Manhattan Taxi Fares

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Analyze a random sample of 49999 New York journeys made in 2013 to help taxi drivers maximize thoer profits. Use regression trees and random forests to build a model that can predict the locations and times when the biggest fares can be earned.

```
# Loading the tidyverse
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --
```

```
## v ggplot2 3.3.3     v purrr   0.3.4
## v tibble  3.1.2     v dplyr   1.0.5
## v tidyr   1.1.3     v stringr 1.4.0
## v readr   1.4.0     v forcats 0.5.1
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
# Reading in the taxi data
taxi <- read.table("C:/Users/Shreya/Documents/Projects/taxi.txt", sep = ",", header = T)

# Taking a look at the first few rows in taxi
head(taxi)
```

```
##                          medallion      pickup_datetime pickup_longitude
## 1 4D24F4D8EF35878595044A52B098DFD2 2013-01-13T10:23:00Z        -73.94646
## 2 A49C37EB966E7B05E69523D1CB7BE303 2013-01-13T04:52:00Z        -73.99827
## 3 1E4B72A8E623888F53A9693C364AC05A 2013-01-13T10:47:00Z        -73.95346
## 4 F7E4E9439C46B8AD5B16AB9F1B3279D7 2013-01-13T11:14:00Z        -73.98137
## 5 A9DC75D59E0EA27E1ED328E8BE8CD828 2013-01-13T11:24:00Z        -73.96800
## 6 19BF1BB516C4E992EA3FBAEDA73D6262 2013-01-13T10:51:00Z        -73.98502
##   pickup_latitude trip_time_in_secs fare_amount tip_amount
## 1        40.77273               600         8.0        2.5
## 2        40.74041               840        18.0        0.0
## 3        40.77586                60         3.5        0.7
## 4        40.72473               720        11.5        2.3
## 5        40.76000               240         6.5        0.0
## 6        40.76341               540         8.5        1.7
```

Data Cleaning

```r
# Renaming the location variables,
# dropping any journeys with zero fares and zero tips,
# and creating the total variable as the log sum of fare and tip
taxi <- taxi %>%
   rename(lat = pickup_latitude, long = pickup_longitude) %>%
filter(fare_amount > 0 | tip_amount > 0) %>% mutate(total = log(fare_amount + tip_amount))
```

```r
# Reducing the data to taxi trips starting in Manhattan
# Manhattan is bounded by the rectangle with
# latitude from 40.70 to 40.83 and
# longitude from -74.025 to -73.93
taxi <- taxi  %>%
    filter(lat >= 40.70, lat <= 40.83, long >=  -74.025, long <= -73.93)
```

```r
# Loading in ggmap and viridis for nice colors
library(ggmap)
```

```
## Google's Terms of Service: https://cloud.google.com/maps-platform/terms/.
```

```
## Please cite ggmap if you use it! See citation("ggmap") for details.
```

```r
library(viridis)
```

```
## Loading required package: viridisLite
```

```r
register_google(key = "AIzaSyD1M0avrjJIOodaqQrRSs2qjBX6IlMksfI", write = TRUE)
```

```
## Replacing old key (AIzaSyD1M0avrjJIOodaqQrRSs2qjBX6IlMksfI) with new key in C:\Users\Shreya/.Renviro
```

```r
# Retrieving a stored map object which originally was created by
manhattan <- get_map("manhattan", zoom = 12, color = "bw")
```

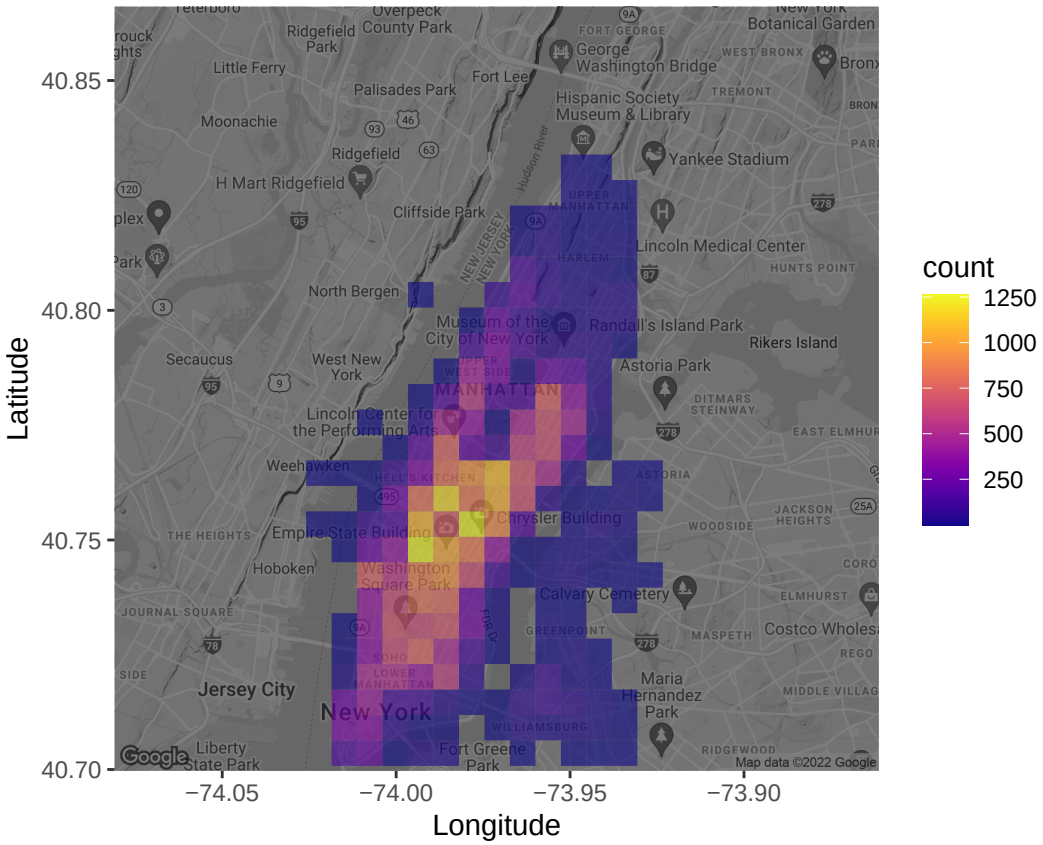
```
## Source : https://maps.googleapis.com/maps/api/staticmap?center=manhattan&zoom=12&size=640x640&scale=
```

```
## Source : https://maps.googleapis.com/maps/api/geocode/json?address=manhattan&key=xxx
```

```r
# <- readRDS("C:/Users/Shreya/Documents/Projects/manhattan.rds")

# Drawing a density map with the number of journey start locations
ggmap(manhattan, darken = 0.5) +
   scale_fill_viridis(option = 'plasma') +
   geom_bin2d(data = taxi, mapping = aes(x = long, y = lat), alpha = 0.6) +
   labs(x = "Longitude", y = "Latitude")
```

```
## Warning: Removed 4 rows containing missing values (geom_tile).
```



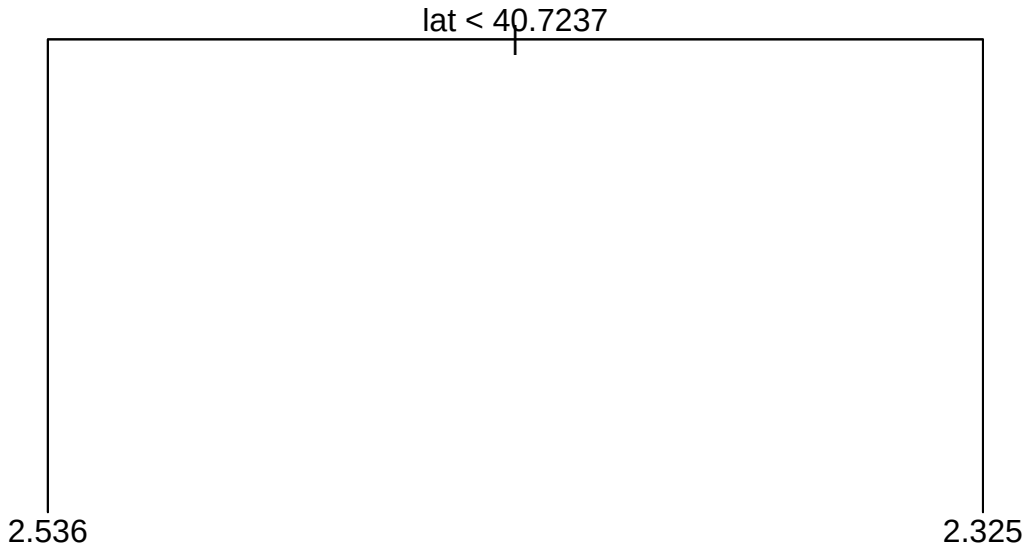
Predicting Taxi Fares Using a Tree

```
# Loading in the tree package
library(tree)
```

```
## Registered S3 method overwritten by 'tree':
##   method     from
##   print.tree cli
```

```
# Fitting a tree to lat and long
fitted_tree <- tree(total~lat+long, data=taxi)

# Draw a diagram of the tree structure
plot(fitted_tree)
text(fitted_tree)
```



It predicts that trips where lat < 40.7237 are more expensive, which makes sense as it is downtown Manhattan.

Adding some more predictors related to the time the taxi trip was made:

```
# Loading in the lubridate package
library(lubridate)
```

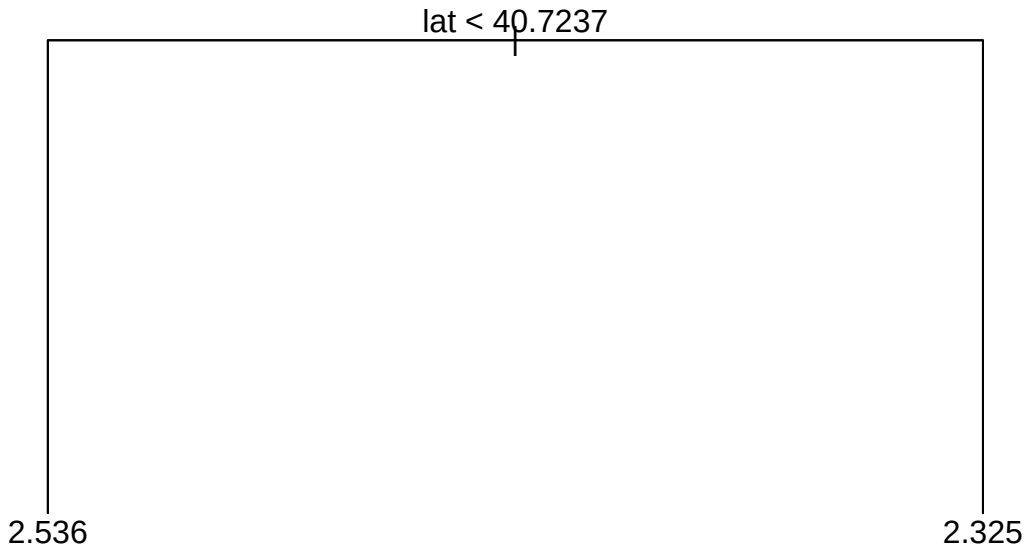
```
##
## Attaching package: 'lubridate'
```

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

```
# Generate the three new time variables
taxi <- taxi %>%
    mutate(hour = hour(pickup_datetime),
           wday = wday(pickup_datetime, label = TRUE),
           month = month(pickup_datetime, label = TRUE))
```

```
# Fitting a tree with total as the outcome and
# lat, long, hour, wday, and month as predictors
fitted_tree <- tree(total~lat+long+hour+wday+month, data=taxi)
```

```r
# draw a diagram of the tree structure
plot(fitted_tree)
text(fitted_tree)
```




```r
# Summarizing the performance of the tree
summary(fitted_tree)
```

```
##
## Regression tree:
## tree(formula = total ~ lat + long + hour + wday + month, data = taxi)
## Variables actually used in tree construction:
## [1] "lat"
## Number of terminal nodes:  2
## Residual mean deviance:  0.3041 = 13910 / 45760
## Distribution of residuals:
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -1.61900 -0.37880 -0.04244  0.00000  0.32660  2.69900
```

Random Forest

```r
# Loading in the randomForest package
library(randomForest)
```

```
## randomForest 4.6-14
```

```
## Type rfNews() to see new features/changes/bug fixes.

##
## Attaching package: 'randomForest'

## The following object is masked from 'package:dplyr':
##
##     combine

## The following object is masked from 'package:ggplot2':
##
##     margin
```

```
# Fitting a random forest
fitted_forest <- randomForest(total~lat+long+hour+wday+month, data=taxi,
                              ntree = 80, sampsize = 10000)

# Printing the fitted_forest object
print(fitted_forest)
```

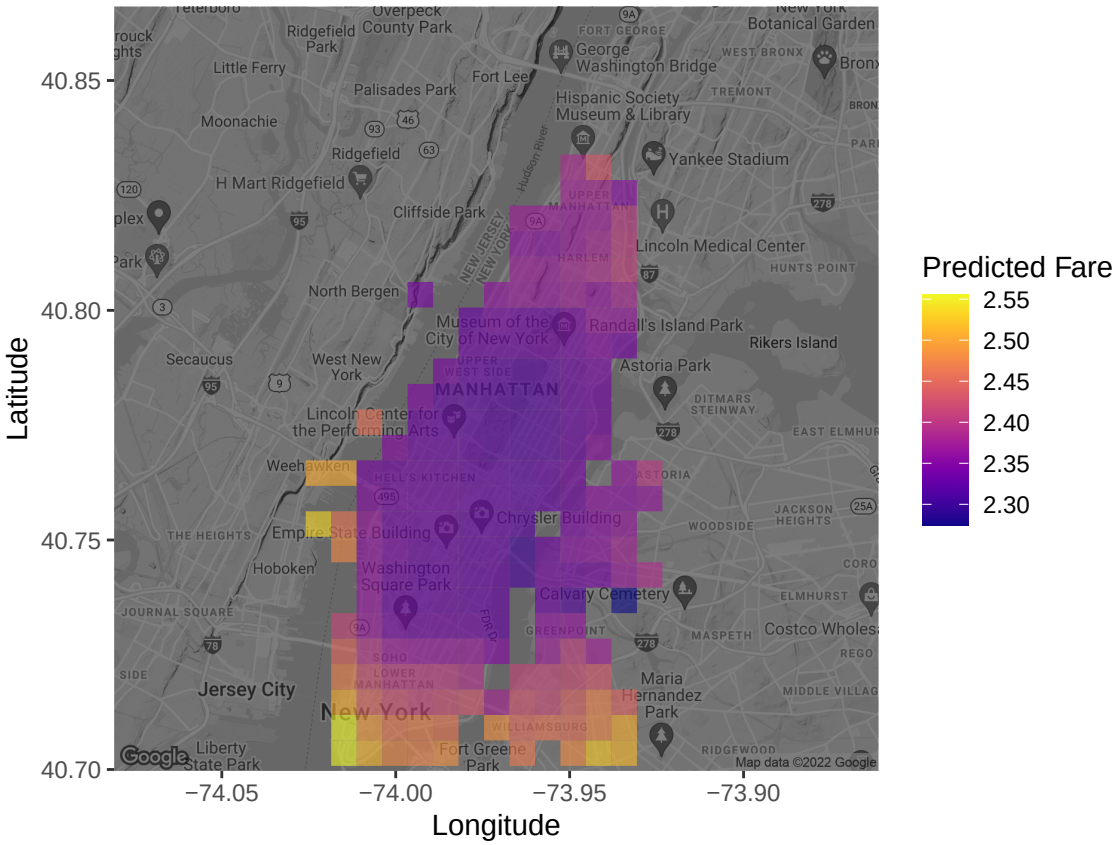
```
##
## Call:
##  randomForest(formula = total ~ lat + long + hour + wday + month,      data = taxi, ntree = 80, samps
##                Type of random forest: regression
##                      Number of trees: 80
## No. of variables tried at each split: 1
##
##           Mean of squared residuals: 0.3029644
##                     % Var explained: 1.74
```

Plotting the Predicted Fare

```
# Extracting the prediction from fitted_forest
taxi$pred_total <- fitted_forest$predicted

# Plotting the predicted mean trip prices from according to the random forest
ggmap(manhattan, darken = 0.5) +
   scale_fill_viridis(option = 'plasma') +
   stat_summary_2d(data = taxi, mapping = aes(x = long, y = lat, , z = pred_total), alpha = 0.6) +
   labs(x = "Longitude", y = "Latitude", fill = "Predicted Fare")
```

```
## Warning: Removed 4 rows containing missing values (geom_tile).
```


Predicted Fare
2.55
2.50
2.45
2.40
2.35
2.30
Latitude
40.85
40.80
40.75
40.70
Longitude
−74.05
−74.00
−73.95
−73.90
Map data ©2022 Google
Google
Overpeck County Park
Ridgefield Park
Little Ferry
Palisades Park
Fort Lee
George Washington Bridge
Botanical Garden
Hispanic Society Museum & Library
Moonachie
Ridgefield
H Mart Ridgefield
Yankee Stadium
Cliffside Park
Lincoln Medical Center
North Bergen
Museum of the City of New York
Randall's Island Park
Rikers Island
Secaucus
West New York
Astoria Park
MANHATTAN
Lincoln Center for the Performing Arts
Weehawken
Chrysler Building
Empire State Building
Hoboken
Washington Square Park
Calvary Cemetery
Costco Wholesale
Jersey City
New York
Maria Hernandez Park
Liberty State Park
Fort Greene Park