CEU-R-Tools-Project

Link to my project on github

https://github.com/AttilaKrajko/CEU-R-Project

CLEAR MEMORY

```
rm(list = ls())
```

```
library(nycflights13)
```

```
## Warning: package 'nycflights13' was built under R version 3.3.2
```

```
library(data.table)
```

```
## Warning: package 'data.table' was built under R version 3.3.2
```

```
library(dplyr)
```

```
## ------------------------------------------------------------------------------
```

```
## data.table + dplyr code now lives in dtplyr.
## Please library(dtplyr)!
```

```
## ------------------------------------------------------------------------------
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:data.table':
##
##     between, first, last
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 3.3.2
```

```
library(scales)
```

```
## Warning: package 'scales' was built under R version 3.3.2
```

```
library(plyr)
```

```
## ------------------------------------------------------------------------------
```

```
## You have loaded plyr after dplyr - this is likely to cause problems.
## If you need functions from both plyr and dplyr, please load plyr first, then dplyr:
## library(plyr); library(dplyr)
```

```
## ------------------------------------------------------------------------------
```

```
##
## Attaching package: 'plyr'
```

```
## The following objects are masked from 'package:dplyr':
##
##     arrange, count, desc, failwith, id, mutate, rename, summarise,
##     summarize
```

```
library(lubridate)
```

```
##
## Attaching package: 'lubridate'
```

```
## The following object is masked from 'package:plyr':
##
##     here
```

```
## The following objects are masked from 'package:data.table':
##
##     hour, isoweek, mday, minute, month, quarter, second, wday,
##     week, yday, year
```

```
## The following object is masked from 'package:base':
##
##     date
```

```
library(tidyr)
```

```
## Warning: package 'tidyr' was built under R version 3.3.2
```

```
library(class)
library(pander)
```

Read the data table.

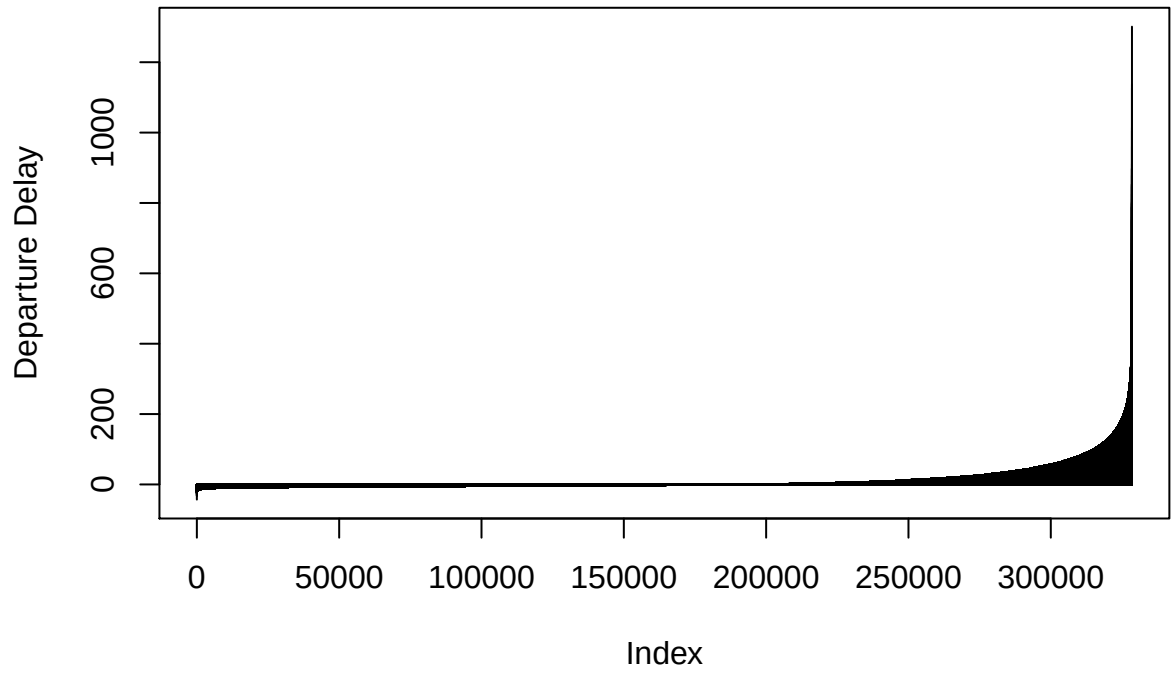
```
dtflights <- data.table(flights)
dtairpoirts <- data.table(airports)
dtairlines <- data.table(airlines)
dtplanes <- data.table(planes)
dtweather <- data.table(weather)
str(flights)
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    336776 obs. of  19 variables:
##  $ year          : int  2013 2013 2013 2013 2013 2013 2013 2013 2013 2013 ...
##  $ month         : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ day           : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ dep_time      : int  517 533 542 544 554 554 555 557 557 558 ...
##  $ sched_dep_time: int  515 529 540 545 600 558 600 600 600 600 ...
##  $ dep_delay     : num  2 4 2 -1 -6 -4 -5 -3 -3 -2 ...
##  $ arr_time      : int  830 850 923 1004 812 740 913 709 838 753 ...
##  $ sched_arr_time: int  819 830 850 1022 837 728 854 723 846 745 ...
##  $ arr_delay     : num  11 20 33 -18 -25 12 19 -14 -8 8 ...
##  $ carrier       : chr  "UA" "UA" "AA" "B6" ...
##  $ flight        : int  1545 1714 1141 725 461 1696 507 5708 79 301 ...
##  $ tailnum       : chr  "N14228" "N24211" "N619AA" "N804JB" ...
##  $ origin        : chr  "EWR" "LGA" "JFK" "JFK" ...
##  $ dest          : chr  "IAH" "IAH" "MIA" "BQN" ...
##  $ air_time      : num  227 227 160 183 116 150 158 53 140 138 ...
##  $ distance      : num  1400 1416 1089 1576 762 ...
##  $ hour          : num  5 5 5 5 6 5 6 6 6 6 ...
##  $ minute        : num  15 29 40 45 0 58 0 0 0 0 ...
##  $ time_hour     : POSIXct, format: "2013-01-01 05:00:00" "2013-01-01 05:00:00" ...
```

```
?flights
```

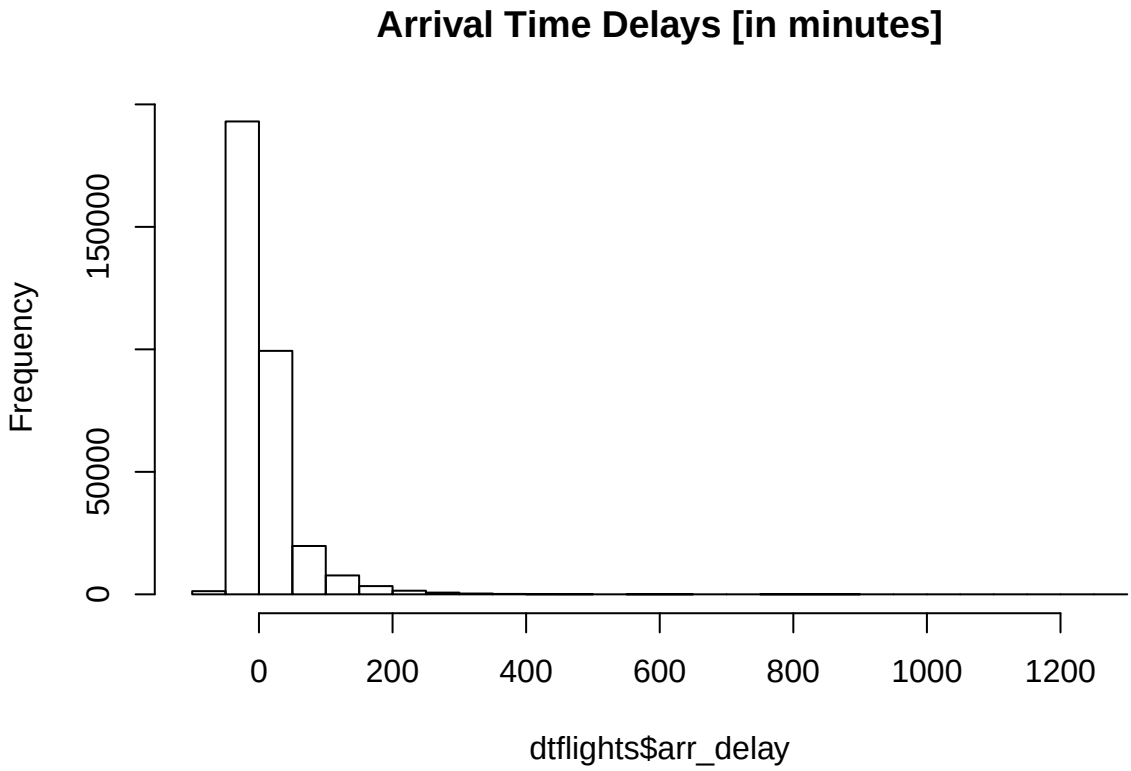
Flights departure delay

```
plot(sort(flights$dep_delay), type="h", ylab="Departure Delay")
```



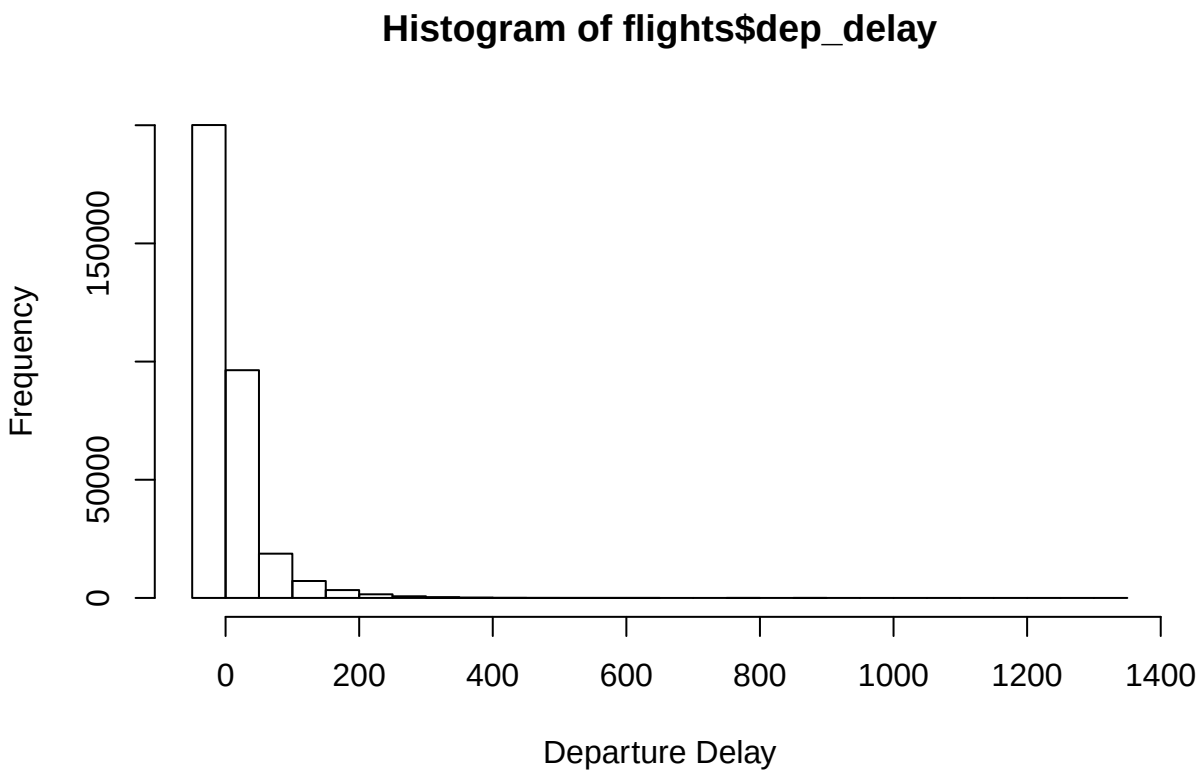
Arrival Time delays in minute

```
hist(dtflights$arr_delay, main = "Arrival Time Delays [in minutes]")
```

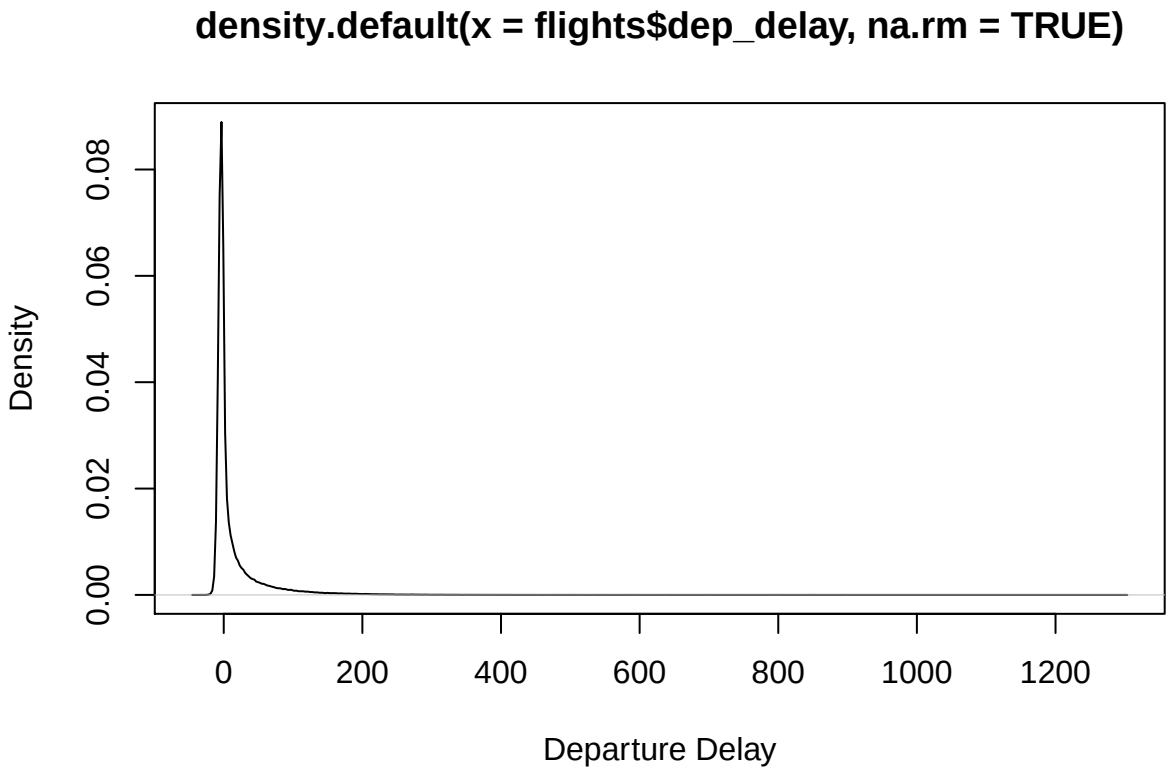


Flights departure delay with histogram and density plot

```
hist(flights$dep_delay, xlab="Departure Delay")
```

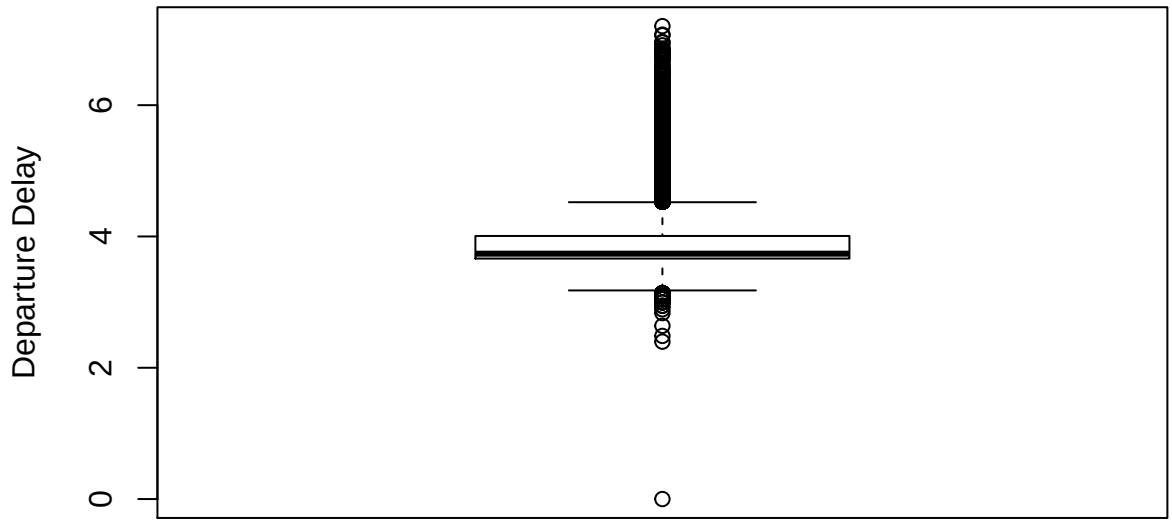



```
plot(density(flights$dep_delay, na.rm=TRUE), xlab="Departure Delay")
```



Flights departure delay with boxplot

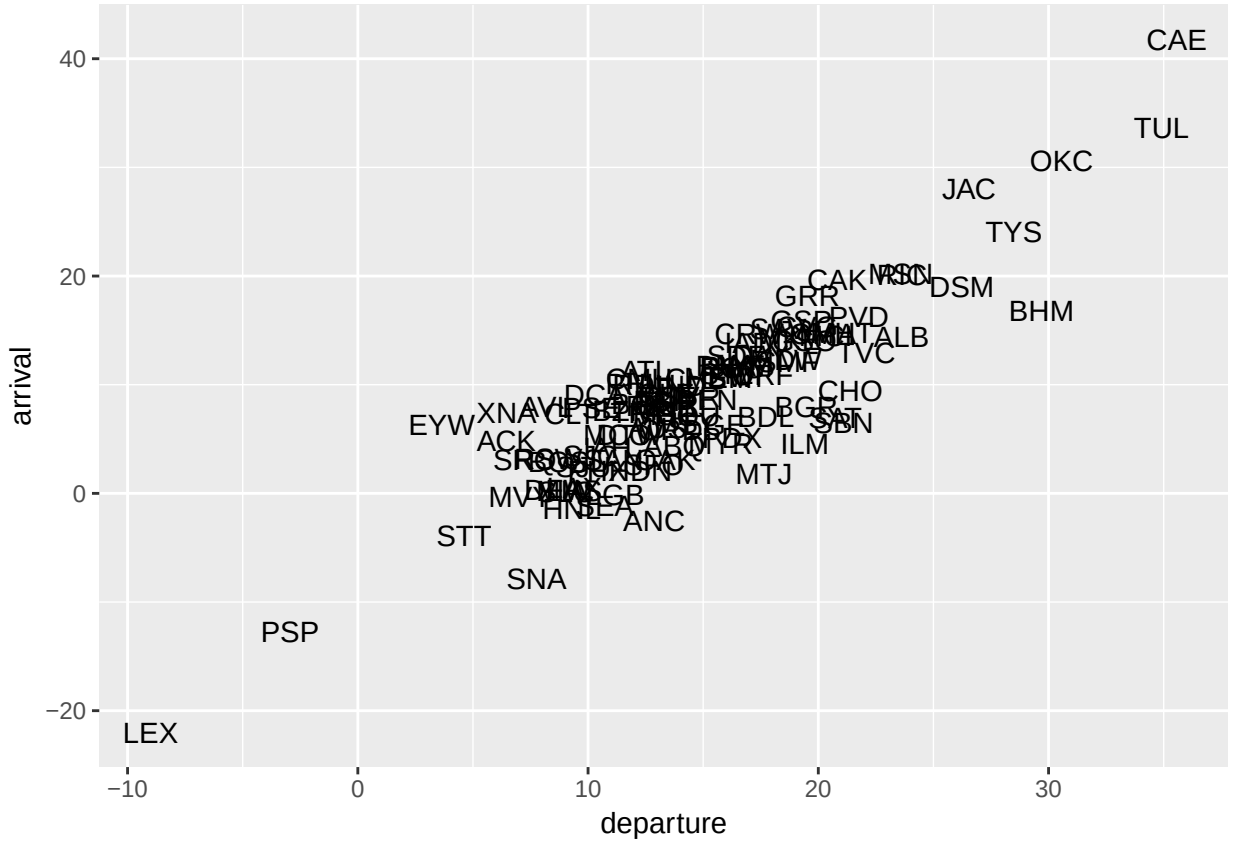
```
boxplot(log(flights$dep_delay -
            min(flights$dep_delay,na.rm=TRUE)
            +1), ylab="Departure Delay")
```



##The average departure and arrival delays per destination

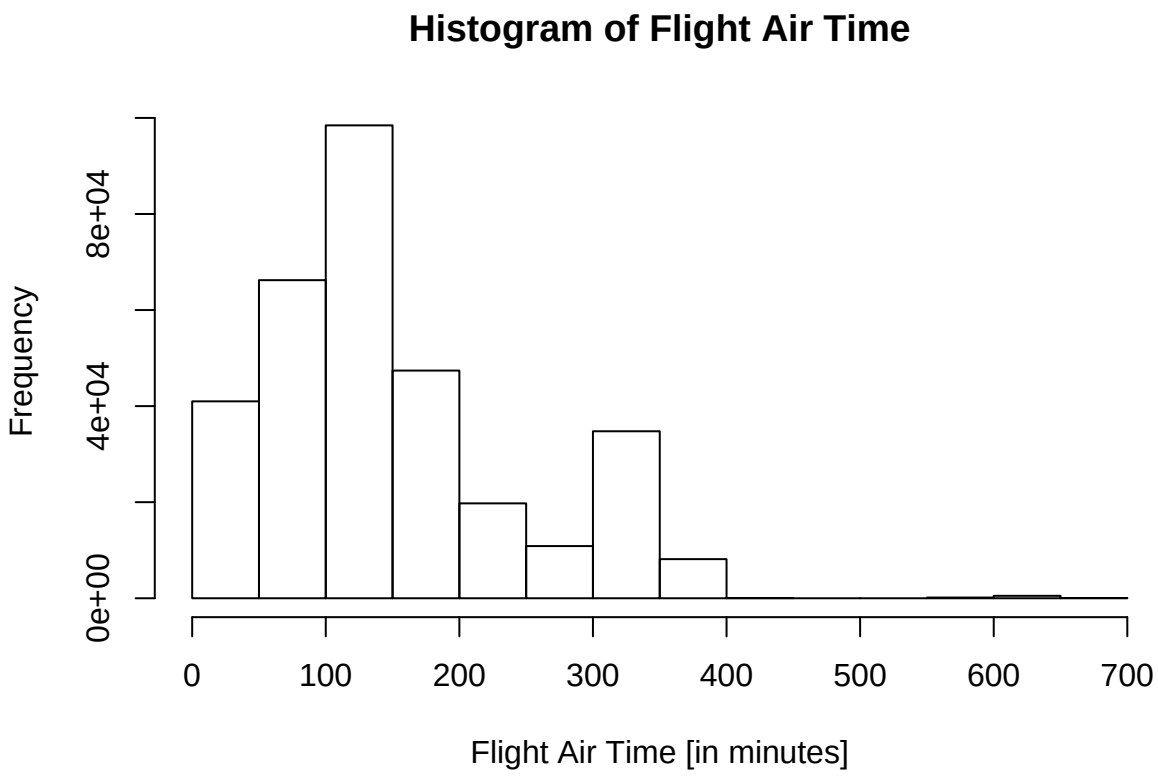
```
dta <- dtflights[, .(departure = mean(dep_delay, na.rm = TRUE),
                arrival = mean(arr_delay, na.rm = TRUE)), by = dest]
ggplot(dta, aes(departure, arrival, label = dest)) + geom_text()
```

```
## Warning: Removed 1 rows containing missing values (geom_text).
```



Histogram of Flight Air time

```
hist(dtflights$air_time, xlab = "Flight Air Time [in minutes]", main = "Histogram of Flight Air Time")
```



Which destination has the lowest average delay from 'EWR'?

```
dta <- dtflights[origin == 'EWR', .(delay = mean(arr_delay, na.rm = TRUE)), by = dest]
setorder(dta, delay)
head(dta)
```

```
##    dest     delay
## 1:  LGA       NaN
## 2:  SNA -7.868227
## 3:  SBN -5.500000
## 4:  EGE -5.349057
## 5:  ANC -2.500000
## 6:  RSW -2.259129
```

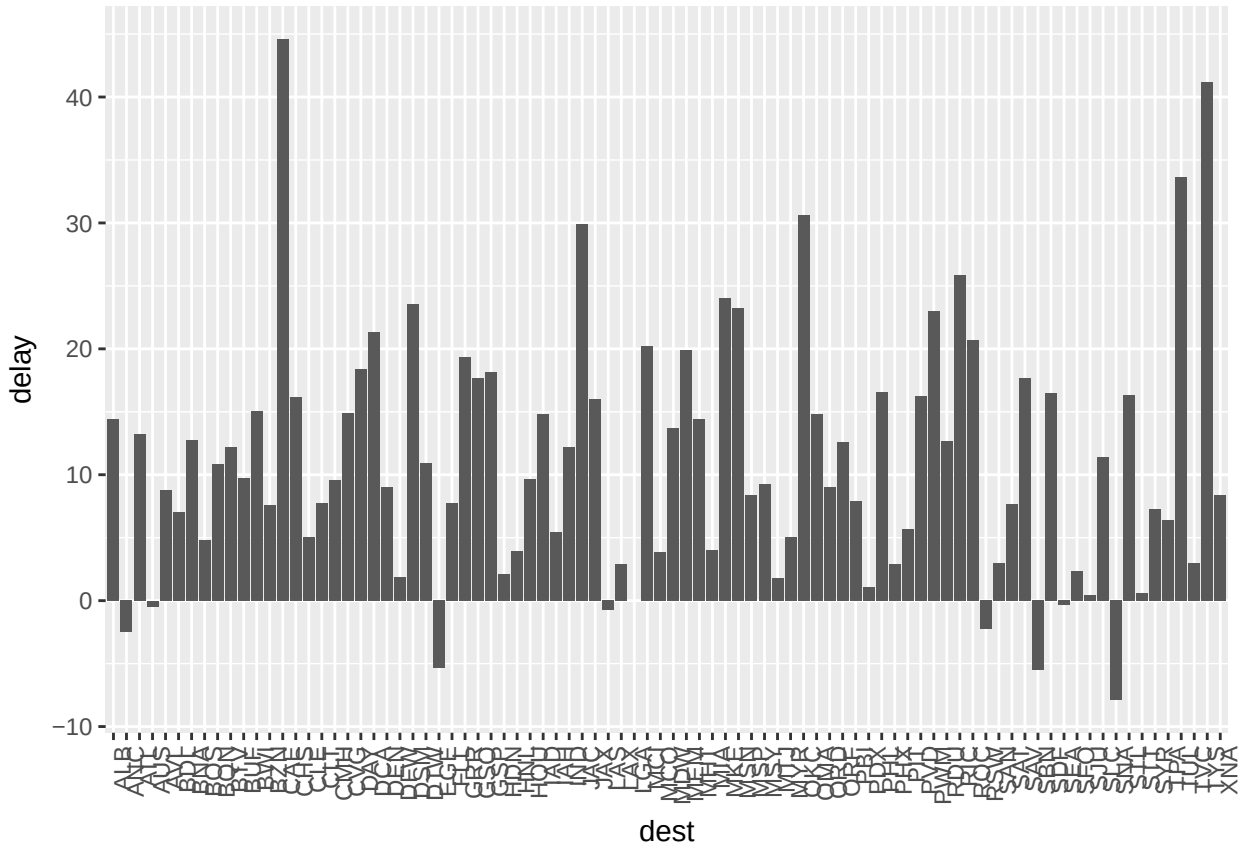
```
dta[1]
```

```
##    dest delay
## 1:  LGA   NaN
```

The average delay to all destinations from 'EWR

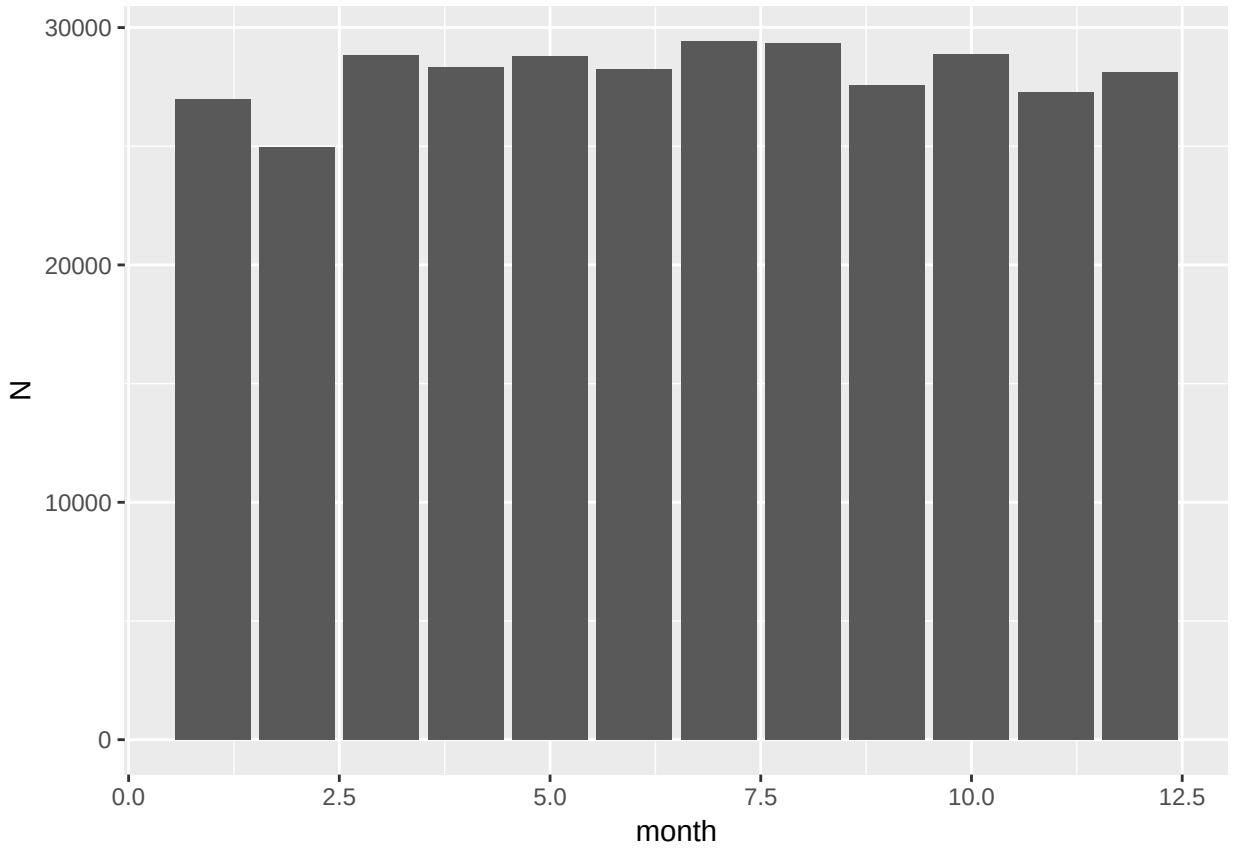
```
ggplot(dta, aes(dest, delay)) + geom_bar(stat = 'identity') + theme(axis.text.x = element_text(angle = 9
```

```
## Warning: Removed 1 rows containing missing values (position_stack).
```



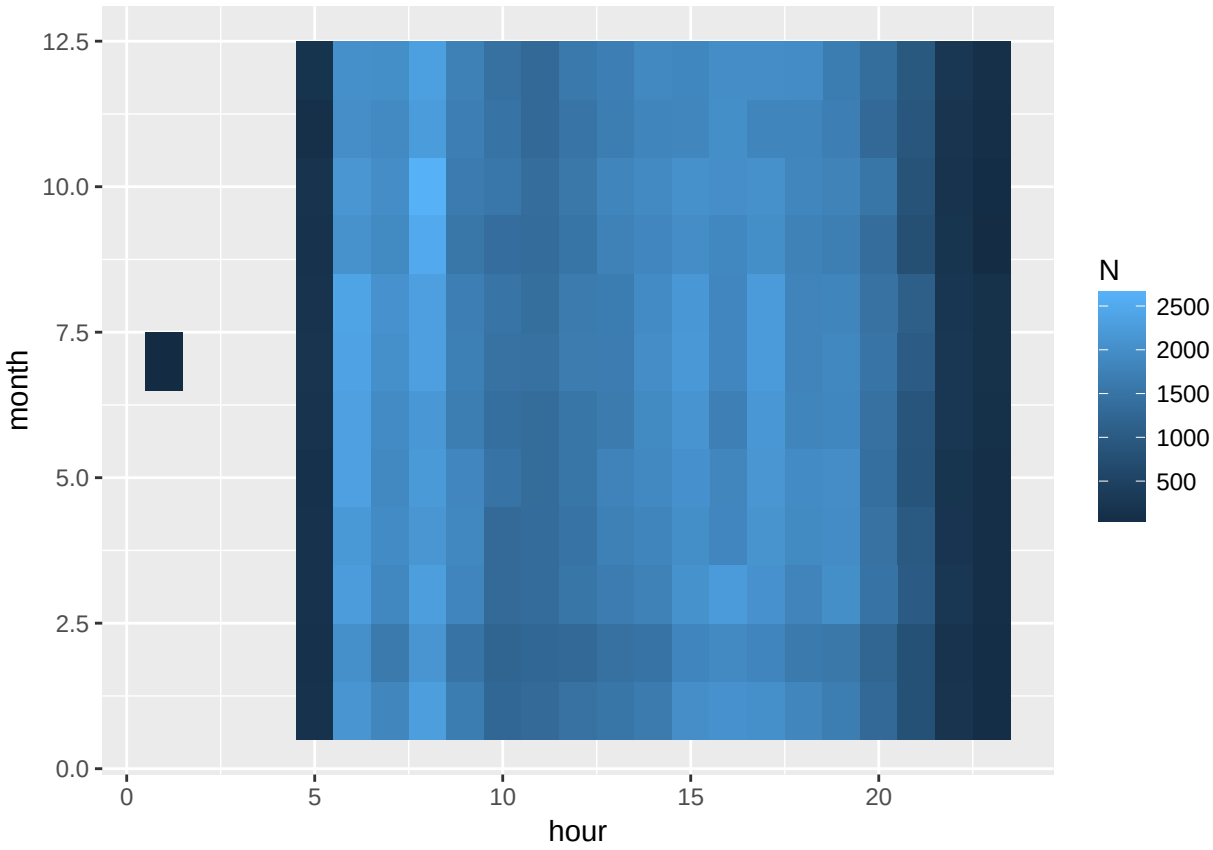
The number of flights per month

```
ggplot(dtflights[, .N, by = month], aes(month, N)) + geom_bar(stat = 'identity')
```



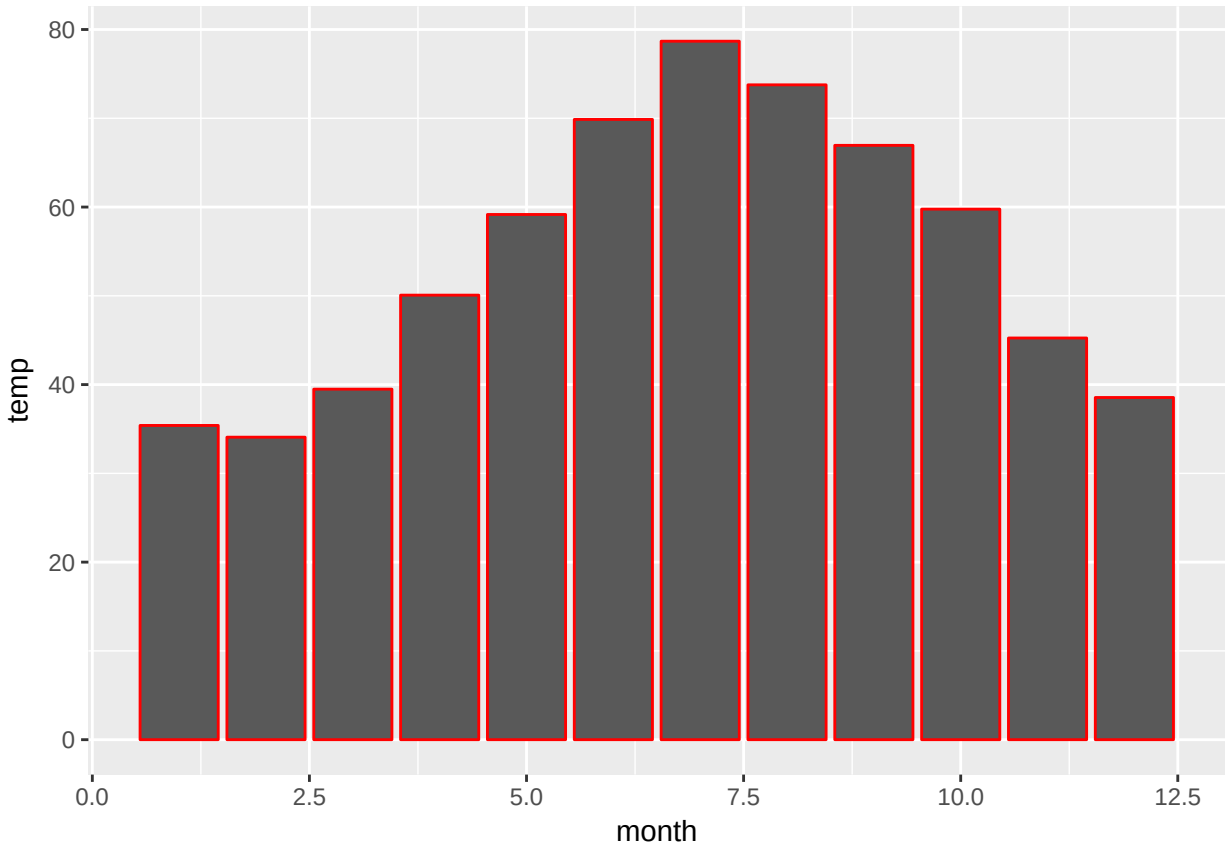
Heatmap on the number of flights per month and hour of the day

```
ggplot(dtflights[, .N, by = .(month, hour)], aes(hour, month, fill = N)) + geom_tile()
```



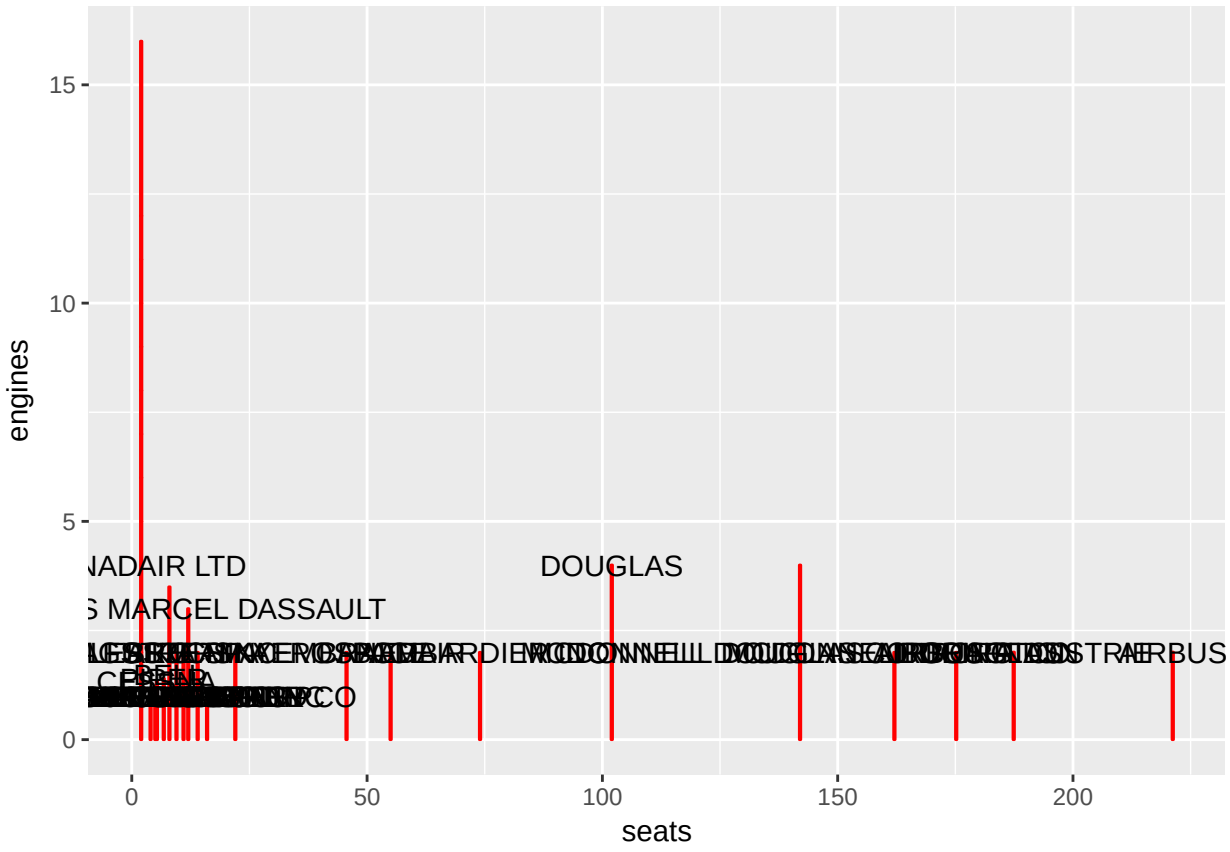
#The average temperature at noon in JFK for each month based on the weather dataset

```
dt <- data.table(weather)
ggplot(dt[origin == 'JFK', .(temp = mean(temp, na.rm = TRUE)), by = month], aes(month, temp)) +
  geom_bar(stat = 'identity', color = 'red')
```



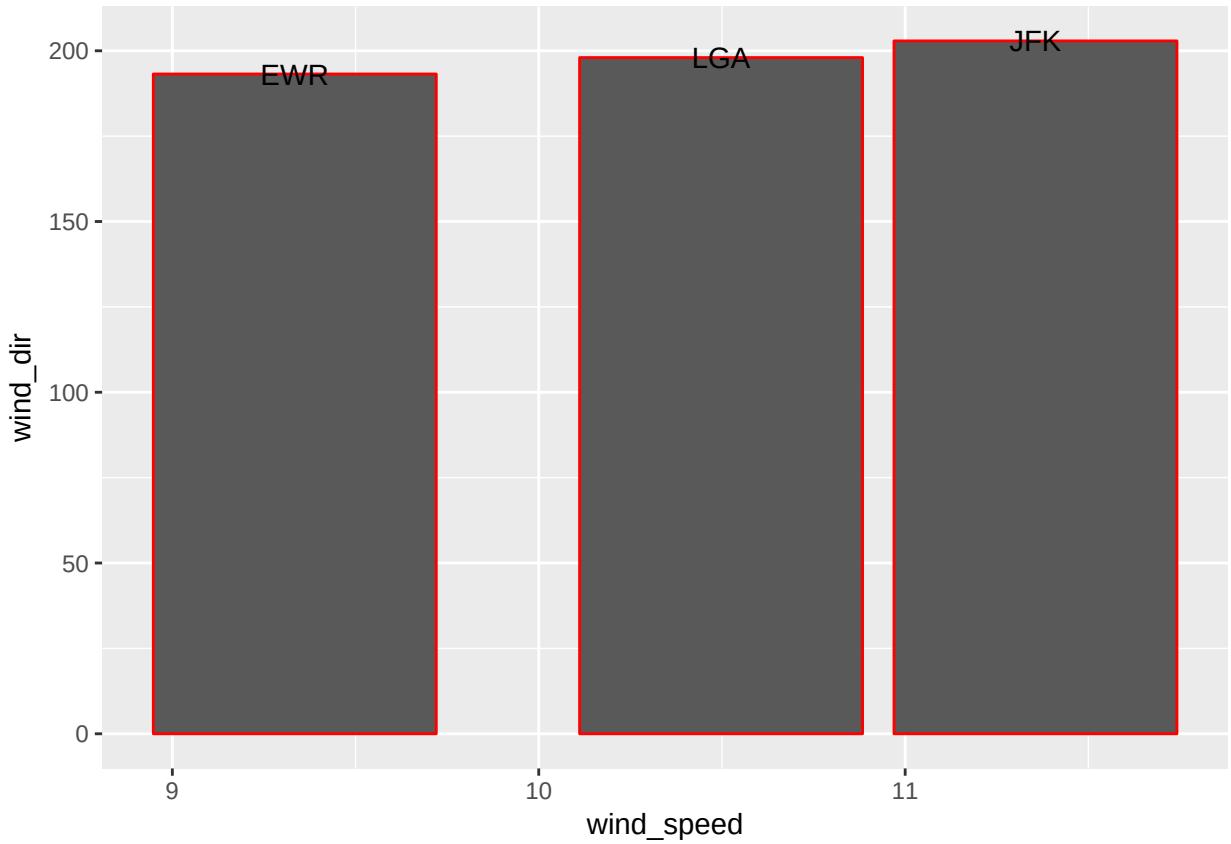
The average seats and engines per manufacturer

```
dta <- dtplanes[, .(seats = mean(seats, na.rm = TRUE),
                    engines = mean(engines, na.rm = TRUE)), by = manufacturer]
ggplot(dta, aes(seats, engines, label = manufacturer)) + geom_bar(stat = 'identity', color = 'red') + g
```



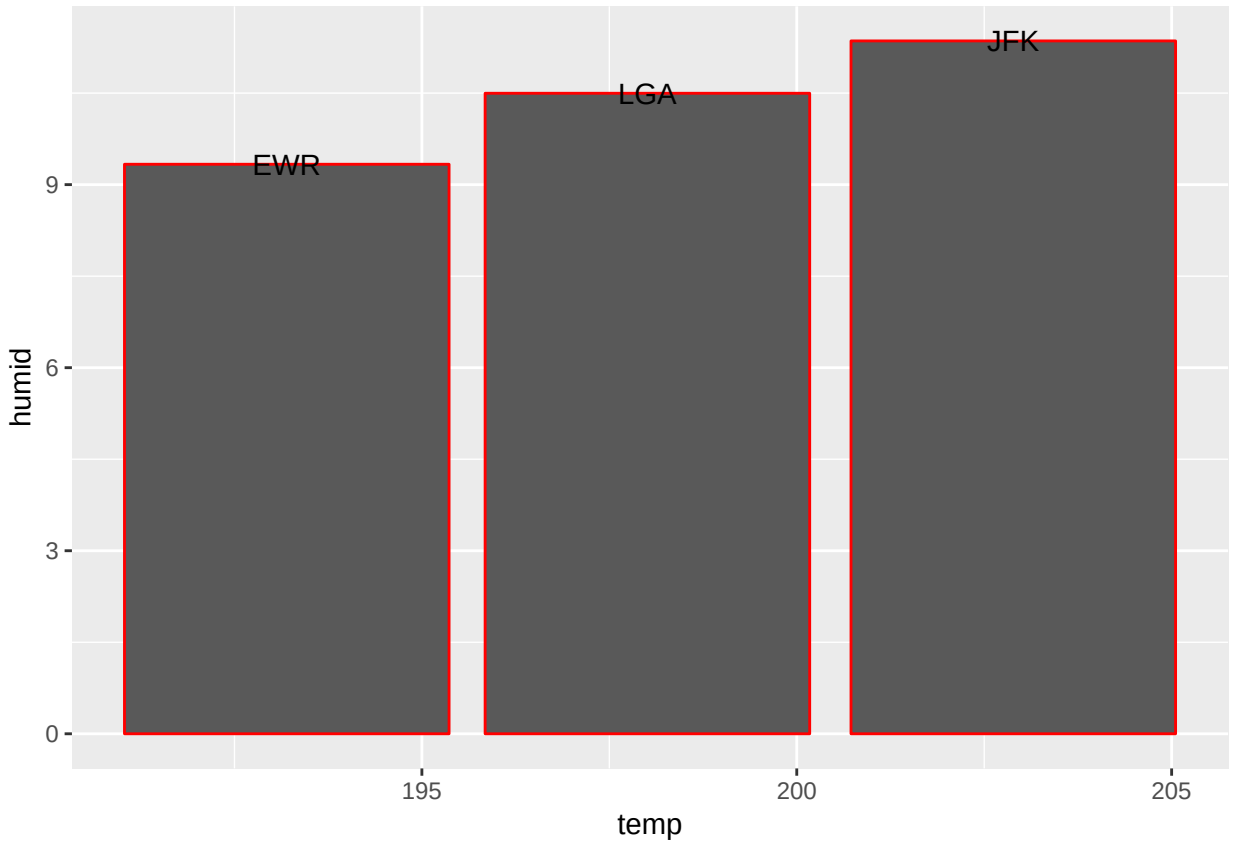
The average windspeed and wind direction per origin

```
dta <- dtweather[, .(wind_dir = mean(wind_dir, na.rm = TRUE),
              wind_speed = mean(wind_speed, na.rm = TRUE)), by = origin]
ggplot(dta, aes(wind_speed, wind_dir, label = origin)) + geom_bar(stat = 'identity', color = 'red') + g
```



The average temperature and humid per origin

```
dta <- dtweather[, .(temp = mean(wind_dir, na.rm = TRUE),
              humid = mean(wind_speed, na.rm = TRUE)), by = origin]
ggplot(dta, aes(temp, humid, label = origin)) + geom_bar(stat = 'identity', color = 'red') + geom_text(
```



How to affect humidity or temperature on delays

Featuring

```
dtflights$hour <- ifelse(dtflights$hour == 24, 0, flights$hour)

flights_weather <- left_join(dtflights, dtweather)
```

```
## Joining, by = c("year", "month", "day", "origin", "hour", "time_hour")
```

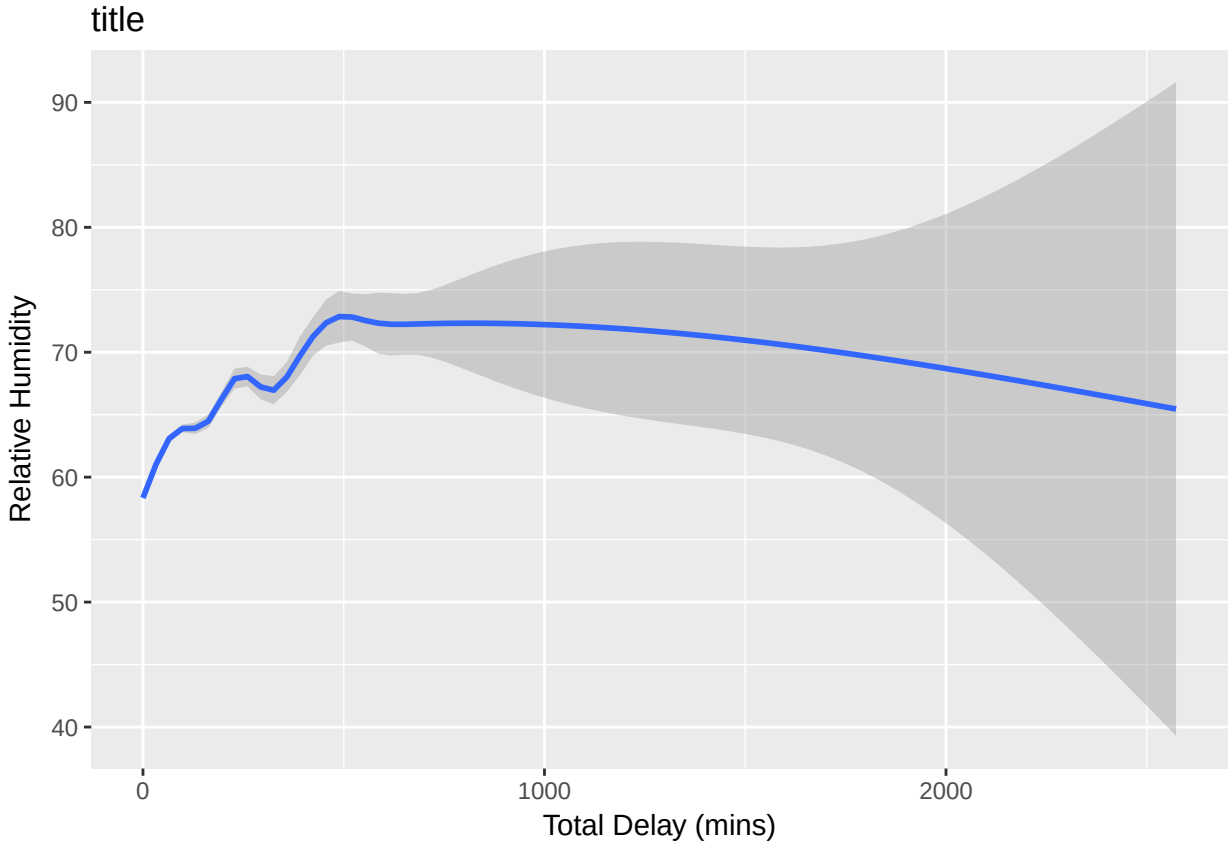
```
flights_weather$arr_delay <- ifelse(flights_weather$arr_delay >= 0,
                                    flights_weather$arr_delay, 0)
flights_weather$dep_delay <- ifelse(flights_weather$dep_delay >= 0,
                                    flights_weather$dep_delay, 0)
flights_weather$total_delay <- flights_weather$arr_delay + flights_weather$dep_delay

data <- select(flights_weather, total_delay, temp, dewp, humid,
                    wind_dir, wind_speed, wind_gust, precip, pressure, visib)
```

Effect of the humidity on delays

```
g <- ggplot(data, aes(y = humid, x = total_delay,
                      title = "Total Delay / Humidity"))
g + geom_smooth() + ylab("Relative Humidity") +
  xlab("Total Delay (mins)")
```

```
## `geom_smooth()` using method = 'gam'
```

```
## Warning: Removed 202037 rows containing non-finite values (stat_smooth).
```

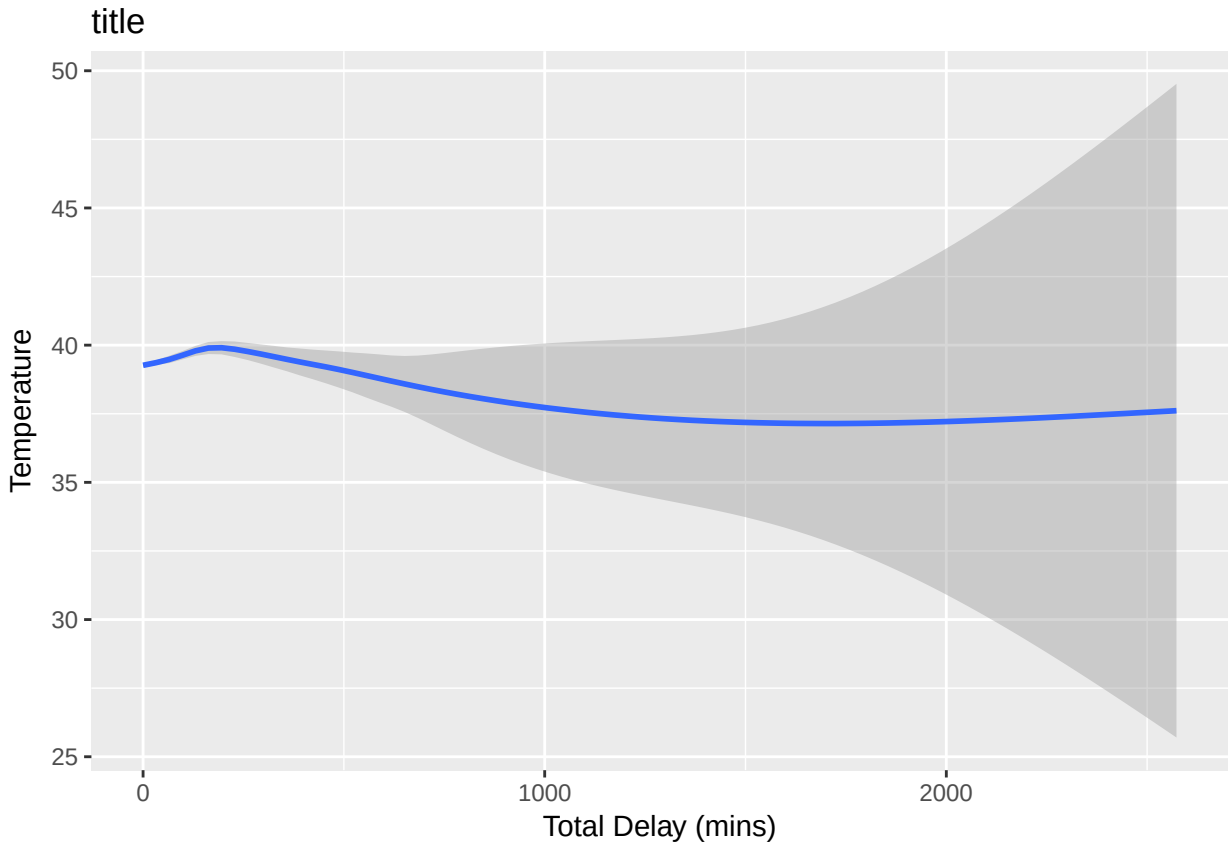


Effect of the temperature on delays

```
g <- ggplot(data, aes(y = temp, x = total_delay,
                      title = "Total Delay / Temperature"))
g + geom_smooth() + ylab("Temperature") +
  xlab("Total Delay (mins)")
```

```
## `geom_smooth()` using method = 'gam'
```

```
## Warning: Removed 202037 rows containing non-finite values (stat_smooth).
```

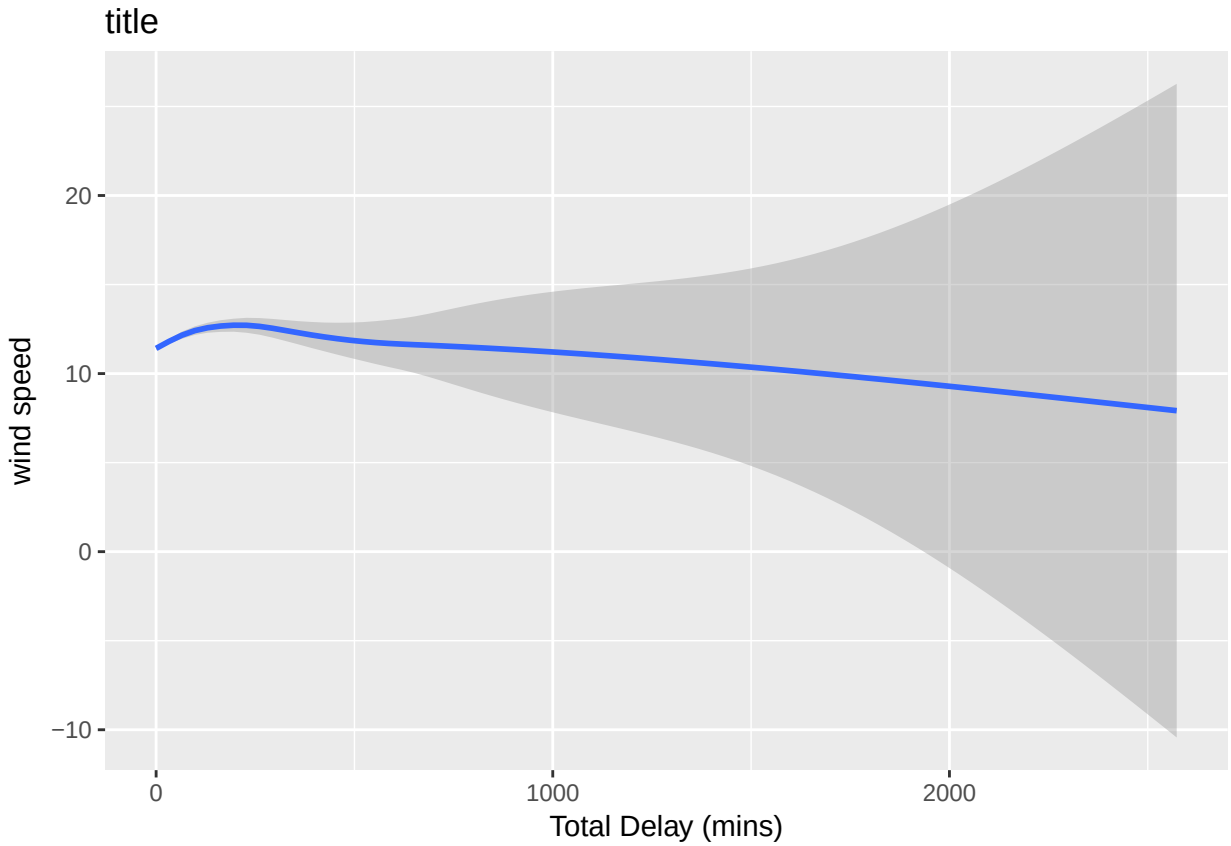


Effect of the wind speed on delays

```
g <- ggplot(data, aes(y = wind_speed, x = total_delay,
                      title = "Total Delay / wind speed"))
g + geom_smooth() + ylab("wind speed") +
  xlab("Total Delay (mins)")
```

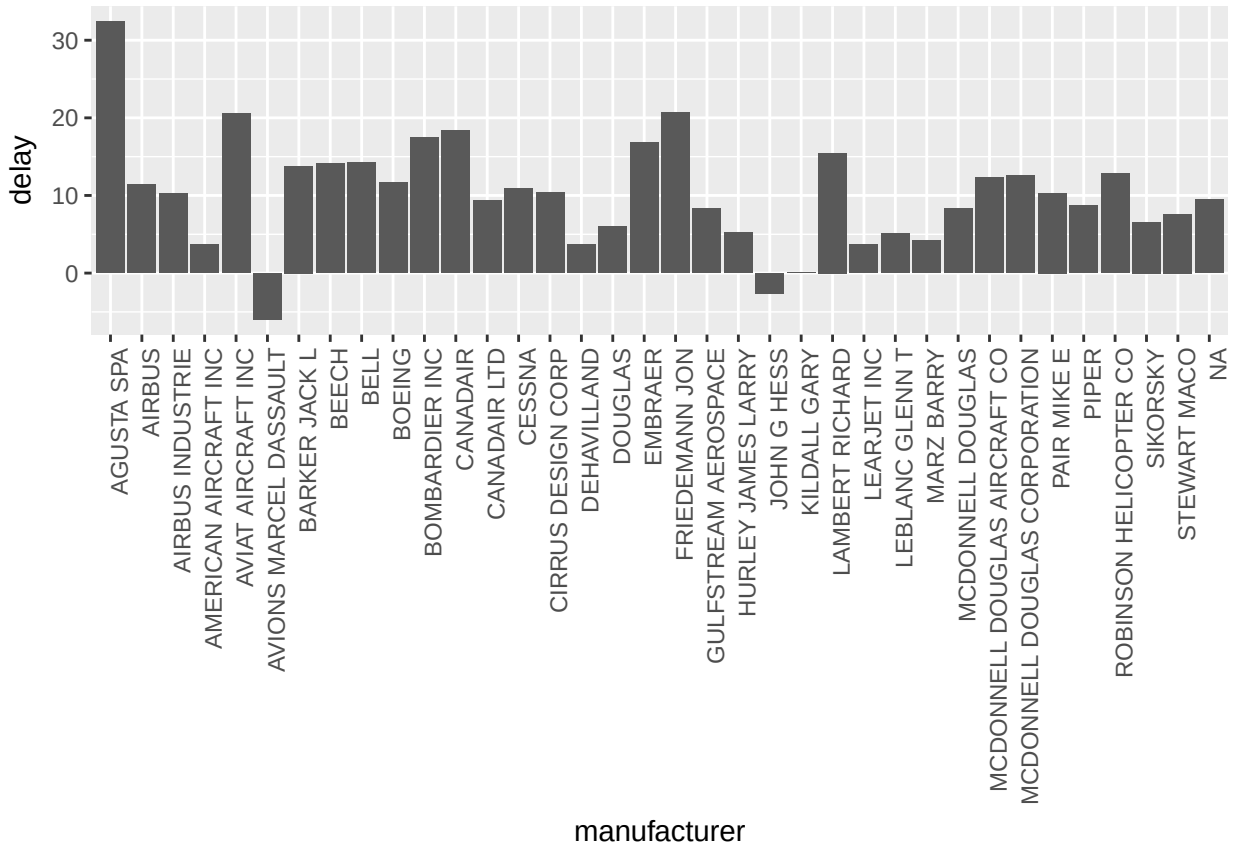
```
## `geom_smooth()` using method = 'gam'
```

```
## Warning: Removed 202053 rows containing non-finite values (stat_smooth).
```



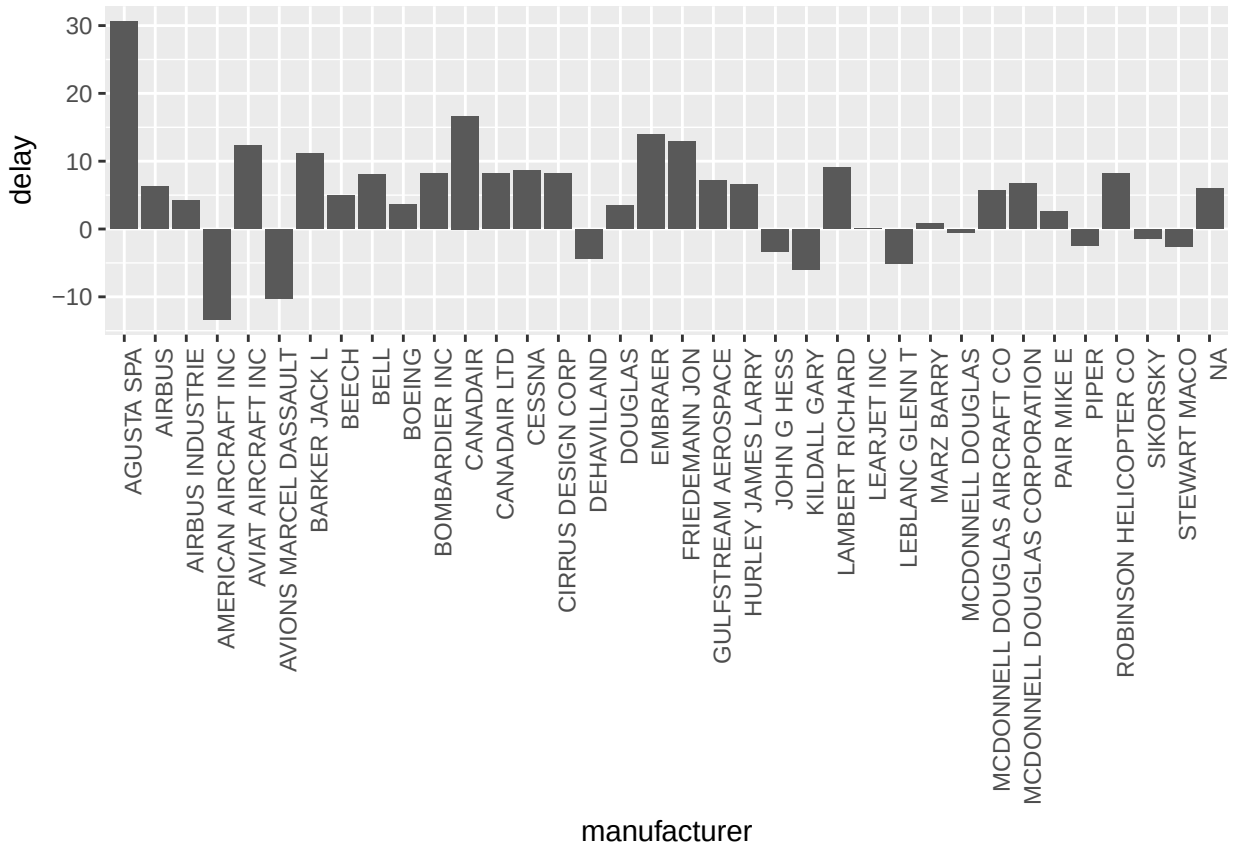
Average departure delay by manufacutrer

```
flights_planes <- left_join(dtflights, dtplanes, by = 'tailnum')
dta <- ddply(flights_planes,~manufacturer,summarise, delay=mean(dep_delay, na.rm=TRUE))
setorder(dta, delay)

ggplot(dta, aes(manufacturer, delay)) + geom_bar(stat = 'identity') + theme(axis.text.x = element_text(a
```



Average arrival delay by manufacutrer

```
dta <- ddply(flights_planes,~manufacturer,summarise, delay=mean(arr_delay, na.rm=TRUE))
setorder(dta, delay)

ggplot(dta, aes(manufacturer, delay)) + geom_bar(stat = 'identity') + theme(axis.text.x = element_text(a
```



More feature engineering

Data table without NA's, make binary variable which shows if an airplane delay more than 15 minutes. I decreased the observations number to 15.0000.

```
dtflights <- subset (flights, !is.na(flights$dep_time) &
    !is.na(flights$dep_delay) &
    !is.na(flights$arr_delay) &
    !is.na(flights$dep_time) &
    !is.na(flights$arr_time))
dtflights$tailnumfac <- as.factor(dtflights$tailnum)
dtflights$carrierfac <- as.factor(dtflights$carrier)
dtflights$originfac <- as.factor(dtflights$origin)
dtflights$destfac <- as.factor(dtflights$dest)

dtflights <- dtflights[sample(1:nrow(dtflights), 15000, replace=FALSE),]

dtflights$tailnumnum <- as.numeric(dtflights$tailnumfac)
dtflights$carriernum <- as.numeric(dtflights$carrierfac)
dtflights$originnum <- as.numeric(dtflights$originfac)
dtflights$destnum <- as.numeric(dtflights$destfac)

dtflights$year <- NULL
dtflights$tail_num <- NULL
dtflights$tailnum <- NULL
dtflights$carrier <- NULL
```

```
dtflights$dest <- NULL
dtflights$origin <- NULL
dtflights$tailnum <- NULL
dtflights$tailnumfac <- NULL
dtflights$carrierfac <- NULL
dtflights$destfac <- NULL
dtflights$originfac <- NULL
dtflights$tailnumfac <- NULL

str(dtflights)
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    15000 obs. of  18 variables:
##  $ month         : int  7 7 3 8 7 12 1 7 6 10 ...
##  $ day           : int  23 12 11 7 31 14 15 28 29 30 ...
##  $ dep_time      : int  1040 541 655 1006 1508 742 1439 454 600 1759 ...
##  $ sched_dep_time: int  749 545 700 959 1430 747 1445 500 600 1803 ...
##  $ dep_delay     : num  171 -4 -5 7 38 -5 -6 -6 0 -4 ...
##  $ arr_time      : int  1147 804 1011 1116 1824 841 1718 628 732 2042 ...
##  $ sched_arr_time: int  859 813 1044 1114 1725 918 1745 640 732 2056 ...
##  $ arr_delay     : num  168 -9 -33 2 59 -37 -27 -12 0 -14 ...
##  $ flight        : int  1818 479 1865 5711 325 4571 153 1431 4108 360 ...
##  $ air_time      : num  44 181 351 44 144 50 138 77 68 136 ...
##  $ distance      : num  187 1416 2586 228 1005 ...
##  $ hour          : num  7 5 7 9 14 7 14 5 6 18 ...
##  $ minute        : num  49 45 0 59 30 47 45 0 0 3 ...
##  $ time_hour     : POSIXct, format: "2013-07-23 07:00:00" "2013-07-12 05:00:00" ...
##  $ tailnumnum    : num  2158 2134 2812 3362 2814 ...
##  $ carriernum    : num  4 12 5 6 4 6 4 13 6 12 ...
##  $ originnum     : num  2 3 2 2 2 1 2 1 1 1 ...
##  $ destnum       : num  12 44 90 43 100 70 54 24 80 71 ...
```

```
dtflights$arrdelay15 <- ifelse(dtflights$arr_delay > 15,1,0)
dtflights$year <- NULL
time_format <- "%Y-%m-%d %H:%M:%S"
dtflights$weekday <- as.factor(format(strptime(dtflights$time_hour, format=time_format),"%A"))
dtflights$time_hour <- NULL
```

2-Nearest Neighbors algorithm

```
dtflights$rnd <-runif(dim(dtflights[1]))
dtflights <- dtflights[order(dtflights$rnd),]


dtflights
```

```
## # A tibble: 15,000 × 20
##    month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int>    <int>          <int>     <dbl>    <int>          <int>
## 1      7    12      541            545        -4      804            813
## 2      8     7     1006            959         7     1116           1114
```

```
## 3     12    14      742           747        -5      841           918
## 4      7    28      454           500        -6      628           640
## 5     10    30     1759          1803        -4     2042          2056
## 6      1    29      603           610        -7      850           910
## 7      1    18     1041          1050        -9     1240          1250
## 8      1    16      919           830        49     1116          1013
## 9      8    10     2033          2030         3     2154          2204
## 10     2    16      713           720        -7     1029          1016
## # ... with 14,990 more rows, and 13 more variables: arr_delay <dbl>,
## #   flight <int>, air_time <dbl>, distance <dbl>, hour <dbl>,
## #   minute <dbl>, tailnumnum <dbl>, carriernum <dbl>, originnum <dbl>,
## #   destnum <dbl>, arrdelay15 <dbl>, weekday <fctr>, rnd <dbl>
```

```
train <- dtflights[0:round((dim(dtflights)[1])*0.7),]
test <- dtflights[(round((dim(dtflights)[1])*0.7)+1):(dim(dtflights)[1]),]
dtflights$rnd <-NULL

fit <- knn(train[,1:15], test[,1:15], train$arrdelay15, k = 2)

pander(table(test$arrdelay15,fit))
```

	0	1
0	3023	425
1	608	444

5-Nearest Neighbors algorithm

```
fit2 <- knn(train[,1:15], test[,1:15], train$arrdelay15, k = 5)
pander(table(test$arrdelay15,fit2))
```

	0	1
0	3312	136
1	731	321

```
total <- dim(test)[1]
```

All in all the 2-NN model has provided 78 % result, the 5- NN model has provided 80 % good result.

Modeling

CLEAR MEMORY

```
rm(list = ls())
```

```
library(h2o)
```

```
## Warning: package 'h2o' was built under R version 3.3.2
```

```
##
## ----------------------------------------------------------------------
##
## Your next step is to start H2O:
##     > h2o.init()
##
## For H2O package documentation, ask for help:
##     > ??h2o
##
## After starting H2O, you can use the Web UI at http://localhost:54321
## For more information visit http://docs.h2o.ai
##
## ----------------------------------------------------------------------
```

```
##
## Attaching package: 'h2o'
```

```
## The following objects are masked from 'package:lubridate':
##
##     day, hour, month, week, year
```

```
## The following objects are masked from 'package:data.table':
##
##     hour, month, week, year
```

```
## The following objects are masked from 'package:stats':
##
##     cor, sd, var
```

```
## The following objects are masked from 'package:base':
##
##     &&, %*%, %in%, ||, apply, as.factor, as.numeric, colnames,
##     colnames<-, ifelse, is.character, is.factor, is.numeric, log,
##     log10, log1p, log2, round, signif, trunc
```

```
h2o.init()
```

```
##
## H2O is not running yet, starting it now...
##
## Note:  In case of errors look at the following log files:
##     /var/folders/_2/ny9pbkp90zb9ks3c034xd0j80000gn/T//RtmpYmpFxS/h2o_Attila_started_from_r.out
##     /var/folders/_2/ny9pbkp90zb9ks3c034xd0j80000gn/T//RtmpYmpFxS/h2o_Attila_started_from_r.err
##
##
## Starting H2O JVM and connecting: ........ Connection successful!
##
```

```
## R is connected to the H2O cluster:
##     H2O cluster uptime:         7 seconds 199 milliseconds
##     H2O cluster version:        3.10.3.3
##     H2O cluster version age:    23 days
##     H2O cluster name:           H2O_started_from_R_Attila_xjx854
##     H2O cluster total nodes:    1
##     H2O cluster total memory:   0.12 GB
##     H2O cluster total cores:    4
##     H2O cluster allowed cores:  2
##     H2O cluster healthy:        TRUE
##     H2O Connection ip:          localhost
##     H2O Connection port:        54321
##     H2O Connection proxy:       NA
##     R Version:                  R version 3.3.1 (2016-06-21)
##
## Note:  As started, H2O is limited to the CRAN default of 2 CPUs.
##        Shut down and restart H2O as shown below to use all your CPUs.
##            > h2o.shutdown()
##            > h2o.init(nthreads = -1)
```

write demo data to disk

```
library(nycflights13)
write.csv(flights, 'flights.csv', row.names = FALSE)
flights.hex <- h2o.uploadFile('flights.csv', destination_frame = 'flights')
```

```
##
  |
  |                                                                      |   0%
  |
  |======================================================================| 100%
```

```
str(flights.hex)
```

```
## Class 'H2OFrame' <environment: 0x7f8f96ce7b18>
##  - attr(*, "op")= chr "Parse"
##  - attr(*, "id")= chr "flights"
##  - attr(*, "eval")= logi FALSE
##  - attr(*, "nrow")= int 336776
##  - attr(*, "ncol")= int 19
##  - attr(*, "types")=List of 19
##   ..$ : chr "int"
##   ..$ : chr "int"
##   ..$ : chr "int"
##   ..$ : chr "int"
##   ..$ : chr "int"
##   ..$ : chr "int"
##   ..$ : chr "int"
##   ..$ : chr "int"
##   ..$ : chr "int"
##   ..$ : chr "enum"
```

```
##   ..$ : chr "int"
##   ..$ : chr "enum"
##   ..$ : chr "enum"
##   ..$ : chr "enum"
##   ..$ : chr "int"
##   ..$ : chr "int"
##   ..$ : chr "int"
##   ..$ : chr "int"
##   ..$ : chr "time"
##  - attr(*, "data")='data.frame': 10 obs. of  19 variables:
##   ..$ year          : num  2013 2013 2013 2013 2013 ...
##   ..$ month         : num  1 1 1 1 1 1 1 1 1 1
##   ..$ day           : num  1 1 1 1 1 1 1 1 1 1
##   ..$ dep_time      : num  517 533 542 544 554 554 555 557 557 558
##   ..$ sched_dep_time: num  515 529 540 545 600 558 600 600 600 600
##   ..$ dep_delay     : num  2 4 2 -1 -6 -4 -5 -3 -3 -2
##   ..$ arr_time      : num  830 850 923 1004 812 ...
##   ..$ sched_arr_time: num  819 830 850 1022 837 ...
##   ..$ arr_delay     : num  11 20 33 -18 -25 12 19 -14 -8 8
##   ..$ carrier       : Factor w/ 16 levels "9E","AA","AS",..: 12 12 2 4 5 12 4 6 4 2
##   ..$ flight        : num  1545 1714 1141 725 461 ...
##   ..$ tailnum       : Factor w/ 4044 levels "D942DN","N0EGMQ",..: 180 524 2401 3204 2661 1142 1829 33
##   ..$ origin        : Factor w/ 3 levels "EWR","JFK","LGA": 1 3 2 2 3 1 1 3 2 3
##   ..$ dest          : Factor w/ 105 levels "ABQ","ACK","ALB",..: 44 44 59 13 5 70 36 43 55 70
##   ..$ air_time      : num  227 227 160 183 116 150 158 53 140 138
##   ..$ distance      : num  1400 1416 1089 1576 762 ...
##   ..$ hour          : num  5 5 5 5 6 5 6 6 6 6
##   ..$ minute        : num  15 29 40 45 0 58 0 0 0 0
##   ..$ time_hour     : num  1.36e+12 1.36e+12 1.36e+12 1.36e+12 1.36e+12 ...
```

```
head(flights.hex)
```

```
##   year month day dep_time sched_dep_time dep_delay arr_time sched_arr_time
## 1 2013     1   1      517            515         2      830            819
## 2 2013     1   1      533            529         4      850            830
## 3 2013     1   1      542            540         2      923            850
## 4 2013     1   1      544            545        -1     1004           1022
## 5 2013     1   1      554            600        -6      812            837
## 6 2013     1   1      554            558        -4      740            728
##   arr_delay carrier flight tailnum origin dest air_time distance hour
## 1        11      UA   1545  N14228    EWR  IAH      227     1400    5
## 2        20      UA   1714  N24211    LGA  IAH      227     1416    5
## 3        33      AA   1141  N619AA    JFK  MIA      160     1089    5
## 4       -18      B6    725  N804JB    JFK  BQN      183     1576    5
## 5       -25      DL    461  N668DN    LGA  ATL      116      762    6
## 6        12      UA   1696  N39463    EWR  ORD      150      719    5
##   minute    time_hour
## 1     15 1.357013e+12
## 2     29 1.357013e+12
## 3     40 1.357013e+12
## 4     45 1.357013e+12
## 5      0 1.357016e+12
## 6     58 1.357013e+12
```

```
head(flights.hex, 3)
```

```
##   year month day dep_time sched_dep_time dep_delay arr_time sched_arr_time
## 1 2013     1   1      517            515         2      830            819
## 2 2013     1   1      533            529         4      850            830
## 3 2013     1   1      542            540         2      923            850
##   arr_delay carrier flight tailnum origin dest air_time distance hour
## 1        11      UA   1545  N14228    EWR  IAH      227     1400    5
## 2        20      UA   1714  N24211    LGA  IAH      227     1416    5
## 3        33      AA   1141  N619AA    JFK  MIA      160     1089    5
##   minute    time_hour
## 1     15 1.357013e+12
## 2     29 1.357013e+12
## 3     40 1.357013e+12
```

```
summary(flights.hex)
```

```
## Warning in summary.H2OFrame(flights.hex): Approximated quantiles
## computed! If you are interested in exact quantiles, please pass the
## `exact_quantiles=TRUE` parameter.
```

```
##  year           month            day             dep_time
##  Min.   :2013   Min.   : 1.000   Min.   : 1.00   Min.   :   1.0
##  1st Qu.: NaN   1st Qu.: 4.000   1st Qu.: 8.00   1st Qu.: 905.8
##  Median : NaN   Median : 7.000   Median :16.00   Median :1400.2
##  Mean   :2013   Mean   : 6.549   Mean   :15.71   Mean   :1349.1
##  3rd Qu.: NaN   3rd Qu.:10.000   3rd Qu.:23.00   3rd Qu.:1743.4
##  Max.   :2013   Max.   :12.000   Max.   :31.00   Max.   :2400.0
##                                                  NA's   :8255
##  sched_dep_time   dep_delay         arr_time       sched_arr_time
##  Min.   : 106.0   Min.   : -43.00   Min.   :   1   Min.   :   1
##  1st Qu.: 903.9   1st Qu.:  -5.34   1st Qu.:1103   1st Qu.:1124
##  Median :1357.0   Median :  -2.65   Median :1535   Median :1556
##  Mean   :1344.3   Mean   :  12.64   Mean   :1502   Mean   :1536
##  3rd Qu.:1728.9   3rd Qu.:  10.80   3rd Qu.:1938   3rd Qu.:1945
##  Max.   :2359.0   Max.   :1301.00   Max.   :2400   Max.   :2359
##                   NA's   :8255      NA's   :8713
##  arr_delay          carrier   flight         tailnum      origin
##  Min.   : -86.000   UA:58665  Min.   :   1   N725MQ: 575  EWR:120835
##  1st Qu.: -18.050   B6:54635  1st Qu.: 545   N722MQ: 513  JFK:111279
##  Median :  -5.819   EV:54173  Median :1488   N723MQ: 507  LGA:104662
##  Mean   :   6.895   DL:48110  Mean   :1972   N711MQ: 486
##  3rd Qu.:  13.207   AA:32729  3rd Qu.:3460   N713MQ: 483
##  Max.   :1272.000   MQ:26397  Max.   :8500   N258JB: 427
##  NA's   :9430                                NA    :2512
##  dest       air_time        distance         hour
##  ORD:17283  Min.   : 20.0   Min.   :  17.0   Min.   : 1.00
##  ATL:17215  1st Qu.: 82.0   1st Qu.: 498.8   1st Qu.: 9.00
##  LAX:16174  Median :129.0   Median : 871.3   Median :13.00
##  BOS:15508  Mean   :150.7   Mean   :1039.9   Mean   :13.18
##  MCO:14082  3rd Qu.:192.0   3rd Qu.:1387.9   3rd Qu.:17.00
##  CLT:14064  Max.   :695.0   Max.   :4983.0   Max.   :23.00
```

```
##             NA's   :9430
##  minute          time_hour
##  Min.   : 0.00
##  1st Qu.: 8.00
##  Median :29.00
##  Mean   :26.23
##  3rd Qu.:44.00
##  Max.   :59.00
##
```

convert numeric to factor/enum

```
flights.hex[, 'flight'] <- as.factor(flights.hex[, 'flight'])
summary(flights.hex)
```

```
## Warning in summary.H2OFrame(flights.hex): Approximated quantiles
## computed! If you are interested in exact quantiles, please pass the
## `exact_quantiles=TRUE` parameter.
```

```
##  year           month            day             dep_time
##  Min.   :2013   Min.   : 1.000   Min.   : 1.00   Min.   :   1.0
##  1st Qu.: NaN   1st Qu.: 4.000   1st Qu.: 8.00   1st Qu.: 905.8
##  Median : NaN   Median : 7.000   Median :16.00   Median :1400.2
##  Mean   :2013   Mean   : 6.549   Mean   :15.71   Mean   :1349.1
##  3rd Qu.: NaN   3rd Qu.:10.000   3rd Qu.:23.00   3rd Qu.:1743.4
##  Max.   :2013   Max.   :12.000   Max.   :31.00   Max.   :2400.0
##                                                  NA's   :8255
##  sched_dep_time   dep_delay         arr_time       sched_arr_time
##  Min.   : 106.0   Min.   : -43.00   Min.   :   1   Min.   :   1
##  1st Qu.: 903.9   1st Qu.:  -5.34   1st Qu.:1103   1st Qu.:1124
##  Median :1357.0   Median :  -2.65   Median :1535   Median :1556
##  Mean   :1344.3   Mean   :  12.64   Mean   :1502   Mean   :1536
##  3rd Qu.:1728.9   3rd Qu.:  10.80   3rd Qu.:1938   3rd Qu.:1945
##  Max.   :2359.0   Max.   :1301.00   Max.   :2400   Max.   :2359
##                   NA's   :8255      NA's   :8713
##  arr_delay          carrier   flight   tailnum      origin      dest
##  Min.   : -86.000   UA:58665  15 :968  N725MQ: 575  EWR:120835  ORD:17283
##  1st Qu.: -18.050   B6:54635  27 :898  N722MQ: 513  JFK:111279  ATL:17215
##  Median :  -5.819   EV:54173  181:882  N723MQ: 507  LGA:104662  LAX:16174
##  Mean   :   6.895   DL:48110  301:871  N711MQ: 486              BOS:15508
##  3rd Qu.:  13.207   AA:32729  161:786  N713MQ: 483              MCO:14082
##  Max.   :1272.000   MQ:26397  695:782  N258JB: 427              CLT:14064
##  NA's   :9430                          NA    :2512
##  air_time        distance         hour            minute
##  Min.   : 20.0   Min.   :  17.0   Min.   : 1.00   Min.   : 0.00
##  1st Qu.: 82.0   1st Qu.: 498.8   1st Qu.: 9.00   1st Qu.: 8.00
##  Median :129.0   Median : 871.3   Median :13.00   Median :29.00
##  Mean   :150.7   Mean   :1039.9   Mean   :13.18   Mean   :26.23
##  3rd Qu.:192.0   3rd Qu.:1387.9   3rd Qu.:17.00   3rd Qu.:44.00
##  Max.   :695.0   Max.   :4983.0   Max.   :23.00   Max.   :59.00
##  NA's   :9430
```

```
##  time_hour
##
##
##
##
##
##
##
```

```
flights.hex$flight <- as.factor(flights.hex$flight)
for (v in c('month', 'day', 'dep_delay', 'arr_delay')) {
    flights.hex[, v] <- as.factor(flights.hex[, v])
}
summary(flights.hex)
```

```
## Warning in summary.H2OFrame(flights.hex): Approximated quantiles
## computed! If you are interested in exact quantiles, please pass the
## `exact_quantiles=TRUE` parameter.
```

```
##  year           month     day       dep_time         sched_dep_time
##  Min.   :2013   7 :29425  18:11399  Min.   :   1.0   Min.   : 106.0
##  1st Qu.: NaN   8 :29327  11:11359  1st Qu.: 905.8   1st Qu.: 903.9
##  Median : NaN   10:28889  22:11345  Median :1400.2   Median :1357.0
##  Mean   :2013   3 :28834  15:11317  Mean   :1349.1   Mean   :1344.3
##  3rd Qu.: NaN   5 :28796  8 :11271  3rd Qu.:1743.4   3rd Qu.:1728.9
##  Max.   :2013   4 :28330  10:11227  Max.   :2400.0   Max.   :2359.0
##                                     NA's   :8255
##  dep_delay arr_time       sched_arr_time arr_delay carrier   flight
##  -5:24821  Min.   :   1   Min.   :   1   -13:7177  UA:58665  15 :968
##  -4:24619  1st Qu.:1103   1st Qu.:1124   -10:7088  B6:54635  27 :898
##  -3:24218  Median :1535   Median :1556   -12:7046  EV:54173  181:882
##  -2:21516  Mean   :1502   Mean   :1536   -14:6975  DL:48110  301:871
##  -6:20701  3rd Qu.:1938   3rd Qu.:1945   -11:6863  AA:32729  161:786
##  -1:18813  Max.   :2400   Max.   :2359   -9 :6815  MQ:26397  695:782
##  NA: 8255  NA's   :8713                  NA :9430
##  tailnum      origin      dest       air_time        distance
##  N725MQ: 575  EWR:120835  ORD:17283  Min.   : 20.0   Min.   :  17.0
##  N722MQ: 513  JFK:111279  ATL:17215  1st Qu.: 82.0   1st Qu.: 498.8
##  N723MQ: 507  LGA:104662  LAX:16174  Median :129.0   Median : 871.3
##  N711MQ: 486              BOS:15508  Mean   :150.7   Mean   :1039.9
##  N713MQ: 483              MCO:14082  3rd Qu.:192.0   3rd Qu.:1387.9
##  N258JB: 427              CLT:14064  Max.   :695.0   Max.   :4983.0
##  NA    :2512                         NA's   :9430
##  hour            minute          time_hour
##  Min.   : 1.00   Min.   : 0.00
##  1st Qu.: 9.00   1st Qu.: 8.00
##  Median :13.00   Median :29.00
##  Mean   :13.18   Mean   :26.23
##  3rd Qu.:17.00   3rd Qu.:44.00
##  Max.   :23.00   Max.   :59.00
##
```

drop columns

```
dt <- data.table(flights)
dt$delay15 <- ifelse(dt$arr_delay > 15,1,0)
str(dt)
```

```
## Classes 'data.table' and 'data.frame':   336776 obs. of  20 variables:
##  $ year          : int  2013 2013 2013 2013 2013 2013 2013 2013 2013 2013 ...
##  $ month         : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ day           : int  1 1 1 1 1 1 1 1 1 1 ...
##  $ dep_time      : int  517 533 542 544 554 554 555 557 557 558 ...
##  $ sched_dep_time: int  515 529 540 545 600 558 600 600 600 600 ...
##  $ dep_delay     : num  2 4 2 -1 -6 -4 -5 -3 -3 -2 ...
##  $ arr_time      : int  830 850 923 1004 812 740 913 709 838 753 ...
##  $ sched_arr_time: int  819 830 850 1022 837 728 854 723 846 745 ...
##  $ arr_delay     : num  11 20 33 -18 -25 12 19 -14 -8 8 ...
##  $ carrier       : chr  "UA" "UA" "AA" "B6" ...
##  $ flight        : int  1545 1714 1141 725 461 1696 507 5708 79 301 ...
##  $ tailnum       : chr  "N14228" "N24211" "N619AA" "N804JB" ...
##  $ origin        : chr  "EWR" "LGA" "JFK" "JFK" ...
##  $ dest          : chr  "IAH" "IAH" "MIA" "BQN" ...
##  $ air_time      : num  227 227 160 183 116 150 158 53 140 138 ...
##  $ distance      : num  1400 1416 1089 1576 762 ...
##  $ hour          : num  5 5 5 5 6 5 6 6 6 6 ...
##  $ minute        : num  15 29 40 45 0 58 0 0 0 0 ...
##  $ time_hour     : POSIXct, format: "2013-01-01 05:00:00" "2013-01-01 05:00:00" ...
##  $ delay15       : num  0 1 1 0 0 0 1 0 0 0 ...
##  - attr(*, ".internal.selfref")=<externalptr>
```

```
dt <- dt[, .(month, day, dest, origin,
             carrier, flight, tailnum, distance, delay15)]
```

transform to factor

```
for (v in c('month', 'day', 'flight', 'carrier')) {
    set(dt, j = v, value = as.factor(dt[, get(v)]))
}
str(dt)
```

```
## Classes 'data.table' and 'data.frame':   336776 obs. of  9 variables:
##  $ month   : Factor w/ 12 levels "1","2","3","4",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ day     : Factor w/ 31 levels "1","2","3","4",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ dest    : chr  "IAH" "IAH" "MIA" "BQN" ...
##  $ origin  : chr  "EWR" "LGA" "JFK" "JFK" ...
##  $ carrier : Factor w/ 16 levels "9E","AA","AS",..: 12 12 2 4 5 12 4 6 4 2 ...
##  $ flight  : Factor w/ 3844 levels "1","2","3","4",..: 1382 1545 1042 677 425 1527 469 3700 69 266 .
##  $ tailnum : chr  "N14228" "N24211" "N619AA" "N804JB" ...
##  $ distance: num  1400 1416 1089 1576 762 ...
##  $ delay15 : num  0 1 1 0 0 0 1 0 0 0 ...
##  - attr(*, ".internal.selfref")=<externalptr>
```

re-upload to H2O

```
h2o.ls()
```

```
##               key
## 1 RTMP_sid_80c2_7
## 2         flights
```

```
h2o.rm('flights')
as.h2o(dt, 'flights')
```

```
##
  |
  |                                                                      |   0%
  |
  |======================================================================| 100%
```

```
##   month day dest origin carrier flight tailnum distance delay15
## 1     1   1  IAH    EWR      UA   1545  N14228     1400       0
## 2     1   1  IAH    LGA      UA   1714  N24211     1416       1
## 3     1   1  MIA    JFK      AA   1141  N619AA     1089       1
## 4     1   1  BQN    JFK      B6    725  N804JB     1576       0
## 5     1   1  ATL    LGA      DL    461  N668DN      762       0
## 6     1   1  ORD    EWR      UA   1696  N39463      719       0
##
## [336776 rows x 9 columns]
```

split the data

```
flights.hex <- h2o.getFrame('flights')
h2o.splitFrame(data = flights.hex , ratios = 0.75, destination_frames = c('train', 'test'))
```

```
## [[1]]
##   month day dest origin carrier flight tailnum distance delay15
## 1     1   1  IAH    EWR      UA   1545  N14228     1400       0
## 2     1   1  ATL    LGA      DL    461  N668DN      762       0
## 3     1   1  ORD    EWR      UA   1696  N39463      719       0
## 4     1   1  IAD    LGA      EV   5708  N829AS      229       0
## 5     1   1  MCO    JFK      B6     79  N593JB      944       0
## 6     1   1  ORD    LGA      AA    301  N3ALAA      733       0
##
## [252624 rows x 9 columns]
##
## [[2]]
##   month day dest origin carrier flight tailnum distance delay15
## 1     1   1  IAH    LGA      UA   1714  N24211     1416       1
## 2     1   1  MIA    JFK      AA   1141  N619AA     1089       1
## 3     1   1  BQN    JFK      B6    725  N804JB     1576       0
## 4     1   1  FLL    EWR      B6    507  N516JB     1065       1
```

```
## 5     1   1  LAS    EWR      UA   1187  N76515     2227       0
## 6     1   1  PBI    EWR      B6    343  N644JB     1023       0
##
## [84152 rows x 9 columns]
```

```
h2o.ls()
```

```
##       key
## 1 flights
## 2    test
## 3   train
```

build the first model

```
flights.rf <- h2o.randomForest(
    x = names(flights.hex),
    y = 'delay15',
    training_frame = 'train',
    validation_frame = 'test')
```

```
## Warning in .verify_dataxy(training_frame, x, y): removing response variable
## from the explanatory variables
```

```
## Warning in .h2o.startModelJob(algo, params, h2oRestApiVersion): Dropping constant columns: [origin,
```

```
##
  |
  |                                                                      |   0%
  |
  |=                                                                     |   2%
  |
  |===                                                                   |   4%
  |
  |=====                                                                 |   8%
  |
  |======                                                                |  10%
  |
  |=========                                                             |  14%
  |
  |============                                                          |  18%
  |
  |=============                                                         |  20%
  |
  |================                                                      |  24%
  |
  |==================                                                    |  26%
  |
  |====================                                                  |  30%
  |
  |=====================                                                 |  32%
```

```
  |
  |======================                                          |  34%
  |
  |=========================                                       |  38%
  |
  |===========================                                     |  42%
  |
  |============================                                    |  44%
  |
  |==============================                                  |  48%
  |
  |================================                                |  52%
  |
  |==================================                              |  56%
  |
  |====================================                            |  58%
  |
  |======================================                          |  60%
  |
  |========================================                        |  62%
  |
  |==========================================                      |  64%
  |
  |============================================                    |  68%
  |
  |==============================================                  |  70%
  |
  |================================================                |  74%
  |
  |==================================================              |  78%
  |
  |====================================================            |  80%
  |
  |======================================================          |  84%
  |
  |========================================================        |  86%
  |
  |==========================================================      |  90%
  |
  |============================================================    |  92%
  |
  |==============================================================  |  94%
  |
  |================================================================|  96%
  |
  |================================================================| 100%
```

```
flights.rf
```

```
## Model Details:
## ==============
##
## H2ORegressionModel: drf
## Model ID:  DRF_model_R_1488055486327_1
```

```
## Model Summary:
##   number_of_trees number_of_internal_trees model_size_in_bytes min_depth
## 1              50                        50             9713962        20
##   max_depth mean_depth min_leaves max_leaves mean_leaves
## 1        20   20.00000       2924      11940  7326.60000
##
##
## H2ORegressionMetrics: drf
## ** Reported on training data. **
## ** Metrics reported on Out-Of-Bag training samples **
##
## MSE:  0.1570826
## RMSE:  0.3963365
## MAE:  0.3211633
## RMSLE:  0.2768073
## Mean Residual Deviance :  0.1570826
##
##
## H2ORegressionMetrics: drf
## ** Reported on validation data. **
##
## MSE:  0.1556628
## RMSE:  0.3945412
## MAE:  0.3210094
## RMSLE:  0.2752681
## Mean Residual Deviance :  0.1556628
```