Analytics 502

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# ABSTRACT

***I am just using this as a scratchpad for noting down ideas. Does not really correlate whith what should go on paper. Please pay more attention to the sections***

Right now the goal is to get a good understanding of the data. AKA exploratory analysis. Relationships worth checking out: *Arr Delay ~ Day of the week* It seems arrival delay is related to day of the week.

Hypothesis Test H0 : Mean arrival delay on Sat-Evening <= 0 H1 : Mean arival delay on Sat-Evening > 0

There should be a section to check t-test assumptions (n>30, etc, etc)

Net Delay ~ Month Dep Delay ~ Dep Airport Arr Delay ~ Arr Airport Net Delay ~ Airline

Prediction query: What is the chance that a flight will be delayed given…….

# DATA LOADING & MANIPULATION

#### Checking out the data

flightData <- read.csv("flights.csv", header = TRUE)  
head(flightData)

## YEAR MONTH DAY DAY\_OF\_WEEK AIRLINE FLIGHT\_NUMBER TAIL\_NUMBER  
## 1 2015 1 1 4 AS 98 N407AS  
## 2 2015 1 1 4 AA 2336 N3KUAA  
## 3 2015 1 1 4 US 840 N171US  
## 4 2015 1 1 4 AA 258 N3HYAA  
## 5 2015 1 1 4 AS 135 N527AS  
## 6 2015 1 1 4 DL 806 N3730B  
## ORIGIN\_AIRPORT DESTINATION\_AIRPORT SCHEDULED\_DEPARTURE DEPARTURE\_TIME  
## 1 ANC SEA 5 2354  
## 2 LAX PBI 10 2  
## 3 SFO CLT 20 18  
## 4 LAX MIA 20 15  
## 5 SEA ANC 25 24  
## 6 SFO MSP 25 20  
## DEPARTURE\_DELAY TAXI\_OUT WHEELS\_OFF SCHEDULED\_TIME ELAPSED\_TIME AIR\_TIME  
## 1 -11 21 15 205 194 169  
## 2 -8 12 14 280 279 263  
## 3 -2 16 34 286 293 266  
## 4 -5 15 30 285 281 258  
## 5 -1 11 35 235 215 199  
## 6 -5 18 38 217 230 206  
## DISTANCE WHEELS\_ON TAXI\_IN SCHEDULED\_ARRIVAL ARRIVAL\_TIME ARRIVAL\_DELAY  
## 1 1448 404 4 430 408 -22  
## 2 2330 737 4 750 741 -9  
## 3 2296 800 11 806 811 5  
## 4 2342 748 8 805 756 -9  
## 5 1448 254 5 320 259 -21  
## 6 1589 604 6 602 610 8  
## DIVERTED CANCELLED CANCELLATION\_REASON AIR\_SYSTEM\_DELAY SECURITY\_DELAY  
## 1 0 0 NA NA  
## 2 0 0 NA NA  
## 3 0 0 NA NA  
## 4 0 0 NA NA  
## 5 0 0 NA NA  
## 6 0 0 NA NA  
## AIRLINE\_DELAY LATE\_AIRCRAFT\_DELAY WEATHER\_DELAY  
## 1 NA NA NA  
## 2 NA NA NA  
## 3 NA NA NA  
## 4 NA NA NA  
## 5 NA NA NA  
## 6 NA NA NA

str(flightData)

## 'data.frame': 1048575 obs. of 31 variables:  
## $ YEAR : int 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 ...  
## $ MONTH : int 1 1 1 1 1 1 1 1 1 1 ...  
## $ DAY : int 1 1 1 1 1 1 1 1 1 1 ...  
## $ DAY\_OF\_WEEK : int 4 4 4 4 4 4 4 4 4 4 ...  
## $ AIRLINE : Factor w/ 14 levels "AA","AS","B6",..: 2 1 12 1 2 4 9 12 1 4 ...  
## $ FLIGHT\_NUMBER : int 98 2336 840 258 135 806 612 2013 1112 1173 ...  
## $ TAIL\_NUMBER : Factor w/ 4523 levels "","D942DN","N001AA",..: 1523 1472 384 1432 2017 1061 2623 2282 1477 3690 ...  
## $ ORIGIN\_AIRPORT : Factor w/ 315 levels "ABE","ABI","ABQ",..: 16 172 273 172 272 273 170 172 273 170 ...  
## $ DESTINATION\_AIRPORT: Factor w/ 315 levels "ABE","ABI","ABQ",..: 272 230 65 199 16 212 212 65 85 19 ...  
## $ SCHEDULED\_DEPARTURE: int 5 10 20 20 25 25 25 30 30 30 ...  
## $ DEPARTURE\_TIME : int 2354 2 18 15 24 20 19 44 19 33 ...  
## $ DEPARTURE\_DELAY : int -11 -8 -2 -5 -1 -5 -6 14 -11 3 ...  
## $ TAXI\_OUT : int 21 12 16 15 11 18 11 13 17 12 ...  
## $ WHEELS\_OFF : int 15 14 34 30 35 38 30 57 36 45 ...  
## $ SCHEDULED\_TIME : int 205 280 286 285 235 217 181 273 195 221 ...  
## $ ELAPSED\_TIME : int 194 279 293 281 215 230 170 249 193 203 ...  
## $ AIR\_TIME : int 169 263 266 258 199 206 154 228 173 186 ...  
## $ DISTANCE : int 1448 2330 2296 2342 1448 1589 1299 2125 1464 1747 ...  
## $ WHEELS\_ON : int 404 737 800 748 254 604 504 745 529 651 ...  
## $ TAXI\_IN : int 4 4 11 8 5 6 5 8 3 5 ...  
## $ SCHEDULED\_ARRIVAL : int 430 750 806 805 320 602 526 803 545 711 ...  
## $ ARRIVAL\_TIME : int 408 741 811 756 259 610 509 753 532 656 ...  
## $ ARRIVAL\_DELAY : int -22 -9 5 -9 -21 8 -17 -10 -13 -15 ...  
## $ DIVERTED : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ CANCELLED : int 0 0 0 0 0 0 0 0 0 0 ...  
## $ CANCELLATION\_REASON: Factor w/ 5 levels "","A","B","C",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ AIR\_SYSTEM\_DELAY : int NA NA NA NA NA NA NA NA NA NA ...  
## $ SECURITY\_DELAY : int NA NA NA NA NA NA NA NA NA NA ...  
## $ AIRLINE\_DELAY : int NA NA NA NA NA NA NA NA NA NA ...  
## $ LATE\_AIRCRAFT\_DELAY: int NA NA NA NA NA NA NA NA NA NA ...  
## $ WEATHER\_DELAY : int NA NA NA NA NA NA NA NA NA NA ...

summary(flightData)

## YEAR MONTH DAY DAY\_OF\_WEEK   
## Min. :2015 Min. :1.000 Min. : 1.00 Min. :1.000   
## 1st Qu.:2015 1st Qu.:1.000 1st Qu.: 6.00 1st Qu.:2.000   
## Median :2015 Median :2.000 Median :13.00 Median :4.000   
## Mean :2015 Mean :1.694 Mean :13.82 Mean :3.953   
## 3rd Qu.:2015 3rd Qu.:2.000 3rd Qu.:21.00 3rd Qu.:6.000   
## Max. :2015 Max. :3.000 Max. :31.00 Max. :7.000   
##   
## AIRLINE FLIGHT\_NUMBER TAIL\_NUMBER ORIGIN\_AIRPORT   
## WN :221586 Min. : 1 : 7750 ATL : 66599   
## DL :147486 1st Qu.: 755 N477HA : 809 ORD : 52961   
## EV :111206 Median :1725 N488HA : 799 DFW : 50933   
## OO :107099 Mean :2257 N476HA : 773 LAX : 38473   
## AA : 97549 3rd Qu.:3485 N485HA : 767 DEN : 38254   
## UA : 87606 Max. :9794 N486HA : 741 IAH : 29802   
## (Other):276043 (Other):1036936 (Other):771553   
## DESTINATION\_AIRPORT SCHEDULED\_DEPARTURE DEPARTURE\_TIME DEPARTURE\_DELAY   
## ATL : 66741 Min. : 1 Min. : 1 Min. : -61.00   
## ORD : 53060 1st Qu.: 920 1st Qu.: 928 1st Qu.: -5.00   
## DFW : 51037 Median :1319 Median :1329 Median : -1.00   
## LAX : 38463 Mean :1323 Mean :1334 Mean : 11.33   
## DEN : 38300 3rd Qu.:1720 3rd Qu.:1731 3rd Qu.: 11.00   
## IAH : 29820 Max. :2359 Max. :2400 Max. :1988.00   
## (Other):771154 NA's :39515 NA's :39515   
## TAXI\_OUT WHEELS\_OFF SCHEDULED\_TIME ELAPSED\_TIME   
## Min. : 1.00 Min. : 1 Min. : 20.0 Min. : 15.0   
## 1st Qu.: 11.00 1st Qu.: 944 1st Qu.: 85.0 1st Qu.: 82.0   
## Median : 14.00 Median :1342 Median :122.0 Median :119.0   
## Mean : 16.65 Mean :1357 Mean :140.3 Mean :136.9   
## 3rd Qu.: 19.00 3rd Qu.:1745 3rd Qu.:173.0 3rd Qu.:169.0   
## Max. :225.00 Max. :2400 Max. :718.0 Max. :766.0   
## NA's :40229 NA's :40229 NA's :2 NA's :43071   
## AIR\_TIME DISTANCE WHEELS\_ON TAXI\_IN   
## Min. : 7.0 Min. : 31.0 Min. : 1 Min. : 1.00   
## 1st Qu.: 60.0 1st Qu.: 368.0 1st Qu.:1110 1st Qu.: 4.00   
## Median : 94.0 Median : 641.0 Median :1516 Median : 6.00   
## Mean :112.8 Mean : 803.4 Mean :1486 Mean : 7.55   
## 3rd Qu.:144.0 3rd Qu.:1046.0 3rd Qu.:1911 3rd Qu.: 9.00   
## Max. :687.0 Max. :4983.0 Max. :2400 Max. :202.00   
## NA's :43071 NA's :41296 NA's :41296   
## SCHEDULED\_ARRIVAL ARRIVAL\_TIME ARRIVAL\_DELAY DIVERTED   
## Min. : 1 Min. : 1 Min. : -82.00 Min. :0.000000   
## 1st Qu.:1120 1st Qu.:1115 1st Qu.: -12.00 1st Qu.:0.000000   
## Median :1524 Median :1521 Median : -3.00 Median :0.000000   
## Mean :1505 Mean :1492 Mean : 7.61 Mean :0.002426   
## 3rd Qu.:1915 3rd Qu.:1917 3rd Qu.: 12.00 3rd Qu.:0.000000   
## Max. :2359 Max. :2400 Max. :1971.00 Max. :1.000000   
## NA's :41296 NA's :43071   
## CANCELLED CANCELLATION\_REASON AIR\_SYSTEM\_DELAY SECURITY\_DELAY   
## Min. :0.00000 :1008048 Min. : 0.0 Min. : 0.0   
## 1st Qu.:0.00000 A: 6974 1st Qu.: 0.0 1st Qu.: 0.0   
## Median :0.00000 B: 28260 Median : 4.0 Median : 0.0   
## Mean :0.03865 C: 5291 Mean : 13.7 Mean : 0.1   
## 3rd Qu.:0.00000 D: 2 3rd Qu.: 19.0 3rd Qu.: 0.0   
## Max. :1.00000 Max. :830.0 Max. :241.0   
## NA's :820047 NA's :820047   
## AIRLINE\_DELAY LATE\_AIRCRAFT\_DELAY WEATHER\_DELAY   
## Min. : 0.0 Min. : 0.0 Min. : 0.0   
## 1st Qu.: 0.0 1st Qu.: 0.0 1st Qu.: 0.0   
## Median : 2.0 Median : 4.0 Median : 0.0   
## Mean : 18.2 Mean : 22.9 Mean : 3.5   
## 3rd Qu.: 18.0 3rd Qu.: 29.0 3rd Qu.: 0.0   
## Max. :1971.0 Max. :1313.0 Max. :1152.0   
## NA's :820047 NA's :820047 NA's :820047

#### Modifying the dataset

flightData <- mutate(flightData, DAY\_OF\_WEEK = as.factor(DAY\_OF\_WEEK))  
flightData$DAY\_OF\_WEEK <- ordered(flightData$DAY\_OF\_WEEK, levels = c("1","2","3","4","5","6","7"))  
levels(flightData$DAY\_OF\_WEEK) <- c("Sunday","Monday","Tuesday","Wednesday","Thursday","Friday","Saturday")

#### Additional modification

Modifying the dataset convert integer time to HH:MM format time

flightData <- mutate(flightData, SCHEDULED\_DEPARTURE = format(strptime(sprintf("%04d",SCHEDULED\_DEPARTURE), format="%H%M"), format = "%H:%M"))  
flightData <- mutate(flightData, DEPARTURE\_TIME = format(strptime(sprintf("%04d",DEPARTURE\_TIME), format="%H%M"), format = "%H:%M"))

Modifying the dataset to have, a column for morning to night clasification for *scheduled* departure time

flightData <- mutate(flightData, DEP\_TIME\_OF\_DAY =   
 ifelse (SCHEDULED\_DEPARTURE >= "18:00","Evening",  
 ifelse (SCHEDULED\_DEPARTURE >= "12:00","Afternoon",  
 ifelse (SCHEDULED\_DEPARTURE >= "06:00","Morning","Night")))  
 )

Ordering the factors in Time of day

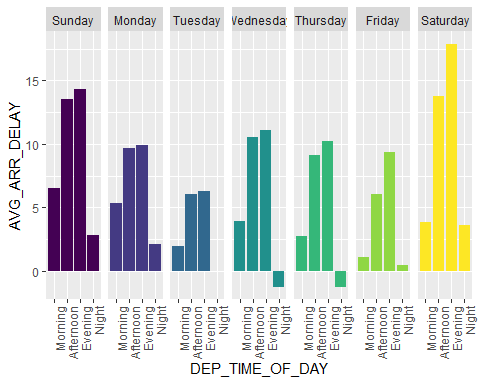
flightData <- mutate(flightData, DEP\_TIME\_OF\_DAY = as.factor(DEP\_TIME\_OF\_DAY))  
flightData$DEP\_TIME\_OF\_DAY <- ordered(flightData$DEP\_TIME\_OF\_DAY, levels = c("Morning","Afternoon", "Evening","Night"))

# EXPLORATORY DATA ANALYSIS

This section should have more graphs, charts and bits ‘n pieces of other small studies. More so to make the report and presentation look ’fuller’. In my next version of this doc, I will add more. But feel free to suggest.

#### Plot of arrival delay vs Day of the week + Time of the day

groupByDayTime <- group\_by(select(flightData, DAY\_OF\_WEEK, DEP\_TIME\_OF\_DAY, ARRIVAL\_DELAY),DAY\_OF\_WEEK,DEP\_TIME\_OF\_DAY)  
groupByDayTime <- groupByDayTime[complete.cases(groupByDayTime),]  
delayByDayTime <- summarise(groupByDayTime, AVG\_ARR\_DELAY = mean(ARRIVAL\_DELAY))  
ggplot(data = delayByDayTime, aes(x = DEP\_TIME\_OF\_DAY, y = AVG\_ARR\_DELAY, fill = DAY\_OF\_WEEK)) + geom\_bar(stat = "identity") + guides(fill = FALSE) + facet\_wrap(vars(DAY\_OF\_WEEK),nrow = 1) + theme(axis.text.x = element\_text(angle = 90, hjust = 1))

 #INFERENCE

This is to prove that for flights departing on saturday evenings, there is definitely a delay on arrival and it is not a result of sample variance.

#### Hypothesis Test

H0 : Mean arrival delay on Sat-Evening <= 0 H1 : Mean arival delay on Sat-Evening > 0

Putting saturday arrival delays in a vector and then running the above hypothesis tests

arrdelaySat <- filter(flightData, DAY\_OF\_WEEK == "Saturday", DEP\_TIME\_OF\_DAY == "Evening")$ARRIVAL\_DELAY  
summary(arrdelaySat)

## Min. 1st Qu. Median Mean 3rd Qu. Max. NA's   
## -69.00 -9.00 3.00 17.89 28.00 1016.00 2186

test\_res <- t.test(arrdelaySat, mu = 0, alternative = "greater")  
test\_res

##   
## One Sample t-test  
##   
## data: arrdelaySat  
## t = 66.843, df = 31428, p-value < 2.2e-16  
## alternative hypothesis: true mean is greater than 0  
## 95 percent confidence interval:  
## 17.45432 Inf  
## sample estimates:  
## mean of x   
## 17.89468

# THE ‘BEST’ MODEL

In the last lecture class, the professor taught us a workflow for determoining the ‘best’ model. I have used the adjusted r squared method. Please use the lecture notes to understand what I did below:

#### STEP 1: FULL MODEL (day,time, airline, origin, destination)

arrDelayModel00 <- lm(ARRIVAL\_DELAY ~ DAY\_OF\_WEEK + DEP\_TIME\_OF\_DAY + AIRLINE + ORIGIN\_AIRPORT + DESTINATION\_AIRPORT , data = flightData)  
summary(arrDelayModel00)$adj.r.squared

## [1] 0.0348465

#### STEP 2: 4-Variable MODEL

From the results below it looks like removing any of the variables gives a lower adjusted r-square. So, **the full model is the best model**

arrDelayModel01 <- lm(ARRIVAL\_DELAY ~ DEP\_TIME\_OF\_DAY + AIRLINE + ORIGIN\_AIRPORT + DESTINATION\_AIRPORT , data = flightData)  
print("No DAY\_OF\_WEEK")  
summary(arrDelayModel01)$adj.r.squared  
rm(arrDelayModel01)  
arrDelayModel02 <- lm(ARRIVAL\_DELAY ~ DAY\_OF\_WEEK + AIRLINE + ORIGIN\_AIRPORT + DESTINATION\_AIRPORT , data = flightData)  
print("No DEP\_TIME\_OF\_DAY")  
summary(arrDelayModel02)$adj.r.squared  
rm(arrDelayModel02)  
arrDelayModel03 <- lm(ARRIVAL\_DELAY ~ DAY\_OF\_WEEK + DEP\_TIME\_OF\_DAY + ORIGIN\_AIRPORT + DESTINATION\_AIRPORT , data = flightData)  
print("No AIRLINE")  
summary(arrDelayModel03)$adj.r.squared  
rm(arrDelayModel03)  
arrDelayModel04 <- lm(ARRIVAL\_DELAY ~ DAY\_OF\_WEEK + DEP\_TIME\_OF\_DAY + AIRLINE + DESTINATION\_AIRPORT , data = flightData)  
print("No ORIGIN\_AIRPORT")  
summary(arrDelayModel04)$adj.r.squared  
rm(arrDelayModel04)  
arrDelayModel05 <- lm(ARRIVAL\_DELAY ~ DAY\_OF\_WEEK + DEP\_TIME\_OF\_DAY + AIRLINE + ORIGIN\_AIRPORT, data = flightData)  
print("No DESTINATION\_AIRPORT")  
summary(arrDelayModel05)$adj.r.squared  
rm(arrDelayModel05)

# PREDICTION

#### Setting prediction Model for day, time, airline, origin & destination (the winning model above)

arrDelayModel <- arrDelayModel00  
summary(arrDelayModel)

##   
## Call:  
## lm(formula = ARRIVAL\_DELAY ~ DAY\_OF\_WEEK + DEP\_TIME\_OF\_DAY +   
## AIRLINE + ORIGIN\_AIRPORT + DESTINATION\_AIRPORT, data = flightData)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -91.07 -19.34 -8.73 5.38 1968.54   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 6.236887 3.066803 2.034 0.041984 \*   
## DAY\_OF\_WEEK.L -0.839439 0.110103 -7.624 2.46e-14 \*\*\*  
## DAY\_OF\_WEEK.Q 4.803135 0.107609 44.635 < 2e-16 \*\*\*  
## DAY\_OF\_WEEK.C 0.299787 0.110156 2.721 0.006499 \*\*   
## DAY\_OF\_WEEK^4 2.707768 0.111729 24.235 < 2e-16 \*\*\*  
## DAY\_OF\_WEEK^5 2.611585 0.110317 23.673 < 2e-16 \*\*\*  
## DAY\_OF\_WEEK^6 -1.577275 0.107267 -14.704 < 2e-16 \*\*\*  
## DEP\_TIME\_OF\_DAY.L -1.489815 0.224410 -6.639 3.16e-11 \*\*\*  
## DEP\_TIME\_OF\_DAY.Q -8.566606 0.177427 -48.282 < 2e-16 \*\*\*  
## DEP\_TIME\_OF\_DAY.C -1.708332 0.108123 -15.800 < 2e-16 \*\*\*  
## AIRLINEAS -2.934488 0.404841 -7.248 4.22e-13 \*\*\*  
## AIRLINEB6 5.185965 0.316334 16.394 < 2e-16 \*\*\*  
## AIRLINEDL -1.195727 0.255650 -4.677 2.91e-06 \*\*\*  
## AIRLINEEV 4.118997 0.276798 14.881 < 2e-16 \*\*\*  
## AIRLINEF9 16.560617 0.423873 39.070 < 2e-16 \*\*\*  
## AIRLINEHA -0.473223 0.802065 -0.590 0.555187   
## AIRLINEMQ 11.051249 0.275692 40.085 < 2e-16 \*\*\*  
## AIRLINENK 9.369165 0.376472 24.887 < 2e-16 \*\*\*  
## AIRLINEOO 6.693698 0.272959 24.523 < 2e-16 \*\*\*  
## AIRLINEUA 0.153772 0.256298 0.600 0.548522   
## AIRLINEUS 0.084981 0.314780 0.270 0.787183   
## AIRLINEVX -1.730950 0.476759 -3.631 0.000283 \*\*\*  
## AIRLINEWN -0.376567 0.252451 -1.492 0.135793   
## ORIGIN\_AIRPORTABI -10.437398 2.886280 -3.616 0.000299 \*\*\*  
## ORIGIN\_AIRPORTABQ -2.870134 2.269042 -1.265 0.205904   
## ORIGIN\_AIRPORTABR 10.542159 4.188228 2.517 0.011833 \*   
## ORIGIN\_AIRPORTABY -2.589946 3.780622 -0.685 0.493307   
## ORIGIN\_AIRPORTACT -10.016651 3.281747 -3.052 0.002272 \*\*   
## ORIGIN\_AIRPORTACV 0.056910 3.216092 0.018 0.985882   
## ORIGIN\_AIRPORTACY -12.069203 2.665388 -4.528 5.95e-06 \*\*\*  
## ORIGIN\_AIRPORTADK -1.430863 9.780724 -0.146 0.883689   
## ORIGIN\_AIRPORTADQ -8.993138 5.765013 -1.560 0.118772   
## ORIGIN\_AIRPORTAEX -4.693925 2.737456 -1.715 0.086400 .   
## ORIGIN\_AIRPORTAGS 1.290601 2.917135 0.442 0.658185   
## ORIGIN\_AIRPORTALB -5.614644 2.449580 -2.292 0.021901 \*   
## ORIGIN\_AIRPORTALO -4.348204 4.483329 -0.970 0.332116   
## ORIGIN\_AIRPORTAMA -4.514774 2.504749 -1.802 0.071469 .   
## ORIGIN\_AIRPORTANC -8.092259 2.380516 -3.399 0.000675 \*\*\*  
## ORIGIN\_AIRPORTAPN -3.040144 4.563617 -0.666 0.505303   
## ORIGIN\_AIRPORTASE -1.061685 2.438301 -0.435 0.663258   
## ORIGIN\_AIRPORTATL -6.541663 2.166176 -3.020 0.002529 \*\*   
## ORIGIN\_AIRPORTATW -5.110885 2.830946 -1.805 0.071018 .   
## ORIGIN\_AIRPORTAUS -4.374150 2.208301 -1.981 0.047617 \*   
## ORIGIN\_AIRPORTAVL -2.598177 2.905869 -0.894 0.371261   
## ORIGIN\_AIRPORTAVP -4.618623 3.478449 -1.328 0.184250   
## ORIGIN\_AIRPORTAZO -5.860086 3.038253 -1.929 0.053760 .   
## ORIGIN\_AIRPORTBDL -3.448395 2.266516 -1.521 0.128147   
## ORIGIN\_AIRPORTBET 1.210133 3.899197 0.310 0.756292   
## ORIGIN\_AIRPORTBFL -6.618257 2.850203 -2.322 0.020231 \*   
## ORIGIN\_AIRPORTBGM 6.093348 7.220953 0.844 0.398758   
## ORIGIN\_AIRPORTBGR 9.797455 9.494751 1.032 0.302128   
## ORIGIN\_AIRPORTBHM -3.807365 2.304502 -1.652 0.098506 .   
## ORIGIN\_AIRPORTBIL -11.183497 2.841561 -3.936 8.30e-05 \*\*\*  
## ORIGIN\_AIRPORTBIS -2.901205 2.695335 -1.076 0.281758   
## ORIGIN\_AIRPORTBJI -17.144730 4.165511 -4.116 3.86e-05 \*\*\*  
## ORIGIN\_AIRPORTBLI -0.854899 3.622738 -0.236 0.813447   
## ORIGIN\_AIRPORTBMI 1.258319 2.814654 0.447 0.654832   
## ORIGIN\_AIRPORTBNA -4.988327 2.200051 -2.267 0.023368 \*   
## ORIGIN\_AIRPORTBOI -3.816310 2.345639 -1.627 0.103742   
## ORIGIN\_AIRPORTBOS 1.960319 2.177895 0.900 0.368068   
## ORIGIN\_AIRPORTBPT 7.212812 3.786371 1.905 0.056788 .   
## ORIGIN\_AIRPORTBQK -6.615853 3.737877 -1.770 0.076736 .   
## ORIGIN\_AIRPORTBQN 6.172869 3.512350 1.757 0.078837 .   
## ORIGIN\_AIRPORTBRD -9.572032 4.432441 -2.160 0.030809 \*   
## ORIGIN\_AIRPORTBRO -5.189025 2.928877 -1.772 0.076448 .   
## ORIGIN\_AIRPORTBRW 0.964308 4.062563 0.237 0.812374   
## ORIGIN\_AIRPORTBTM -21.881572 4.220817 -5.184 2.17e-07 \*\*\*  
## ORIGIN\_AIRPORTBTR -0.001297 2.416020 -0.001 0.999572   
## ORIGIN\_AIRPORTBTV -2.765974 2.885907 -0.958 0.337840   
## ORIGIN\_AIRPORTBUF -3.605652 2.288987 -1.575 0.115207   
## ORIGIN\_AIRPORTBUR -4.154412 2.266166 -1.833 0.066768 .   
## ORIGIN\_AIRPORTBWI -0.129605 2.183662 -0.059 0.952672   
## ORIGIN\_AIRPORTBZN -5.700311 2.728729 -2.089 0.036708 \*   
## ORIGIN\_AIRPORTCAE -0.714030 2.476921 -0.288 0.773138   
## ORIGIN\_AIRPORTCAK -8.946907 2.456647 -3.642 0.000271 \*\*\*  
## ORIGIN\_AIRPORTCDC -9.534997 4.416468 -2.159 0.030853 \*   
## ORIGIN\_AIRPORTCDV -10.974444 4.824694 -2.275 0.022928 \*   
## ORIGIN\_AIRPORTCEC -1.085399 4.343918 -0.250 0.802691   
## ORIGIN\_AIRPORTCHA -8.934547 2.646307 -3.376 0.000735 \*\*\*  
## ORIGIN\_AIRPORTCHO 1.249685 2.988449 0.418 0.675822   
## ORIGIN\_AIRPORTCHS -6.989783 2.353711 -2.970 0.002981 \*\*   
## ORIGIN\_AIRPORTCID 2.849398 2.421652 1.177 0.239342   
## ORIGIN\_AIRPORTCIU -5.952379 4.312403 -1.380 0.167497   
## ORIGIN\_AIRPORTCLD -8.048242 2.927777 -2.749 0.005979 \*\*   
## ORIGIN\_AIRPORTCLE -4.780857 2.211479 -2.162 0.030631 \*   
## ORIGIN\_AIRPORTCLL -6.217319 3.007653 -2.067 0.038719 \*   
## ORIGIN\_AIRPORTCLT -4.996238 2.182351 -2.289 0.022057 \*   
## ORIGIN\_AIRPORTCMH -3.064667 2.240528 -1.368 0.171365   
## ORIGIN\_AIRPORTCMI 3.586549 2.986178 1.201 0.229732   
## ORIGIN\_AIRPORTCMX -11.809546 4.423536 -2.670 0.007592 \*\*   
## ORIGIN\_AIRPORTCNY -32.387057 4.401901 -7.358 1.88e-13 \*\*\*  
## ORIGIN\_AIRPORTCOD -8.884442 4.225672 -2.102 0.035510 \*   
## ORIGIN\_AIRPORTCOS -0.741698 2.443050 -0.304 0.761437   
## ORIGIN\_AIRPORTCOU -1.119206 3.401871 -0.329 0.742158   
## ORIGIN\_AIRPORTCPR -14.986875 3.061153 -4.896 9.79e-07 \*\*\*  
## ORIGIN\_AIRPORTCRP -4.819829 2.475669 -1.947 0.051549 .   
## ORIGIN\_AIRPORTCRW 5.532500 3.001733 1.843 0.065314 .   
## ORIGIN\_AIRPORTCSG -3.156621 3.618378 -0.872 0.382998   
## ORIGIN\_AIRPORTCVG -6.236302 2.258390 -2.761 0.005756 \*\*   
## ORIGIN\_AIRPORTCWA -7.422264 3.332654 -2.227 0.025939 \*   
## ORIGIN\_AIRPORTDAB -3.314861 3.244021 -1.022 0.306858   
## ORIGIN\_AIRPORTDAL -3.480243 2.194261 -1.586 0.112725   
## ORIGIN\_AIRPORTDAY -8.479095 2.377794 -3.566 0.000363 \*\*\*  
## ORIGIN\_AIRPORTDBQ -3.798858 3.956834 -0.960 0.337018   
## ORIGIN\_AIRPORTDCA -5.876103 2.182720 -2.692 0.007100 \*\*   
## ORIGIN\_AIRPORTDEN -0.572459 2.166539 -0.264 0.791605   
## ORIGIN\_AIRPORTDFW -0.935174 2.170168 -0.431 0.666525   
## ORIGIN\_AIRPORTDHN 2.272140 3.391200 0.670 0.502851   
## ORIGIN\_AIRPORTDIK -8.309595 3.452169 -2.407 0.016081 \*   
## ORIGIN\_AIRPORTDLH -7.203128 3.196074 -2.254 0.024213 \*   
## ORIGIN\_AIRPORTDRO 2.608316 3.014088 0.865 0.386833   
## ORIGIN\_AIRPORTDSM -1.566037 2.372371 -0.660 0.509180   
## ORIGIN\_AIRPORTDTW -2.961609 2.175254 -1.362 0.173356   
## ORIGIN\_AIRPORTDVL -0.066501 5.282811 -0.013 0.989956   
## ORIGIN\_AIRPORTEAU -5.506626 4.213243 -1.307 0.191220   
## ORIGIN\_AIRPORTECP -2.807747 2.794208 -1.005 0.314972   
## ORIGIN\_AIRPORTEGE 0.138392 2.719471 0.051 0.959414   
## ORIGIN\_AIRPORTEKO -9.572481 4.220822 -2.268 0.023334 \*   
## ORIGIN\_AIRPORTELM -5.094699 3.036606 -1.678 0.093394 .   
## ORIGIN\_AIRPORTELP -4.534998 2.320518 -1.954 0.050666 .   
## ORIGIN\_AIRPORTERI 2.953167 3.582306 0.824 0.409726   
## ORIGIN\_AIRPORTESC -4.379301 4.516633 -0.970 0.332249   
## ORIGIN\_AIRPORTEUG -9.376765 2.675714 -3.504 0.000458 \*\*\*  
## ORIGIN\_AIRPORTEVV -1.095355 2.692080 -0.407 0.684096   
## ORIGIN\_AIRPORTEWN -5.560800 4.360343 -1.275 0.202199   
## ORIGIN\_AIRPORTEWR -1.788258 2.174709 -0.822 0.410908   
## ORIGIN\_AIRPORTEYW -13.199789 2.831424 -4.662 3.13e-06 \*\*\*  
## ORIGIN\_AIRPORTFAI -0.598940 3.148419 -0.190 0.849125   
## ORIGIN\_AIRPORTFAR -6.282728 2.519994 -2.493 0.012662 \*   
## ORIGIN\_AIRPORTFAT 0.458038 2.415263 0.190 0.849589   
## ORIGIN\_AIRPORTFAY -0.101804 3.111614 -0.033 0.973900   
## ORIGIN\_AIRPORTFCA -17.588105 3.264790 -5.387 7.16e-08 \*\*\*  
## ORIGIN\_AIRPORTFLG -7.090336 3.255315 -2.178 0.029400 \*   
## ORIGIN\_AIRPORTFLL -7.387217 2.181185 -3.387 0.000707 \*\*\*  
## ORIGIN\_AIRPORTFNT -12.825116 2.587664 -4.956 7.19e-07 \*\*\*  
## ORIGIN\_AIRPORTFSD -3.190543 2.453949 -1.300 0.193544   
## ORIGIN\_AIRPORTFSM -4.520863 2.963355 -1.526 0.127112   
## ORIGIN\_AIRPORTFWA -3.522477 2.623271 -1.343 0.179343   
## ORIGIN\_AIRPORTGCC -17.470334 3.521038 -4.962 6.99e-07 \*\*\*  
## ORIGIN\_AIRPORTGCK -5.755004 4.313864 -1.334 0.182181   
## ORIGIN\_AIRPORTGEG -5.678021 2.363931 -2.402 0.016309 \*   
## ORIGIN\_AIRPORTGFK -8.621939 4.639329 -1.858 0.063106 .   
## ORIGIN\_AIRPORTGGG -1.688334 4.496859 -0.375 0.707328   
## ORIGIN\_AIRPORTGJT -12.129630 2.764606 -4.387 1.15e-05 \*\*\*  
## ORIGIN\_AIRPORTGNV -1.308233 2.828304 -0.463 0.643687   
## ORIGIN\_AIRPORTGPT -11.261364 2.642613 -4.261 2.03e-05 \*\*\*  
## ORIGIN\_AIRPORTGRB -7.993757 2.578245 -3.100 0.001932 \*\*   
## ORIGIN\_AIRPORTGRI -5.075525 4.353962 -1.166 0.243726   
## ORIGIN\_AIRPORTGRK -6.556031 2.610950 -2.511 0.012040 \*   
## ORIGIN\_AIRPORTGRR -6.005368 2.326708 -2.581 0.009850 \*\*   
## ORIGIN\_AIRPORTGSO -4.749182 2.416260 -1.966 0.049356 \*   
## ORIGIN\_AIRPORTGSP -4.250955 2.470609 -1.721 0.085322 .   
## ORIGIN\_AIRPORTGTF -10.634676 3.177856 -3.346 0.000818 \*\*\*  
## ORIGIN\_AIRPORTGTR 0.492998 3.772878 0.131 0.896037   
## ORIGIN\_AIRPORTGUC -0.572625 3.754019 -0.153 0.878764   
## ORIGIN\_AIRPORTGUM -17.280664 5.469174 -3.160 0.001580 \*\*   
## ORIGIN\_AIRPORTHDN -0.542769 3.083371 -0.176 0.860270   
## ORIGIN\_AIRPORTHIB -11.106659 4.100619 -2.709 0.006758 \*\*   
## ORIGIN\_AIRPORTHLN -18.649682 3.415630 -5.460 4.76e-08 \*\*\*  
## ORIGIN\_AIRPORTHNL -8.039111 2.262543 -3.553 0.000381 \*\*\*  
## ORIGIN\_AIRPORTHOB -6.792070 4.580029 -1.483 0.138081   
## ORIGIN\_AIRPORTHOU -4.475097 2.197977 -2.036 0.041750 \*   
## ORIGIN\_AIRPORTHPN 3.567087 2.410405 1.480 0.138908   
## ORIGIN\_AIRPORTHRL -8.584511 2.728324 -3.146 0.001653 \*\*   
## ORIGIN\_AIRPORTHSV -7.611282 2.560496 -2.973 0.002953 \*\*   
## ORIGIN\_AIRPORTHYS -6.121159 4.455761 -1.374 0.169516   
## ORIGIN\_AIRPORTIAD 0.677560 2.206288 0.307 0.758764   
## ORIGIN\_AIRPORTIAG 0.434306 5.418723 0.080 0.936119   
## ORIGIN\_AIRPORTIAH -6.631170 2.167769 -3.059 0.002221 \*\*   
## ORIGIN\_AIRPORTICT -0.935382 2.412695 -0.388 0.698244   
## ORIGIN\_AIRPORTIDA -13.330691 3.006633 -4.434 9.26e-06 \*\*\*  
## ORIGIN\_AIRPORTILG 4.500393 6.193138 0.727 0.467426   
## ORIGIN\_AIRPORTILM -3.480234 3.164974 -1.100 0.271503   
## ORIGIN\_AIRPORTIMT -5.437983 4.596544 -1.183 0.236786   
## ORIGIN\_AIRPORTIND -5.198867 2.239114 -2.322 0.020242 \*   
## ORIGIN\_AIRPORTINL 3.152558 4.807939 0.656 0.512018   
## ORIGIN\_AIRPORTISN -6.176264 2.794893 -2.210 0.027117 \*   
## ORIGIN\_AIRPORTISP -0.721421 2.628062 -0.275 0.783695   
## ORIGIN\_AIRPORTITH -16.929009 20.788814 -0.814 0.415455   
## ORIGIN\_AIRPORTITO -12.630267 2.565259 -4.924 8.50e-07 \*\*\*  
## ORIGIN\_AIRPORTJAC -3.381586 2.624456 -1.288 0.197576   
## ORIGIN\_AIRPORTJAN -4.154721 2.437604 -1.704 0.088301 .   
## ORIGIN\_AIRPORTJAX -3.458752 2.272671 -1.522 0.128037   
## ORIGIN\_AIRPORTJFK 2.684152 2.180683 1.231 0.218369   
## ORIGIN\_AIRPORTJLN -4.950903 4.353962 -1.137 0.255495   
## ORIGIN\_AIRPORTJMS 13.753561 6.132660 2.243 0.024918 \*   
## ORIGIN\_AIRPORTJNU 1.023957 2.958520 0.346 0.729264   
## ORIGIN\_AIRPORTKOA -12.171913 2.370640 -5.134 2.83e-07 \*\*\*  
## ORIGIN\_AIRPORTKTN -4.137992 3.209372 -1.289 0.197278   
## ORIGIN\_AIRPORTLAN 0.745957 2.982368 0.250 0.802493   
## ORIGIN\_AIRPORTLAR -13.263416 4.341965 -3.055 0.002253 \*\*   
## ORIGIN\_AIRPORTLAS -2.606879 2.171492 -1.201 0.229945   
## ORIGIN\_AIRPORTLAW -4.650087 3.444139 -1.350 0.176970   
## ORIGIN\_AIRPORTLAX -3.979127 2.166654 -1.837 0.066279 .   
## ORIGIN\_AIRPORTLBB -1.350771 2.540913 -0.532 0.594997   
## ORIGIN\_AIRPORTLBE -5.946828 3.605563 -1.649 0.099077 .   
## ORIGIN\_AIRPORTLCH -9.081700 3.078007 -2.951 0.003173 \*\*   
## ORIGIN\_AIRPORTLEX -4.960456 2.503991 -1.981 0.047589 \*   
## ORIGIN\_AIRPORTLFT -1.872646 2.504836 -0.748 0.454694   
## ORIGIN\_AIRPORTLGA 2.905056 2.174405 1.336 0.181542   
## ORIGIN\_AIRPORTLGB -9.123532 2.395303 -3.809 0.000140 \*\*\*  
## ORIGIN\_AIRPORTLIH -14.370278 2.383505 -6.029 1.65e-09 \*\*\*  
## ORIGIN\_AIRPORTLIT -3.140379 2.352153 -1.335 0.181841   
## ORIGIN\_AIRPORTLNK -12.143948 2.908816 -4.175 2.98e-05 \*\*\*  
## ORIGIN\_AIRPORTLRD -12.750649 2.950787 -4.321 1.55e-05 \*\*\*  
## ORIGIN\_AIRPORTLSE -8.941612 3.362084 -2.660 0.007825 \*\*   
## ORIGIN\_AIRPORTLWS -17.987401 4.406018 -4.082 4.46e-05 \*\*\*  
## ORIGIN\_AIRPORTMAF -3.348083 2.379253 -1.407 0.159369   
## ORIGIN\_AIRPORTMBS -10.110064 3.097227 -3.264 0.001098 \*\*   
## ORIGIN\_AIRPORTMCI -6.665278 2.209619 -3.016 0.002557 \*\*   
## ORIGIN\_AIRPORTMCO -4.090476 2.173677 -1.882 0.059860 .   
## ORIGIN\_AIRPORTMDT -1.233408 2.674703 -0.461 0.644700   
## ORIGIN\_AIRPORTMDW -3.827324 2.184664 -1.752 0.079790 .   
## ORIGIN\_AIRPORTMEI 14.705102 5.531379 2.658 0.007849 \*\*   
## ORIGIN\_AIRPORTMEM -2.632637 2.300660 -1.144 0.252501   
## ORIGIN\_AIRPORTMFE -5.779816 2.612456 -2.212 0.026939 \*   
## ORIGIN\_AIRPORTMFR -4.761779 2.901086 -1.641 0.100719   
## ORIGIN\_AIRPORTMGM -3.307419 2.731260 -1.211 0.225915   
## ORIGIN\_AIRPORTMHK -11.117529 3.229040 -3.443 0.000575 \*\*\*  
## ORIGIN\_AIRPORTMHT -6.318666 2.535529 -2.492 0.012701 \*   
## ORIGIN\_AIRPORTMIA -5.289050 2.187152 -2.418 0.015596 \*   
## ORIGIN\_AIRPORTMKE -5.866146 2.223955 -2.638 0.008347 \*\*   
## ORIGIN\_AIRPORTMKG -11.283894 4.395054 -2.567 0.010246 \*   
## ORIGIN\_AIRPORTMLB -6.333932 3.350369 -1.891 0.058689 .   
## ORIGIN\_AIRPORTMLI -1.271253 2.573238 -0.494 0.621286   
## ORIGIN\_AIRPORTMLU -2.323963 2.821763 -0.824 0.410175   
## ORIGIN\_AIRPORTMMH -13.467810 4.938212 -2.727 0.006386 \*\*   
## ORIGIN\_AIRPORTMOB -3.100714 2.530002 -1.226 0.220358   
## ORIGIN\_AIRPORTMOT -8.009023 3.134527 -2.555 0.010616 \*   
## ORIGIN\_AIRPORTMQT -7.467349 5.935849 -1.258 0.208389   
## ORIGIN\_AIRPORTMRY -6.866598 2.692910 -2.550 0.010776 \*   
## ORIGIN\_AIRPORTMSN -7.742366 2.365241 -3.273 0.001063 \*\*   
## ORIGIN\_AIRPORTMSO -14.957326 3.254521 -4.596 4.31e-06 \*\*\*  
## ORIGIN\_AIRPORTMSP -7.563884 2.177683 -3.473 0.000514 \*\*\*  
## ORIGIN\_AIRPORTMSY -6.667423 2.206269 -3.022 0.002511 \*\*   
## ORIGIN\_AIRPORTMTJ -6.264950 3.050940 -2.053 0.040029 \*   
## ORIGIN\_AIRPORTMYR -5.039428 2.703702 -1.864 0.062336 .   
## ORIGIN\_AIRPORTOAJ -2.461133 3.454700 -0.712 0.476216   
## ORIGIN\_AIRPORTOAK -1.100757 2.209596 -0.498 0.618363   
## ORIGIN\_AIRPORTOGG -11.057511 2.286208 -4.837 1.32e-06 \*\*\*  
## ORIGIN\_AIRPORTOKC -4.847777 2.284130 -2.122 0.033807 \*   
## ORIGIN\_AIRPORTOMA -3.813976 2.270842 -1.680 0.093047 .   
## ORIGIN\_AIRPORTOME 2.081577 4.391136 0.474 0.635471   
## ORIGIN\_AIRPORTONT -2.655919 2.272004 -1.169 0.242414   
## ORIGIN\_AIRPORTORD 3.485568 2.163820 1.611 0.107215   
## ORIGIN\_AIRPORTORF -0.342629 2.365774 -0.145 0.884847   
## ORIGIN\_AIRPORTORH -12.370340 4.442104 -2.785 0.005356 \*\*   
## ORIGIN\_AIRPORTOTH 2.847901 7.227909 0.394 0.693570   
## ORIGIN\_AIRPORTOTZ 4.800368 4.662605 1.030 0.303223   
## ORIGIN\_AIRPORTPAH -12.509440 4.394723 -2.846 0.004421 \*\*   
## ORIGIN\_AIRPORTPBG 6.469334 5.555318 1.165 0.244210   
## ORIGIN\_AIRPORTPBI -1.634848 2.231676 -0.733 0.463824   
## ORIGIN\_AIRPORTPDX -6.980203 2.208093 -3.161 0.001571 \*\*   
## ORIGIN\_AIRPORTPHF 3.517017 3.317393 1.060 0.289065   
## ORIGIN\_AIRPORTPHL -0.667405 2.190736 -0.305 0.760634   
## ORIGIN\_AIRPORTPHX -2.870404 2.170811 -1.322 0.186078   
## ORIGIN\_AIRPORTPIA -1.516144 2.625725 -0.577 0.563656   
## ORIGIN\_AIRPORTPIB -5.434945 4.920578 -1.105 0.269362   
## ORIGIN\_AIRPORTPIH 2.959836 4.232618 0.699 0.484370   
## ORIGIN\_AIRPORTPIT -6.375268 2.238516 -2.848 0.004400 \*\*   
## ORIGIN\_AIRPORTPLN 5.893495 4.514714 1.305 0.191758   
## ORIGIN\_AIRPORTPNS -7.374145 2.431506 -3.033 0.002423 \*\*   
## ORIGIN\_AIRPORTPPG -6.130840 9.304666 -0.659 0.509960   
## ORIGIN\_AIRPORTPSC -14.510787 3.010962 -4.819 1.44e-06 \*\*\*  
## ORIGIN\_AIRPORTPSE -6.593112 4.068268 -1.621 0.105100   
## ORIGIN\_AIRPORTPSG -8.599139 4.971961 -1.730 0.083715 .   
## ORIGIN\_AIRPORTPSP -2.325710 2.310314 -1.007 0.314096   
## ORIGIN\_AIRPORTPUB -1.157530 4.486216 -0.258 0.796392   
## ORIGIN\_AIRPORTPVD -4.500113 2.348423 -1.916 0.055336 .   
## ORIGIN\_AIRPORTPWM -5.567344 2.817728 -1.976 0.048175 \*   
## ORIGIN\_AIRPORTRAP -9.379892 2.872615 -3.265 0.001094 \*\*   
## ORIGIN\_AIRPORTRDD -17.575461 3.721104 -4.723 2.32e-06 \*\*\*  
## ORIGIN\_AIRPORTRDM -9.514274 3.067471 -3.102 0.001924 \*\*   
## ORIGIN\_AIRPORTRDU -4.486677 2.222366 -2.019 0.043501 \*   
## ORIGIN\_AIRPORTRHI -11.073027 3.907744 -2.834 0.004603 \*\*   
## ORIGIN\_AIRPORTRIC -1.501426 2.296260 -0.654 0.513204   
## ORIGIN\_AIRPORTRKS -10.658268 3.741028 -2.849 0.004385 \*\*   
## ORIGIN\_AIRPORTRNO -4.018478 2.316385 -1.735 0.082776 .   
## ORIGIN\_AIRPORTROA -1.337300 3.166339 -0.422 0.672770   
## ORIGIN\_AIRPORTROC -2.705460 2.438849 -1.109 0.267293   
## ORIGIN\_AIRPORTROW 5.593120 3.827601 1.461 0.143944   
## ORIGIN\_AIRPORTRST -3.837898 3.015928 -1.273 0.203181   
## ORIGIN\_AIRPORTRSW -4.223258 2.209748 -1.911 0.055980 .   
## ORIGIN\_AIRPORTSAF -2.539321 3.373848 -0.753 0.451661   
## ORIGIN\_AIRPORTSAN -5.123498 2.185508 -2.344 0.019063 \*   
## ORIGIN\_AIRPORTSAT -5.534969 2.224722 -2.488 0.012849 \*   
## ORIGIN\_AIRPORTSAV -4.028342 2.437201 -1.653 0.098361 .   
## ORIGIN\_AIRPORTSBA -6.841684 2.479143 -2.760 0.005786 \*\*   
## ORIGIN\_AIRPORTSBN 3.164923 2.561321 1.236 0.216585   
## ORIGIN\_AIRPORTSBP -8.928804 2.565875 -3.480 0.000502 \*\*\*  
## ORIGIN\_AIRPORTSCC -8.666850 5.602433 -1.547 0.121868   
## ORIGIN\_AIRPORTSCE 6.824488 4.137868 1.649 0.099091 .   
## ORIGIN\_AIRPORTSDF -6.542884 2.341663 -2.794 0.005204 \*\*   
## ORIGIN\_AIRPORTSEA -4.675874 2.183397 -2.142 0.032229 \*   
## ORIGIN\_AIRPORTSFO -0.670162 2.171262 -0.309 0.757587   
## ORIGIN\_AIRPORTSGF 0.129073 2.452818 0.053 0.958033   
## ORIGIN\_AIRPORTSGU -10.574466 3.142542 -3.365 0.000766 \*\*\*  
## ORIGIN\_AIRPORTSHV 0.982169 2.482323 0.396 0.692352   
## ORIGIN\_AIRPORTSIT -2.477599 3.990570 -0.621 0.534690   
## ORIGIN\_AIRPORTSJC -2.583134 2.212087 -1.168 0.242914   
## ORIGIN\_AIRPORTSJT -10.943034 3.253403 -3.364 0.000769 \*\*\*  
## ORIGIN\_AIRPORTSJU -3.718725 2.236904 -1.662 0.096424 .   
## ORIGIN\_AIRPORTSLC -10.300599 2.180223 -4.725 2.31e-06 \*\*\*  
## ORIGIN\_AIRPORTSMF -1.389312 2.213502 -0.628 0.530231   
## ORIGIN\_AIRPORTSMX 8.076133 4.191640 1.927 0.054014 .   
## ORIGIN\_AIRPORTSNA -5.447459 2.212430 -2.462 0.013809 \*   
## ORIGIN\_AIRPORTSPI -7.439512 3.306086 -2.250 0.024433 \*   
## ORIGIN\_AIRPORTSPS -2.456306 3.551193 -0.692 0.489135   
## ORIGIN\_AIRPORTSRQ -1.877154 2.630289 -0.714 0.475432   
## ORIGIN\_AIRPORTSTC -2.324681 5.187149 -0.448 0.654037   
## ORIGIN\_AIRPORTSTL -6.023760 2.199446 -2.739 0.006167 \*\*   
## ORIGIN\_AIRPORTSTT -4.712705 2.522482 -1.868 0.061723 .   
## ORIGIN\_AIRPORTSTX -2.534809 3.649779 -0.695 0.487362   
## ORIGIN\_AIRPORTSUN -11.545317 3.653206 -3.160 0.001576 \*\*   
## ORIGIN\_AIRPORTSUX 2.167191 4.437884 0.488 0.625310   
## ORIGIN\_AIRPORTSWF -1.166803 4.125202 -0.283 0.777294   
## ORIGIN\_AIRPORTSYR -3.399818 2.529695 -1.344 0.178960   
## ORIGIN\_AIRPORTTLH -6.958903 2.653634 -2.622 0.008731 \*\*   
## ORIGIN\_AIRPORTTOL -14.751353 3.896910 -3.785 0.000153 \*\*\*  
## ORIGIN\_AIRPORTTPA -5.033513 2.185022 -2.304 0.021243 \*   
## ORIGIN\_AIRPORTTRI -5.333919 3.070169 -1.737 0.082328 .   
## ORIGIN\_AIRPORTTTN 15.062401 2.910649 5.175 2.28e-07 \*\*\*  
## ORIGIN\_AIRPORTTUL -6.730359 2.287950 -2.942 0.003265 \*\*   
## ORIGIN\_AIRPORTTUS -7.827009 2.274898 -3.441 0.000580 \*\*\*  
## ORIGIN\_AIRPORTTVC -5.422562 2.934816 -1.848 0.064651 .   
## ORIGIN\_AIRPORTTWF -17.164153 4.269162 -4.020 5.81e-05 \*\*\*  
## ORIGIN\_AIRPORTTXK -15.260321 3.866306 -3.947 7.91e-05 \*\*\*  
## ORIGIN\_AIRPORTTYR -4.429900 3.009729 -1.472 0.141059   
## ORIGIN\_AIRPORTTYS 0.268440 2.448363 0.110 0.912694   
## ORIGIN\_AIRPORTUST -38.743016 7.929345 -4.886 1.03e-06 \*\*\*  
## ORIGIN\_AIRPORTVEL -10.741492 4.460373 -2.408 0.016031 \*   
## ORIGIN\_AIRPORTVLD -1.485413 3.718705 -0.399 0.689566   
## ORIGIN\_AIRPORTVPS -2.654034 2.592050 -1.024 0.305876   
## ORIGIN\_AIRPORTWRG -5.763002 5.069914 -1.137 0.255661   
## ORIGIN\_AIRPORTXNA 1.276360 2.380228 0.536 0.591797   
## ORIGIN\_AIRPORTYAK -22.388844 4.945623 -4.527 5.98e-06 \*\*\*  
## ORIGIN\_AIRPORTYUM -6.816728 3.051792 -2.234 0.025504 \*   
## DESTINATION\_AIRPORTABI -5.858382 2.892915 -2.025 0.042859 \*   
## DESTINATION\_AIRPORTABQ 0.854868 2.274497 0.376 0.707029   
## DESTINATION\_AIRPORTABR -14.618653 4.235144 -3.452 0.000557 \*\*\*  
## DESTINATION\_AIRPORTABY 1.888143 3.790328 0.498 0.618380   
## DESTINATION\_AIRPORTACT 0.364583 3.272465 0.111 0.911292   
## DESTINATION\_AIRPORTACV -4.181648 3.228542 -1.295 0.195247   
## DESTINATION\_AIRPORTACY -0.777715 2.671974 -0.291 0.771003   
## DESTINATION\_AIRPORTADK -15.727803 9.783522 -1.608 0.107927   
## DESTINATION\_AIRPORTADQ 2.538000 5.769702 0.440 0.660021   
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## DESTINATION\_AIRPORTCHO 11.111924 2.985327 3.722 0.000198 \*\*\*  
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## DESTINATION\_AIRPORTCMX -4.808249 4.456152 -1.079 0.280582   
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## DESTINATION\_AIRPORTSAT 3.414624 2.230090 1.531 0.125730   
## DESTINATION\_AIRPORTSAV 2.569448 2.440968 1.053 0.292509   
## DESTINATION\_AIRPORTSBA -4.057114 2.482348 -1.634 0.102178   
## DESTINATION\_AIRPORTSBN 5.258909 2.568309 2.048 0.040598 \*   
## DESTINATION\_AIRPORTSBP -8.230586 2.569791 -3.203 0.001361 \*\*   
## DESTINATION\_AIRPORTSCC 2.301397 4.046179 0.569 0.569504   
## DESTINATION\_AIRPORTSCE 1.504868 4.174680 0.360 0.718492   
## DESTINATION\_AIRPORTSDF 2.178553 2.347139 0.928 0.353318   
## DESTINATION\_AIRPORTSEA -1.165759 2.189041 -0.533 0.594350   
## DESTINATION\_AIRPORTSFO 2.347994 2.176992 1.079 0.280789   
## DESTINATION\_AIRPORTSGF 4.101272 2.459583 1.667 0.095422 .   
## DESTINATION\_AIRPORTSGU -0.744387 3.144030 -0.237 0.812841   
## DESTINATION\_AIRPORTSHV 1.043560 2.486425 0.420 0.674702   
## DESTINATION\_AIRPORTSIT -2.762569 4.017323 -0.688 0.491664   
## DESTINATION\_AIRPORTSJC -1.630541 2.217732 -0.735 0.462200   
## DESTINATION\_AIRPORTSJT -2.077351 3.250940 -0.639 0.522823   
## DESTINATION\_AIRPORTSJU 3.999139 2.242558 1.783 0.074539 .   
## DESTINATION\_AIRPORTSLC -3.890806 2.185919 -1.780 0.075086 .   
## DESTINATION\_AIRPORTSMF 0.400526 2.219207 0.180 0.856774   
## DESTINATION\_AIRPORTSMX -12.121345 4.194631 -2.890 0.003856 \*\*   
## DESTINATION\_AIRPORTSNA -4.527787 2.218162 -2.041 0.041228 \*   
## DESTINATION\_AIRPORTSPI -3.789391 3.313305 -1.144 0.252753   
## DESTINATION\_AIRPORTSPS -5.753293 3.559781 -1.616 0.106053   
## DESTINATION\_AIRPORTSRQ 0.119624 2.631085 0.045 0.963736   
## DESTINATION\_AIRPORTSTC 6.537337 5.189702 1.260 0.207787   
## DESTINATION\_AIRPORTSTL 0.269744 2.204949 0.122 0.902633   
## DESTINATION\_AIRPORTSTT 2.963849 2.516374 1.178 0.238866   
## DESTINATION\_AIRPORTSTX 2.258453 3.653456 0.618 0.536464   
## DESTINATION\_AIRPORTSUN -2.365623 3.680874 -0.643 0.520432   
## DESTINATION\_AIRPORTSUX 5.621451 4.440736 1.266 0.205555   
## DESTINATION\_AIRPORTSWF 3.407030 4.117639 0.827 0.407997   
## DESTINATION\_AIRPORTSYR 3.571998 2.531111 1.411 0.158175   
## DESTINATION\_AIRPORTTLH 0.417417 2.659282 0.157 0.875272   
## DESTINATION\_AIRPORTTOL 2.059219 3.875640 0.531 0.595195   
## DESTINATION\_AIRPORTTPA 0.391339 2.190697 0.179 0.858223   
## DESTINATION\_AIRPORTTRI -1.936512 3.063073 -0.632 0.527248   
## DESTINATION\_AIRPORTTTN 25.328398 2.923183 8.665 < 2e-16 \*\*\*  
## DESTINATION\_AIRPORTTUL 0.377475 2.293298 0.165 0.869259   
## DESTINATION\_AIRPORTTUS -0.499382 2.280582 -0.219 0.826673   
## DESTINATION\_AIRPORTTVC 1.087333 2.940763 0.370 0.711572   
## DESTINATION\_AIRPORTTWF -3.848787 4.284598 -0.898 0.369034   
## DESTINATION\_AIRPORTTXK -9.011086 3.853495 -2.338 0.019366 \*   
## DESTINATION\_AIRPORTTYR 1.438955 3.007732 0.478 0.632352   
## DESTINATION\_AIRPORTTYS 4.039318 2.452486 1.647 0.099552 .   
## DESTINATION\_AIRPORTUST -27.888681 7.928425 -3.518 0.000436 \*\*\*  
## DESTINATION\_AIRPORTVEL -17.918869 4.509096 -3.974 7.07e-05 \*\*\*  
## DESTINATION\_AIRPORTVLD -0.756066 3.734189 -0.202 0.839548   
## DESTINATION\_AIRPORTVPS -0.117476 2.603624 -0.045 0.964012   
## DESTINATION\_AIRPORTWRG 7.827983 5.027001 1.557 0.119426   
## DESTINATION\_AIRPORTXNA 3.567511 2.384930 1.496 0.134691   
## DESTINATION\_AIRPORTYAK -1.495619 4.919727 -0.304 0.761125   
## DESTINATION\_AIRPORTYUM -6.538165 3.051835 -2.142 0.032164 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 41.35 on 1004853 degrees of freedom  
## (43071 observations deleted due to missingness)  
## Multiple R-squared: 0.03547, Adjusted R-squared: 0.03485   
## F-statistic: 56.85 on 650 and 1004853 DF, p-value: < 2.2e-16

#### Predicting for a specific query to demonstrate prediction power

Predicting ARRIVAL\_DELAY for a flight departing from Oakland, on a friday afternoon for Baltimore via Spirit Airlines

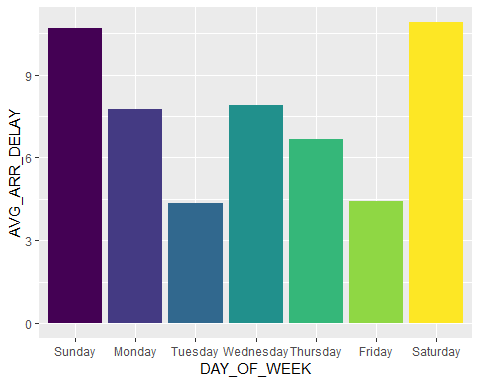
predict(arrDelayModel, data.frame(DAY\_OF\_WEEK = "Friday", DEP\_TIME\_OF\_DAY = "Afternoon", AIRLINE = "NK", ORIGIN\_AIRPORT = "OAK", DESTINATION\_AIRPORT = "BWI"))

## 1   
## 15.71989

# APPENDIX (All extra bits of analysis that were superceded by the above code)

Plot of arrival delay vs Day of the week

groupByDay <- group\_by(select(flightData, DAY\_OF\_WEEK, ARRIVAL\_DELAY),DAY\_OF\_WEEK)  
groupByDay <- groupByDay[complete.cases(groupByDay),]  
delayByDay <- summarise(groupByDay, AVG\_ARR\_DELAY = mean(ARRIVAL\_DELAY))  
ggplot(data = delayByDay, aes(x = DAY\_OF\_WEEK, y = AVG\_ARR\_DELAY, fill = DAY\_OF\_WEEK)) + geom\_bar(stat = "identity") + guides(fill = FALSE)



#### Hypothesis Test

H0 : Mean arrival delay on Sat <= 0 H1 : Mean arival delay > 0

Putting saturday arrival delays in a vector and then running the above hypothesis tests

arrdelaySat <- filter(flightData, DAY\_OF\_WEEK == "Saturday")$ARRIVAL\_DELAY  
summary(arrdelaySat)

## Min. 1st Qu. Median Mean 3rd Qu. Max. NA's   
## -72.00 -12.00 -2.00 10.91 16.00 1593.00 7786

test\_res <- t.test(arrdelaySat, mu = 0, alternative = "greater")  
test\_res

##   
## One Sample t-test  
##   
## data: arrdelaySat  
## t = 85.686, df = 140890, p-value < 2.2e-16  
## alternative hypothesis: true mean is greater than 0  
## 95 percent confidence interval:  
## 10.7038 Inf  
## sample estimates:  
## mean of x   
## 10.9133