arrival time. Early arrivals set to 0.
ArrDel15	Arrival Delay Indicator, 15 Minutes or More (1=Yes)
ArrivalDelayGroups	Arrival Delay intervals, every (15-minutes from <-15 to >180)
ArrTimeBlk	CRS Arrival Time Block, Hourly Intervals
Cancelled	Cancelled Flight Indicator (1=Yes)
CancellationCode	Specifies The Reason For Cancellation
Diverted	Diverted Flight Indicator (1=Yes)
CRSElapsedTime	CRS Elapsed Time of Flight, in Minutes
ActualElapsedTime	Elapsed Time of Flight, in Minutes
AirTime	Flight Time, in Minutes
Flights	Number of Flights
Distance	Distance between airports (miles)
DistanceGroup	Distance Intervals, every 250 Miles, for Flight Segment
CarrierDelay	Carrier Delay, in Minutes
WeatherDelay	Weather Delay, in Minutes
NASDelay	National Air System Delay, in Minutes
SecurityDelay	Security Delay, in Minutes
LateAircraftDelay	Late Aircraft Delay, in Minutes
FirstDepTime	First Gate Departure Time at Origin Airport
TotalAddGTime	Total Ground Time Away from Gate for Gate Return or Cancelled Flight
LongestAddGTime	Longest Time Away from Gate for Gate Return or Cancelled Flight
DivAirportLandings	Number of Diverted Airport Landings
DivReachedDest	Diverted Flight Reaching Scheduled Destination Indicator (1=Yes)
DivActualElapsedTime	Elapsed Time of Diverted Flight Reaching Scheduled Destination, in Minutes. The ActualElapsedTime column remains NULL for all diverted flights.
DivArrDelay	Difference in minutes between scheduled and actual arrival time for a diverted flight reaching scheduled destination. The ArrDelay column remains NULL for all diverted flights.
DivDistance	Distance between scheduled destination and final diverted airport (miles). Value will be 0 for diverted flight reaching scheduled destination.
Div1Airport	Diverted Airport Code1
Div1AirportID	Airport ID of Diverted Airport 1. Airport ID is a Unique Key for an Airport
Div1AirportSeqID	Airport Sequence ID of Diverted Airport 1. Unique Key for Time Specific Information for an Airport
Div1WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code1
Div1TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code1
Div1LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code1
Div1WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code1
Div1TailNum	Aircraft Tail Number for Diverted Airport Code1
Div2Airport	Diverted Airport Code2
Div2AirportID	Airport ID of Diverted Airport 2. Airport ID is a Unique Key for an Airport
Div2AirportSeqID	Airport Sequence ID of Diverted Airport 2. Unique Key for Time Specific Information for an Airport
Div2WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code2
Div2TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code2

Column name	Explanation of Column Name and Codes
Div2LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code2
Div2WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code2
Div2TailNum	Aircraft Tail Number for Diverted Airport Code2
Div3Airport	Diverted Airport Code3
Div3AirportID	Airport ID of Diverted Airport 3. Airport ID is a Unique Key for an Airport
Div3AirportSeqID	Airport Sequence ID of Diverted Airport 3. Unique Key for Time Specific Information for an Airport
Div3WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code3
Div3TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code3
Div3LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code3
Div3WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code3
Div3TailNum	Aircraft Tail Number for Diverted Airport Code3
Div4Airport	Diverted Airport Code4
Div4AirportID	Airport ID of Diverted Airport 4. Airport ID is a Unique Key for an Airport
Div4AirportSeqID	Airport Sequence ID of Diverted Airport 4. Unique Key for Time Specific Information for an Airport
Div4WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code4
Div4TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code4
Div4LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code4
Div4WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code4
Div4TailNum	Aircraft Tail Number for Diverted Airport Code4
Div5Airport	Diverted Airport Code5
Div5AirportID	Airport ID of Diverted Airport 5. Airport ID is a Unique Key for an Airport
Div5AirportSeqID	Airport Sequence ID of Diverted Airport 5. Unique Key for Time Specific Information for an Airport
Div5WheelsOn	Wheels On Time (local time: hhmm) at Diverted Airport Code5
Div5TotalGTime	Total Ground Time Away from Gate at Diverted Airport Code5
Div5LongestGTime	Longest Ground Time Away from Gate at Diverted Airport Code5
Div5WheelsOff	Wheels Off Time (local time: hhmm) at Diverted Airport Code5
Div5TailNum	Aircraft Tail Number for Diverted Airport Code5

3.3 Explore Data

3.3.1 Data Exploration Report

This report will be part of the following documents:

- Preliminary Report
- Final Paper

3.4 Verify Data Quality

3.4.1 Data Quality Report

This report will be part of the following documents:

- Preliminary Report
- Final Paper

4 Contributors

Student: Gábor Horváth
Mentor: Gergely Daróczi

Contents

References

Shearer, Colin. 2000. “The Crisp-Dm Model - the New Blueprint for Data Mining.” Journal of Data Warehousing 5 (4): 13–22.

13 Appendix 4 - Estimate of Resource Needs

The following pages contain the Estimate of Resource Needs, which is the third deliverable described as the “Students estimates the resource needs of the project. Who needs to be involved? What time do they need to devote to the project? Any new software or data needs to purchased?” in the final project requirements.

Estimate of resource needs of the Final Paper

for the CEU MSc in Business Analytics program

Gábor Horváth

2017

1 Human resource needs

1.1 Stakeholders & people to involve

As this final paper is a pet project, there is no actual business management behind the requirements, therefore no business stakeholders are identified and involved. The completion of the project requires feedback and guidance from the mentor (Gergely Daroczi), but no other person (or role) needs to be involved.

1.2 Dedication for the project

There are no additional time dedication requirements identified above the requirements stated by CEU in the Final Project description document.

1.3 Training requirements

As stated earlier no additional organized / official training requirements are required above the trainings received during the courses in the program. There are tools and techniques used to fulfill the project, which have not been described in the program at CEU. There are several useful user manuals available on the webpages of the creators of the tools, which would enable the use of these tools and resources for any student who have been part of the program.

2 Software and data resource needs

2.1 Tools & resources used

As stated earlier, fulfilling the completion need for the project the following tools are planned to be used:

- Programming language:
  - R: https://www.r-project.org/
- IDE for the programming language:
  - RStudio: https://www.rstudio.com/
- Documentation is created using:
  - knitr: https://yihui.name/knitr/
  - MiKTeX: https://miktex.org/
  - ReporteRs: https://cran.r-project.org/web/packages/ReporteRs/index.html
- Data visualization:
  - ggplot2: http://ggplot2.org/
- Data manipulation:
  - access2csv: https://github.com/AccelerationNet/access2csv
  - dtplyr: https://cran.r-project.org/web/packages/dtplyr/index.html
- Project plan / task management:
  - Buckets: https://www.buckets.co/
- Source code repository:
  - GitHub: https://github.com/

Note: The list above do not contain the list of all the tools and packages used to create the project, but the full list will be provided in the source code.

2.2 Data sources

As stated earlier, the project will use the following data provided by multiple US government agencies:

- Federal Aviation Administration: Wildlife Strike Database
- United States Department of Transportation: Bureau of Transportation Statistics

Note: In case data enrichment would be required for the successful risk modelling, additional data sources might be used as well. These possible additional data sources will be listed in the Final Paper.

3 Contributors

Student: Gábor Horváth
Mentor: Gergely Daróczi

14 Appendix 5 - Full Data Exploration Report (1990-2016)

14.1 Data Exploration Report (1990 - 2016)

14.1.1 Animal Strike Data (1990 - 2016)

The first summary table shows the number of distinct items for each year regarding the Airline operators, Aircraft, Aircraft types, Aircraft mass types, and Engine types, which have been reported as being affected in an animal strike. (Please note that the data for 2016 is available until 30-4-2016.)

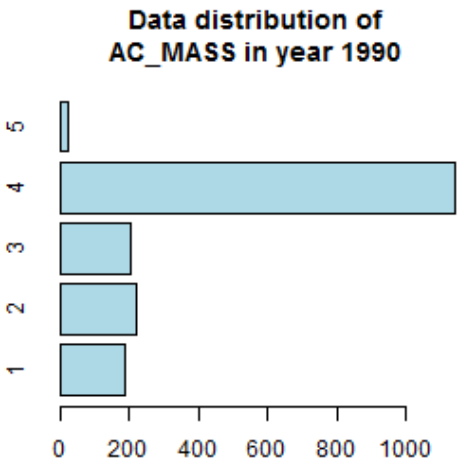
Year	# of reports	Operators	Aircraft	Aircraft type	Aircraft mass type	Engine type
1990	1847	316	329	4	5	9
1991	2388	316	329	4	5	9
1992	2566	316	329	4	5	9
1993	2575	316	329	4	5	9
1994	2635	316	329	4	5	9
1995	2768	316	329	4	5	9
1996	2936	316	329	4	5	9
1997	3455	316	329	4	5	9
1998	3799	316	329	4	5	9
1999	5113	316	329	4	5	9
2000	6000	353	394	3	5	9
2001	5820	353	394	3	5	9
2002	6225	353	394	3	5	9
2003	6002	353	394	3	5	9
2004	6561	353	394	3	5	9
2005	7227	353	394	3	5	9
2006	7240	353	394	3	5	9
2007	7745	353	394	3	5	9
2008	7632	353	394	3	5	9
2009	9508	353	394	3	5	9
2010	9904	281	392	4	5	10
2011	10115	281	392	4	5	10
2012	10905	281	392	4	5	10
2013	11403	281	392	4	5	10
2014	13692	281	392	4	5	10
2015	13167	281	392	4	5	10
2016	1391	281	392	4	5	10

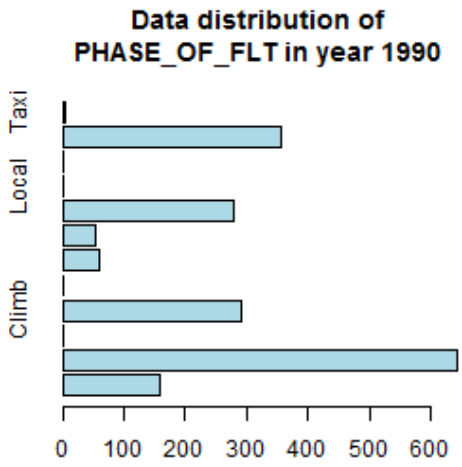
The second summary table shows the number of distinct items for each year regarding the Time of day, Airports, States, Phase of flight, weather conditions (Sky and Precipitation), and the flag for showing if the pilot has been warned or not about birds / wildlife in the reports. (Please note that the data for 2016 is available until 30-4-2016.)

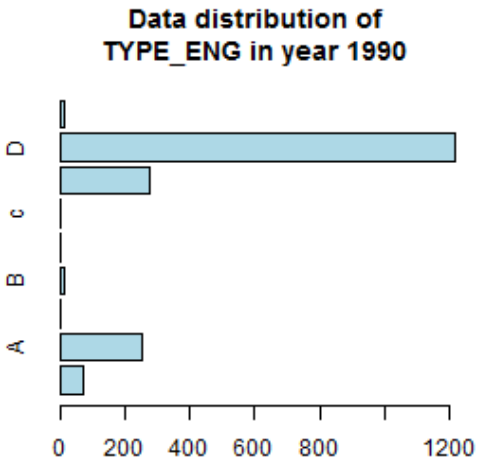
Year	Time of day	Airports	States	Phase of flight	Sky	Precipitation	Warned
1990	5	1175	61	12	7	8	4
1991	5	1175	61	12	7	8	4
1992	5	1175	61	12	7	8	4
1993	5	1175	61	12	7	8	4
1994	5	1175	61	12	7	8	4
1995	5	1175	61	12	7	8	4
1996	5	1175	61	12	7	8	4
1997	5	1175	61	12	7	8	4

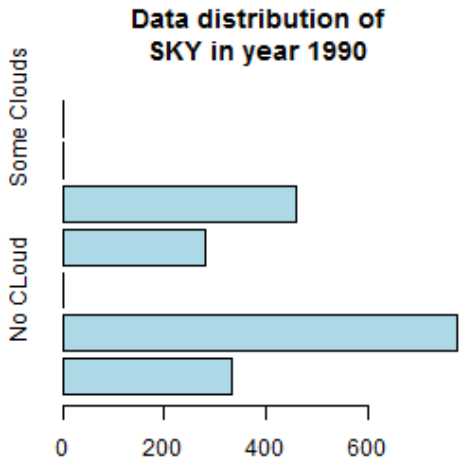
Year	Time of day	Airports	States	Phase of flight	Sky	Precipitation	Warned
1998	5	1175	61	12	7	8	4
1999	5	1175	61	12	7	8	4
2000	7	1499	63	12	5	9	5
2001	7	1499	63	12	5	9	5
2002	7	1499	63	12	5	9	5
2003	7	1499	63	12	5	9	5
2004	7	1499	63	12	5	9	5
2005	7	1499	63	12	5	9	5
2006	7	1499	63	12	5	9	5
2007	7	1499	63	12	5	9	5
2008	7	1499	63	12	5	9	5
2009	7	1499	63	12	5	9	5
2010	5	1497	63	12	4	9	5
2011	5	1497	63	12	4	9	5
2012	5	1497	63	12	4	9	5
2013	5	1497	63	12	4	9	5
2014	5	1497	63	12	4	9	5
2015	5	1497	63	12	4	9	5
2016	5	1497	63	12	4	9	5

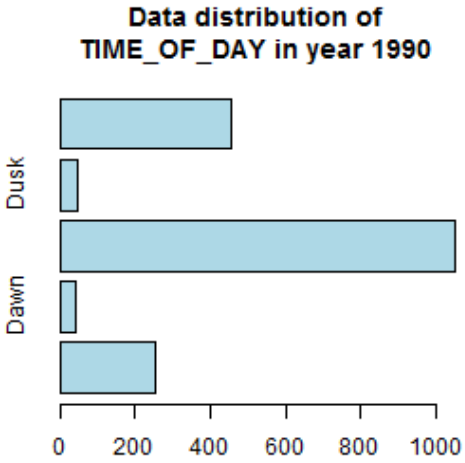
The following graphs show the distributions of some of the selected distinct items summarized in the tables above.

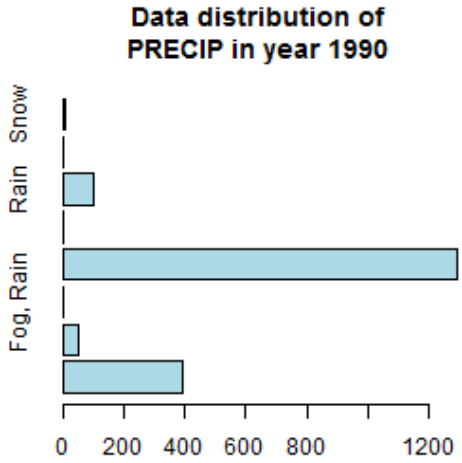

Data distribution of
AC_MASS in year 1990
5
4
3
2
1
0
200
400
600
800
1000

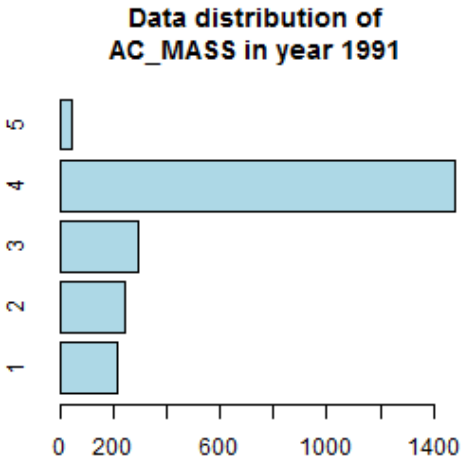

Data distribution of
PHASE_OF_FLT in year 1990
Taxi
Local
Climb
0
100
200
300
400
500
600

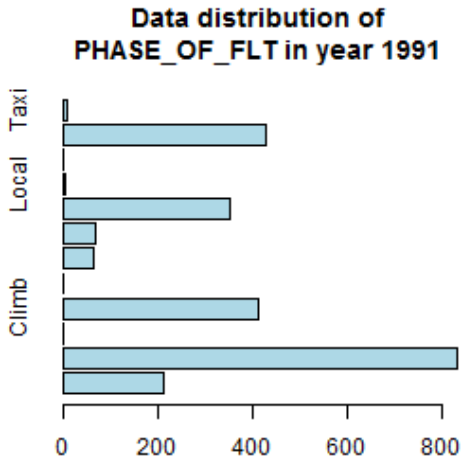

Data distribution of
TYPE_ENG in year 1990
D
c
B
A
0
200
400
600
800
1200

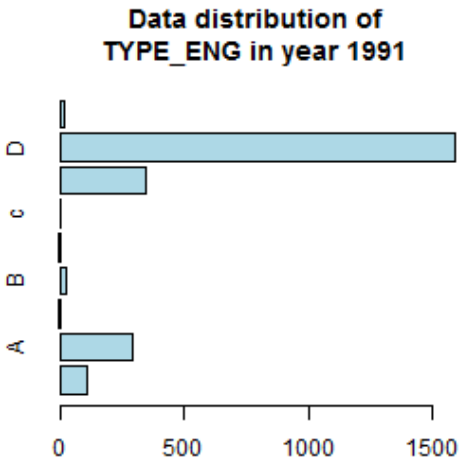

Data distribution of
SKY in year 1990
Some Clouds
No CLoud
0
200
400
600

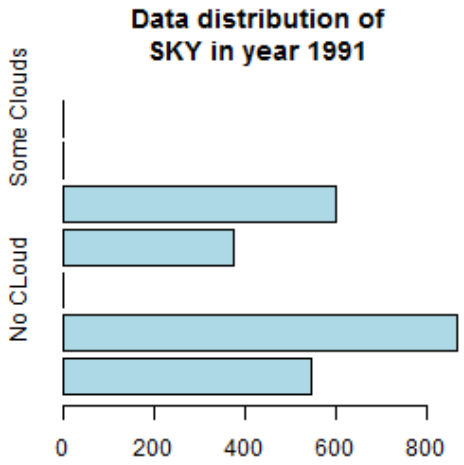

Data distribution of
TIME_OF_DAY in year 1990
Dusk
Dawn
0
200
400
600
800
1000

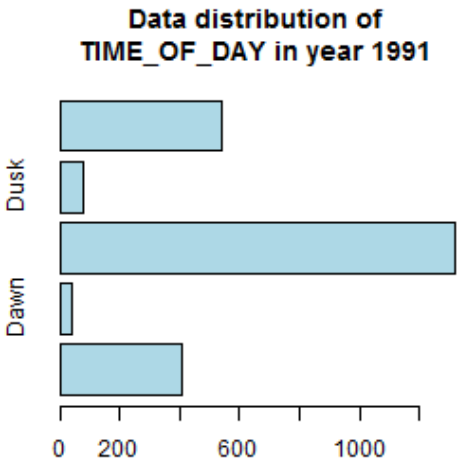

Data distribution of
PRECIP in year 1990
Snow
Rain
Fog, Rain
0
200
400
600
800
1200

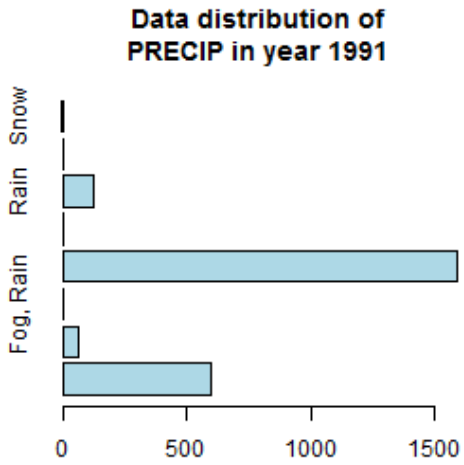

Data distribution of
AC_MASS in year 1991
5
4
3
2
1
0
200
600
1000
1400

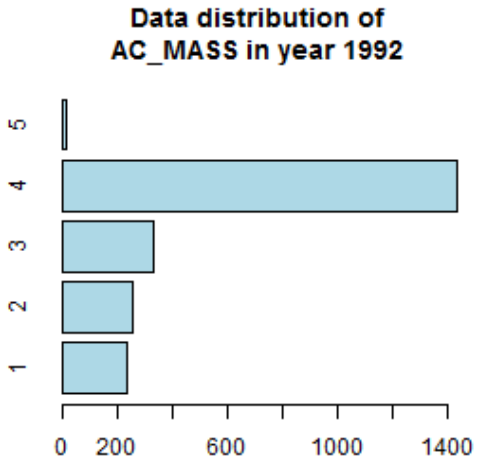

Data distribution of
PHASE_OF_FLT in year 1991
Taxi
Local
Climb
0
200
400
600
800


Data distribution of
TYPE_ENG in year 1991
D
c
B
A
0
500
1000
1500


Data distribution of
SKY in year 1991
Some Clouds
No CLoud
0
200
400
600
800


Data distribution of
TIME_OF_DAY in year 1991
Dusk
Dawn
0
200
600
1000


Data distribution of
PRECIP in year 1991
Snow
Rain
Fog, Rain
0
500
1000
1500


Data distribution of
AC_MASS in year 1992
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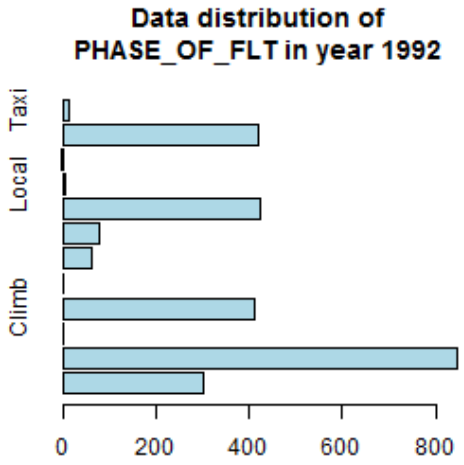
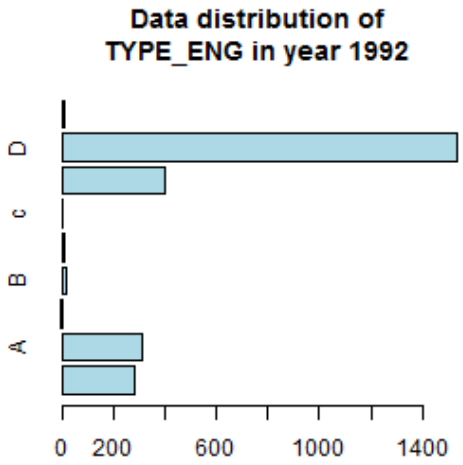
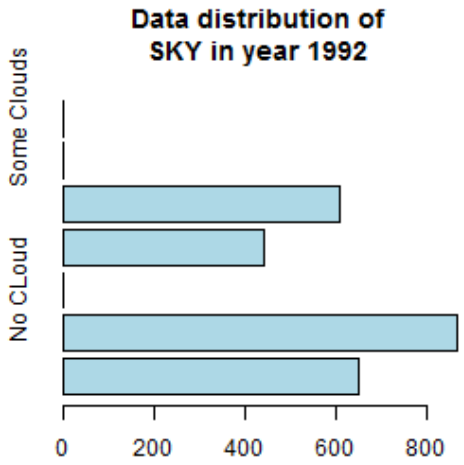
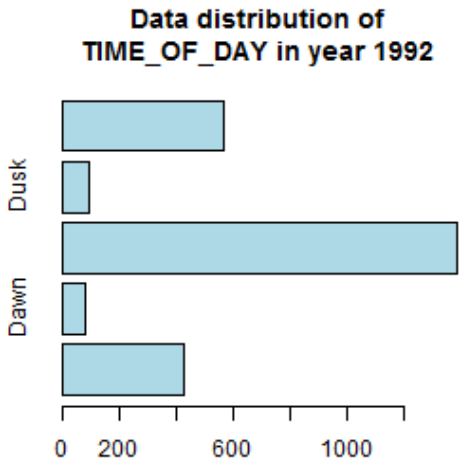
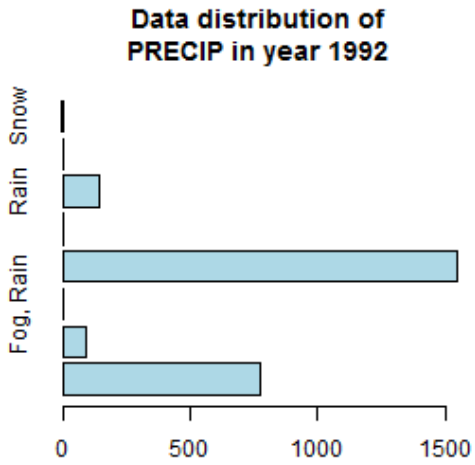
4
3
2
1
0
200
600
1000
1400

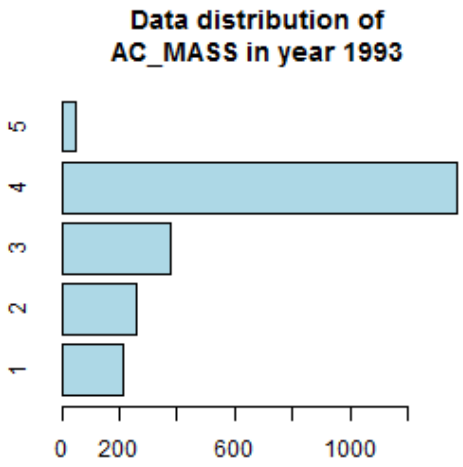

Data distribution of
PHASE_OF_FLT in year 1992
Taxi
Local
Climb
0
200
400
600
800


Data distribution of
TYPE_ENG in year 1992
D
c
B
A
0
200
600
1000
1400


Data distribution of
SKY in year 1992
Some Clouds
No CLoud
0
200
400
600
800


Data distribution of
TIME_OF_DAY in year 1992
Dusk
Dawn
0
200
600
1000


Data distribution of
PRECIP in year 1992
Snow
Rain
Fog, Rain
0
500
1000
1500


Data distribution of
AC_MASS in year 1993
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4
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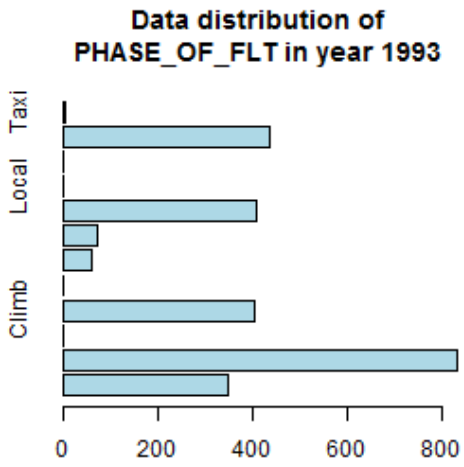
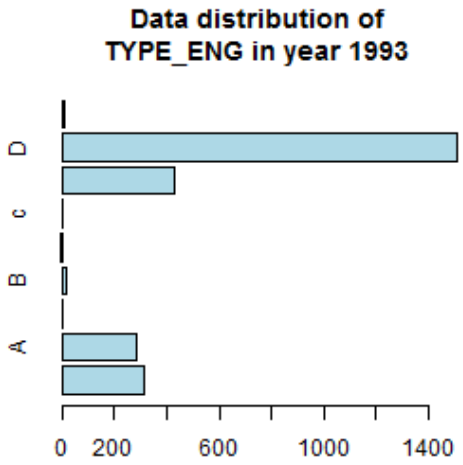
2
1
0
200
600
1000


Data distribution of
PHASE_OF_FLT in year 1993
Taxi
Local
Climb
0
200
400
600
800


Data distribution of
TYPE_ENG in year 1993
D
c
B
A
0
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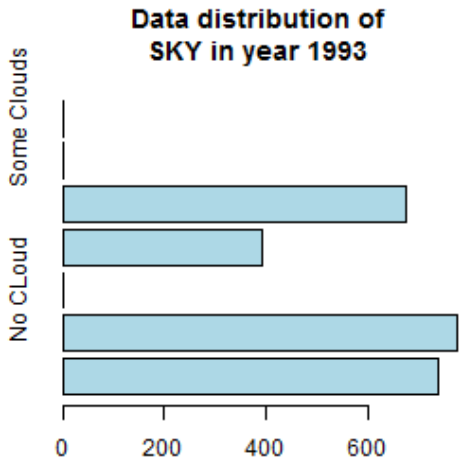
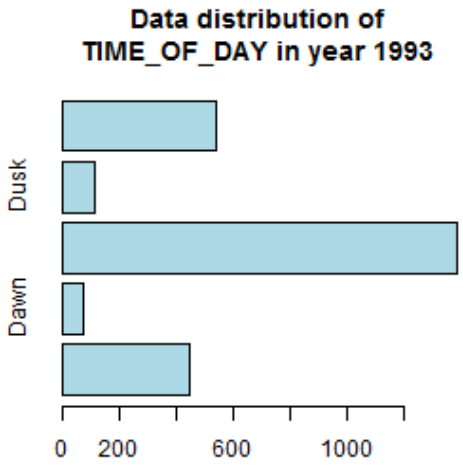
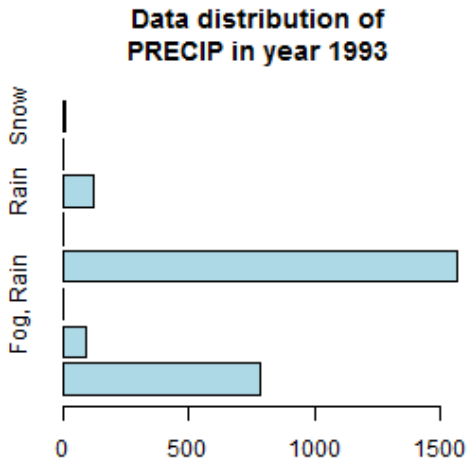
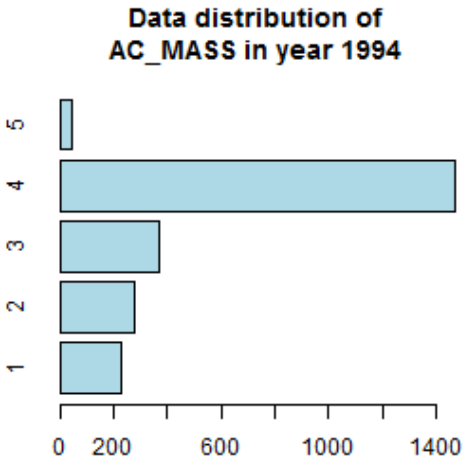
600
1000
1400


Data distribution of
SKY in year 1993
Some Clouds
No CLoud
0
200
400
600


Data distribution of
TIME_OF_DAY in year 1993
Dusk
Dawn
0
200
600
1000


Data distribution of
PRECIP in year 1993
Snow
Rain
Fog, Rain
0
500
1000
1500


Data distribution of
AC_MASS in year 1994
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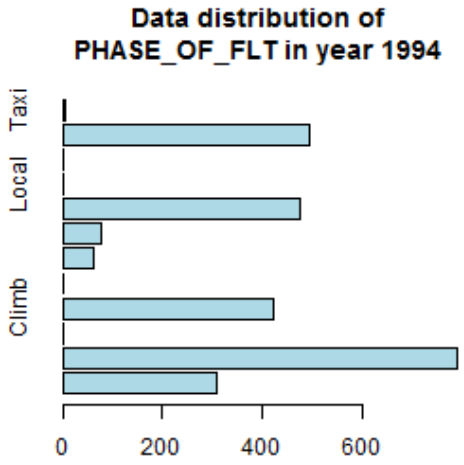
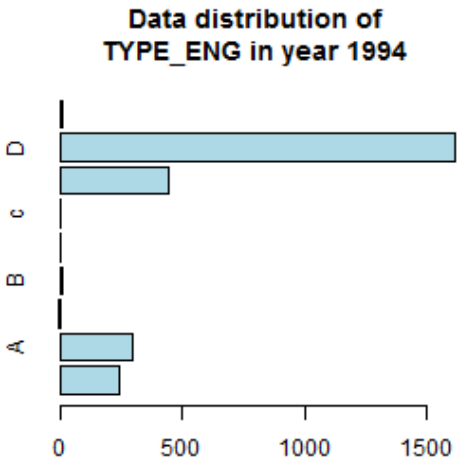
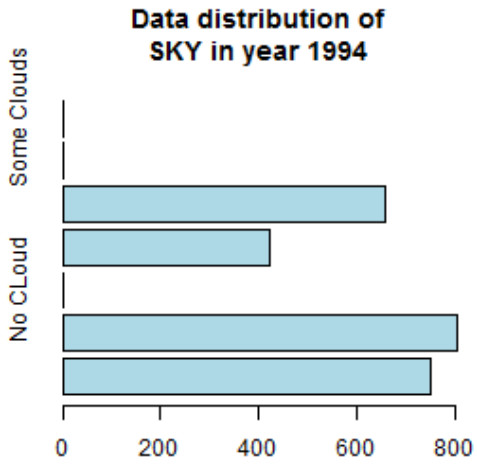
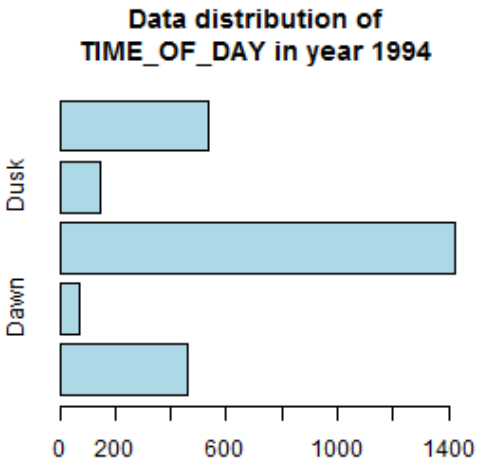
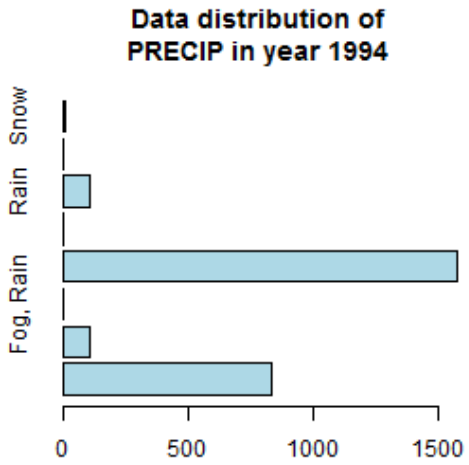
4
3
2
1
0
200
600
1000
1400

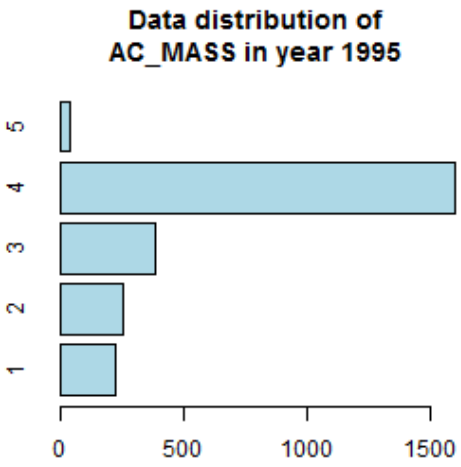

Data distribution of
PHASE_OF_FLT in year 1994
Taxi
Local
Climb
0
200
400
600


Data distribution of
TYPE_ENG in year 1994
D
c
B
A
0
500
1000
1500


Data distribution of
SKY in year 1994
Some Clouds
No CLoud
0
200
400
600
800


Data distribution of
TIME_OF_DAY in year 1994
Dusk
Dawn
0
200
600
1000
1400


Data distribution of
PRECIP in year 1994
Snow
Rain
Fog, Rain
0
500
1000
1500


Data distribution of
AC_MASS in year 1995
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4
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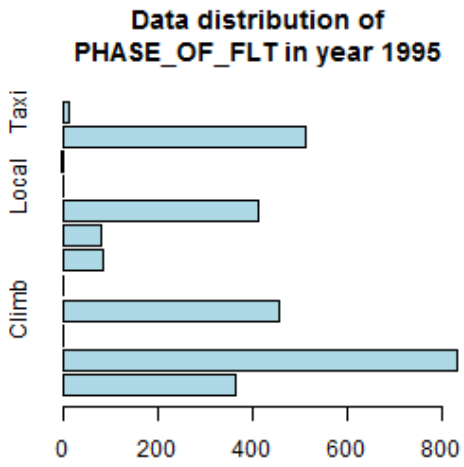
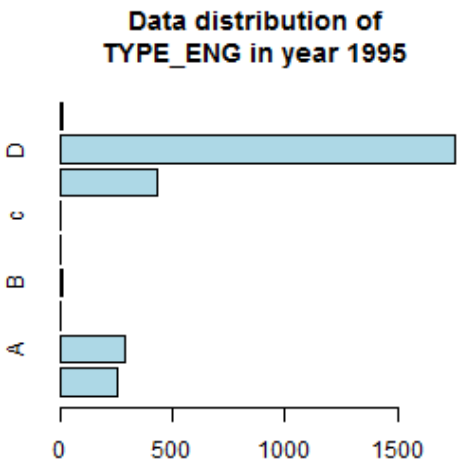
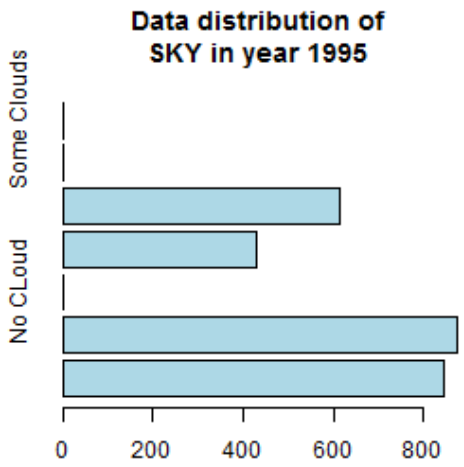
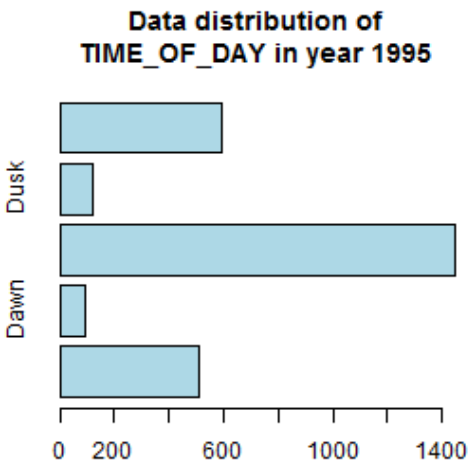
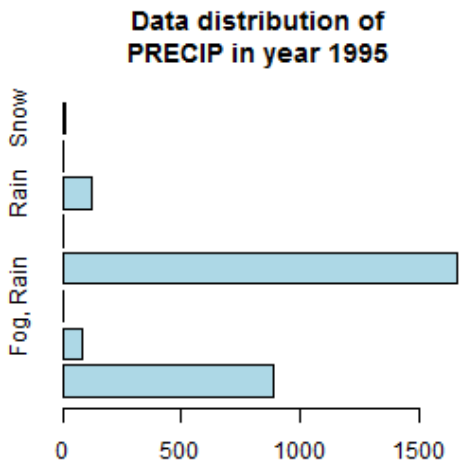
2
1
0
500
1000
1500

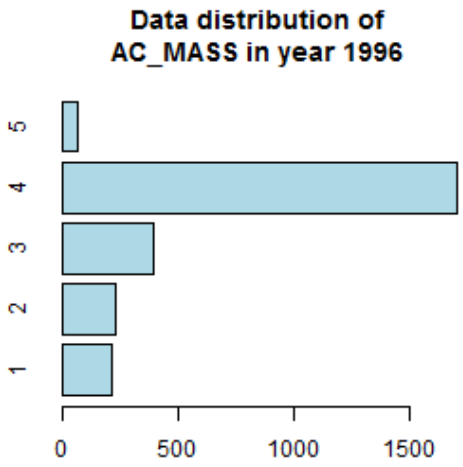

Data distribution of
PHASE_OF_FLT in year 1995
Taxi
Local
Climb
0
200
400
600
800

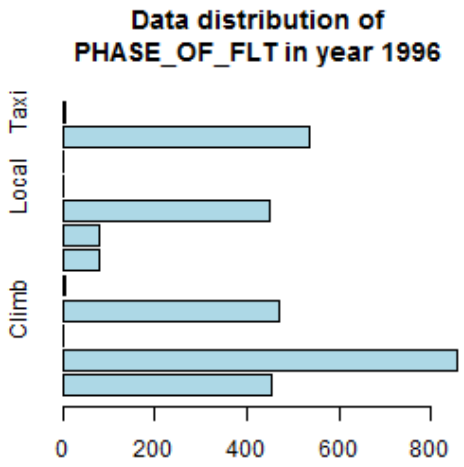

Data distribution of
TYPE_ENG in year 1995
D
c
B
A
0
500
1000
1500

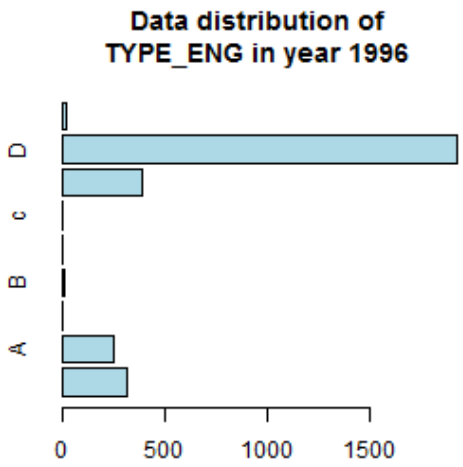

Data distribution of
SKY in year 1995
Some Clouds
No CLoud
0
200
400
600
800

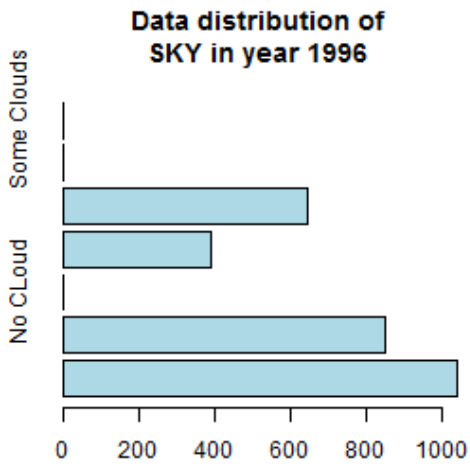

Data distribution of
TIME_OF_DAY in year 1995
Dusk
Dawn
0
200
600
1000
1400

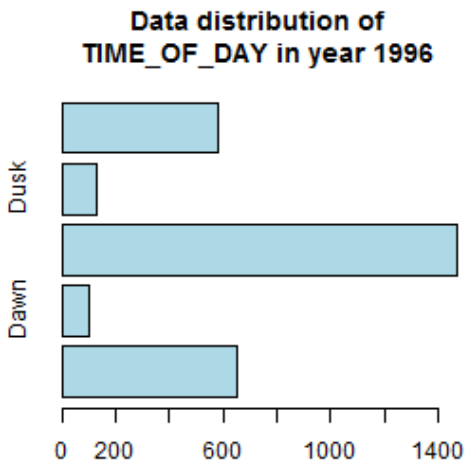

Data distribution of
PRECIP in year 1995
Snow
Rain
Fog, Rain
0
500
1000
1500

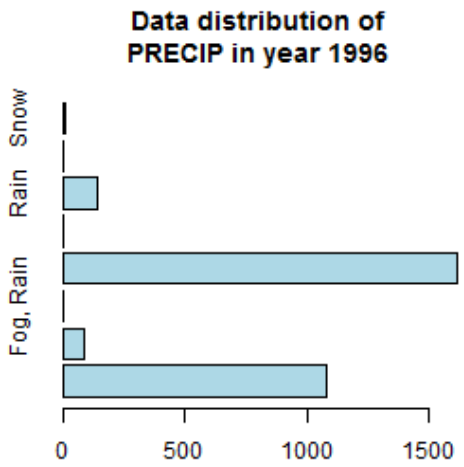

Data distribution of
AC_MASS in year 1996
5
4
3
2
1
0
500
1000
1500

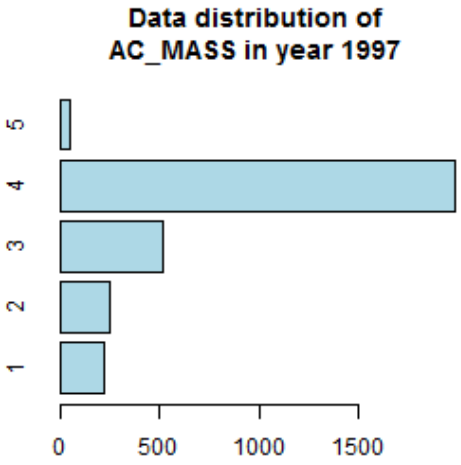

Data distribution of
PHASE_OF_FLT in year 1996
Taxi
Local
Climb
0
200
400
600
800

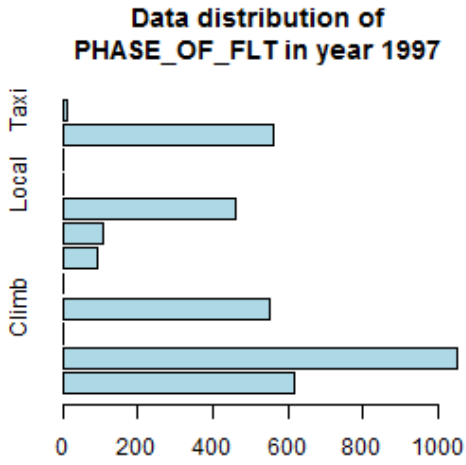

Data distribution of
TYPE_ENG in year 1996
D
c
B
A
0
500
1000
1500

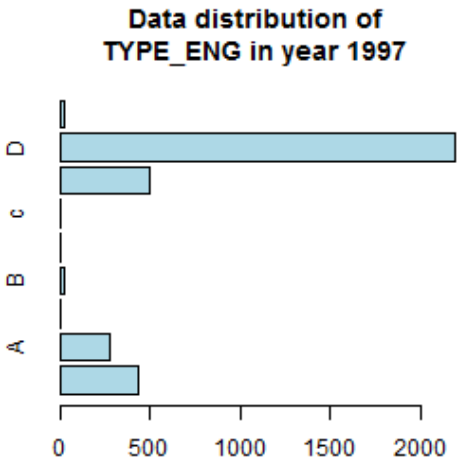

Data distribution of
SKY in year 1996
Some Clouds
No CLoud
0
200
400
600
800
1000

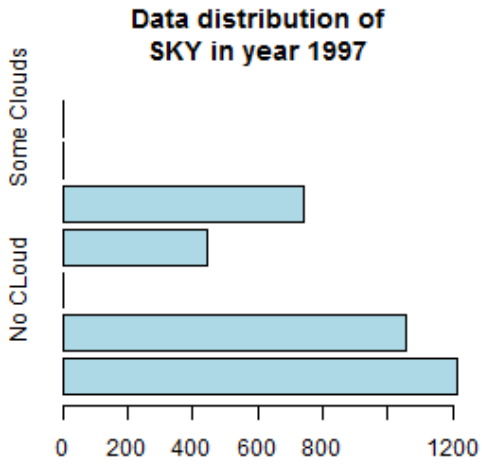

Data distribution of
TIME_OF_DAY in year 1996
Dusk
Dawn
0
200
600
1000
1400

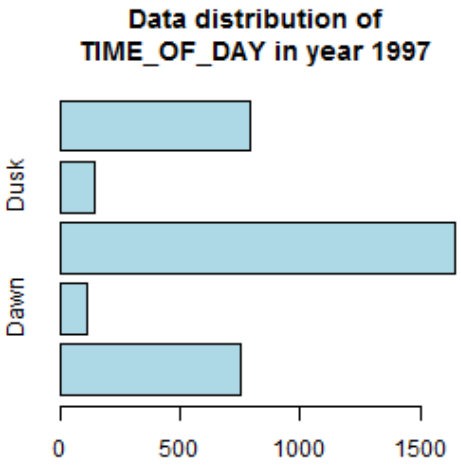

Data distribution of
PRECIP in year 1996
Snow
Rain
Fog, Rain
0
500
1000
1500

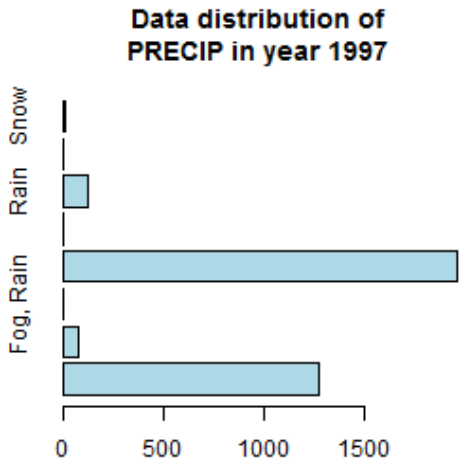

Data distribution of
AC_MASS in year 1997
5
4
3
2
1
0
500
1000
1500

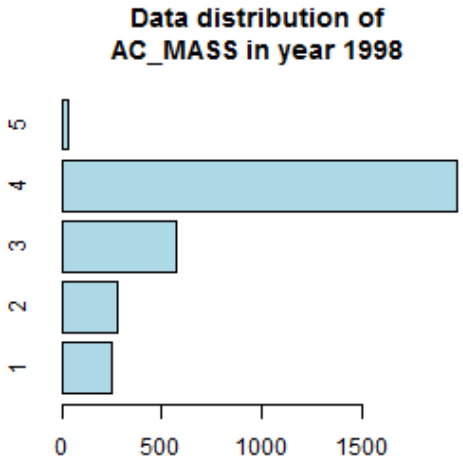

Data distribution of
PHASE_OF_FLT in year 1997
Taxi
Local
Climb
0
200
400
600
800
1000

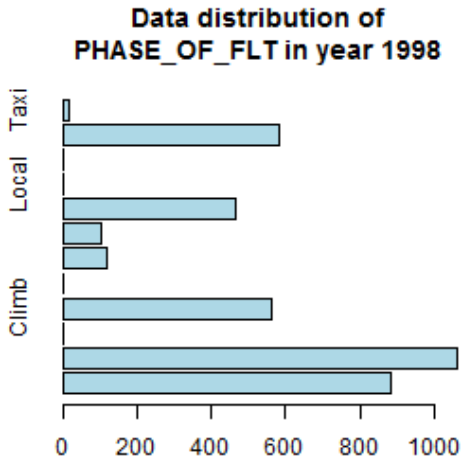

Data distribution of
TYPE_ENG in year 1997
D
c
B
A
0
500
1000
1500
2000

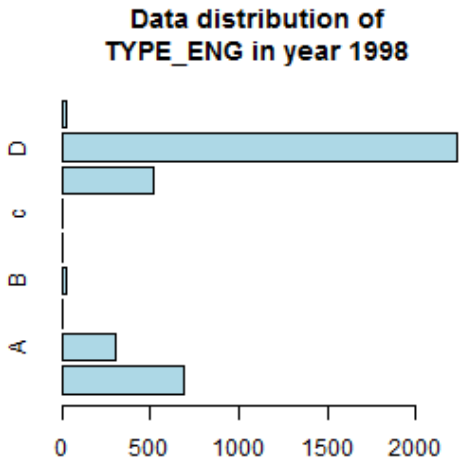

Data distribution of
SKY in year 1997
Some Clouds
No CLoud
0
200
400
600
800
1200

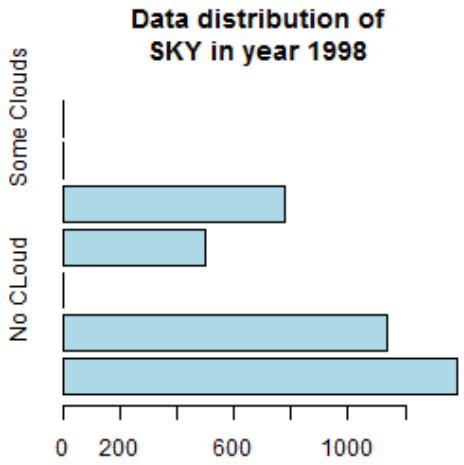

Data distribution of
TIME_OF_DAY in year 1997
Dusk
Dawn
0
500
1000
1500

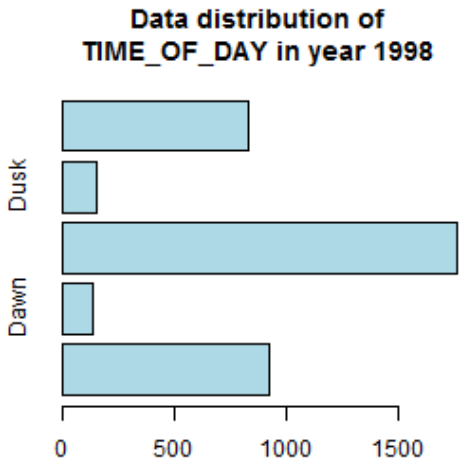

Data distribution of
PRECIP in year 1997
Snow
Rain
Fog, Rain
0
500
1000
1500

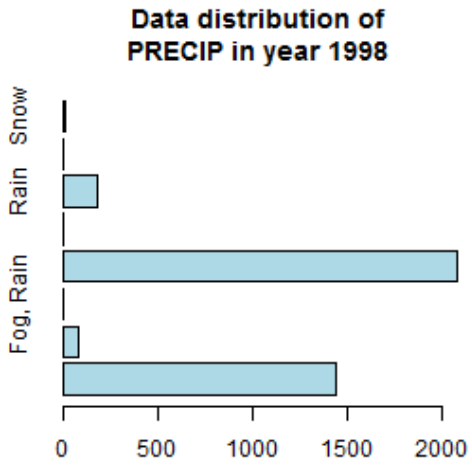

Data distribution of
AC_MASS in year 1998
5
4
3
2
1
0
500
1000
1500

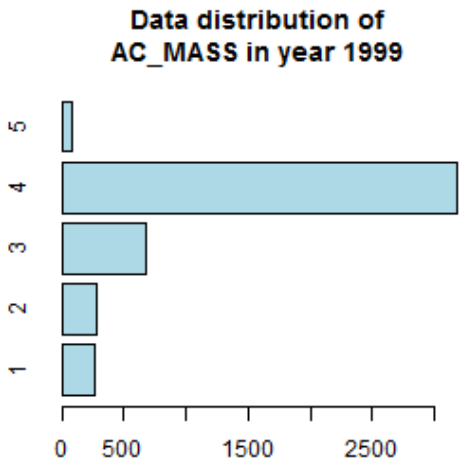

Data distribution of
PHASE_OF_FLT in year 1998
Taxi
Local
Climb
0
200
400
600
800
1000

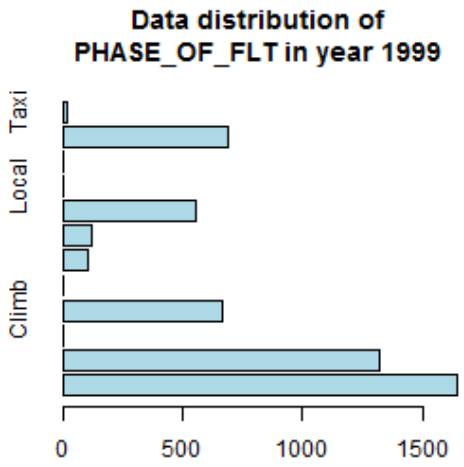

Data distribution of
TYPE_ENG in year 1998
D
c
B
A
0
500
1000
1500
2000

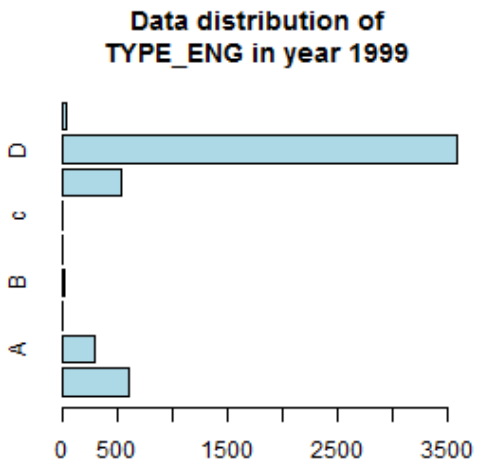

Data distribution of
SKY in year 1998
Some Clouds
No CLoud
0
200
600
1000

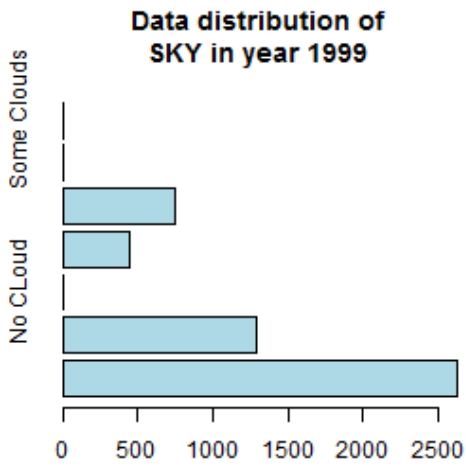

Data distribution of
TIME_OF_DAY in year 1998
Dusk
Dawn
0
500
1000
1500

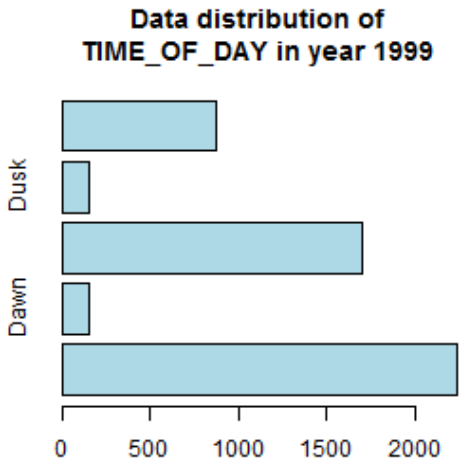

Data distribution of
PRECIP in year 1998
Snow
Rain
Fog, Rain
0
500
1000
1500
2000

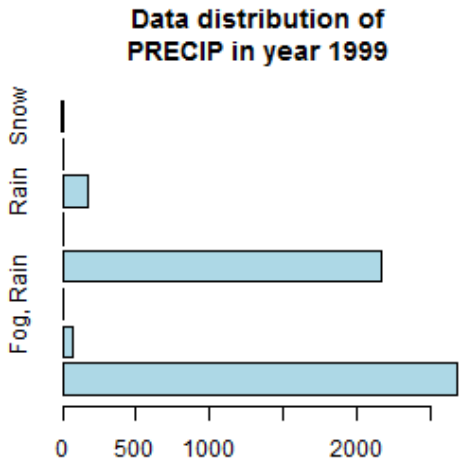

Data distribution of
AC_MASS in year 1999
5
4
3
2
1
0
500
1500
2500

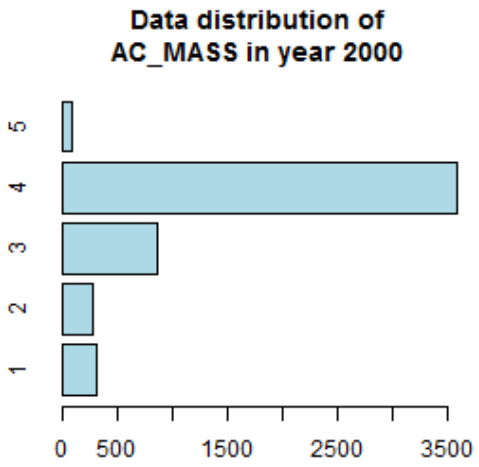

Data distribution of
PHASE_OF_FLT in year 1999
Taxi
Local
Climb
0
500
1000
1500

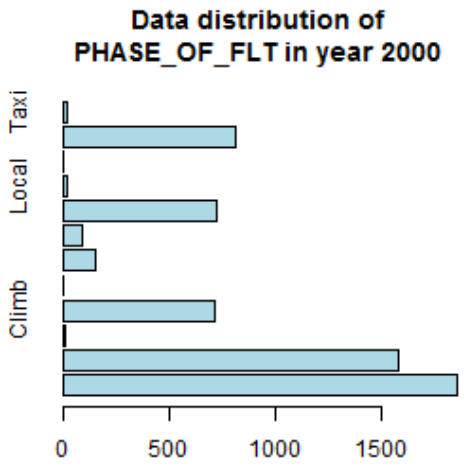

Data distribution of
TYPE_ENG in year 1999
D
c
B
A
0
500
1500
2500
3500

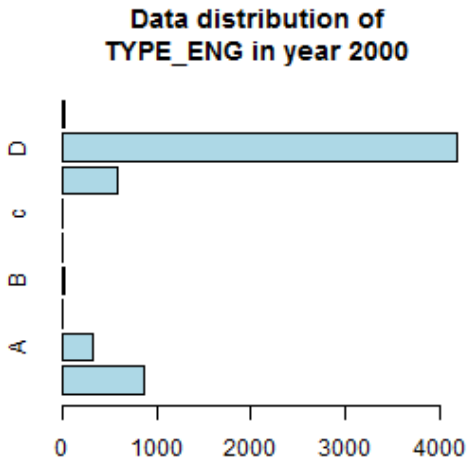

Data distribution of
SKY in year 1999
Some Clouds
No CLoud
0
500
1000
1500
2000
2500

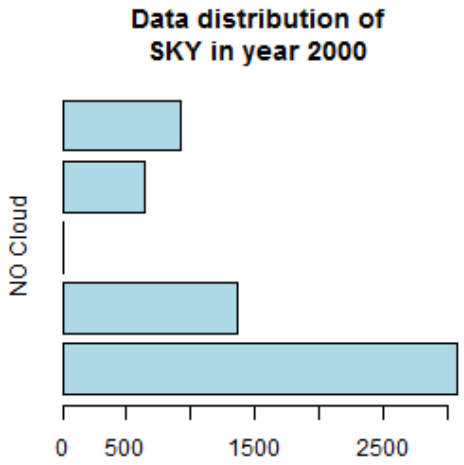

Data distribution of
TIME_OF_DAY in year 1999
Dusk
Dawn
0
500
1000
1500
2000

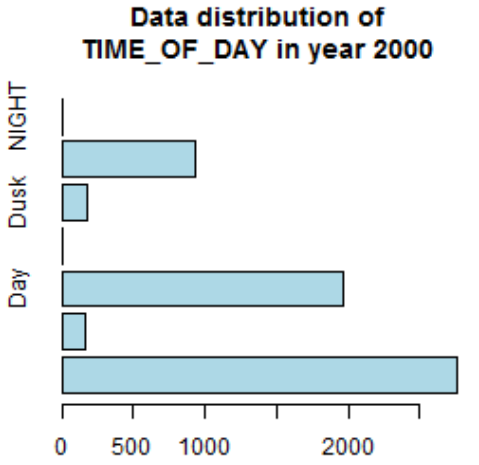

Data distribution of
PRECIP in year 1999
Snow
Rain
Fog, Rain
0
500
1000
2000

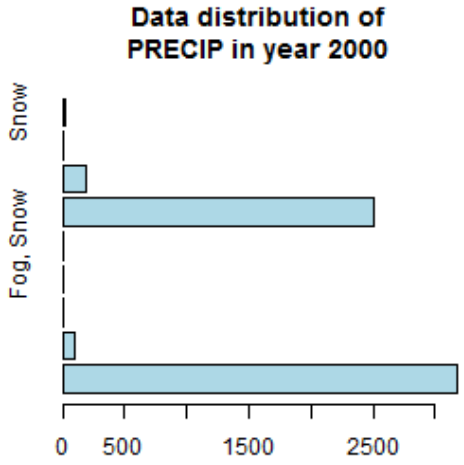

Data distribution of
AC_MASS in year 2000
5
4
3
2
1
0
500
1500
2500
3500

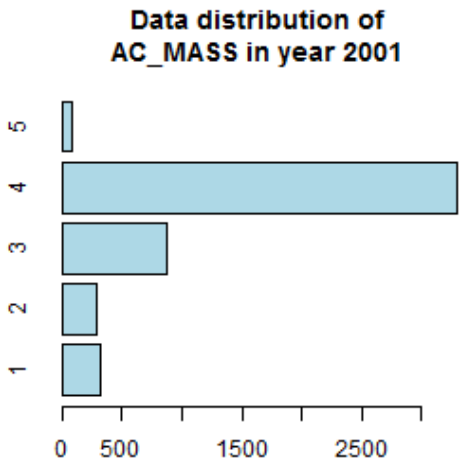

Data distribution of
PHASE_OF_FLT in year 2000
Taxi
Local
Climb
0
500
1000
1500

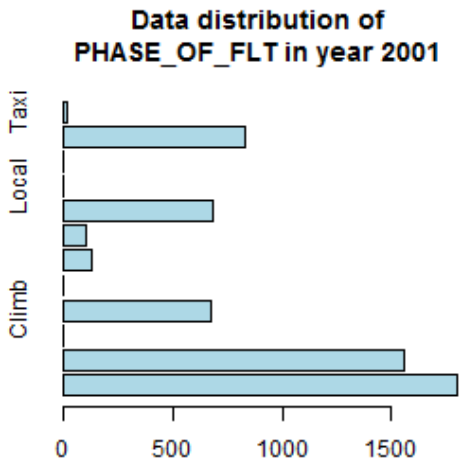

Data distribution of
TYPE_ENG in year 2000
D
c
B
A
0
1000
2000
3000
4000

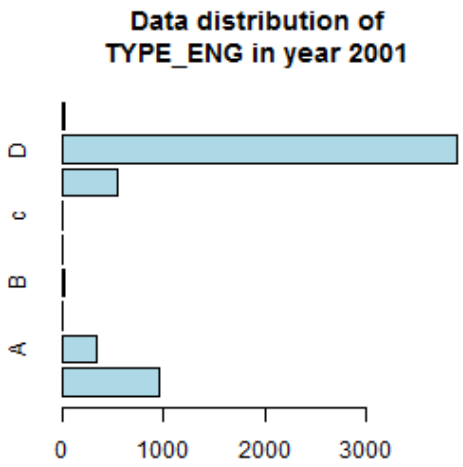

Data distribution of
SKY in year 2000
NO Cloud
0
500
1500
2500

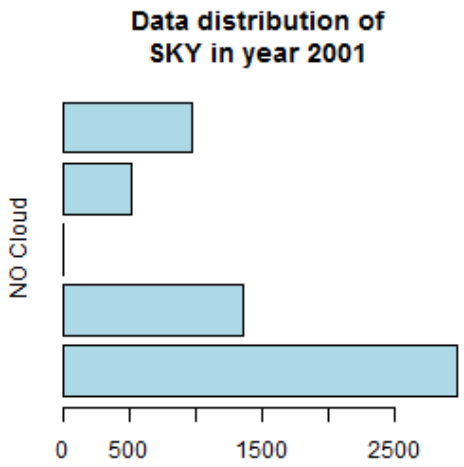

Data distribution of
TIME_OF_DAY in year 2000
NIGHT
Dusk
Day
0
500
1000
2000

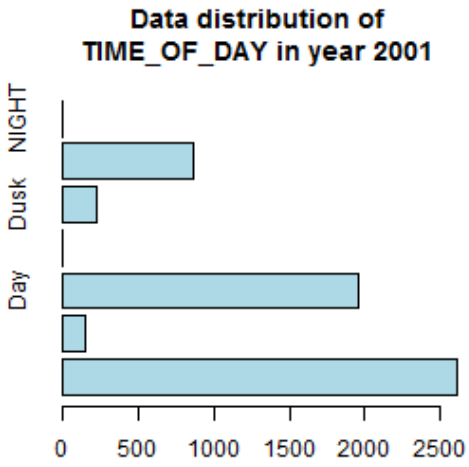

Data distribution of
PRECIP in year 2000
Snow
Fog, Snow
0
500
1500
2500

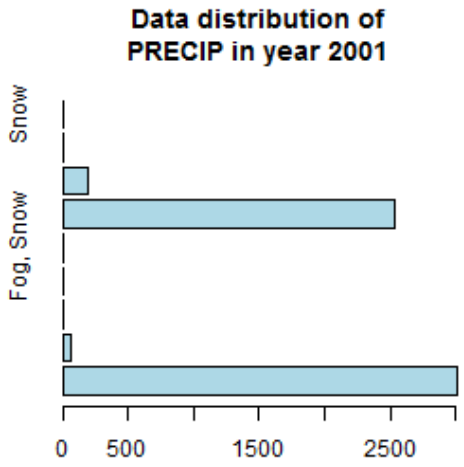

Data distribution of
AC_MASS in year 2001
5
4
3
2
1
0
500
1500
2500

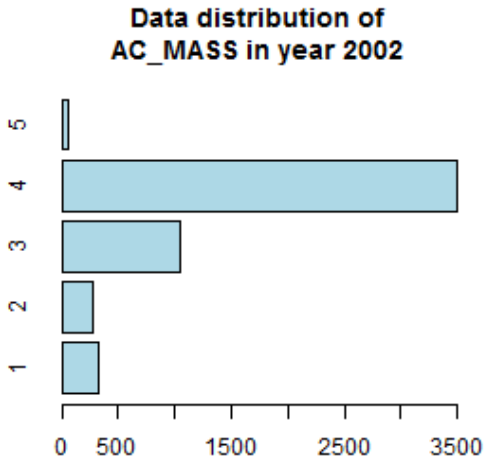

Data distribution of
PHASE_OF_FLT in year 2001
Taxi
Local
Climb
0
500
1000
1500

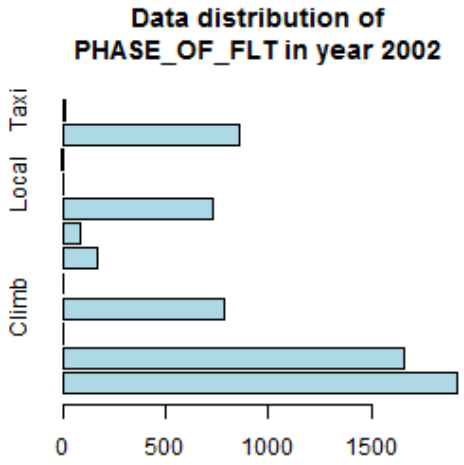

Data distribution of
TYPE_ENG in year 2001
D
c
B
A
0
1000
2000
3000

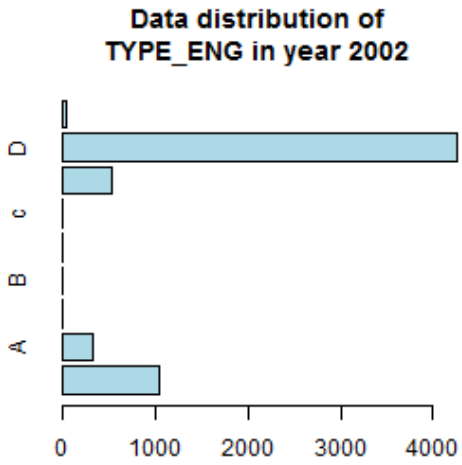

Data distribution of
SKY in year 2001
NO Cloud
0
500
1500
2500

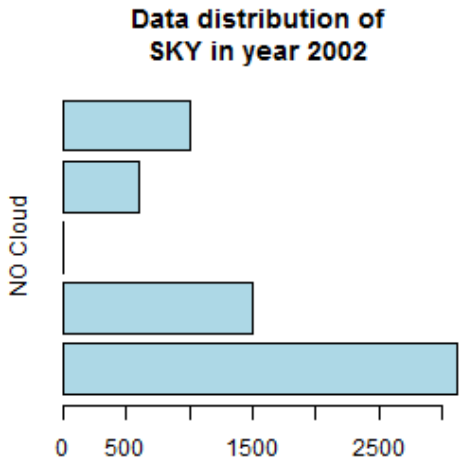

Data distribution of
TIME_OF_DAY in year 2001
NIGHT
Dusk
Day
0
500
1000
1500
2000
2500

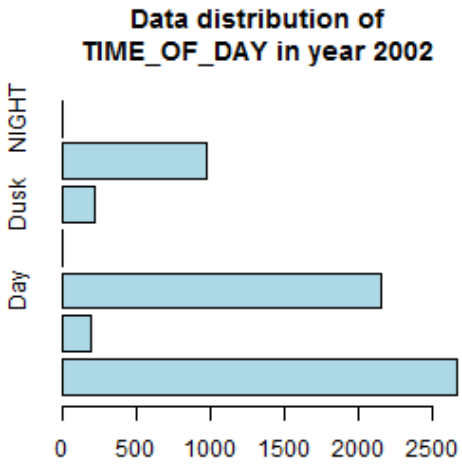

Data distribution of
PRECIP in year 2001
Snow
Fog, Snow
0
500
1500
2500

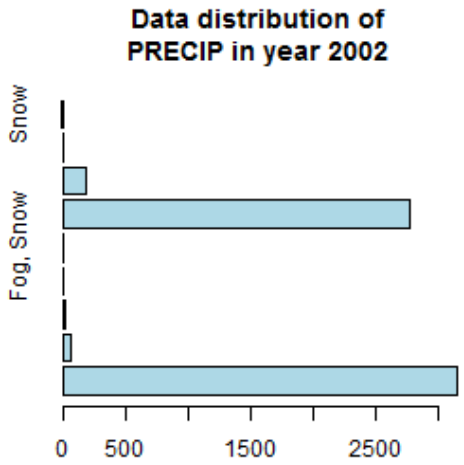

Data distribution of
AC_MASS in year 2002
5
4
3
2
1
0
500
1500
2500
3500

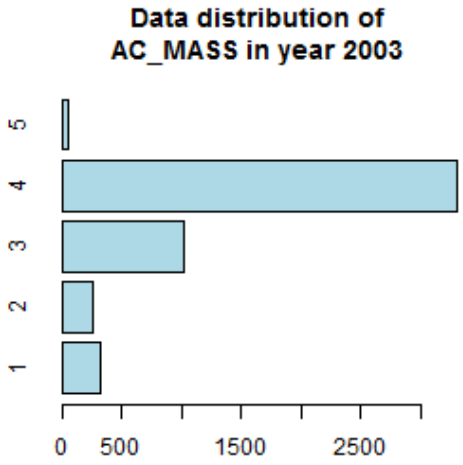

Data distribution of
PHASE_OF_FLT in year 2002
Taxi
Local
Climb
0
500
1000
1500

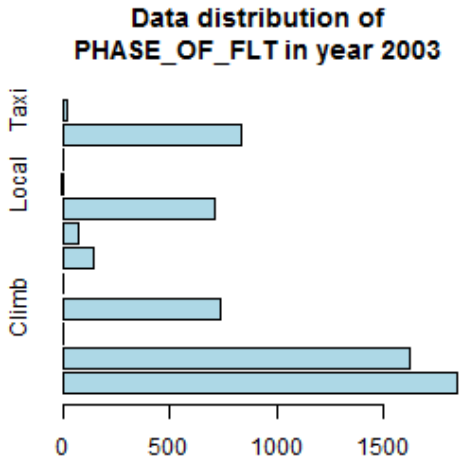

Data distribution of
TYPE_ENG in year 2002
D
c
B
A
0
1000
2000
3000
4000

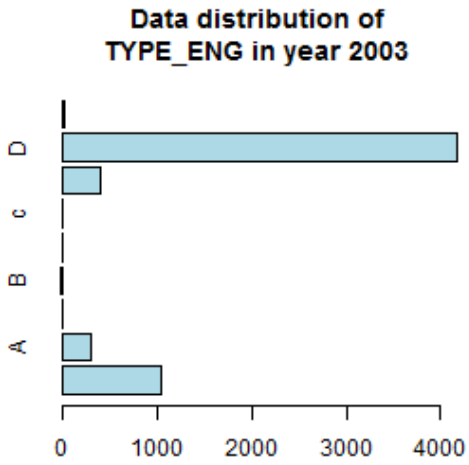

Data distribution of
SKY in year 2002
NO Cloud
0
500
1500
2500

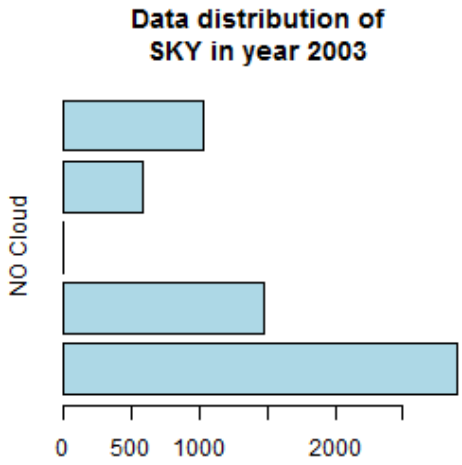

Data distribution of
TIME_OF_DAY in year 2002
NIGHT
Dusk
Day
0
500
1000
1500
2000
2500

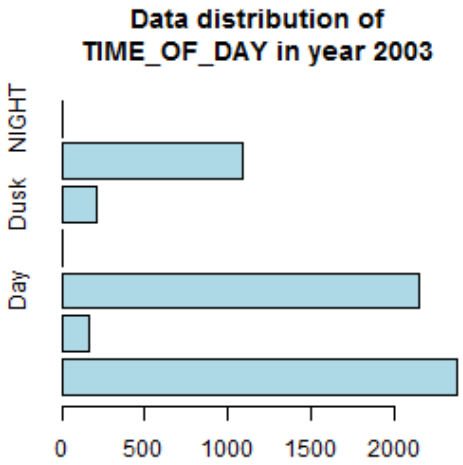

Data distribution of
PRECIP in year 2002
Snow
Fog, Snow
0
500
1500
2500

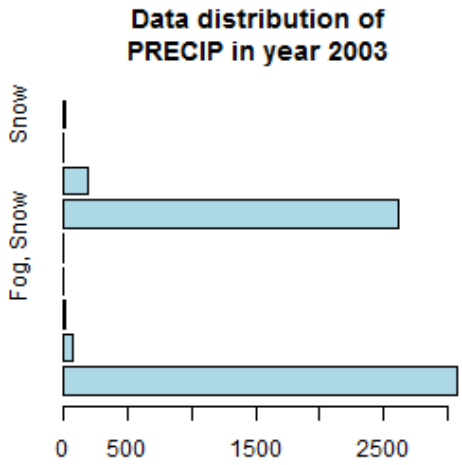

Data distribution of
AC_MASS in year 2003
5
4
3
2
1
0
500
1500
2500

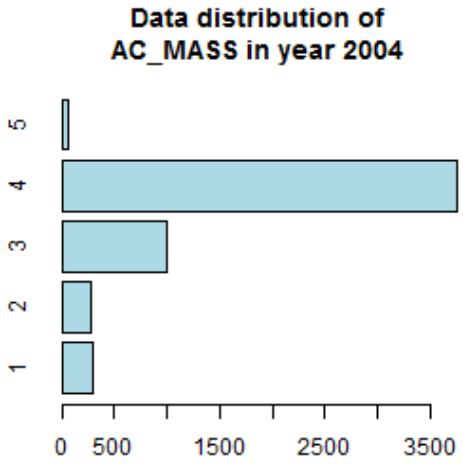

Data distribution of
PHASE_OF_FLT in year 2003
Taxi
Local
Climb
0
500
1000
1500

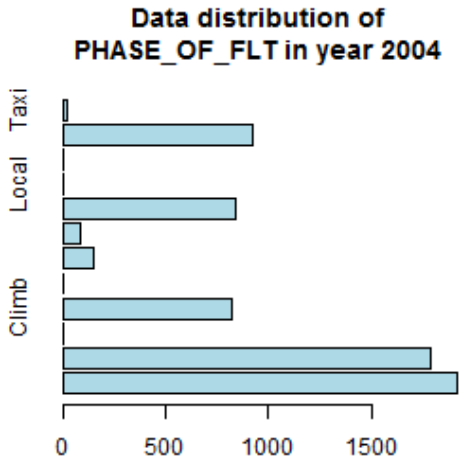

Data distribution of
TYPE_ENG in year 2003
D
c
B
A
0
1000
2000
3000
4000

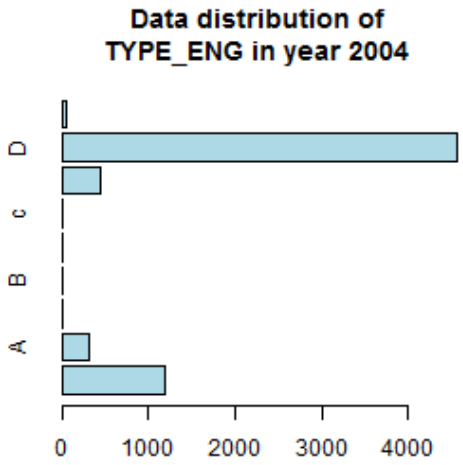

Data distribution of
SKY in year 2003
NO Cloud
0
500
1000
2000

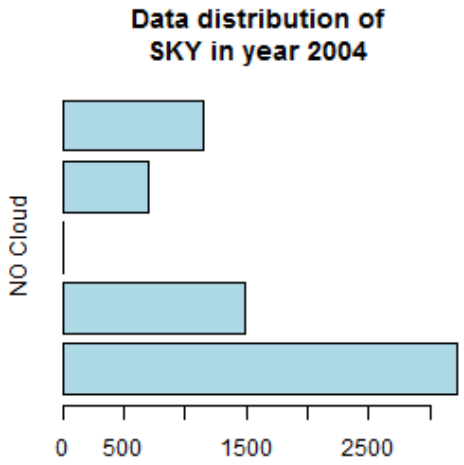

Data distribution of
TIME_OF_DAY in year 2003
NIGHT
Dusk
Day
0
500
1000
1500
2000

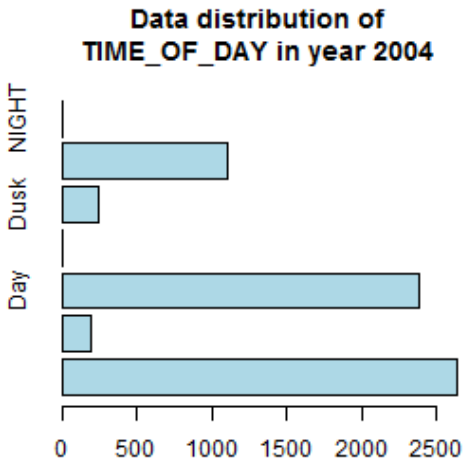

Data distribution of
PRECIP in year 2003
Snow
Fog, Snow
0
500
1500
2500

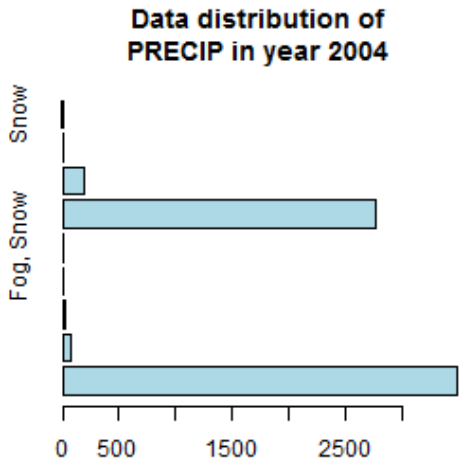

Data distribution of
AC_MASS in year 2004
5
4
3
2
1
0
500
1500
2500
3500

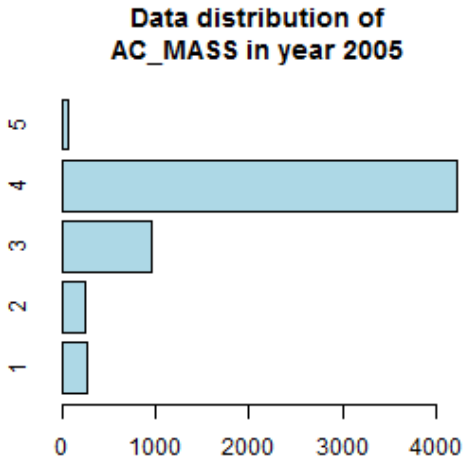

Data distribution of
PHASE_OF_FLT in year 2004
Taxi
Local
Climb
0
500
1000
1500

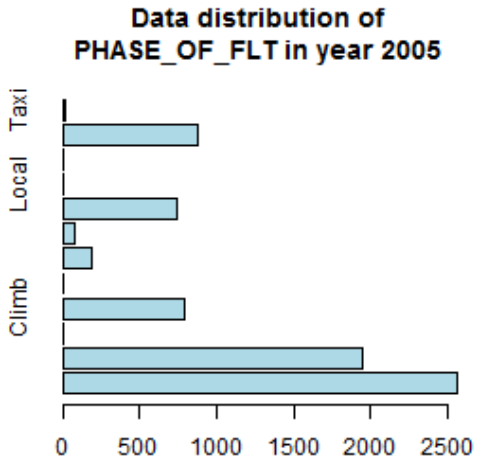

Data distribution of
TYPE_ENG in year 2004
D
c
B
A
0
1000
2000
3000
4000

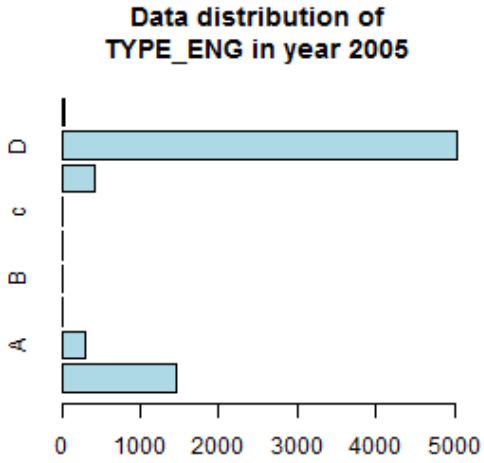

Data distribution of
SKY in year 2004
NO Cloud
0
500
1500
2500

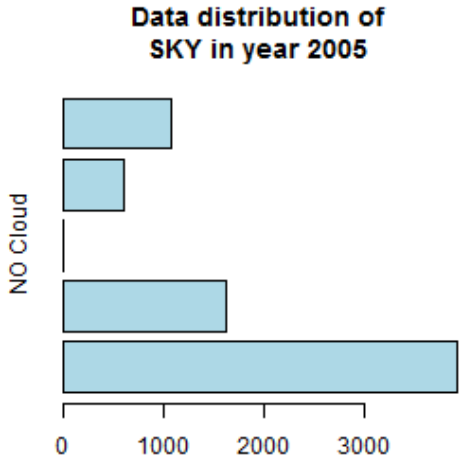

Data distribution of
TIME_OF_DAY in year 2004
NIGHT
Dusk
Day
0
500
1000
1500
2000
2500

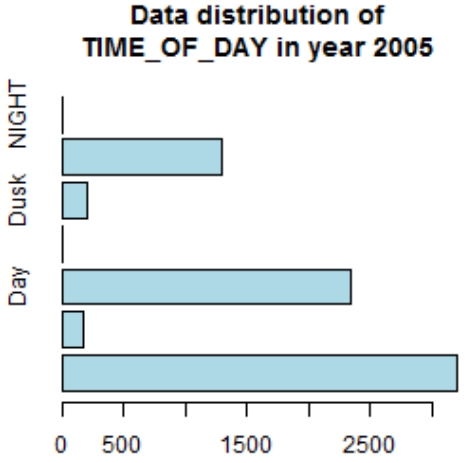

Data distribution of
PRECIP in year 2004
Snow
Fog, Snow
0
500
1500
2500

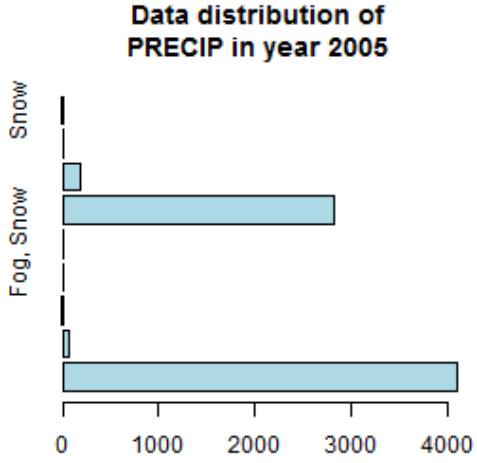

Data distribution of
AC_MASS in year 2005
5
4
3
2
1
0
1000
2000
3000
4000

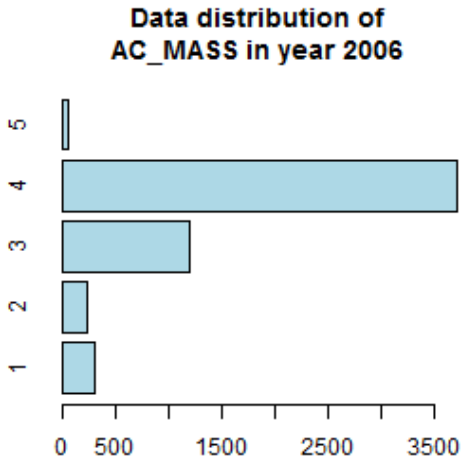

Data distribution of
PHASE_OF_FLT in year 2005
Taxi
Local
Climb
0
500
1000
1500
2000
2500

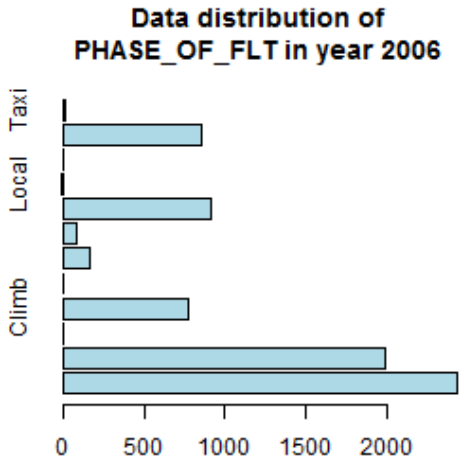

Data distribution of
TYPE_ENG in year 2005
D
c
B
A
0
1000
2000
3000
4000
5000

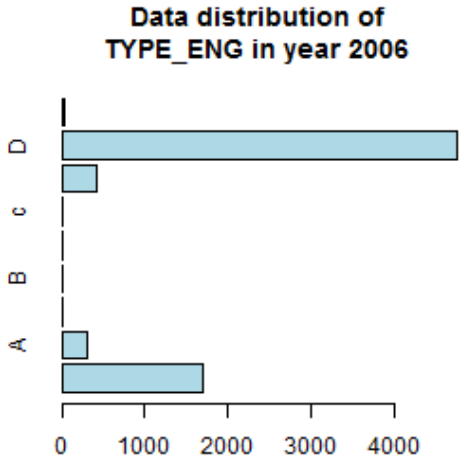

Data distribution of
SKY in year 2005
NO Cloud
0
1000
2000
3000

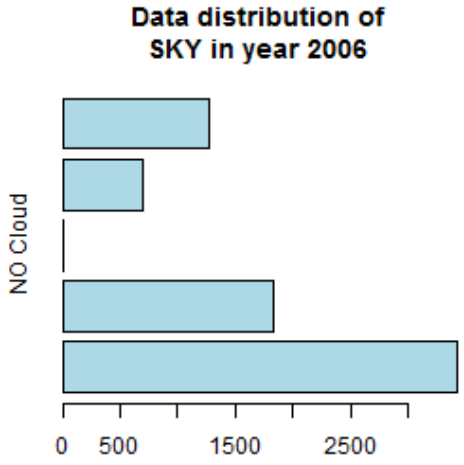

Data distribution of
TIME_OF_DAY in year 2005
NIGHT
Dusk
Day
0
500
1500
2500

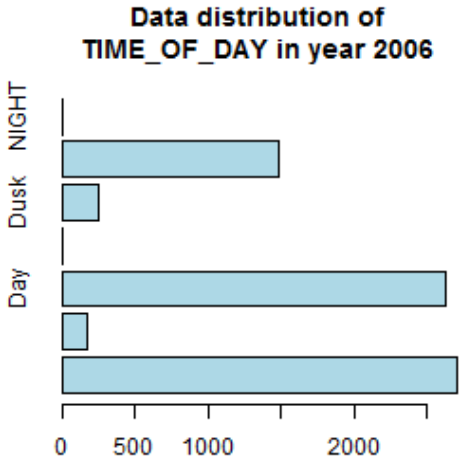

Data distribution of
PRECIP in year 2005
Snow
Fog, Snow
0
1000
2000
3000
4000

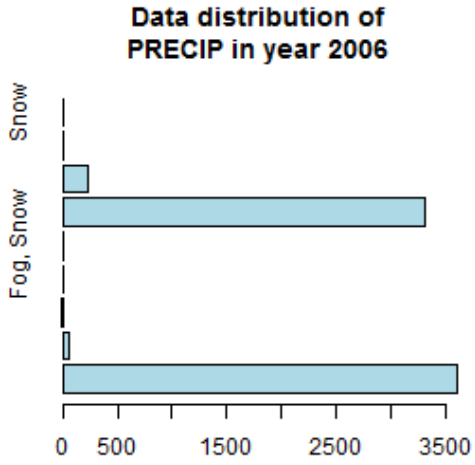

Data distribution of
AC_MASS in year 2006
5
4
3
2
1
0
500
1500
2500
3500

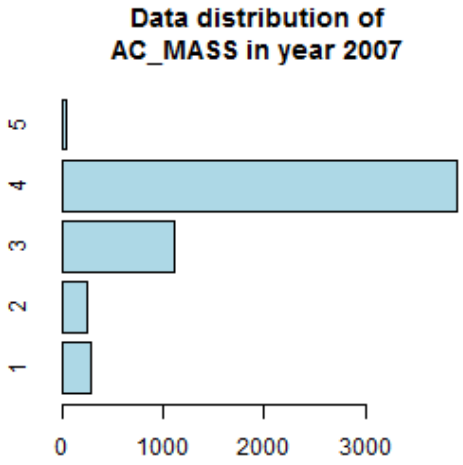

Data distribution of
PHASE_OF_FLT in year 2006
Taxi
Local
Climb
0
500
1000
1500
2000

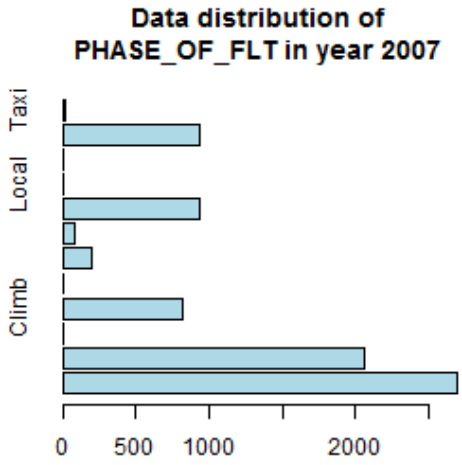

Data distribution of
TYPE_ENG in year 2006
D
c
B
A
0
1000
2000
3000
4000

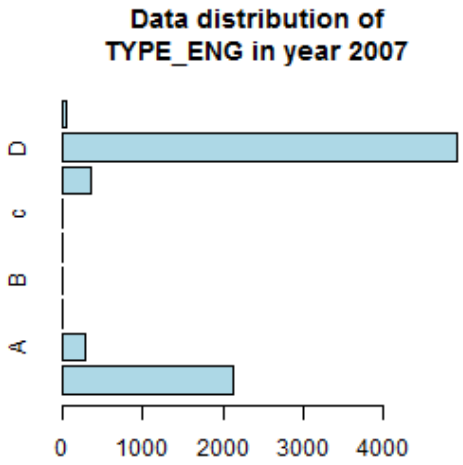

Data distribution of
SKY in year 2006
NO Cloud
0
500
1500
2500

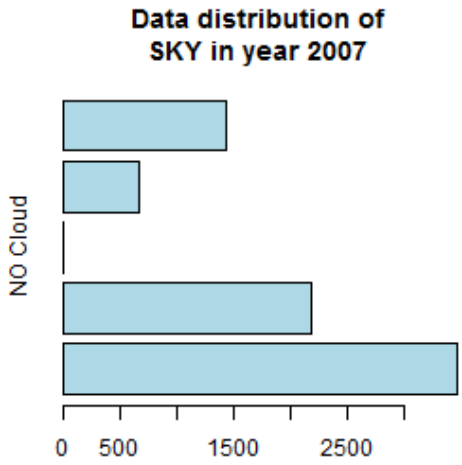

Data distribution of
TIME_OF_DAY in year 2006
NIGHT
Dusk
Day
0
500
1000
2000

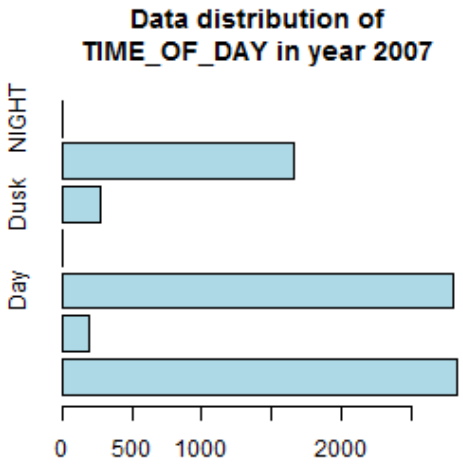

Data distribution of
PRECIP in year 2006
Snow
Fog, Snow
0
500
1500
2500
3500

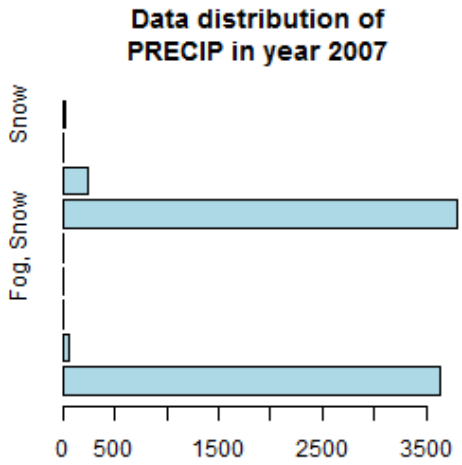

Data distribution of
AC_MASS in year 2007
5
4
3
2
1
0
1000
2000
3000

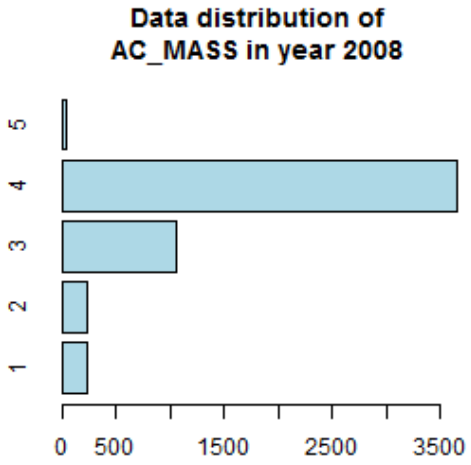

Data distribution of
PHASE_OF_FLT in year 2007
Taxi
Local
Climb
0
500
1000
2000

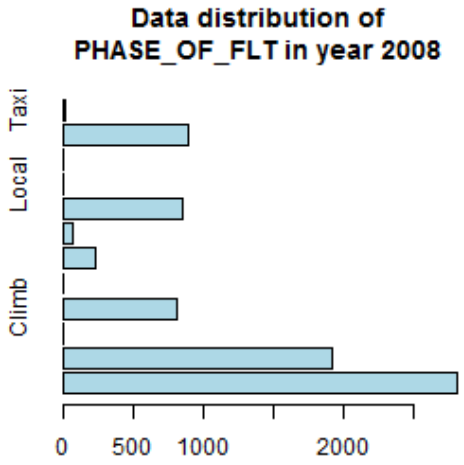

Data distribution of
TYPE_ENG in year 2007
D
c
B
A
0
1000
2000
3000
4000

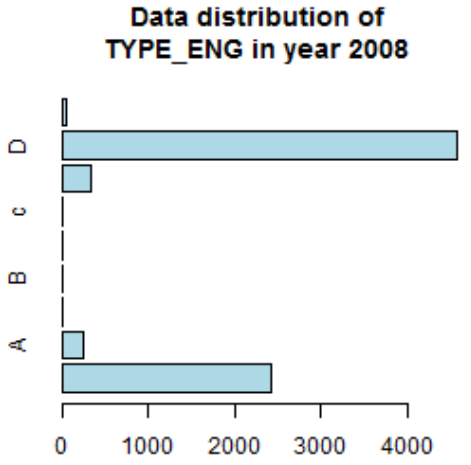

Data distribution of
SKY in year 2007
NO Cloud
0
500
1500
2500

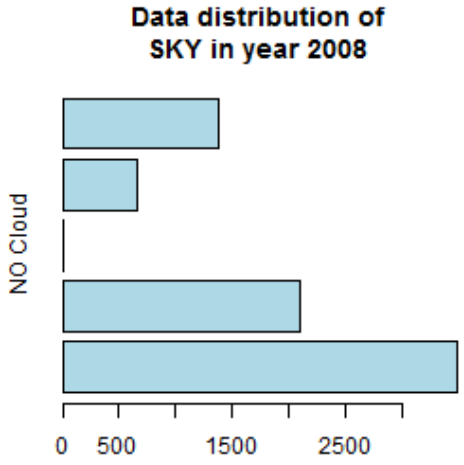

Data distribution of
TIME_OF_DAY in year 2007
NIGHT
Dusk
Day
0
500
1000
2000

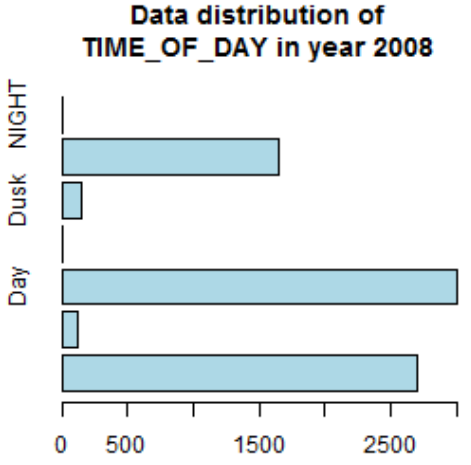

Data distribution of
PRECIP in year 2007
Snow
Fog, Snow
0
500
1500
2500
3500

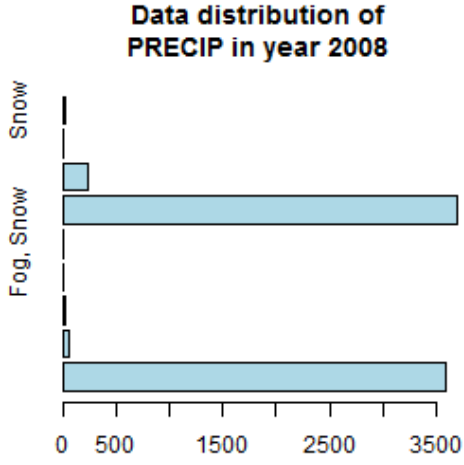

Data distribution of
AC_MASS in year 2008
5
4
3
2
1
0
500
1500
2500
3500

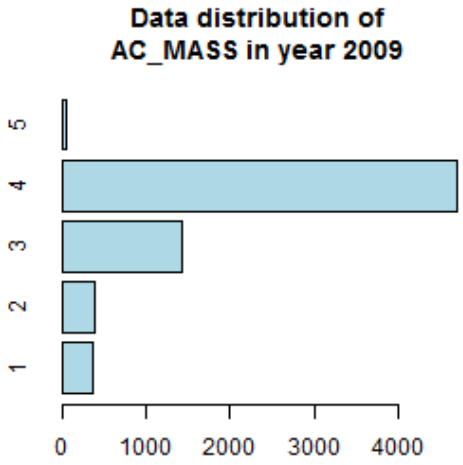

Data distribution of
PHASE_OF_FLT in year 2008
Taxi
Local
Climb
0
500
1000
2000

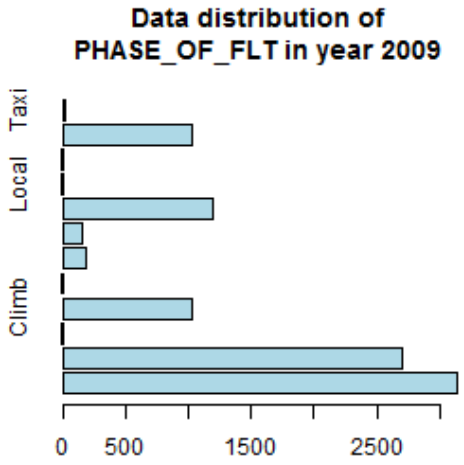

Data distribution of
TYPE_ENG in year 2008
D
c
B
A
0
1000
2000
3000
4000

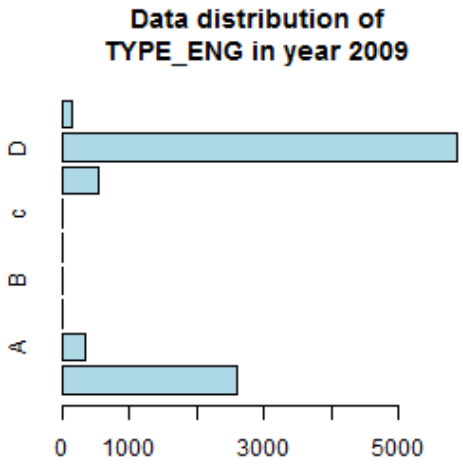

Data distribution of
SKY in year 2008
NO Cloud
0
500
1500
2500

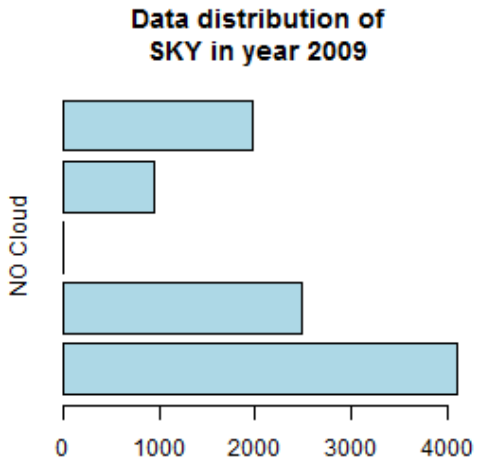

Data distribution of
TIME_OF_DAY in year 2008
NIGHT
Dusk
Day
0
500
1500
2500

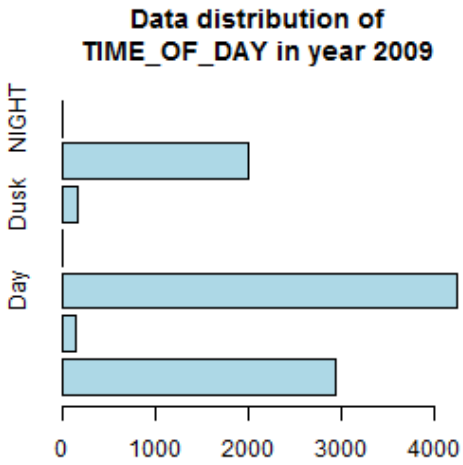

Data distribution of
PRECIP in year 2008
Snow
Fog, Snow
0
500
1500
2500
3500

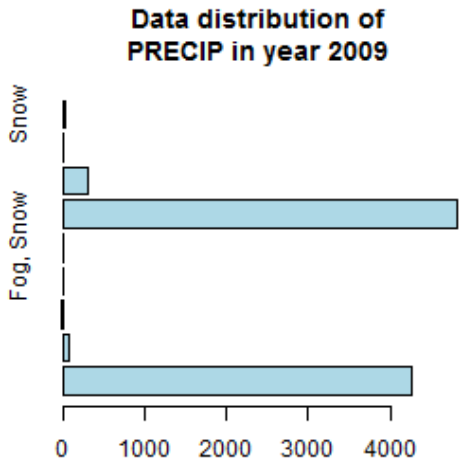

Data distribution of
AC_MASS in year 2009
5
4
3
2
1
0
1000
2000
3000
4000

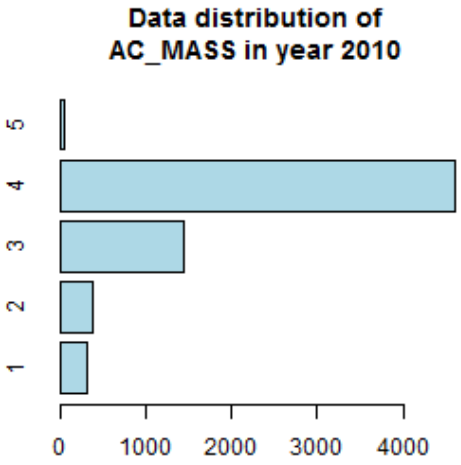

Data distribution of
PHASE_OF_FLT in year 2009
Taxi
Local
Climb
0
500
1500
2500

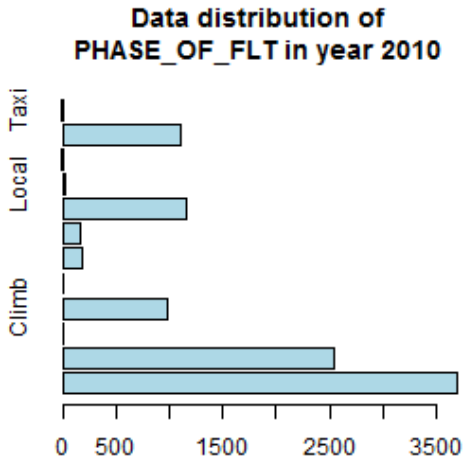

Data distribution of
TYPE_ENG in year 2009
D
c
B
A
0
1000
3000
5000

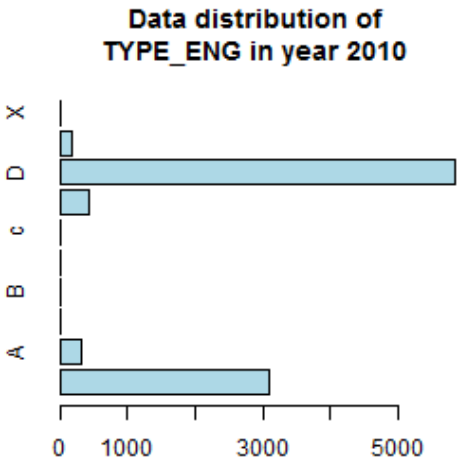

Data distribution of
SKY in year 2009
NO Cloud
0
1000
2000
3000
4000

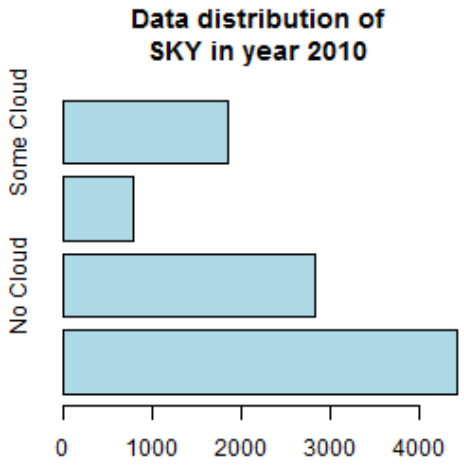

Data distribution of
TIME_OF_DAY in year 2009
NIGHT
Dusk
Day
0
1000
2000
3000
4000

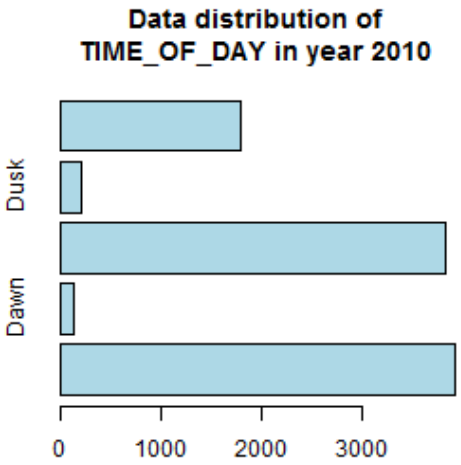

Data distribution of
PRECIP in year 2009
Snow
Fog, Snow
0
1000
2000
3000
4000

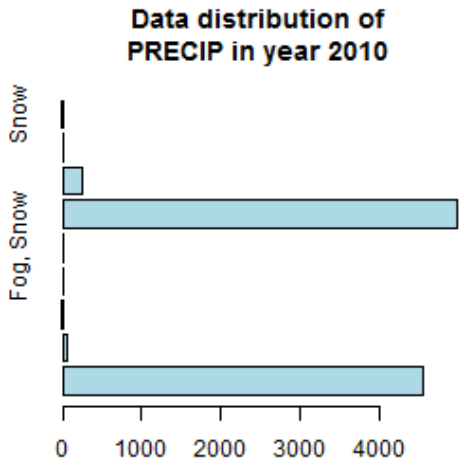

Data distribution of
AC_MASS in year 2010
5
4
3
2
1
0
1000
2000
3000
4000

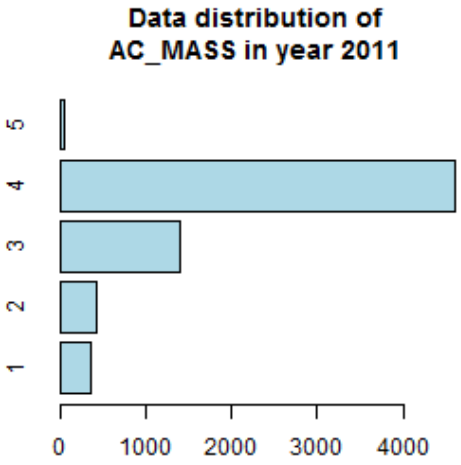

Data distribution of
PHASE_OF_FLT in year 2010
Taxi
Local
Climb
0
500
1500
2500
3500

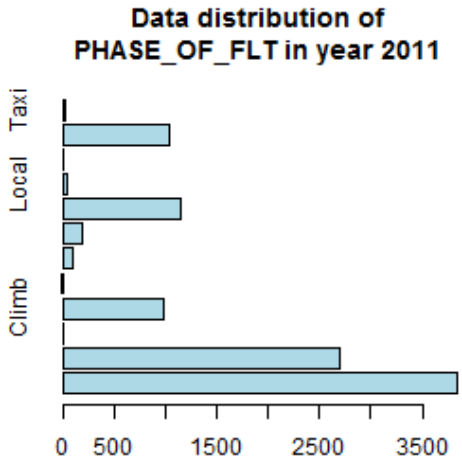

Data distribution of
TYPE_ENG in year 2010
X
D
c
B
A
0
1000
3000
5000

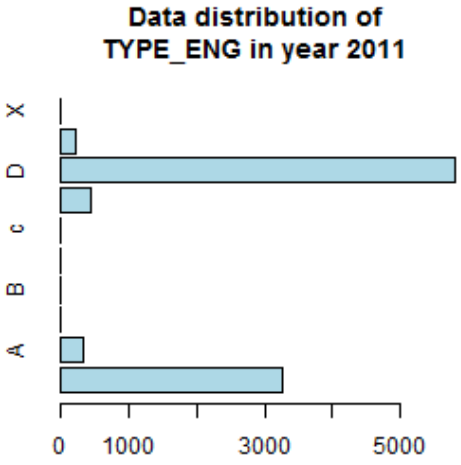

Data distribution of
SKY in year 2010
Some Cloud
No Cloud
0
1000
2000
3000
4000

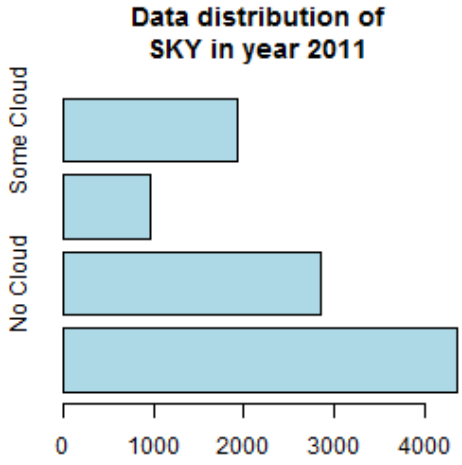

Data distribution of
TIME_OF_DAY in year 2010
Dusk
Dawn
0
1000
2000
3000

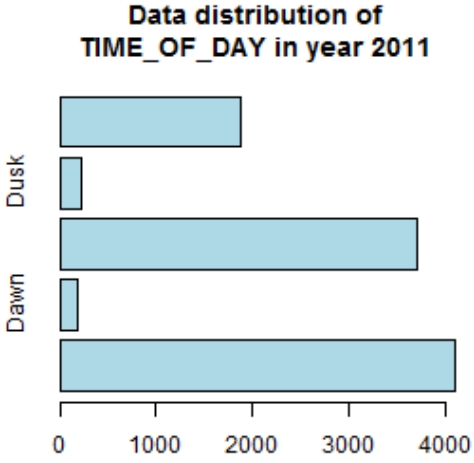

Data distribution of
PRECIP in year 2010
Snow
Fog, Snow
0
1000
2000
3000
4000

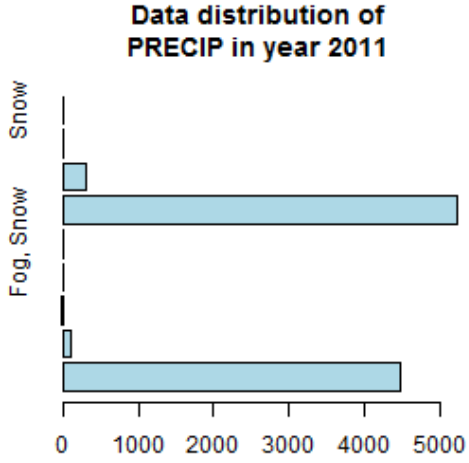

Data distribution of
AC_MASS in year 2011
5
4
3
2
1
0
1000
2000
3000
4000

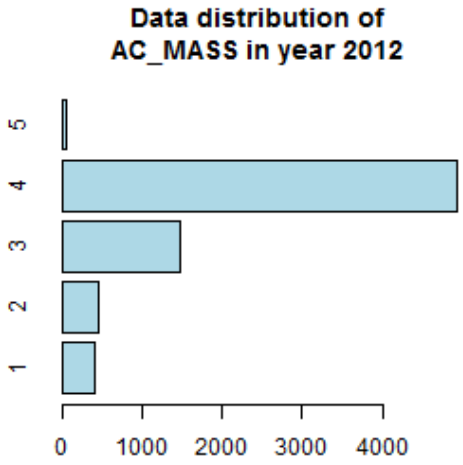

Data distribution of
PHASE_OF_FLT in year 2011
Taxi
Local
Climb
0
500
1500
2500
3500

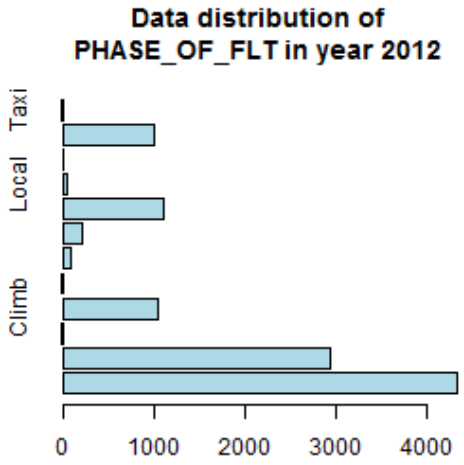

Data distribution of
TYPE_ENG in year 2011
X
D
c
B
A
0
1000
3000
5000

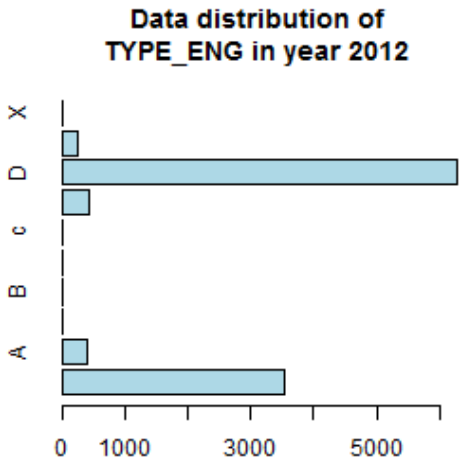

Data distribution of
SKY in year 2011
Some Cloud
No Cloud
0
1000
2000
3000
4000

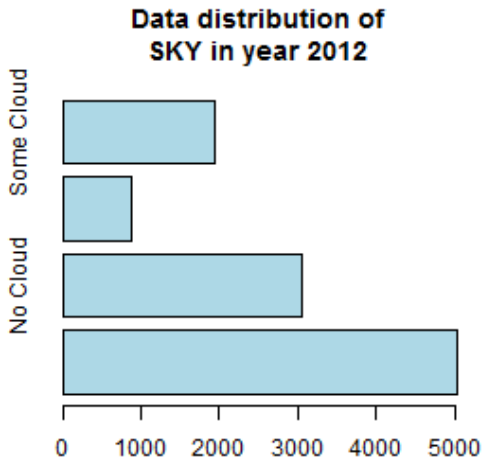

Data distribution of
TIME_OF_DAY in year 2011
Dusk
Dawn
0
1000
2000
3000
4000

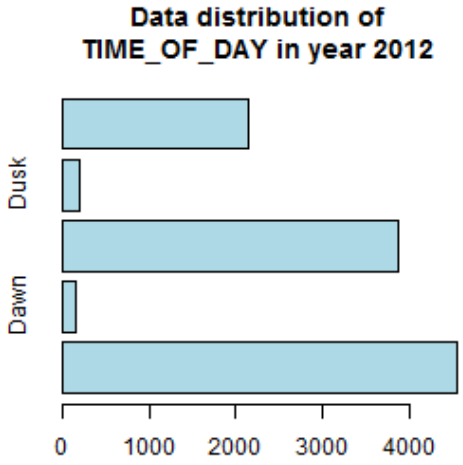

Data distribution of
PRECIP in year 2011
Snow
Fog, Snow
0
1000
2000
3000
4000
5000

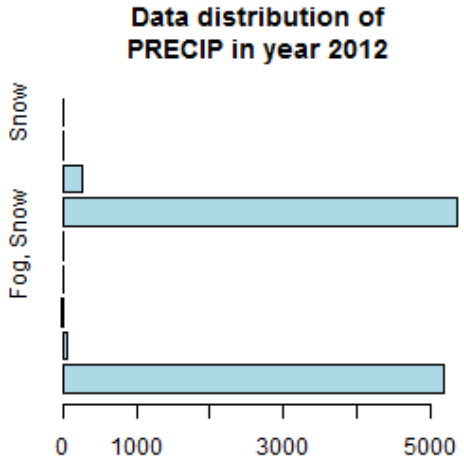

Data distribution of
AC_MASS in year 2012
5
4
3
2
1
0
1000
2000
3000
4000

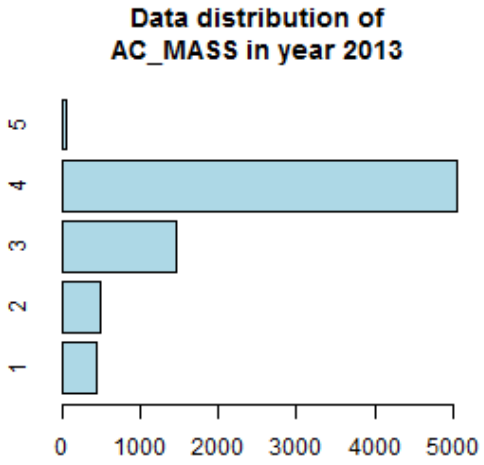

Data distribution of
PHASE_OF_FLT in year 2012
Taxi
Local
Climb
0
1000
2000
3000
4000

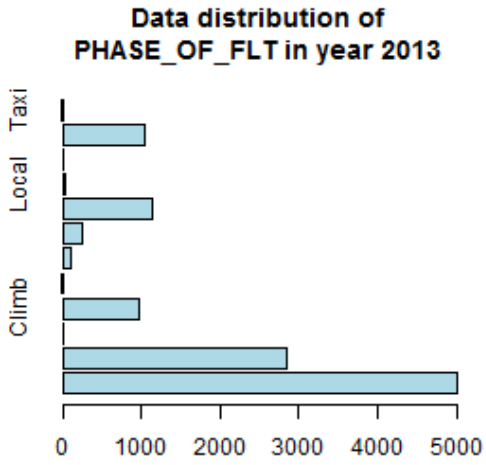

Data distribution of
TYPE_ENG in year 2012
X
D
c
B
A
0
1000
3000
5000

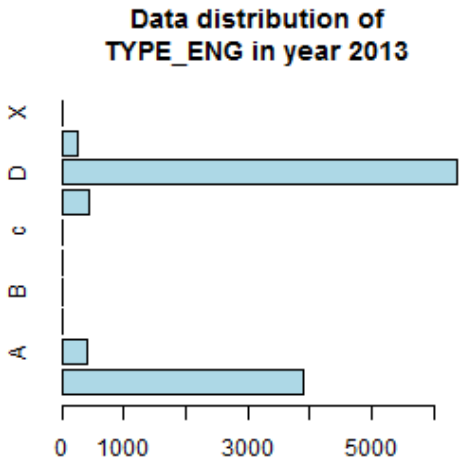

Data distribution of
SKY in year 2012
Some Cloud
No Cloud
0
1000
2000
3000
4000
5000

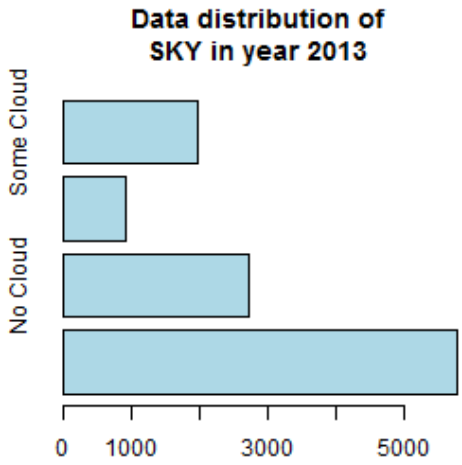

Data distribution of
TIME_OF_DAY in year 2012
Dusk
Dawn
0
1000
2000
3000
4000

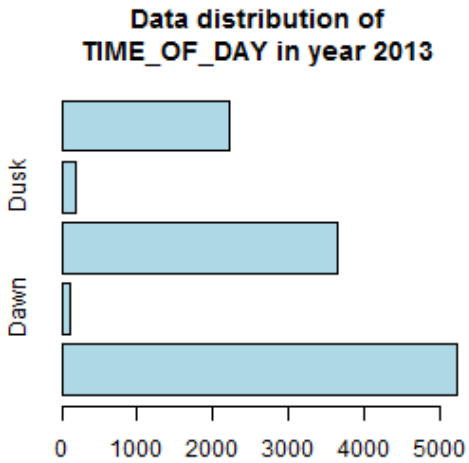

Data distribution of
PRECIP in year 2012
Snow
Fog, Snow
0
1000
3000
5000

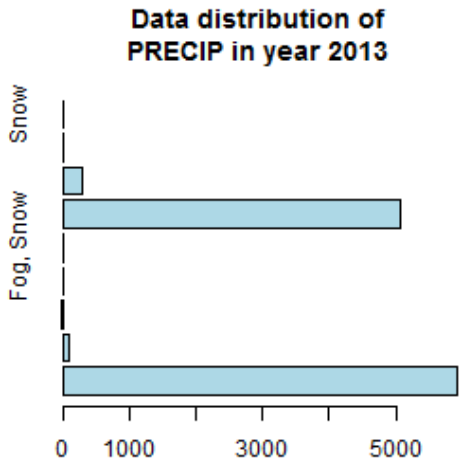

Data distribution of
AC_MASS in year 2013
5
4
3
2
1
0
1000
2000
3000
4000
5000

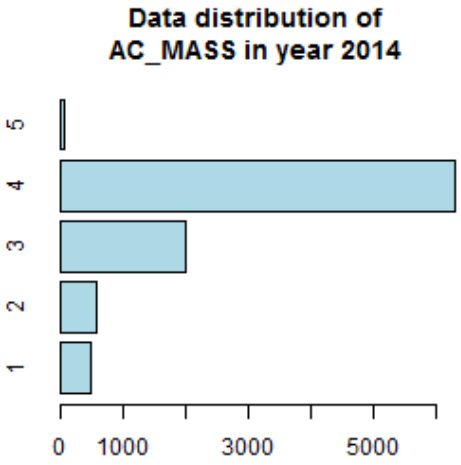

Data distribution of
PHASE_OF_FLT in year 2013
Taxi
Local
Climb
0
1000
2000
3000
4000
5000

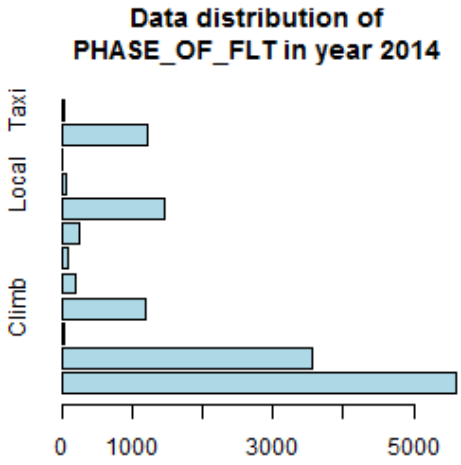

Data distribution of
TYPE_ENG in year 2013
X
D
c
B
A
0
1000
3000
5000

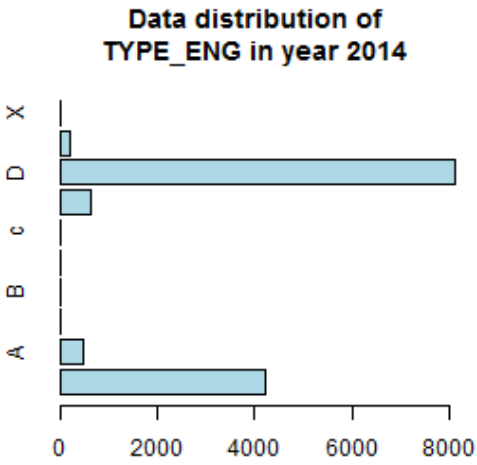

Data distribution of
SKY in year 2013
Some Cloud
No Cloud
0
1000
3000
5000

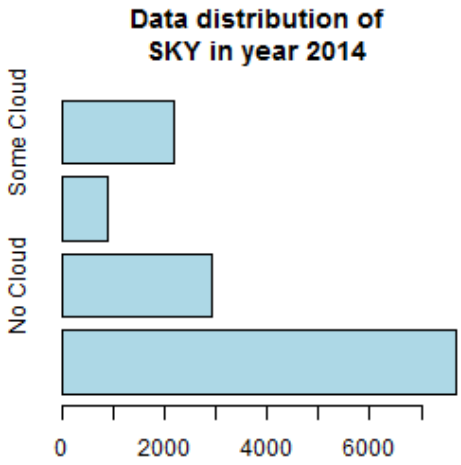

Data distribution of
TIME_OF_DAY in year 2013
Dusk
Dawn
0
1000
2000
3000
4000
5000

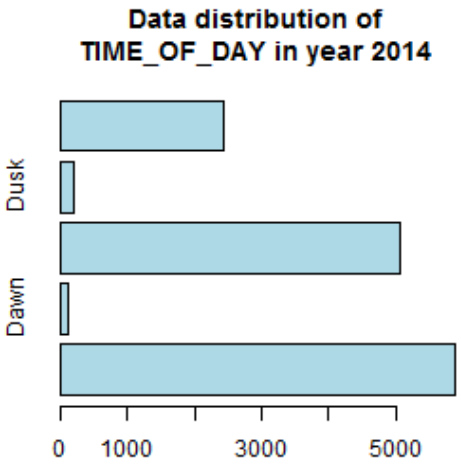

Data distribution of
PRECIP in year 2013
Snow
Fog, Snow
0
1000
3000
5000

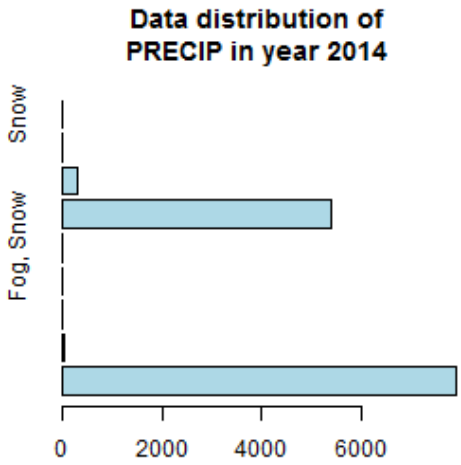

Data distribution of
AC_MASS in year 2014
5
4
3
2
1
0
1000
3000
5000

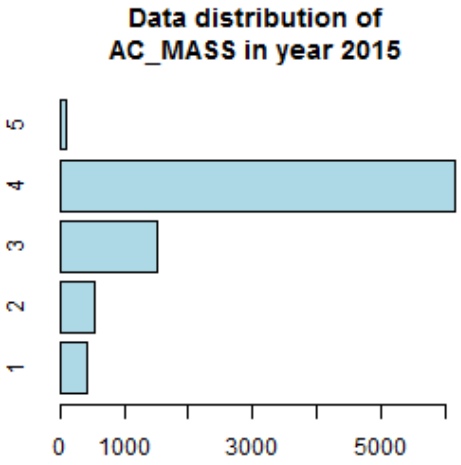

Data distribution of
PHASE_OF_FLT in year 2014
Taxi
Local
Climb
0
1000
3000
5000

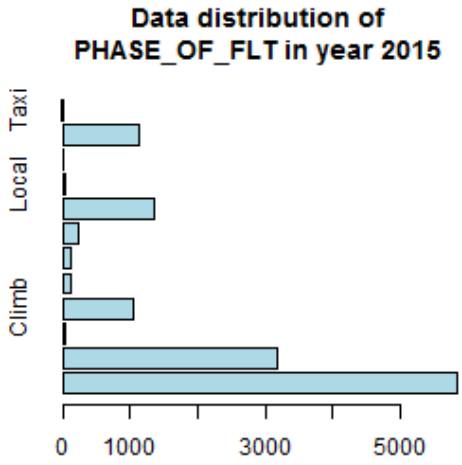

Data distribution of
TYPE_ENG in year 2014
X
D
c
B
A
0
2000
4000
6000
8000

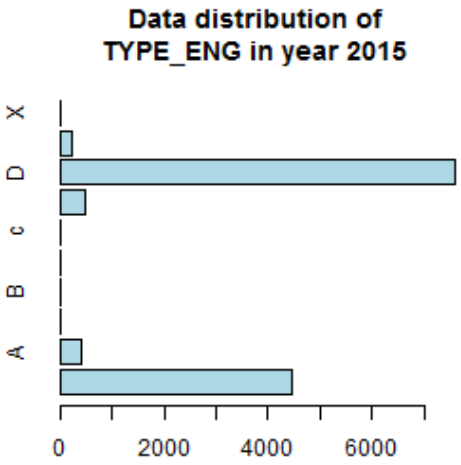

Data distribution of
SKY in year 2014
Some Cloud
No Cloud
0
2000
4000
6000

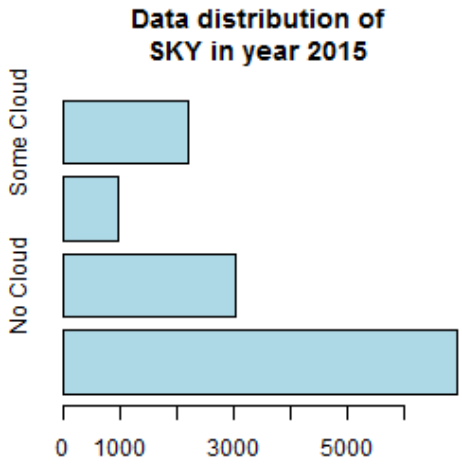

Data distribution of
TIME_OF_DAY in year 2014
Dusk
Dawn
0
1000
3000
5000

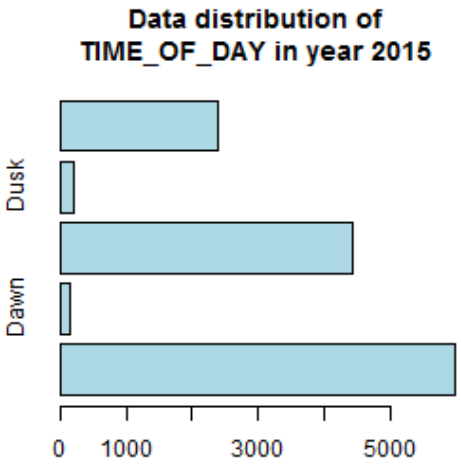

Data distribution of
PRECIP in year 2014
Snow
Fog, Snow
0
2000
4000
6000

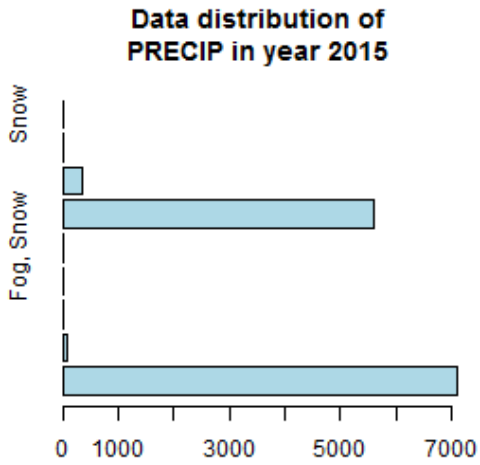

Data distribution of
AC_MASS in year 2015
5
4
3
2
1
0
1000
3000
5000

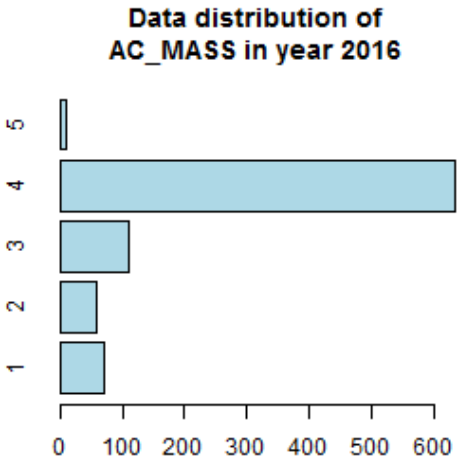

Data distribution of
PHASE_OF_FLT in year 2015
Taxi
Local
Climb
0
1000
3000
5000

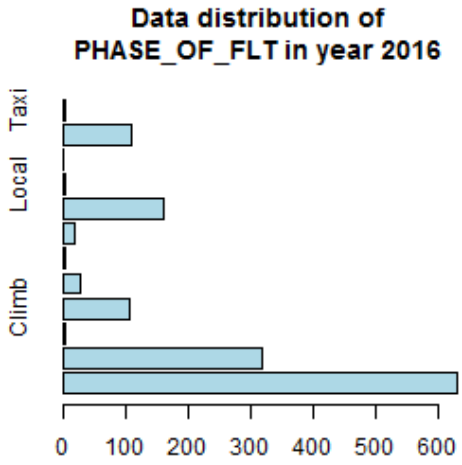

Data distribution of
TYPE_ENG in year 2015
X
D
c
B
A
0
2000
4000
6000

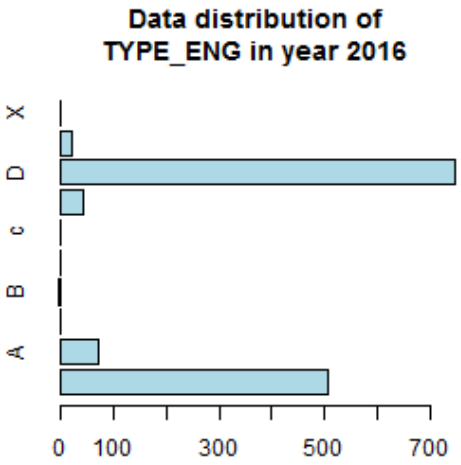

Data distribution of
SKY in year 2015
Some Cloud
No Cloud
0
1000
3000
5000

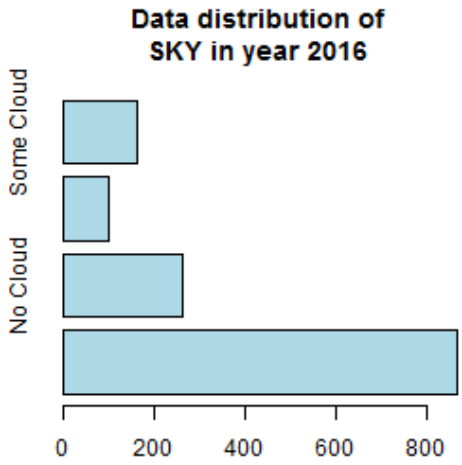

Data distribution of
TIME_OF_DAY in year 2015
Dusk
Dawn
0
1000
3000
5000

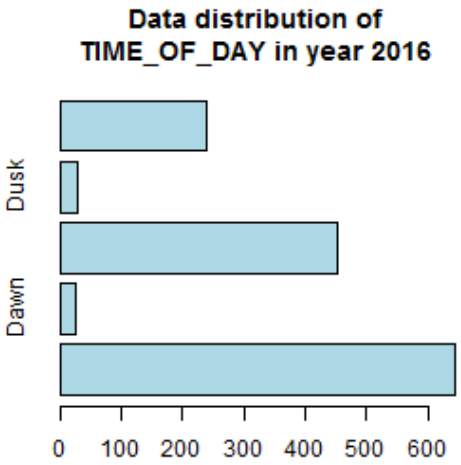

Data distribution of
PRECIP in year 2015
Snow
Fog, Snow
0
1000
3000
5000
7000

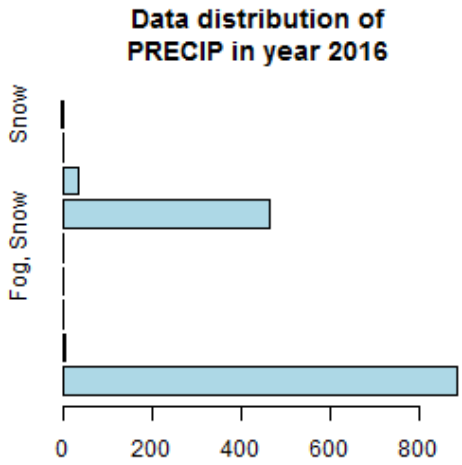

Data distribution of
AC_MASS in year 2016
5
4
3
2
1
0
100
200
300
400
500
600


Data distribution of
PHASE_OF_FLT in year 2016
Taxi
Local
Climb
0
100
200
300
400
500
600


Data distribution of
TYPE_ENG in year 2016
X
D
c
B
A
0
100
300
500
700


Data distribution of
SKY in year 2016
Some Cloud
No Cloud
0
200
400
600
800


Data distribution of
TIME_OF_DAY in year 2016
Dusk
Dawn
0
100
200
300
400
500
600


Data distribution of
PRECIP in year 2016
Snow
Fog, Snow
0
200
400
600
800

14.1.2 Flight Data (1990 - 2016)

The first summary table shows the number of distinct items for each year regarding the number of records, the carriers, Origin and destination airports.

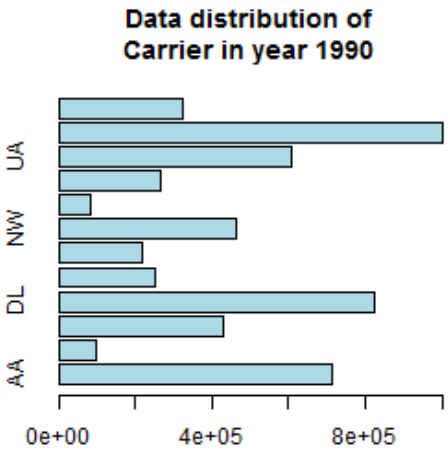
Year	# of flights	# of carriers	Origin airports	Origin states	Destination airports	Destination states
1990	5270893	12	235	53	236	53
1991	5076925	12	233	52	233	52
1992	5092157	10	233	52	233	52
1993	5070501	10	227	52	227	52
1994	5180048	10	224	52	225	52
1995	5327435	10	218	52	218	52
1996	5351983	10	211	52	212	52
1997	5411843	10	205	51	206	52
1998	5384721	10	207	51	208	51
1999	5527884	10	205	51	205	51
2000	5683047	11	206	51	206	51
2001	5967780	12	231	51	230	51
2002	5271359	10	218	50	219	50
2003	6488540	18	282	51	282	51
2004	7129270	19	285	51	288	51
2005	7140596	20	286	51	289	51
2006	7141922	21	289	52	296	52
2007	7455458	20	304	52	310	52
2008	7009726	20	303	51	304	51
2009	6450285	19	296	51	296	51
2010	6450117	18	305	52	305	52
2011	6085281	16	299	52	301	52
2012	6096762	15	312	52	313	52
2013	6369482	16	320	53	318	53
2014	5819811	14	325	53	324	53
2015	5819079	14	322	53	322	53
2016	5617658	12	313	52	310	52

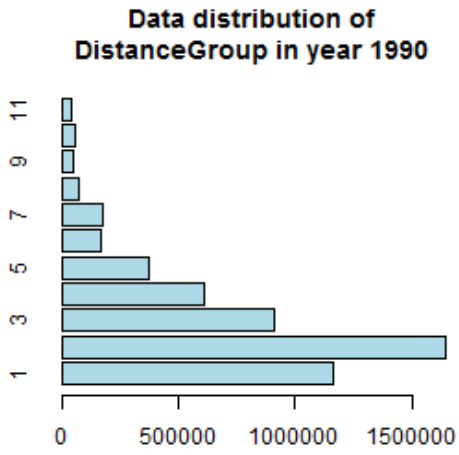
The second summary table shows the number of distinct items for each year the departure time group and distance between the airports.

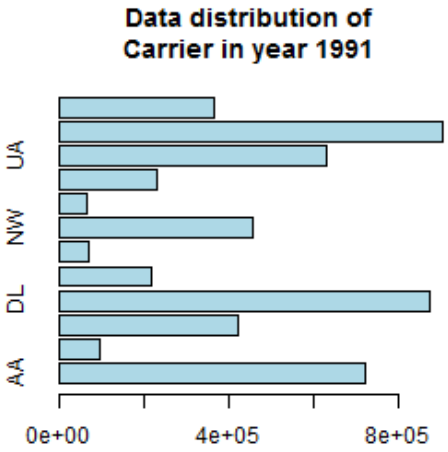
Year	Departure time block	Distance group
1990	19	11
1991	19	11
1992	19	11
1993	19	11
1994	19	11
1995	19	11
1996	19	11
1997	19	11
1998	19	11
1999	19	11
2000	19	11
2001	19	11
2002	19	11
2003	19	11

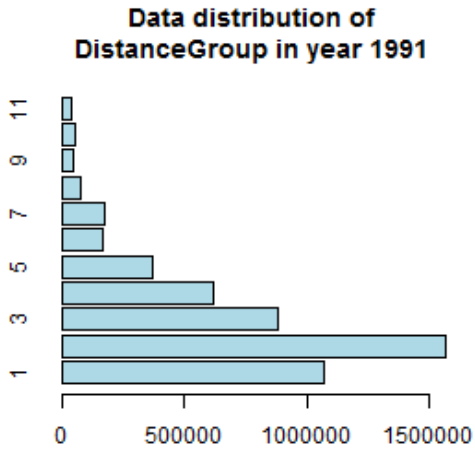
Year	Departure time block	Distance group
2004	19	11
2005	19	11
2006	19	11
2007	19	11
2008	19	11
2009	19	11
2010	19	11
2011	19	11
2012	20	11
2013	19	11
2014	19	11
2015	19	11
2016	19	11

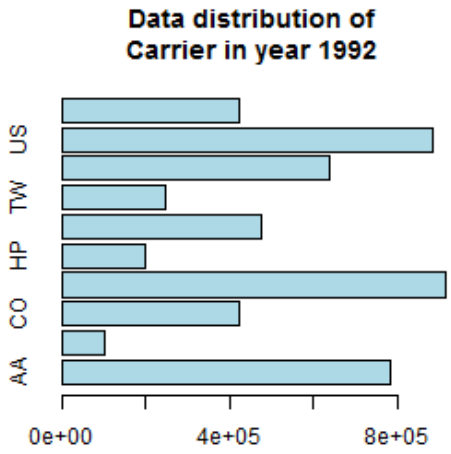
The following graphs show the distributions of some of the selected distinct items summarized in the tables above.

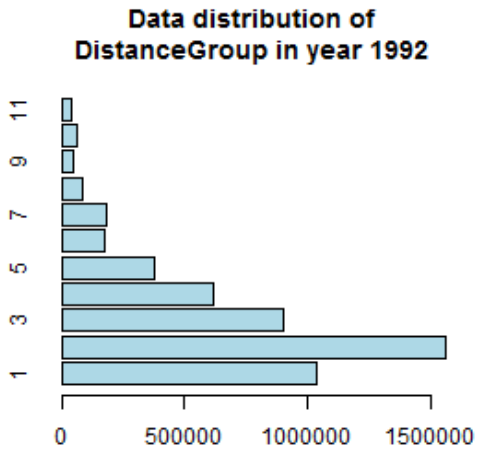


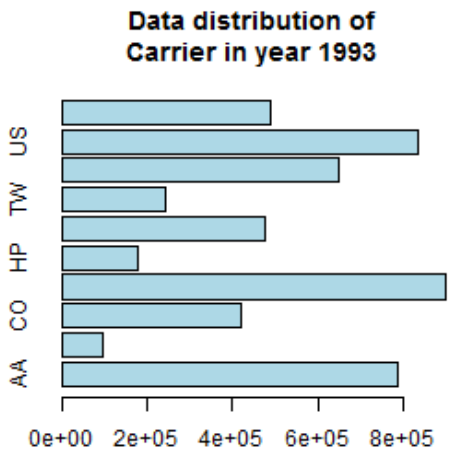


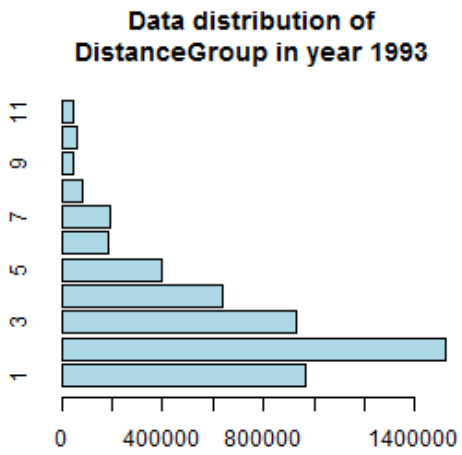


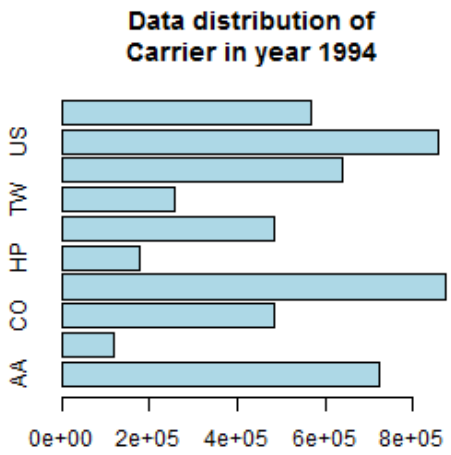


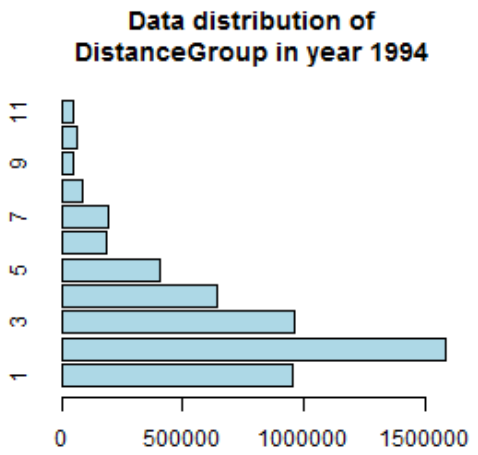

Data distribution of
Carrier in year 1992
AA
CO
HP
TW
US
0e+00
4e+05
8e+05

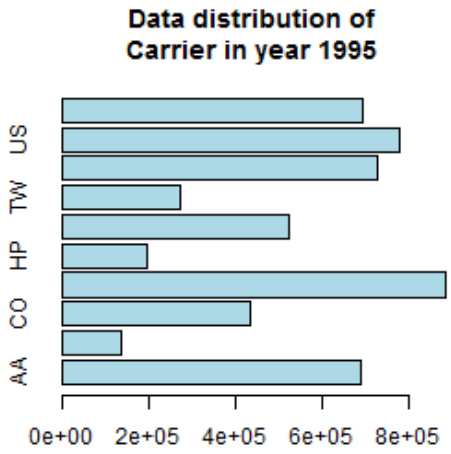

Data distribution of
DistanceGroup in year 1992
1
3
5
7
9
11
0
500000
1000000
1500000

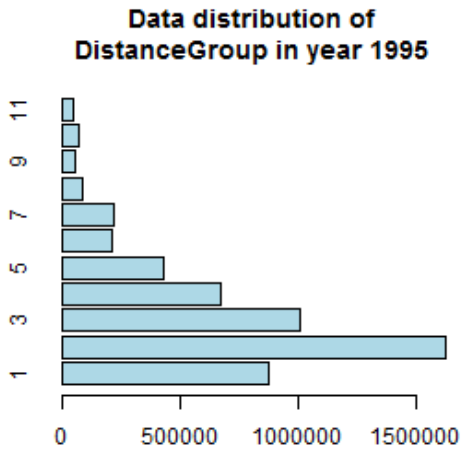

Data distribution of
Carrier in year 1993
AA
CO
HP
TW
US
0e+00
2e+05
4e+05
6e+05
8e+05

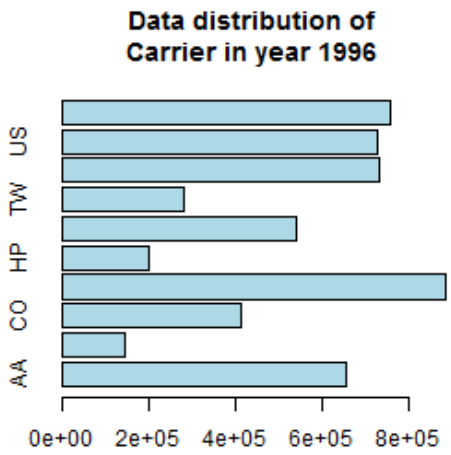

Data distribution of
DistanceGroup in year 1993
1
3
5
7
9
11
0
400000
800000
1400000

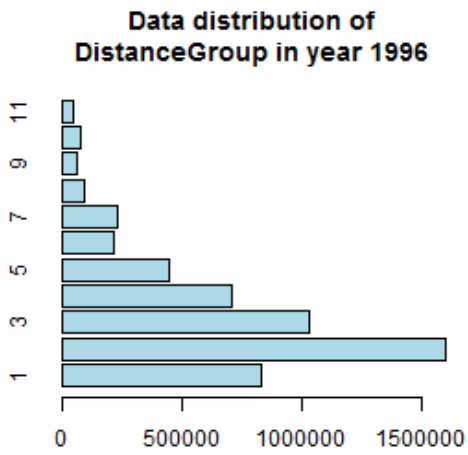

Data distribution of
Carrier in year 1994
AA
CO
HP
TW
US
0e+00
2e+05
4e+05
6e+05
8e+05

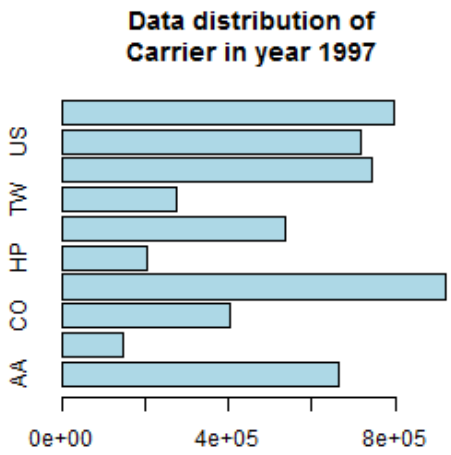

Data distribution of
DistanceGroup in year 1994
1
3
5
7
9
11
0
500000
1000000
1500000

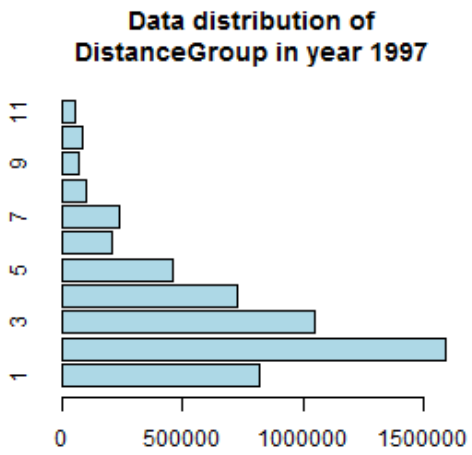

Data distribution of
Carrier in year 1995
AA
CO
HP
TW
US
0e+00
2e+05
4e+05
6e+05
8e+05

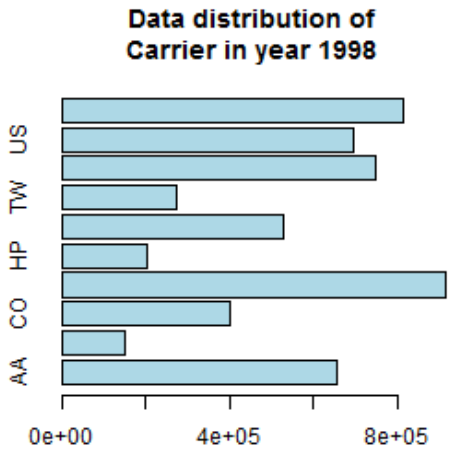

Data distribution of
DistanceGroup in year 1995
1
3
5
7
9
11
0
500000
1000000
1500000

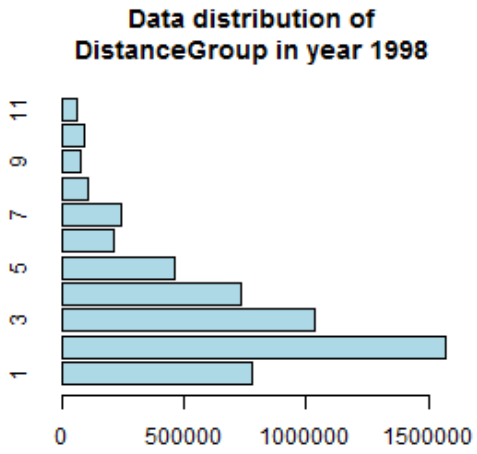

Data distribution of
Carrier in year 1996
AA
CO
HP
TW
US
0e+00
2e+05
4e+05
6e+05
8e+05

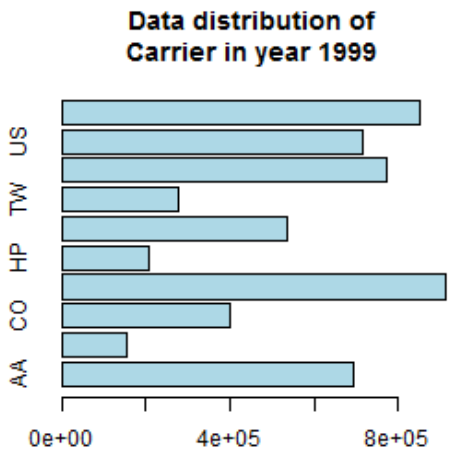

Data distribution of
DistanceGroup in year 1996
1
3
5
7
9
11
0
500000
1000000
1500000

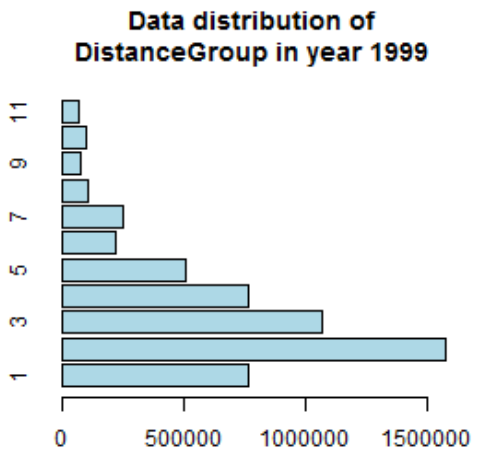

Data distribution of
Carrier in year 1997
AA
CO
HP
TW
US
0e+00
4e+05
8e+05

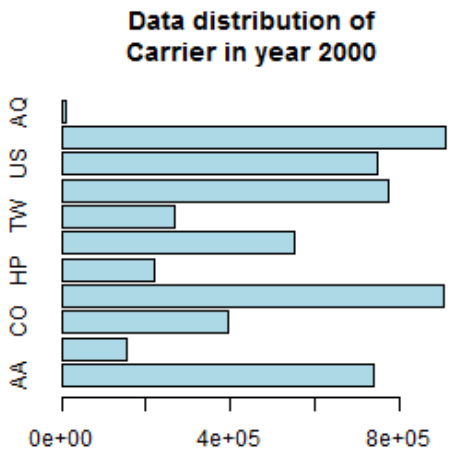

Data distribution of
DistanceGroup in year 1997
1
3
5
7
9
11
0
500000
1000000
1500000

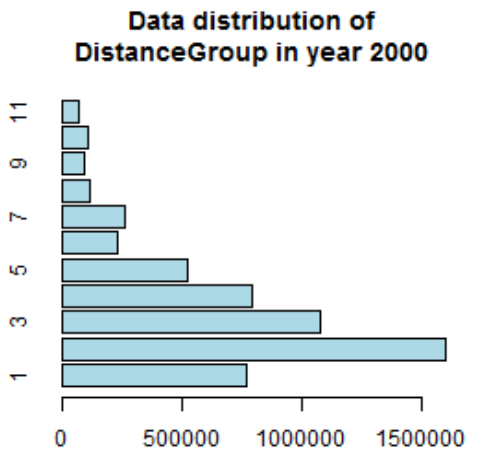

Data distribution of
Carrier in year 1998
AA
CO
HP
TW
US
0e+00
4e+05
8e+05

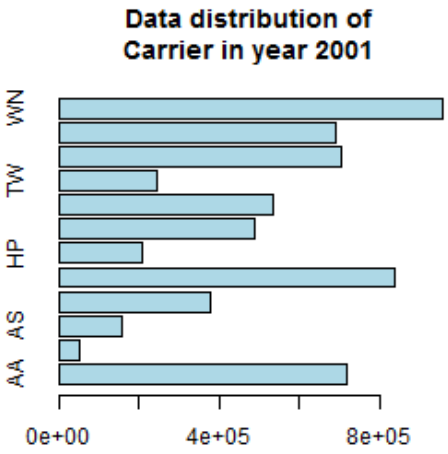

Data distribution of
DistanceGroup in year 1998
1
3
5
7
9
11
0
500000
1000000
1500000

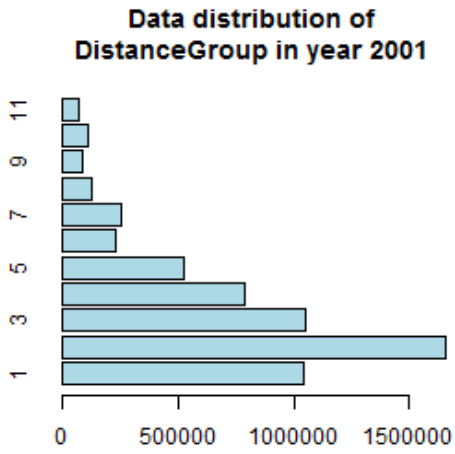

Data distribution of
Carrier in year 1999
AA
CO
HP
TW
US
0e+00
4e+05
8e+05

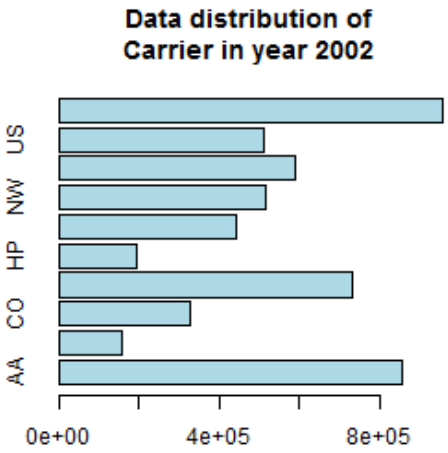

Data distribution of
DistanceGroup in year 1999
1
3
5
7
9
11
0
500000
1000000
1500000

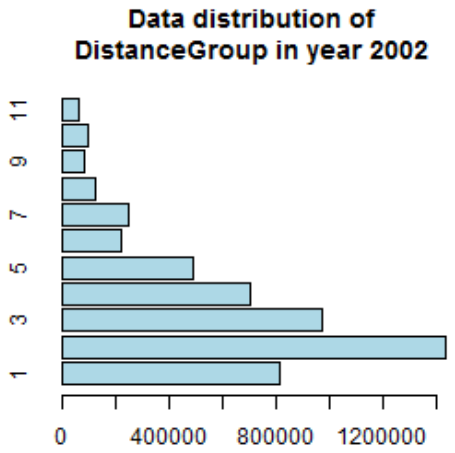

Data distribution of
Carrier in year 2000
AA
CO
HP
TW
US
AQ
0e+00
4e+05
8e+05

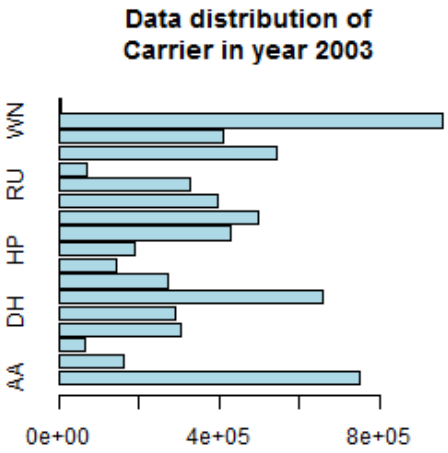

Data distribution of
DistanceGroup in year 2000
1
3
5
7
9
11
0
500000
1000000
1500000

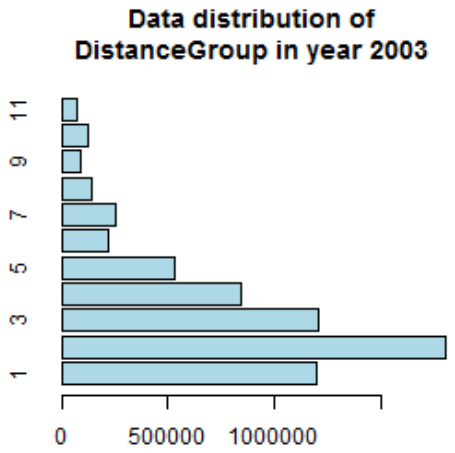

Data distribution of
Carrier in year 2001
WN
TW
HP
AS
AA
0e+00
4e+05
8e+05

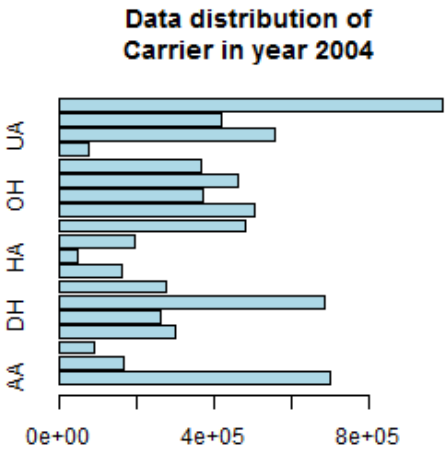

Data distribution of
DistanceGroup in year 2001
11
9
7
5
3
1
0
500000
1000000
1500000

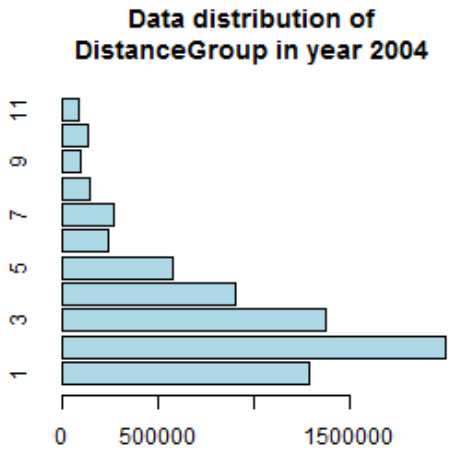

Data distribution of
Carrier in year 2002
US
NW
HP
CO
AA
0e+00
4e+05
8e+05

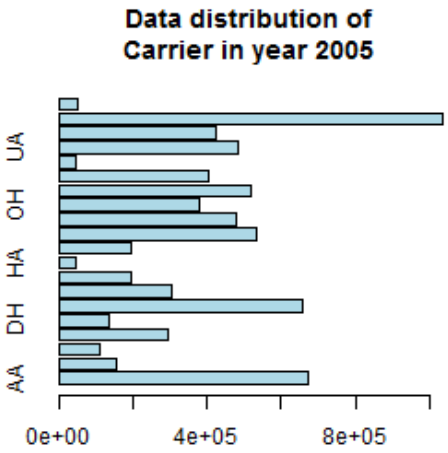

Data distribution of
DistanceGroup in year 2002
11
9
7
5
3
1
0
400000
800000
1200000

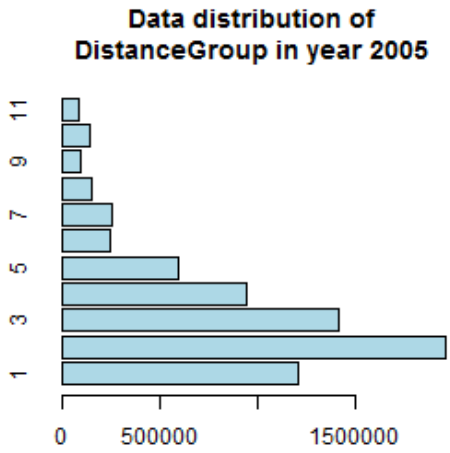

Data distribution of
Carrier in year 2003
WN
RU
HP
DH
AA
0e+00
4e+05
8e+05

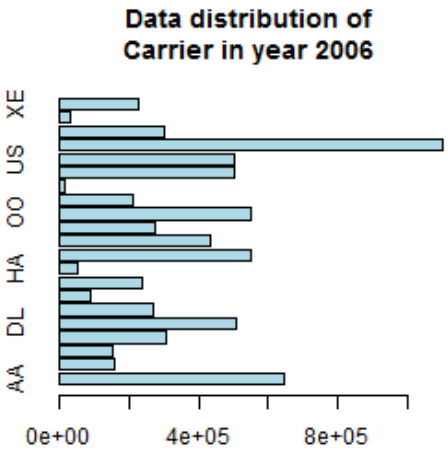

Data distribution of
DistanceGroup in year 2003
11
9
7
5
3
1
0
500000
1000000

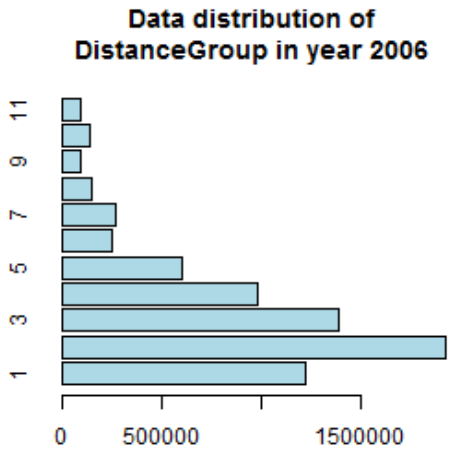

Data distribution of
Carrier in year 2004
AA
DH
HA
OH
UA
0e+00
4e+05
8e+05

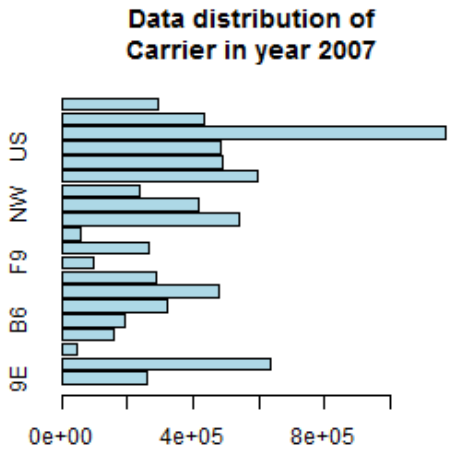

Data distribution of
DistanceGroup in year 2004
1
3
5
7
9
11
0
500000
1500000

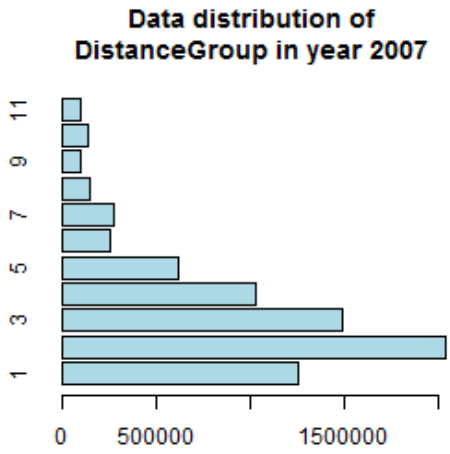

Data distribution of
Carrier in year 2005
AA
DH
HA
OH
UA
0e+00
4e+05
8e+05

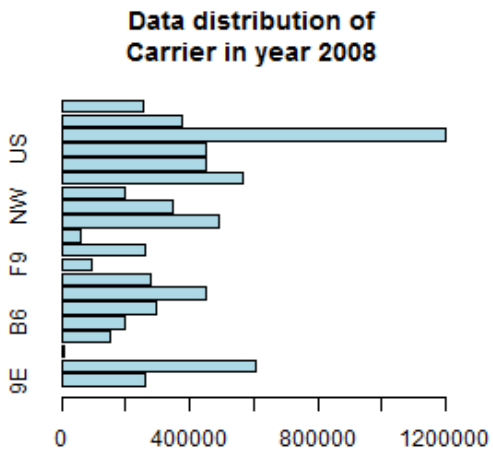

Data distribution of
DistanceGroup in year 2005
1
3
5
7
9
11
0
500000
1500000

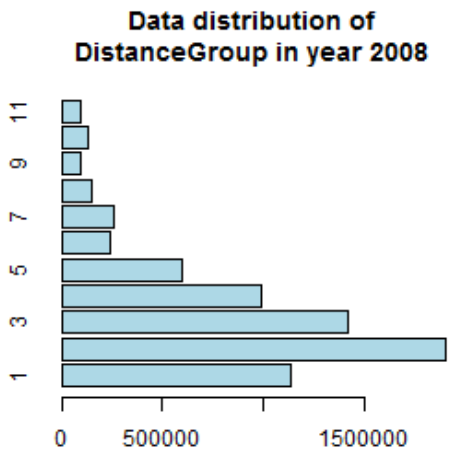

Data distribution of
Carrier in year 2006
AA
DL
HA
OO
US
XE
0e+00
4e+05
8e+05

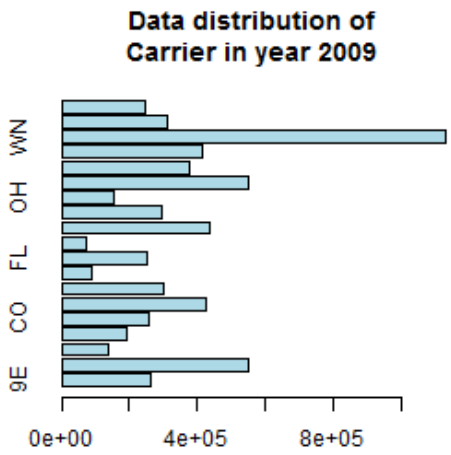

Data distribution of
DistanceGroup in year 2006
1
3
5
7
9
11
0
500000
1500000

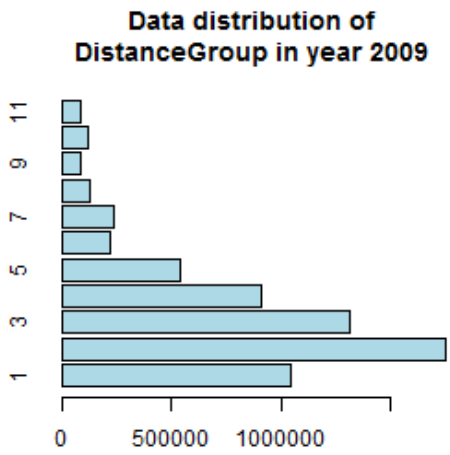

Data distribution of
Carrier in year 2007
US
NW
F9
B6
9E
0e+00
4e+05
8e+05

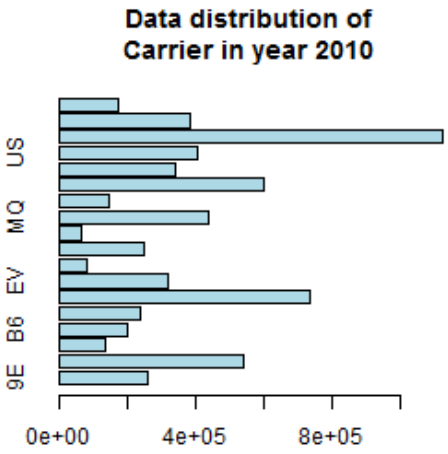

Data distribution of
DistanceGroup in year 2007
11
9
7
5
3
1
0
500000
1500000

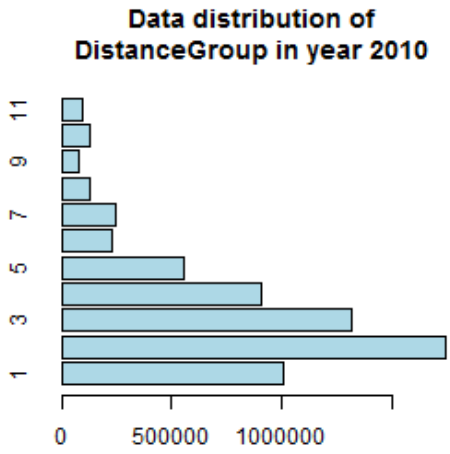

Data distribution of
Carrier in year 2008
US
NW
F9
B6
9E
0
400000
800000
1200000

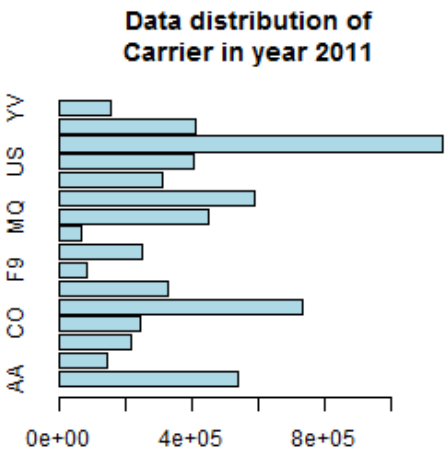

Data distribution of
DistanceGroup in year 2008
11
9
7
5
3
1
0
500000
1500000

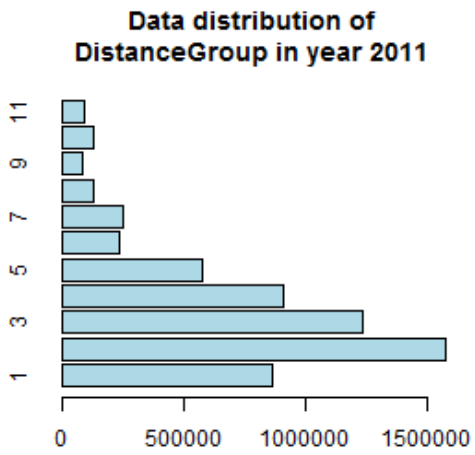

Data distribution of
Carrier in year 2009
WN
OH
FL
CO
9E
0e+00
4e+05
8e+05

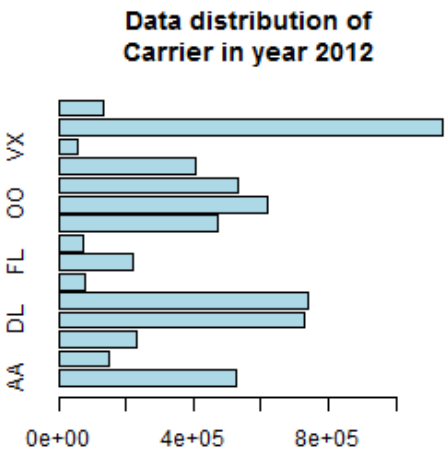

Data distribution of
DistanceGroup in year 2009
11
9
7
5
3
1
0
500000
1000000

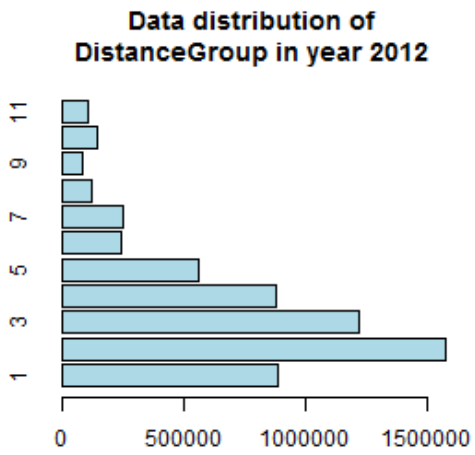

Data distribution of
Carrier in year 2010
9E
B6
EV
MQ
US
0e+00
4e+05
8e+05

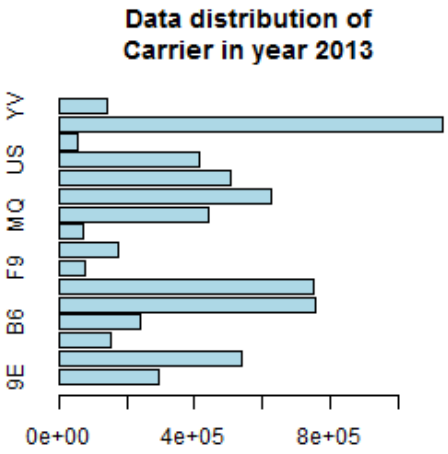

Data distribution of
DistanceGroup in year 2010
1
3
5
7
9
11
0
500000
1000000

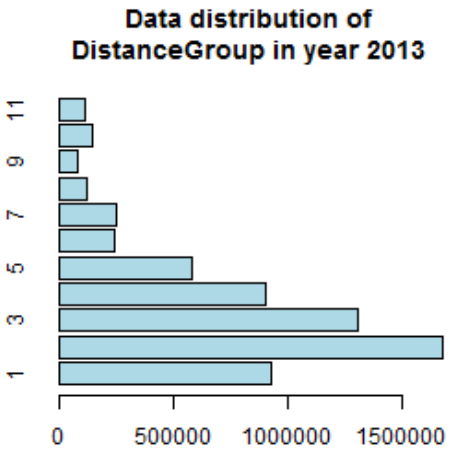

Data distribution of
Carrier in year 2011
AA
CO
F9
MQ
US
YV
0e+00
4e+05
8e+05

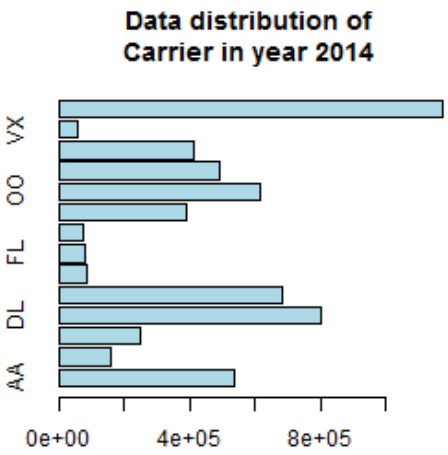

Data distribution of
DistanceGroup in year 2011
1
3
5
7
9
11
0
500000
1000000
1500000

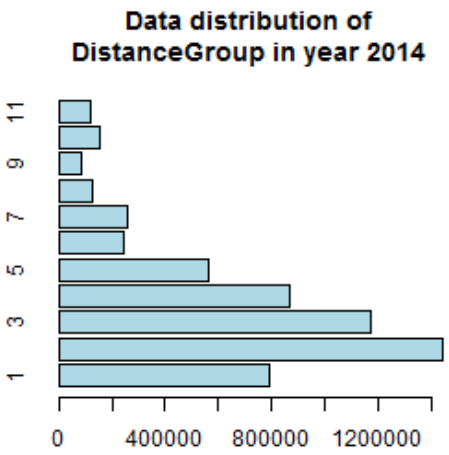

Data distribution of
Carrier in year 2012
AA
DL
FL
OO
VX
0e+00
4e+05
8e+05

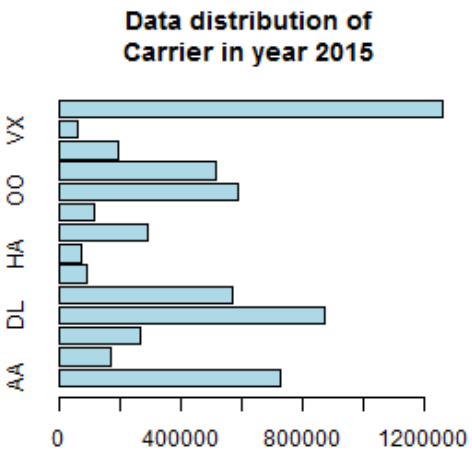

Data distribution of
DistanceGroup in year 2012
1
3
5
7
9
11
0
500000
1000000
1500000

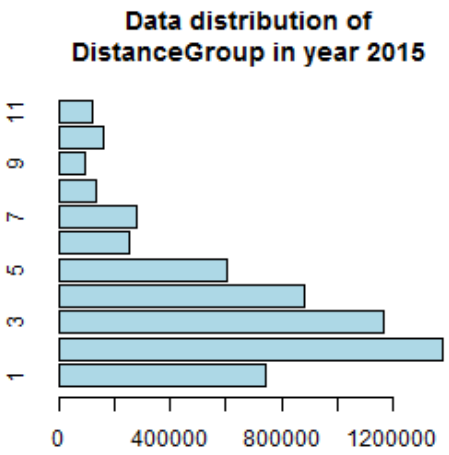

Data distribution of
Carrier in year 2013
YV
US
MQ
F9
B6
9E
0e+00
4e+05
8e+05

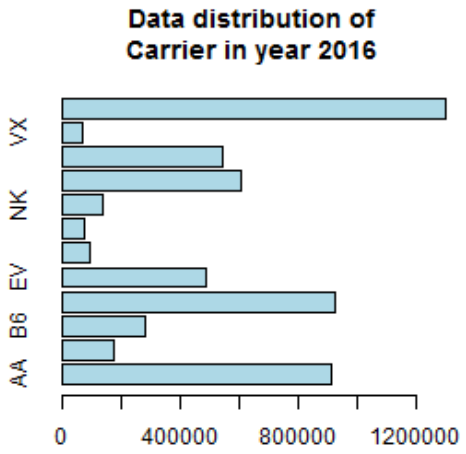

Data distribution of
DistanceGroup in year 2013
11
9
7
5
3
1
0
500000
1000000
1500000

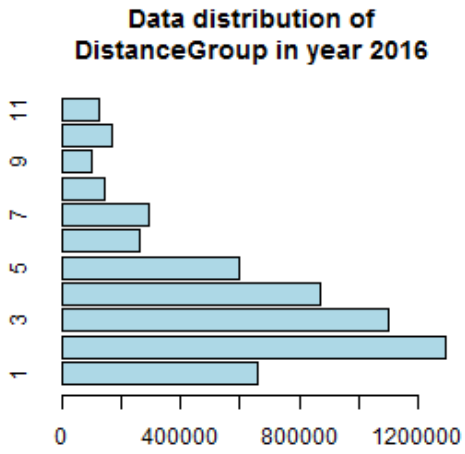

Data distribution of
Carrier in year 2014
VX
OO
FL
DL
AA
0e+00
4e+05
8e+05


Data distribution of
DistanceGroup in year 2014
11
9
7
5
3
1
0
400000
800000
1200000


Data distribution of
Carrier in year 2015
VX
OO
HA
DL
AA
0
400000
800000
1200000


Data distribution of
DistanceGroup in year 2015
11
9
7
5
3
1
0
400000
800000
1200000


Data distribution of
Carrier in year 2016
AA
B6
EV
NK
VX
0
400000
800000
1200000


Data distribution of
DistanceGroup in year 2016
1
3
5
7
9
11
0
400000
800000
1200000

15 Appendix 6 - Source code

The following pages contain the source code of the project.

```
# #'
# #' \code{wildLifeStrikeDataSet} based on the configuration
# #' items checkes if the wildlife strike data set file has been:
# #'  - downloaded
# #'  - uncompressed
# #'  - included tables extracted
# #' if not, then execute these tasks.
# #'
# #' @examples
# #' wildLifeStrikeDataSet()
# #'
# wildLifeStrikeDataSet <- function() {
#   #setting the download parameters
#   URL <- getWData()
#   destfile <- paste(getDataDir(), "wildlife.zip", sep = "/")
#
#   method="auto"
#
#   #if the file exists then do not download again
#   if (file.exists(destfile) != TRUE)
#   {
#     download.file(URL, destfile, method)
#   } else
#   {
#     message("File exists no download required.")
#   }
#
#   destdir <- getDataDir()
#
#   #unzip the file
#   unzip(destfile, exdir = destdir)
#
#   csvfile <- paste(destdir,
#                    "/STRIKE_REPORTS (1990-1999).csv",
#                    sep="")
#
#   if (file.exists(csvfile) != TRUE)
#   {
#     setwd(getDataDir())
#     system(paste("java -jar ",
#                  getDataDir(),
#                  "/access2csv.jar ",
#                  getDataDir(),
#                  "/wildlife.accdb",
#                  sep = ""))
#     setwd(getMainDir())
#   } else
#   {
#     message("File exists no extract required.")
#   }
```

```
#
# }
# #'
# #' \code{onTimeFlightPerformanceDataSet} based on the configuration
# #' items checkes if the commercial flight data set files have been:
# #'  - downloaded
# #'  - uncompressed
# #' if not, then execute these tasks.
# #'
# #' @examples
# #' onTimeFlightPerformanceDataSet()
# #'
# onTimeFlightPerformanceDataSet <- function() {
#
#   method="auto"
#   dataDir <- getDataDir()
#   startYear <- getStartYear()
#   endYear <- getEndYear()
#   startMonth <- getStartMonth()
#   endMonth <- getEndMonth()
#
#   for (i in startYear:endYear){
#     for (j in startMonth:endMonth){
#
#       variableName <- paste("On_Time_On_Time_Performance_",
#                             i,
#                             "_",
#                             j,
#                             sep = "")
#
#       sourceFile <- paste(variableName, ".zip", sep = "")
#       URL <- paste(getFData(), sourceFile, sep = "")
#       destinationFile <- paste(dataDir, "/", sourceFile, sep = "")
#
#       #if the file exists then do not download again
#       if (file.exists(destinationFile) != TRUE)
#       {
#         message("Downloading ", sourceFile)
#         download.file(URL, destinationFile, method)
#         Sys.sleep(0.1)
#       } else
#       {
#         message(sourceFile,
#                 " file exists, no download is required.")
#       }
#
#       zippedFileName <- sourceFile
#       zippedFile <- destinationFile
#       unzippedFileName <- paste(variableName,
#                                 ".csv",
#                                 sep = "")
#       unzippedFile <- paste(dataDir, "/", unzippedFileName, sep = "")
#
```

```
#       #if the file exists then do not unzip it again
#       if (file.exists(unzippedFile) != TRUE)
#       {
#         message("Unzipping ", zippedFileName)
#         unzip(zippedFile,
#               overwrite = FALSE,
#               exdir = dataDir) #No overwrite
#         #Clear warnings
#         assign("last.warning", NULL, envir = baseenv())
#       } else
#       {
#         message(unzippedFileName,
#                 " file exists, no unzip is required.")
#       }
#
#     } #end of "for (j in startMonth:endMonth)"
#   } #end of "for (i in startYear:endYear)"
#
# }
# #'
# #' \code{wildLifeStrikeDataSetSplitByYear} splits the strike data
# #' into RDS files by year, so that the data files would be aligned
# #' across the different data sets
# #'
# #' @examples
# #' wildLifeStrikeDataSetSplitByYear()
# #'
# wildLifeStrikeDataSetSplitByYear <- function() {
#
#   dataDir <- getDataDir()
#   startYear <- getStartYear()
#   endYear <- getEndYear()
#
#   for (i in startYear:endYear){
#     RDSFileName <- paste(i,
#                          "_Animal_Strikes_01_Orig.rds",
#                          sep = "")
#
#     RDSFile <- paste(dataDir,
#                      "/",
#                      RDSFileName,
#                      sep = "")
#
#     if (file.exists(RDSFile) != TRUE){
#
#       if (exists("sr_1990_1999") != TRUE){
#
#         message("Reading sr_1990_1999")
#
#         variableName <- "sr_1990_1999"
#
#         assign(variableName,
#                data.table(
```

```
#                   read.csv(
#                     paste(
#                       dataDir,
#                       "/STRIKE_REPORTS (1990-1999).csv",
#                       sep=""),
#                     header = FALSE)),
#                 envir = .GlobalEnv)
#
#         names(sr_1990_1999) <- c("INDEX_NR",
#                                  "OPID",
#                                  "OPERATOR",
#                                  "ATYPE",
#                                  "AMA",
#                                  "AMO",
#                                  "EMA",
#                                  "EMO",
#                                  "AC_CLASS",
#                                  "AC_MASS",
#                                  "NUM_ENGS",
#                                  "TYPE_ENG",
#                                  "ENG_1_POS",
#                                  "ENG_2_POS",
#                                  "ENG_3_POS",
#                                  "ENG_4_POS",
#                                  "REG",
#                                  "FLT",
#                                  "REMAINS_COLLECTED",
#                                  "REMAINS_SENT",
#                                  "INCIDENT_DATE",
#                                  "INCIDENT_MONTH",
#                                  "INCIDENT_YEAR",
#                                  "TIME_OF_DAY",
#                                  "TIME",
#                                  "AIRPORT_ID",
#                                  "AIRPORT",
#                                  "STATE",
#                                  "FAAREGION",
#                                  "ENROUTE",
#                                  "RUNWAY",
#                                  "LOCATION",
#                                  "HEIGHT",
#                                  "SPEED",
#                                  "DISTANCE",
#                                  "PHASE_OF_FLT",
#                                  "DAMAGE",
#                                  "STR_RAD",
#                                  "DAM_RAD",
#                                  "STR_WINDSHLD",
#                                  "DAM_WINDSHLD",
#                                  "STR_NOSE",
#                                  "DAM_NOSE",
#                                  "STR_ENG1",
#                                  "DAM_ENG1",
#                                  "STR_ENG2",
```

```
#                                   ”DAM_ENG2”,
#                                   ”STR_ENG3”,
#                                   ”DAM_ENG3”,
#                                   ”STR_ENG4”,
#                                   ”DAM_ENG4”,
#                                   ”INGESTED”,
#                                   ”STR_PROP”,
#                                   ”DAM_PROP”,
#                                   ”STR_WING_ROT”,
#                                   ”DAM_WING_ROT”,
#                                   ”STR_FUSE”,
#                                   ”DAM_FUSE”,
#                                   ”STR_LG”,
#                                   ”DAM_LG”,
#                                   ”STR_TAIL”,
#                                   ”DAM_TAIL”,
#                                   ”STR_LGHTS”,
#                                   ”DAM_LGHTS”,
#                                   ”STR_OTHER”,
#                                   ”DAM_OTHER”,
#                                   ”OTHER_SPECIFY”,
#                                   ”EFFECT”,
#                                   ”EFFECT_OTHER”,
#                                   ”SKY”,
#                                   ”PRECIP”,
#                                   ”SPECIES_ID”,
#                                   ”SPECIES”,
#                                   ”BIRDS_SEEN”,
#                                   ”BIRDS_STRUCK”,
#                                   ”SIZE”,
#                                   ”WARNED”,
#                                   ”COMMENTS”,
#                                   ”REMARKS”,
#                                   ”AOS”,
#                                   ”COST_REPAIRS”,
#                                   ”COST_OTHER”,
#                                   ”COST_REPAIRS_INFL_ADJ”,
#                                   ”COST_OTHER_INFL_ADJ”,
#                                   ”REPORTED_NAME”,
#                                   ”REPORTED_TITLE”,
#                                   ”REPORTED_DATE”,
#                                   ”SOURCE”,
#                                   ”PERSON”,
#                                   ”NR_INJURIES”,
#                                   ”NR_FATALITIES”,
#                                   ”LUPDATE”,
#                                   ”TRANSFER”,
#                                   ”INDICATED_DAMAGE”)
#       }
#
#       if (exists(”sr_2000_2009”) != TRUE){
#
#         message(”Reading sr_2000_2009”)
#
```

```
#         variableName <- ”sr_2000_2009”
#
#         assign(variableName,
#                data.table(
#                  read.csv(
#                    paste(
#                      dataDir,
#                      ”/STRIKE_REPORTS (2000-2009).csv”,
#                      sep=””),
#                    header = FALSE)),
#                envir = .GlobalEnv)
#
#         names(sr_2000_2009) <- c(”INDEX_NR”,
#                                  ”OPID”,
#                                  ”OPERATOR”,
#                                  ”ATYPE”,
#                                  ”AMA”,
#                                  ”AMO”,
#                                  ”EMA”,
#                                  ”EMO”,
#                                  ”AC_CLASS”,
#                                  ”AC_MASS”,
#                                  ”NUM_ENGS”,
#                                  ”TYPE_ENG”,
#                                  ”ENG_1_POS”,
#                                  ”ENG_2_POS”,
#                                  ”ENG_3_POS”,
#                                  ”ENG_4_POS”,
#                                  ”REG”,
#                                  ”FLT”,
#                                  ”REMAINS_COLLECTED”,
#                                  ”REMAINS_SENT”,
#                                  ”INCIDENT_DATE”,
#                                  ”INCIDENT_MONTH”,
#                                  ”INCIDENT_YEAR”,
#                                  ”TIME_OF_DAY”,
#                                  ”TIME”,
#                                  ”AIRPORT_ID”,
#                                  ”AIRPORT”,
#                                  ”STATE”,
#                                  ”FAAREGION”,
#                                  ”ENROUTE”,
#                                  ”RUNWAY”,
#                                  ”LOCATION”,
#                                  ”HEIGHT”,
#                                  ”SPEED”,
#                                  ”DISTANCE”,
#                                  ”PHASE_OF_FLT”,
#                                  ”DAMAGE”,
#                                  ”STR_RAD”,
#                                  ”DAM_RAD”,
#                                  ”STR_WINDSHLD”,
#                                  ”DAM_WINDSHLD”,
#                                  ”STR_NOSE”,
```

```
#                                       ”DAM_NOSE”,
#                                       ”STR_ENG1”,
#                                       ”DAM_ENG1”,
#                                       ”STR_ENG2”,
#                                       ”DAM_ENG2”,
#                                       ”STR_ENG3”,
#                                       ”DAM_ENG3”,
#                                       ”STR_ENG4”,
#                                       ”DAM_ENG4”,
#                                       ”INGESTED”,
#                                       ”STR_PROP”,
#                                       ”DAM_PROP”,
#                                       ”STR_WING_ROT”,
#                                       ”DAM_WING_ROT”,
#                                       ”STR_FUSE”,
#                                       ”DAM_FUSE”,
#                                       ”STR_LG”,
#                                       ”DAM_LG”,
#                                       ”STR_TAIL”,
#                                       ”DAM_TAIL”,
#                                       ”STR_LGHTS”,
#                                       ”DAM_LGHTS”,
#                                       ”STR_OTHER”,
#                                       ”DAM_OTHER”,
#                                       ”OTHER_SPECIFY”,
#                                       ”EFFECT”,
#                                       ”EFFECT_OTHER”,
#                                       ”SKY”,
#                                       ”PRECIP”,
#                                       ”SPECIES_ID”,
#                                       ”SPECIES”,
#                                       ”BIRDS_SEEN”,
#                                       ”BIRDS_STRUCK”,
#                                       ”SIZE”,
#                                       ”WARNED”,
#                                       ”COMMENTS”,
#                                       ”REMARKS”,
#                                       ”AOS”,
#                                       ”COST_REPAIRS”,
#                                       ”COST_OTHER”,
#                                       ”COST_REPAIRS_INFL_ADJ”,
#                                       ”COST_OTHER_INFL_ADJ”,
#                                       ”REPORTED_NAME”,
#                                       ”REPORTED_TITLE”,
#                                       ”REPORTED_DATE”,
#                                       ”SOURCE”,
#                                       ”PERSON”,
#                                       ”NR_INJURIES”,
#                                       ”NR_FATALITIES”,
#                                       ”LUPDATE”,
#                                       ”TRANSFER”,
#                                       ”INDICATED_DAMAGE”)
#       }
#
```

```
#       if (exists("sr_2010_Current") != TRUE){
#
#         message("Reading sr_2010_Current")
#
#         variableName <- "sr_2010_Current"
#
#         assign(variableName,
#                data.table(
#                  read.csv(
#                    paste(
#                      dataDir,
#                      "/STRIKE_REPORTS (2010-Current).csv",
#                      sep=""),
#                    header = FALSE)),
#                envir = .GlobalEnv)
#
#         names(sr_2010_Current) <- c("INDEX_NR",
#                                     "OPID",
#                                     "OPERATOR",
#                                     "ATYPE",
#                                     "AMA",
#                                     "AMO",
#                                     "EMA",
#                                     "EMO",
#                                     "AC_CLASS",
#                                     "AC_MASS",
#                                     "NUM_ENGS",
#                                     "TYPE_ENG",
#                                     "ENG_1_POS",
#                                     "ENG_2_POS",
#                                     "ENG_3_POS",
#                                     "ENG_4_POS",
#                                     "REG",
#                                     "FLT",
#                                     "REMAINS_COLLECTED",
#                                     "REMAINS_SENT",
#                                     "INCIDENT_DATE",
#                                     "INCIDENT_MONTH",
#                                     "INCIDENT_YEAR",
#                                     "TIME_OF_DAY",
#                                     "TIME",
#                                     "AIRPORT_ID",
#                                     "AIRPORT",
#                                     "STATE",
#                                     "FAAREGION",
#                                     "ENROUTE",
#                                     "RUNWAY",
#                                     "LOCATION",
#                                     "HEIGHT",
#                                     "SPEED",
#                                     "DISTANCE",
#                                     "PHASE_OF_FLT",
#                                     "DAMAGE",
#                                     "STR_RAD",
```

```
#                                   ”DAM_RAD”,
#                                   ”STR_WINDSHLD”,
#                                   ”DAM_WINDSHLD”,
#                                   ”STR_NOSE”,
#                                   ”DAM_NOSE”,
#                                   ”STR_ENG1”,
#                                   ”DAM_ENG1”,
#                                   ”STR_ENG2”,
#                                   ”DAM_ENG2”,
#                                   ”STR_ENG3”,
#                                   ”DAM_ENG3”,
#                                   ”STR_ENG4”,
#                                   ”DAM_ENG4”,
#                                   ”INGESTED”,
#                                   ”STR_PROP”,
#                                   ”DAM_PROP”,
#                                   ”STR_WING_ROT”,
#                                   ”DAM_WING_ROT”,
#                                   ”STR_FUSE”,
#                                   ”DAM_FUSE”,
#                                   ”STR_LG”,
#                                   ”DAM_LG”,
#                                   ”STR_TAIL”,
#                                   ”DAM_TAIL”,
#                                   ”STR_LGHTS”,
#                                   ”DAM_LGHTS”,
#                                   ”STR_OTHER”,
#                                   ”DAM_OTHER”,
#                                   ”OTHER_SPECIFY”,
#                                   ”EFFECT”,
#                                   ”EFFECT_OTHER”,
#                                   ”SKY”,
#                                   ”PRECIP”,
#                                   ”SPECIES_ID”,
#                                   ”SPECIES”,
#                                   ”BIRDS_SEEN”,
#                                   ”BIRDS_STRUCK”,
#                                   ”SIZE”,
#                                   ”WARNED”,
#                                   ”COMMENTS”,
#                                   ”REMARKS”,
#                                   ”AOS”,
#                                   ”COST_REPAIRS”,
#                                   ”COST_OTHER”,
#                                   ”COST_REPAIRS_INFL_ADJ”,
#                                   ”COST_OTHER_INFL_ADJ”,
#                                   ”REPORTED_NAME”,
#                                   ”REPORTED_TITLE”,
#                                   ”REPORTED_DATE”,
#                                   ”SOURCE”,
#                                   ”PERSON”,
#                                   ”NR_INJURIES”,
#                                   ”NR_FATALITIES”,
#                                   ”LUPDATE”,
```

```
#                                   ”TRANSFER”,
#                                   ”INDICATED_DAMAGE”)
#       }
#
#       #STRIKE_REPORTS_BASH --> contains only military data, not required
#
#
#       if (i >= 1990 && i <= 1999) {
#         dataOfWholeYear <- sr_1990_1999[INCIDENT_YEAR == i]
#       }
#       else if (i >= 2000 && i <= 2009) {
#         dataOfWholeYear <- sr_2000_2009[INCIDENT_YEAR == i]
#       }
#       else if (i >= 2010 && i <= 2019) {
#         dataOfWholeYear <- sr_2010_Current[INCIDENT_YEAR == i]
#       }
#
#       saveRDS(dataOfWholeYear, file = RDSFile)
#       message(RDSFileName,” created.”)
#
#       #free up memory
#       rm(dataOfWholeYear)
#       rm(list = ls(pattern = ”sr_*”))
#       gc()
#
#     }
#     else {
#       message(RDSFileName,
#               ” exists, no further action is required.”)
#     }
#
#
#   } #end of ”for (i in startYear:endYear)”
#
# }
# #'
# #' \code{onTimeFlightPerformanceDataSetMergeByYear} merges the flight data
# #' into RDS files by year, so that working with the data would not consume
# #' all the memory of the running environment
# #'
# #' @examples
# #' onTimeFlightPerformanceDataSetMergeByYear()
# #'
# onTimeFlightPerformanceDataSetMergeByYear <- function() {
#   dataDir <- getDataDir()
#   startYear <- getStartYear()
#   endYear <- getEndYear()
#   startMonth <- getStartMonth()
#   endMonth <- getEndMonth()
#
#   for (i in startYear:endYear){
#
#     RDSFileName <- paste(i,
```

```
#                           "_On_Time_On_Time_Performance_01_Orig.rds",
#                           sep = "")
#
#     RDSFile <- paste(dataDir,
#                      "/",
#                      RDSFileName,
#                      sep = "")
#
#     #Create the RDS files only if they do not exist yet
#     if (file.exists(RDSFile) != TRUE){
#
#       for (j in startMonth:endMonth){
#
#         variableName <- paste("On_Time_On_Time_Performance_",
#                               i,
#                               "_",
#                               j,
#                               sep = "")
#
#         unzippedFileName <- paste(variableName,
#                                   ".csv",
#                                   sep = "")
#
#         unzippedFile <- paste(dataDir,
#                               "/",
#                               unzippedFileName,
#                               sep = "")
#
#         assign(variableName,
#                data.table(read.csv(unzippedFile,
#                                    header = TRUE)))
#
#         if (j == startMonth){
#           dataOfWholeYear <- get(variableName)
#           rm(list = ls(pattern = "On_Time_On_Time_Performance*"))
#           gc()
#         }
#         else {
#           dataOfWholeYear <- rbindlist(list(dataOfWholeYear,
#                                             get(variableName)))
#           rm(list = ls(pattern = "On_Time_On_Time_Performance*"))
#           gc()
#         }
#
#       } #end of "for (j in startMonth:endMonth)"
#
#       saveRDS(dataOfWholeYear, file = RDSFile)
#       message(RDSFileName," created.")
#
#       #free up memory
#       rm(dataOfWholeYear)
#       gc()
#
#     }
```

```
#     else {
#       message(RDSFileName,
#               " exists, no further action is required.")
#     }
#
#   } #end of "for (i in startYear:endYear)"
#
# }
# #'
# #' \code{ExploreWildLifeStrikeDataSet} creates the inputs
# #' for the Data Exploration Report based on the WildLife
# #' strike data set
# #'
# #' @examples
# #' ExploreWildLifeStrikeDataSet()
# #'
# ExploreWildLifeStrikeDataSet <- function() {
#
#   dataDir <- getDataDir()
#   startYear <- getStartYear()
#   endYear <- getEndYear()
#
#   dataSummary <- data.table(
#     dataYear = character(),
#     numberOfRecords = integer(),
#     factorOPID = integer(),
#     factopATYPE = integer(),
#     factorAC_CLASS = integer(),
#     factorAC_MASS = integer(),
#     factorTYPE_ENG = integer(),
#     factorTIME_OF_DAY = integer(),
#     factorAIRPORT_ID = integer(),
#     factorSTATE = integer(),
#     factorPHASE_OF_FLT = integer(),
#     factorSKY = integer(),
#     factorPRECIP = integer(),
#     factorWARNED = integer()
#   )
#
#   for (i in startYear:endYear){
#     RDSFileName <- paste(i,
#                          "_Animal_Strikes_01_Orig.rds",
#                          sep = "")
#
#     RDSFile <- paste(dataDir,
#                      "/",
#                      RDSFileName,
#                      sep = "")
#
#     if (file.exists(RDSFile) != TRUE){
#       message(RDSFileName,
#               "is not available, ",
#               "please re-run the preparation scripts!")
```

```
#     } else {
#       #Read the data file into a variable
#       variableName <- paste("AS_", i, sep="")
#       assign(variableName, readRDS(file = RDSFile))
#
#       dataSummary <- rbindlist(
#         list(
#           dataSummary,
#           list(as.character(i),
#                nrow(get(variableName)),
#                length(levels(get(variableName)$OPID)),
#                length(levels(get(variableName)$ATYPE)),
#                length(levels(get(variableName)$AC_CLASS)),
#                length(levels(as.factor(get(variableName)$AC_MASS))),
#                length(levels(get(variableName)$TYPE_ENG)),
#                length(levels(get(variableName)$TIME_OF_DAY)),
#                length(levels(get(variableName)$AIRPORT_ID)),
#                length(levels(get(variableName)$STATE)),
#                length(levels(get(variableName)$PHASE_OF_FLT)),
#                length(levels(get(variableName)$SKY)),
#                length(levels(get(variableName)$PRECIP)),
#                length(levels(get(variableName)$WARNED))
#                )
#           ))
#
#       #Save the plots as PNG files
#       saveBarPlotPNG(DataYear = i,
#                      DataSet = "AnimalStrike",
#                      DataField = "AC_CLASS",
#                      DataStage = "01_Orig",
#                      DataObject = table(get(variableName)$AC_CLASS))
#       saveBarPlotPNG(DataYear = i,
#                      DataSet = "AnimalStrike",
#                      DataField = "AC_MASS",
#                      DataStage = "01_Orig",
#                      DataObject = table(get(variableName)$AC_MASS))
#       saveBarPlotPNG(DataYear = i,
#                      DataSet = "AnimalStrike",
#                      DataField = "TYPE_ENG",
#                      DataStage = "01_Orig",
#                      DataObject = table(get(variableName)$TYPE_ENG))
#       saveBarPlotPNG(DataYear = i,
#                      DataSet = "AnimalStrike",
#                      DataField = "TIME_OF_DAY",
#                      DataStage = "01_Orig",
#                      DataObject = table(get(variableName)$TIME_OF_DAY))
#       saveBarPlotPNG(DataYear = i,
#                      DataSet = "AnimalStrike",
#                      DataField = "PHASE_OF_FLT",
#                      DataStage = "01_Orig",
#                      DataObject = table(get(variableName)$PHASE_OF_FLT))
#       saveBarPlotPNG(DataYear = i,
#                      DataSet = "AnimalStrike",
#                      DataField = "SKY",
```

```
#                       DataStage = "01_Orig",
#                       DataObject = table(get(variableName)$SKY))
#       saveBarPlotPNG(DataYear = i,
#                       DataSet = "AnimalStrike",
#                       DataField = "PRECIP",
#                       DataStage = "01_Orig",
#                       DataObject = table(get(variableName)$PRECIP))
#
#       #Free up the memory
#       rm(list = variableName)
#       rm(variableName)
#       gc()
#
#     } #end of "if (file.exists(RDSFile) != TRUE)"
#
#   } #end of "for (i in startYear:endYear)"
#
#
#   RDSExpFileName <- "01_EXP_Animal_Strikes.rds"
#
#   RDSExpFile <- paste(dataDir,
#                       "/",
#                       RDSExpFileName,
#                       sep = "")
#
#   if (file.exists(RDSExpFile) != TRUE) {
#     saveRDS(dataSummary, file = RDSExpFile)
#   } else {
#     file.remove(RDSExpFile)
#     saveRDS(dataSummary, file = RDSExpFile)
#   }
#
# }
# #'
# #' \code{ExploreOnTimeFlightPerformanceDataSet} creates
# #' the inputs for the Data Exploration Report based on
# #' the Flight data set
# #'
# #' @examples
# #' ExploreOnTimeFlightPerformanceDataSet()
# #'
# ExploreOnTimeFlightPerformanceDataSet <- function() {
#
#   dataDir <- getDataDir()
#   startYear <- getStartYear()
#   endYear <- getEndYear()
#
#   dataSummary <- data.table(
#     dataYear = character(),
#     numberOfRecords = integer(),
#     factorCarrier = integer(),
#     factorOrigin = integer(),
#     factorOriginState = integer(),
```

```
#     factorDest = integer(),
#     factorDestState = integer(),
#     factorDepTimeBlk = integer(),
#     factorDistanceGroup = integer()
#   )
#
#   for (i in startYear:endYear){
#     RDSFileName <- paste(i,
#                          "_On_Time_On_Time_Performance_01_Orig.rds",
#                          sep = "")
#
#     RDSFile <- paste(dataDir,
#                      "/",
#                      RDSFileName,
#                      sep = "")
#
#     if (file.exists(RDSFile) != TRUE){
#       message(RDSFileName,
#               "is not available, ",
#               "please re-run the preparation scripts!")
#     } else {
#       #Read the data file into a variable
#       variableName <- paste("FP_", i, sep="")
#       assign(variableName, readRDS(file = RDSFile))
#
#       dataSummary <- rbindlist(
#         list(
#           dataSummary,
#           list(as.character(i),
#                nrow(get(variableName)),
#                length(levels(get(variableName)$Carrier)),
#                length(levels(get(variableName)$Origin)),
#                length(levels(get(variableName)$OriginState)),
#                length(levels(get(variableName)$Dest)),
#                length(levels(get(variableName)$DestState)),
#                length(levels(get(variableName)$DepTimeBlk)),
#                length(levels(as.factor(get(variableName)$DistanceGroup)))
#           )))
#
#       #Save the plots as PNG files
#       saveBarPlotPNG(DataYear = i,
#                      DataSet = "FlightData",
#                      DataField = "Carrier",
#                      DataStage = "01_Orig",
#                      DataObject = table(get(variableName)$Carrier))
#
#       saveBarPlotPNG(DataYear = i,
#                      DataSet = "FlightData",
#                      DataField = "DistanceGroup",
#                      DataStage = "01_Orig",
#                      DataObject = table(get(variableName)$DistanceGroup))
#
#       #Free up the memory
#       rm(list = variableName)
```

```
#       rm(variableName)
#       gc()
#
#     } #end of "if (file.exists(RDSFile) != TRUE)"
#
#   } #end of "for (i in startYear:endYear)"
#
#   RDSExpFileName <- "02_EXP_Flight_Data.rds"
#
#   RDSExpFile <- paste(dataDir,
#                       "/",
#                       RDSExpFileName,
#                       sep = "")
#
#   if (file.exists(RDSExpFile) != TRUE) {
#     saveRDS(dataSummary, file = RDSExpFile)
#   } else {
#     file.remove(RDSExpFile)
#     saveRDS(dataSummary, file = RDSExpFile)
#   }
#
# }
# #'
# #' \code{DescribeWildLifeStrikeDataSet} re-creates the
# #' inputs based on the column selection of the data
# #' verification report
# #'
# #' @examples
# #' DescribeWildLifeStrikeDataSet()
# #'
# DescribeWildLifeStrikeDataSet <- function() {
#
#   dataDir <- getDataDir()
#   startYear <- getStartYear()
#   endYear <- getEndYear()
#
#   for (i in startYear:endYear){
#     RDSFileName <- paste(i,
#                          "_Animal_Strikes_01_Orig.rds",
#                          sep = "")
#
#     RDSFile <- paste(dataDir,
#                      "/",
#                      RDSFileName,
#                      sep = "")
#
#     RDSFileNameDescibed <- paste(i,
#                                  "_Animal_Strikes_02_Desc.rds",
#                                  sep = "")
#
#     RDSFileDescibed <- paste(dataDir,
#                              "/",
#                              RDSFileNameDescibed,
```

```
#                               sep = "")
#
#     if (file.exists(RDSFile) != TRUE){
#       message(RDSFileName,
#               "is not available, ",
#               "please re-run the preparation scripts!")
#     } else {
#
#       if (file.exists(RDSFileDescibed) == TRUE){
#         message(RDSFileNameDescibed,
#                 " exists, no further action is required.")
#       } else {
#
#         #Read the data file into a variable
#         variableName <- paste("AS_", i, sep="")
#         assign(variableName, readRDS(file = RDSFile))
#
#         #set the required column names
#         ColumnNames <- c("INDEX_NR",
#                          "OPID",
#                          "OPERATOR",
#                          "ATYPE",
#                          "AC_CLASS",
#                          "AC_MASS",
#                          "TYPE_ENG",
#                          "REG",
#                          "FLT",
#                          "INCIDENT_DATE",
#                          "INCIDENT_MONTH",
#                          "INCIDENT_YEAR",
#                          "TIME_OF_DAY",
#                          "TIME",
#                          "AIRPORT_ID",
#                          "AIRPORT",
#                          "STATE",
#                          "FAAREGION",
#                          "ENROUTE",
#                          "RUNWAY",
#                          "HEIGHT",
#                          "SPEED",
#                          "DISTANCE",
#                          "PHASE_OF_FLT",
#                          "SKY",
#                          "PRECIP",
#                          "WARNED")
#
#         #Move reduces data into a new data set
#         describedDataSet <- get(variableName)[, ..ColumnNames]
#
#         saveRDS(describedDataSet, file = RDSFileDescibed)
#
#         #Free up the memory
#         rm(list = variableName)
#         rm(variableName)
```

```
#         rm(describedDataSet)
#         gc()
#
#       } #end of "if (file.exists(RDSFileDescibed) == TRUE)"
#
#     } #end of "if (file.exists(RDSFile) != TRUE)"
#
#   } #end of "for (i in startYear:endYear)"
#
# }
# #'
# #' \code{DescribeOnTimeFlightPerformanceDataSet} re-creates the
# #' inputs based on the column selection of the data
# #' verification report
# #'
# #' @examples
# #' DescribeOnTimeFlightPerformanceDataSet()
# #'
# DescribeOnTimeFlightPerformanceDataSet <- function() {
#
#   dataDir <- getDataDir()
#   startYear <- getStartYear()
#   endYear <- getEndYear()
#
#   for (i in startYear:endYear){
#     RDSFileName <- paste(i,
#                          "_On_Time_On_Time_Performance_01_Orig.rds",
#                          sep = "")
#
#     RDSFile <- paste(dataDir,
#                      "/",
#                      RDSFileName,
#                      sep = "")
#
#     RDSFileNameDescibed <- paste(i,
#                                  "_On_Time_On_Time_Performance_02_Desc.rds",
#                                  sep = "")
#
#     RDSFileDescibed <- paste(dataDir,
#                              "/",
#                              RDSFileNameDescibed,
#                              sep = "")
#
#     if (file.exists(RDSFile) != TRUE){
#       message(RDSFileName,
#               " is not available, ",
#               "please re-run the preparation scripts!")
#     } else {
#
#       if (file.exists(RDSFileDescibed) == TRUE){
#         message(RDSFileNameDescibed,
#                 " exists, no further action is required.")
#       } else {
```

```
#
#         #Read the data file into a variable
#         variableName <- paste("AS_", i, sep="")
#         assign(variableName, readRDS(file = RDSFile))
#
#         #set the required column names
#         ColumnNames <- c("Year",
#                          "Quarter",
#                          "Month",
#                          "DayofMonth",
#                          "DayOfWeek",
#                          "FlightDate",
#                          "Carrier",
#                          "FlightNum",
#                          "Origin",
#                          "OriginCityName",
#                          "OriginState",
#                          "OriginStateName",
#                          "Dest",
#                          "DestCityName",
#                          "DestState",
#                          "DestStateName",
#                          "CRSDepTime",
#                          "DepTimeBlk",
#                          "CRSArrTime",
#                          "ArrTimeBlk",
#                          "CRSElapsedTime",
#                          "Distance",
#                          "DistanceGroup")
#
#         #Move reduces data into a new data set
#         describedDataSet <- get(variableName)[, ..ColumnNames]
#
#
#         saveRDS(describedDataSet, file = RDSFileDescibed)
#
#         #Free up the memory
#         rm(list = variableName)
#         rm(variableName)
#         rm(describedDataSet)
#         gc()
#
#       } #end of "if (file.exists(RDSFileDescibed) == TRUE)"
#
#     } #end of "if (file.exists(RDSFile) != TRUE)"
#
#   } #end of "for (i in startYear:endYear)"
#
# }
# #'
# #' \code{SelectWildLifeStrikeDataSet} executes the identified
# #' exclusions and inclusions in the data set validation report
# #'
```

```
# #' @examples
# #' SelectWildLifeStrikeDataSet()
# #'
# SelectWildLifeStrikeDataSet <- function() {
#
#   dataDir <- getDataDir()
#   startYear <- getStartYear()
#   endYear <- getEndYear()
#
#   for (i in startYear:endYear){
#     RDSFileName <- paste(i,
#                          "_Animal_Strikes_02_Desc.rds",
#                          sep = "")
#
#     RDSFile <- paste(dataDir,
#                      "/",
#                      RDSFileName,
#                      sep = "")
#
#     RDSFileNameSelected <- paste(i,
#                                  "_Animal_Strikes_03_Sel.rds",
#                                  sep = "")
#
#     RDSFileSelected <- paste(dataDir,
#                              "/",
#                              RDSFileNameSelected,
#                              sep = "")
#
#     if (file.exists(RDSFile) != TRUE){
#       message(RDSFileName,
#               "is not available, ",
#               "please re-run the preparation scripts!")
#     } else {
#
#
#       if (file.exists(RDSFileSelected) == TRUE){
#         message(RDSFileNameSelected,
#                 " exists, no further action is required.")
#       } else {
#
#         #Read the data file into a variable
#         variableName <- paste("AS_", i, sep="")
#         assign(variableName, readRDS(file = RDSFile))
#
#         #OPID column selection
#         selectedDataSet <- get(variableName)[!OPID %in% c("PVT",
#                                                           "BUS",
#                                                           "GOV",
#                                                           "MIL",
#                                                           "UNKC",
#                                                           "UNK"),]
#
#         #AC_CLASS selection
#         selectedDataSet <- selectedDataSet[!AC_CLASS %in% c("B",
```

```
#                                                                   "C",
#                                                                   "D",
#                                                                   "F",
#                                                                   "I",
#                                                                   "J",
#                                                                   "Y",
#                                                                   "Z"),]
#         #TODO  |AC_CLASS|""|Value is empty.|
#
#         #TYPE_ENG selection
#         selectedDataSet <- selectedDataSet[!TYPE_ENG %in% c("E",
#                                                                   "F"),]
#         #TODO  |TYPE_ENG|""|Value is empty.|
#
#         saveRDS(selectedDataSet, file = RDSFileSelected)
#
#         #Free up the memory
#         rm(list = variableName)
#         rm(variableName)
#         gc()
#
#       } #end of "if (file.exists(RDSFileSelected) == TRUE)"
#
#     } #end of "if (file.exists(RDSFile) != TRUE)"
#
#   } #end of "for (i in startYear:endYear)"
#
# }
# #'
# #' \code{SelectOnTimeFlightPerformanceDataSet} executes the identified
# #' exclusions and inclusions in the data set validation report
# #'
# #' @examples
# #' SelectOnTimeFlightPerformanceDataSet()
# #'
# SelectOnTimeFlightPerformanceDataSet <- function() {
#
#   dataDir <- getDataDir()
#   startYear <- getStartYear()
#   endYear <- getEndYear()
#
#   for (i in startYear:endYear){
#
#     RDSFileName <- paste(i,
#                          "_On_Time_On_Time_Performance_02_Desc.rds",
#                          sep = "")
#
#     RDSFile <- paste(dataDir,
#                      "/",
#                      RDSFileName,
#                      sep = "")
#
#     RDSFileNameSelected <- paste(i,
```

```
#                                 "_On_Time_On_Time_Performance_03_Sel.rds",
#                                 sep = "")
#
#     RDSFileSelected <- paste(dataDir,
#                              "/",
#                              RDSFileNameSelected,
#                              sep = "")
#
#
#     if (file.exists(RDSFile) != TRUE){
#       message(RDSFileName,
#               "is not available, ",
#               "please re-run the preparation scripts!")
#     } else {
#
#       if (file.exists(RDSFileSelected) == TRUE){
#         message(RDSFileNameSelected,
#                 " exists, no further action is required.")
#       } else {
#
#         #Read the data file into a variable
#         variableName <- paste("FP_", i, sep="")
#         assign(variableName, readRDS(file = RDSFile))
#
#         #TODO
#
#         if (i == 2016) {
#           selectedDataSet <- get(variableName)[Month < 5,]
#         } else {
#           selectedDataSet <- get(variableName)
#         }
#
#
#         saveRDS(selectedDataSet, file = RDSFileSelected)
#
#         #Free up the memory
#         rm(list = variableName)
#         rm(variableName)
#         gc()
#
#       } #end of "if (file.exists(RDSFileSelected) == TRUE)"
#
#     } #end of "if (file.exists(RDSFile) != TRUE)"
#
#   } #end of "for (i in startYear:endYear)"
#
# }
# #'
# #' \code{loadLibraries} checkes if the required libraries are
# #'  - installed and
# #'  - loaded
# #' if not, the it installs (if required) and loads them.
# #'
```

```
# #' @examples
# #' loadLibraries()
# #'
# loadLibraries <- function() {
#   if (!require(installr)) {install.packages("installr"); require(installr)}
#   if (!require(RODBC)) {install.packages("RODBC"); require(RODBC)}
#   if (!require(knitr)) {install.packages("knitr"); require(knitr)}
#   if (!require(data.table)) {install.packages("data.table"); require(data.table)}
#   if (!require(dplyr)) {install.packages("dplyr"); require(dplyr)}
#   if (!require(dtplyr)) {install.packages("dtplyr"); require(dtplyr)}
#   if (!require(ggplot2)) {install.packages("ggplot2"); require(ggplot2)}
#   if (!require(ReporteRs)) {install.packages("ReporteRs"); require(ReporteRs)}
#   if (!require(yaml)) {install.packages("yaml"); require(yaml)}
#   if (!require(png)) {install.packages("png"); require(png)}
#   if (!require(grid)) {install.packages("grid"); require(grid)}
#   if (!require(pander)) {install.packages("pander"); require(pander)}
#
#   #update R
#   updateR(TRUE)
#
#   #update MiKTeX packages
#   #system("mpm --update --quiet")
#
#   #require(lattice)
#   #require(ggplot2movies)
#   #require(latticeExtra)
# }
#
#
# #'
# #' \code{versionDetails} provides details about the running environment
# #'
# #' @return text with the versions of R, RStudio, and used packages
# #'
# #' @examples
# #' versionDetails()
# #'
# versionDetails <- function() {
#
#   cat(paste(
#     "R Studio version 1.0.143\n\n",
#     version$version.string, " ", version$`svn rev`,"\n\n",
#     "Package versions:\n",
#     "- RODBC version ", packageVersion("RODBC"),"\n",
#     "- knitr version ", packageVersion("knitr"),"\n",
#     "- data.table version ", packageVersion("data.table"),"\n",
#     "- dplyr version ", packageVersion("dplyr"),"\n",
#     "- dtplyr version ", packageVersion("dtplyr"),"\n",
#     "- ReporteRs version ", packageVersion("ReporteRs"),"\n",
#     "- ReporteRsjars version ", packageVersion("ReporteRsjars"),"\n",
#     "- installr version ", packageVersion("installr"),"\n",
#     "- stringr version ", packageVersion("stringr"),"\n",
#     "- ggplot2 version ", packageVersion("ggplot2"),"\n",
#     "- yaml version ", packageVersion("yaml"),"\n",
```

```
#     "- png version ", packageVersion("png"),"\n",
#     "- grid version ", packageVersion("grid"),"\n",
#     "- pander version ", packageVersion("pander"),"\n\n",
#     "Base package versions:\n",
#     "- stats version ", packageVersion("stats"),"\n",
#     "- graphics version ", packageVersion("graphics"),"\n",
#     "- grDevices version ", packageVersion("grDevices"),"\n",
#     "- utils version ", packageVersion("utils"),"\n",
#     "- datasets version ", packageVersion("datasets"),"\n",
#     "- methods version ", packageVersion("methods"),"\n",
#     "- base version ", packageVersion("base"),sep=""))
# }
#
#
# #'
# #' \code{versionDetailsMiKTeX} provides details about the running
# #' environment
# #'
# #' @return text with the versions of MiKTeX
# #'
# #' @examples
# #' versionDetailsMiKTeX()
# #'
# versionDetailsMiKTeX <- function() {
#   cat(system("mpm --version", intern = TRUE), sep = '\n')
# }
#
#
# #'
# #' \code{versionDetailsMiKTeXPackages} provides details about the
# #' running environment
# #'
# #' @return text with the versions of the installed MiKTeX packages
# #'
# #' @examples
# #' versionDetailsMiKTeXPackages()
# #'
# versionDetailsMiKTeXPackages <- function() {
#   cat(system("mpm --list", intern = TRUE), sep = '\n')
# }
#
#
# #'
# #' \code{readConfigFile} reads the YAML config file into a global
# #' environment variable
# #'
# #' @param a boolean
# #' The YAML config file is in the working directory or in the parent
# #' directory (i.e. one directory above)
# #'
# #' @examples
# #' readConfigFile(TRUE)
# #'
# readConfigFile <- function(a) {
```

```
#   vName <- ”config”
#   if (a == TRUE){
#     assign(vName, yaml.load_file(”91-Config.yaml”), envir = .GlobalEnv)
#   }
#   else {
#     assign(vName, yaml.load_file(”../91-Config.yaml”), envir = .GlobalEnv)
#   }
# }
#
#
# #'
# #' \code{getMainDir} provides the value of the specific
# #' configuration item
# #'
# #' @return the value of the maindir configuration item
# #'
# #' @examples
# #' getMainDir()
# #'
# getMainDir <- function() {
#   return(config$directories$maindir)
# }
#
#
# #'
# #' \code{getBackupDir} provides the value of the specific
# #' configuration item and creates the directory if it does
# #' not exist
# #'
# #' @return the value of the backupdir configuration item
# #'
# #' @examples
# #' getBackupDir()
# #'
# getBackupDir <- function() {
#   backupdir <- config$directories$backupdir
#   subdir <- Sys.Date()
#   returnvalue <- file.path(backupdir, subdir)
#
#   if (!file.exists(returnvalue)){
#     dir.create(returnvalue)
#     dir.create(file.path(returnvalue, ”Documents”))
#   }
#   return(returnvalue)
# }
#
#
# #'
# #' \code{getDocDir} provides the value of the specific
# #' configuration item
# #'
# #' @return the value of the documents configuration item
# #'
# #' @examples
```

```
# #' getDocDir()
# #'
# getDocDir <- function() {
#   return(config$directories$documents)
# }
#
#
# #'
# #' \code{getDocInputDir} provides the value of the specific
# #' configuration item
# #'
# #' @return the value of the documentinput configuration item
# #'
# #' @examples
# #' getDocInputDir()
# #'
# getDocInputDir <- function() {
#   return(config$directories$documentinput)
# }
#
#
# #'
# #' \code{getDocOutputDir} provides the value of the specific
# #' configuration item
# #'
# #' @return the value of the documentoutput configuration item
# #'
# #' @examples
# #' getDocOutputDir()
# #'
# getDocOutputDir <- function() {
#   return(config$directories$documentoutput)
# }
#
#
# #'
# #' \code{getDataDir} provides the value of the specific
# #' configuration item
# #'
# #' @return the value of the datasets configuration item
# #'
# #' @examples
# #' getDataDir()
# #'
# getDataDir <- function() {
#   return(config$directories$datasets)
# }
#
#
# #'
# #' \code{getStartYear} provides the value of the specific
# #' configuration item
# #'
# #' @return the value of the startyear configuration item
```

```
# #'
# #' @examples
# #' getStartYear()
# #'
# getStartYear <- function() {
#   return(config$years$startyear)
# }
#
#
# #'
# #' \code{getEndYear} provides the value of the specific
# #' configuration item
# #'
# #' @return the value of the endyear configuration item
# #'
# #' @examples
# #' getEndYear()
# #'
# getEndYear <- function() {
#   return(config$years$endyear)
# }
#
#
# #'
# #' \code{getStartMonth} provides the value of the specific
# #' configuration item
# #'
# #' @return the value of the startmonth configuration item
# #'
# #' @examples
# #' getStartMonth()
# #'
# getStartMonth <- function() {
#   return(config$months$startmonth)
# }
#
#
# #'
# #' \code{getEndMonth} provides the value of the specific
# #' configuration item
# #'
# #' @return the value of the endmonth configuration item
# #'
# #' @examples
# #' getEndMonth()
# #'
# getEndMonth <- function() {
#   return(config$months$endmonth)
# }
#
#
# #'
# #' \code{backupFiles} makes a copy of the most important
# #' files to a safe location set by the YAML configuration
```

```
# #' file
# #'
# #' @examples
# #' backupFiles()
# #'
# backupFiles <- function() {
#   #Main directory files
#   filesMain <- list.files(getMainDir(), full.names = TRUE)
#   file.copy(filesMain, getBackupDir(), overwrite = TRUE)
#   #Documents folder
#   filesDocuments <- list.files(getDocDir(), full.names = TRUE)
#   file.copy(filesDocuments,
#             file.path(getBackupDir(),
#                       "Documents"),
#             overwrite = TRUE)
# }
#
#
# #'
# #' \code{getWData} provides the value of the specific
# #' configuration item
# #'
# #' @return the value of the wildlife configuration item
# #'
# #' @examples
# #' getWData()
# #'
# getWData <- function() {
#   return(config$sources$wildlife)
# }
#
#
# #'
# #' \code{getFData} provides the value of the specific
# #' configuration item
# #'
# #' @return the value of the flightdata configuration item
# #'
# #' @examples
# #' getFData()
# #'
# getFData <- function() {
#   return(config$sources$flightdata)
# }
#
#
# #'
# #' \code{removeDataSetVariables} removes the data set variables
# #' from the memory and calls the garbage collection to free up
# #' memory - currently disabled
# #'
# #' @examples
# #' removeDataSetVariables()
# #'
```

```
# removeDataSetVariables <- function() {
#   # rm(list = ls(pattern = "On_Time_On_Time_Performance*",
#   #              envir = .GlobalEnv),
#   #    envir = .GlobalEnv)
#   # rm(list = ls(pattern = "sr_*",
#   #              envir = .GlobalEnv),
#   #    envir = .GlobalEnv)
#   # gc()
# }
#
#
# #'
# #' \code{loadSourceCodeFunctions} makes the functions created
# #' in different R files available for further use and process
# #' management
# #'
# #' @examples
# #' loadSourceCodeFunctions()
# #'
# loadSourceCodeFunctions <- function() {
#   source("01-WildLiveStrikeDataSetDataPreparation.R")
#   source("02-OnTimeFlightPerformanceDataSetDataPreparation.R")
#   source("03-WildLifeStrikeDataSetSplitByYear.R")
#   source("04-OnTimeFlightPerformanceDataSetMergeByYear.R")
#   source("05-ExploreWildLifeStrikeDataSet.R")
#   source("06-ExploreOnTimeFlightPerformanceDataSet.R")
#   source("07-DescribeWildLifeStrikeDataSet.R")
#   source("08-DescribeOnTimeFlightPerformanceDataSet.R")
#   source("09-SelectWildLifeStrikeDataSet.R")
#   source("10-SelectOnTimeFlightPerformanceDataSet.R")
# }
#
#
# #'
# #' \code{saveBarPlotPNG} saves the required bar plot based on
# #' the details in the YAML config file
# #'
# #' @param DataYear integer
# #' The year of the data set being used for the plot
# #'
# #' @param DataSet string
# #' The name of the data set the plot is being created from
# #'
# #' @param DataField string
# #' The name of the data field the plot is being created from
# #'
# #' @param DataStage string
# #' The name of the stage of the data
# #'
# #' @param DataObject object
# #' The data object to create the plot
# #'
# #' @examples
# #' saveBarPlotPNG(1990, "Animal Strike", DT)
```

```
# #'
# saveBarPlotPNG <- function(DataYear, DataSet, DataField, DataStage, DataObject) {
#   currentWorkingDir <- getwd()
#   setwd(getDocInputDir())
#   targetFileName <- paste(DataYear,
#                           "_",
#                           DataSet,
#                           "_",
#                           DataField,
#                           "_",
#                           DataStage,
#                           ".png",
#                           sep="")
#   png(
#     targetFileName, #File name, no directory!
#     units = "px", #units are in pixels
#     width = 300, #width of the plot in px (should be the same as the height)
#     height = 300, #height of the plot in px (should be the same as the width)
#     res = 72 #nominal resolution in ppi (pixels per inch)
#   )
#
#   #barplot(DataObject)
#   barplot(DataObject,
#           horiz = TRUE,
#           col = "lightblue",
#           main = paste("Data distribution of\n",
#                        DataField,
#                        " in year ",
#                        DataYear,
#                        sep=""))
#
#   dev.off() #flush the plot to the file and close the file
#
#   setwd(currentWorkingDir)
# }
#
#
# #'
# #' \code{printTable} saves the required bar plot based on
# #' the details in the YAML config file
# #'
# #' @param Full boolean
# #' Flag to have the full data set or just the first year to print
# #'
# #' @param DataFile string
# #' The name of the RDS data file to load the data from
# #'
# #' @param ColumnNames string list
# #' The name of columns to be extracted from the data table
# #'
# #' @param ColumnTitles string list
# #' The titles the columns should have in the table
# #'
# #' @examples
```

```
# #' printTable()
# #'
# printTable <- function(Full, DataFile, ColumnNames, ColumnTitles) {
#
#   dataDir <- getDataDir()
#
#   RDSExpFile <- paste(dataDir,
#                       "/",
#                       DataFile,
#                       sep = "")
#
#   dataTable <- readRDS(file = RDSExpFile)
#
#   if (Full == TRUE) {
#     kable(dataTable[, ..ColumnNames],
#           col.names = ColumnTitles,
#           align = "c")
#   } else {
#     kable(dataTable[1, ..ColumnNames],
#           col.names = ColumnTitles,
#           align = "c")
#   }
#
# }
```

References

Shearer, Colin. 2000. “The Crisp-Dm Model - the New Blueprint for Data Mining.” Journal of Data Warehousing 5 (4): 13–22.