

CS6140 Project

Authors

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Description of problem

Airbnb is a popular online company through which property owners can short-term rent their space to consumers as an alternative to hotels. Using data on Airbnb property listings in Boston, we will develop and test methods for determining the optimal price per night an owner should set for their property.

Summary of data

The Inside Airbnb project by Murray Cox has collected public Airbnb listing data for 40+ popular international cities. We will use the Boston dataset containing ~5000 property listings and their features for the Boston area. (<http://insideairbnb.com/get-the-data.html>)

Features

- *super_host?* (categorical) [yes/no]
- *verified_host?* (categorical) [yes/no]
- *zip_code* (categorical) [...]
- *property_type* (categorical) [House, Apartment, etc.]
- *room_type* (categorical) [Shared Room, Private Room, etc.]
- *accommodates* (continuous)
- *bathrooms* (continuous)
- *bedrooms* (continuous)
- *beds* (continuous)
- *bed_type* (categorical) [Real Bed, Futon, etc.]
- *minimum_nights* (continuous)
- *cancelation_policy* (ordered categorical) [Flexible, Moderate, Strict]
- **price** (continuous)

One-variable summary statistics

```
summary(boston)
```

##	X	accommodates	bathrooms	bedrooms
##	Min. : 1	Min. : 1.000	Min. : 0.000	Min. : 0.000
##	1st Qu.: 1215	1st Qu.: 2.000	1st Qu.: 1.000	1st Qu.: 1.000
##	Median : 2444	Median : 3.000	Median : 1.000	Median : 1.000
##	Mean : 2439	Mean : 3.308	Mean : 1.247	Mean : 1.341
##	3rd Qu.: 3660	3rd Qu.: 4.000	3rd Qu.: 1.000	3rd Qu.: 2.000
##	Max. : 4870	Max. : 16.000	Max. : 6.000	Max. : 10.000
##	beds	price	guests_included	minimum_nights
##	Min. : 0.000	Min. : 0.0	Min. : 1.000	Min. : 1.000

```

## 1st Qu.: 1.000    1st Qu.: 80.0    1st Qu.: 1.000    1st Qu.: 1.000
## Median : 1.000    Median : 140.0    Median : 1.000    Median : 2.000
## Mean   : 1.754    Mean   : 173.1    Mean   : 1.529    Mean   : 3.541
## 3rd Qu.: 2.000    3rd Qu.: 200.0    3rd Qu.: 2.000    3rd Qu.: 3.000
## Max.   :16.000    Max.   :4000.0    Max.   :16.000    Max.   :365.000
## number_of_reviews host_is_superhost host_identity_verified
## Min.    : 0.00    Min.    :0.0000    Min.    :0.0000
## 1st Qu.: 1.00    1st Qu.:0.0000    1st Qu.:0.0000
## Median : 7.00    Median :0.0000    Median :1.0000
## Mean   : 24.79    Mean   :0.1934    Mean   :0.6017
## 3rd Qu.: 28.00    3rd Qu.:0.0000    3rd Qu.:1.0000
## Max.   :401.00    Max.   :1.0000    Max.   :1.0000
## instant_bookable is_business_travel_ready
## Min.    :0.0000    Min.    :0.000
## 1st Qu.:0.0000    1st Qu.:0.000
## Median :0.0000    Median :0.000
## Mean   :0.3499    Mean   :0.154
## 3rd Qu.:1.0000    3rd Qu.:0.000
## Max.   :1.0000    Max.   :1.000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02108
## Min.    :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean   :0.02283
## 3rd Qu.:0.00000
## Max.   :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02108.0211
## Min.    :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean   :0.0002076
## 3rd Qu.:0.0000000
## Max.   :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02109
## Min.    :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean   :0.01619
## 3rd Qu.:0.00000
## Max.   :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02110
## Min.    :0.000000
## 1st Qu.:0.000000
## Median :0.000000
## Mean   :0.006434
## 3rd Qu.:0.000000
## Max.   :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02111
## Min.    :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean   :0.03321
## 3rd Qu.:0.00000
## Max.   :1.00000

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## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02113
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.03238
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02114
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.06517
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02115
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.04857
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02116
## Min. :0.0000
## 1st Qu.:0.0000
## Median :0.0000
## Mean :0.0988
## 3rd Qu.:0.0000
## Max. :1.0000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02118
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.05957
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02119
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.03321
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02120
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.01889
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02121
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.01266

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## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02122
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.01536
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02124
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.02615
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02125
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.03549
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02126
## Min. :0.000000
## 1st Qu.:0.000000
## Median :0.000000
## Mean :0.007057
## 3rd Qu.:0.000000
## Max. :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02127
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.05542
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02128
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.05106
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02129
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.02968
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02130
## Min. :0.00000
## 1st Qu.:0.00000

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## Median :0.00000
## Mean   :0.08676
## 3rd Qu.:0.00000
## Max.   :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02131
## Min.    :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean    :0.02138
## 3rd Qu.:0.00000
## Max.    :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02132
## Min.    :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean    :0.01183
## 3rd Qu.:0.00000
## Max.    :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02134
## Min.    :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean    :0.05915
## 3rd Qu.:0.00000
## Max.    :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02134.1704
## Min.    :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0002076
## 3rd Qu.:0.0000000
## Max.    :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02135
## Min.    :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean    :0.05729
## 3rd Qu.:0.00000
## Max.    :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02136
## Min.    :0.000000
## 1st Qu.:0.000000
## Median :0.000000
## Mean    :0.009132
## 3rd Qu.:0.000000
## Max.    :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02138
## Min.    :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0004151
## 3rd Qu.:0.0000000
## Max.    :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02139

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## Min.      :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0006227
## 3rd Qu.:0.0000000
## Max.     :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02142
## Min.      :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0002076
## 3rd Qu.:0.0000000
## Max.     :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02143
## Min.      :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0002076
## 3rd Qu.:0.0000000
## Max.     :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02145
## Min.      :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.001245
## 3rd Qu.:0.0000000
## Max.     :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02150
## Min.      :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0002076
## 3rd Qu.:0.0000000
## Max.     :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02151
## Min.      :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0004151
## 3rd Qu.:0.0000000
## Max.     :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02152
## Min.      :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0006227
## 3rd Qu.:0.0000000
## Max.     :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02163
## Min.      :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0006227
## 3rd Qu.:0.0000000

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## Max.      :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02186
## Min.      :0.0000000
## 1st Qu.   :0.0000000
## Median    :0.0000000
## Mean      :0.0002076
## 3rd Qu.   :0.0000000
## Max.      :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02199
## Min.      :0.0000000
## 1st Qu.   :0.0000000
## Median    :0.0000000
## Mean      :0.0004151
## 3rd Qu.   :0.0000000
## Max.      :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02210
## Min.      :0.00000
## 1st Qu.   :0.00000
## Median    :0.00000
## Mean      :0.01204
## 3rd Qu.   :0.00000
## Max.      :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02215
## Min.      :0.00000
## 1st Qu.   :0.00000
## Median    :0.00000
## Mean      :0.06434
## 3rd Qu.   :0.00000
## Max.      :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02445
## Min.      :0.000000
## 1st Qu.   :0.000000
## Median    :0.000000
## Mean      :0.001245
## 3rd Qu.   :0.000000
## Max.      :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02446
## Min.      :0.0000000
## 1st Qu.   :0.0000000
## Median    :0.0000000
## Mean      :0.0008302
## 3rd Qu.   :0.0000000
## Max.      :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02458
## Min.      :0.0000000
## 1st Qu.   :0.0000000
## Median    :0.0000000
## Mean      :0.0002076
## 3rd Qu.   :0.0000000
## Max.      :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02467
## Min.      :0.00000
## 1st Qu.   :0.00000
## Median    :0.00000

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## Mean      :0.00166
## 3rd Qu.   :0.00000
## Max.      :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmd02472
## Min.      :0.0000000
## 1st Qu.   :0.0000000
## Median    :0.0000000
## Mean      :0.0002076
## 3rd Qu.   :0.0000000
## Max.      :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdBed...Break
## Min.      :0.000000
## 1st Qu.   :0.000000
## Median    :0.000000
## Mean      :0.005604
## 3rd Qu.   :0.000000
## Max.      :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdBoat
## Min.      :0.000000
## 1st Qu.   :0.000000
## Median    :0.000000
## Mean      :0.002906
## 3rd Qu.   :0.000000
## Max.      :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdBoutique.h
## Min.      :0.000000
## 1st Qu.   :0.000000
## Median    :0.000000
## Mean      :0.002076
## 3rd Qu.   :0.000000
## Max.      :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdCondominium
## Min.      :0.00000
## 1st Qu.   :0.00000
## Median    :0.00000
## Mean      :0.09527
## 3rd Qu.   :0.00000
## Max.      :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdDorm
## Min.      :0.0000000
## 1st Qu.   :0.0000000
## Median    :0.0000000
## Mean      :0.0006227
## 3rd Qu.   :0.0000000
## Max.      :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdGuest.suite
## Min.      :0.000000
## 1st Qu.   :0.000000
## Median    :0.000000
## Mean      :0.002491
## 3rd Qu.   :0.000000
## Max.      :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdGuesthouse
## Min.      :0.0000000

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## 1st Qu.:0.0000000
## Median :0.0000000
## Mean   :0.0008302
## 3rd Qu.:0.0000000
## Max.    :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdHostel
## Min.     :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0008302
## 3rd Qu.:0.0000000
## Max.     :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdHouse
## Min.     :0.0000
## 1st Qu.:0.0000
## Median :0.0000
## Mean    :0.1615
## 3rd Qu.:0.0000
## Max.     :1.0000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdIn.law
## Min.     :0.000000
## 1st Qu.:0.000000
## Median :0.000000
## Mean    :0.001245
## 3rd Qu.:0.000000
## Max.     :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdLoft
## Min.     :0.000000
## 1st Qu.:0.000000
## Median :0.000000
## Mean    :0.007057
## 3rd Qu.:0.000000
## Max.     :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdOther
## Min.     :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean    :0.01743
## 3rd Qu.:0.00000
## Max.     :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdServiced.ap
## Min.     :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0002076
## 3rd Qu.:0.0000000
## Max.     :1.0000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdTimeshare
## Min.     :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean    :0.0006227
## 3rd Qu.:0.0000000
## Max.     :1.0000000

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## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdTownhouse
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.01494
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdVilla
## Min. :0.000000
## 1st Qu.:0.000000
## Median :0.000000
## Mean :0.002283
## 3rd Qu.:0.000000
## Max. :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdPrivate.room
## Min. :0.0000
## 1st Qu.:0.0000
## Median :0.0000
## Mean :0.3649
## 3rd Qu.:1.0000
## Max. :1.0000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdShared.room
## Min. :0.00000
## 1st Qu.:0.00000
## Median :0.00000
## Mean :0.01162
## 3rd Qu.:0.00000
## Max. :1.00000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdCouch
## Min. :0.000000
## 1st Qu.:0.000000
## Median :0.000000
## Mean :0.001453
## 3rd Qu.:0.000000
## Max. :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdFuton
## Min. :0.000000
## 1st Qu.:0.000000
## Median :0.000000
## Mean :0.008302
## 3rd Qu.:0.000000
## Max. :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdPull.out.S
## Min. :0.000000
## 1st Qu.:0.000000
## Median :0.000000
## Mean :0.004981
## 3rd Qu.:0.000000
## Max. :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.RmdReal.Bed
## Min. :0.0000
## 1st Qu.:1.0000
## Median :1.0000
## Mean :0.9776

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## 3rd Qu.:1.0000
## Max. :1.0000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmdmoderate
## Min. :0.0000
## 1st Qu.:0.0000
## Median :0.0000
## Mean :0.2397
## 3rd Qu.:0.0000
## Max. :1.0000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmdstrict
## Min. :0.0000
## 1st Qu.:0.0000
## Median :1.0000
## Mean :0.5176
## 3rd Qu.:1.0000
## Max. :1.0000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmdsuper_stri
## Min. :0.000000
## 1st Qu.:0.000000
## Median :0.000000
## Mean :0.008717
## 3rd Qu.:0.000000
## Max. :1.000000
## X.Users.philip.School.Machine.Learning.Project.CS6140_project.CS6140_project_proposal.Rmdsuper_stri
## Min. :0.0000000
## 1st Qu.:0.0000000
## Median :0.0000000
## Mean :0.0004151
## 3rd Qu.:0.0000000
## Max. :1.0000000
```

Two-variable summary statistics

Findings

Highly correlated predictors

Categorical predictors

The categorical predictors in the dataset are “host_is_superhost”, “host_identity_verified”, “zipcode”, “property_type”, “room_type”, “bed_type”, “instant_bookable”, “is_business_travel_ready”, and “cancellation_policy”.

Missing values

There were 53 rows with missing values. This was a small number, so we removed them.

Outliers

Methods

- We will perform and compare a variety of regression techniques, including linear regression and kernel methods. The comparison between the results of these methods is straightforward.
- We will also consider approaching the problem from a classification point of view, dividing the prices into ordered categorical ranges. Doing this will allow us to investigate the use of classification methods such as logistic regression and tree-based approaches.
- We will research/develop a means of comparing the results of the regression and classification methods.