Chapter 2 HW

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Conceptual Questions

Exercise 2: Explain whether each scenario is a classification or regression prob-lem, and indicate whether we are most interested in inference or prediction. Finally, provide n := sample size and p := predictors.

(a) We collect a set of data on the top 500 firms in the US. For each firm we record profit, number of employees, industry and the CEO salary. We are interested in understanding which factors affect CEO salary.

- This describes an instance of regressional inference because our y i.e the CEO salary is a continous variable and it is an example of an inference problem since the goal is not primarily to predict a given output but more so the decipher the underlying relationships between profit, number of employees, industry and the CEO salary. Regression fits this use case because instead of primarily focusing upon using input to predict changes in the CEO salary, we want to see which of these factors effect CEO salary not necessarily how they will effect CEO salary. Here we have $n = 500\,,\, p = 3$.

(b) We are considering launching a new product and wish to know whether it will be a success or a failure. We collect data on 20 similar products that were previously launched. For each product we have recorded whether it was a success or failure, price charged for the product, marketing budget, competition price, and ten other variables.

- This describes an instance of a classification problem geared towards prediction. This falls into the category of classification as it deals with a y (success/failuere) which is categorical in nature moreover its goal is to predict the success or failure of the new product using collected data from similar products. Here $n = 20\,,\, p = 13$

(c) We are interested in predicting the % change in the USD/Euro exchange rate in relation to the weekly changes in the world stock markets. Hence we collect weekly data for all of 2012. For each week we record the % change in the USD/Euro, the % change in the US market, the % change in the British market, and the % change in the German market.

- This is an example of a regressional prediction problem. It falls into the category of regression as it deals with a y which is continous in nature and fits into the category of prediction since its primary goal is to use input data i.e the precent change in the US, British and German markets to predict the % change in the USD/Euro exchange rate. Here $n = 52\,,\, p = 3$.

Exercise 4: You will now think of some real-life applications for statistical learn-ing.

(a) Describe three real-life applications in which classification might be useful. Describe the response, as well as the predictors. Is the goal of each application inference or prediction? Explain your answer.

- One example of a real life application in which classification would be useful is in sentiment analysis possibly for something like product reviews. Where in the response could be a sentiment label i.e an indicator for Positive, Negative and possibly Neutral reception. Then some predictors could be Text data (for isntance review wording), star ratings, and reviewer history to gauge tendency of a user to leave either highly negative or positive reviews. The goal of this example would be primarily prediction since our intent is to classiffy new product reviews into categories based on learned patterns from data.The model would be trained on labeled reviews where the sentiment is already known and then it would predict the sentiment of unseen reviews.

- Another example of a real life application could be Handwritten digit recognition where in the response would be a digit label i.e (0-9) and the predictors could be pixel valus of the image, edge detection features and shape descriptors. The primary goal would be prediction i.e trying to predict the correct digit for new/unseen images. So the model would take an input of a handwritten digit and classify it as one of the digits 0-9 and then use that to predit the most likely represents.
- A real life application could be in transaction classification i.e fraudulent or legitimate. Predictors such as transaction amount, time of the transaction , location , device used and transaction history. The goal here would again be precition becuase the main intent would be to identify fraudulent transactions in real time using past transaction data to train out model with transactions labeled as either fraudulent or legitimate. When a new transaction is made the model would predict whether it is a valid transaction i.e non fraudulent based on its feautures. So the task here would be classifying new transactions rather than undersrantinng the causes of fraud.

(b) Describe three real-life applications in which regression might be useful. Describe the response, as well as the predictors. Is the goal of each application inference or prediction? Explain your answer.

- One real-life application where regression may be found useful is in the analysis of drivers of life expectancy. A response value for this would be the persons life expectancy at birth (a continous val. in years). Predictors in this example could be things like GDP per capita, access to healthcare, sanitation, education, and other social factors. The goal of this application would be inference since the main intent would be to understand the relationship between the predictors and the response i.e life expectancy. The model would be used to understand how the predictors effect life expectancy and not necessarily to predict life expectancy.
- Another example of an application where regression would be of use is in forcasting retail demand. A response value for this use case could be Daily sales volume (units sold) and the predictors could be things like day of the week, time of the year, weather, promotions, competitor pricing and maybe historical data like sales from the past 30 days. The goal of this application would be prediction since the main intent would be to predict future sales volume based on past sales data and other predictors to gauge future demand for inventory management. The model would be used to predict future sales volume based on past sales data and could help in anticipating holiday sales for a specific product to optimize stock levels.
- An example of an application that could use regression is also in predicting renewable energy production i.e solar power, wind farms. A response value for this could be the amount of energy produced in a given time period. Predictors could be things like weather data for instance wind speed, temperature and air pressure, time of day, season, and location. The goal of this application would be prediction since the main intent would be to predict the amount of energy produced in the future based on past data. The model would be used to predict future energy production based on trends in previous energy production and could help in optimizing energy storage and distribution.

(c) Describe three real-life applications in which cluster analysis might be useful.

- One real-life application where cluster analysis might be useful is in customer segmentation. For instance in a retail setting, where the goal would be to segment customers into distinct groups based on their purchasing behavior / history. Clustered data could be customer transaction history , customer demographics, and engagement metrics. Predictors could be things like purchase frequency, average amount spent per order and product preferences. Demographic data that could be used can be age, location, and income and behaviral data would be things like website click or email open rates. This could help in tailoring marketing strategies to each group. For instance, a cluster of customers who buy mostly electronics could be targeted with electronics promotions because they may be more likely to be interested in those products.

- Another real-life application where cluster analysis might be useful is in anomaly detection. For instance in network security where the goal would be to detect unusual behavior in network traffic. Clustered data could be network traffic data, user activity logs, and system logs such access attempts. Features here would be things like data transfer rates, login attempts, IP addresses, file access times, protocol type and time of day. This could help in identifying unusual patterns in network traffic that could be indicative of a security breach becuase clustering may help in distinguishing normal activity from anomalous clusters and security teams could prioritize investigating outliers flagged by the model.
- Another real-life application where cluster analysis might be useful is in recommendation systems. For instance in a streaming service like Netflix where the goal would be to recommend movies or shows to users based on their viewing history. Clustered data could be user behavior for isntance viewing history, user ratings, search queries, and time spent on content or potentially content attributes like genre, actors, directors, and release year. Features here could be viewing habits, with similar themes or audience appeal as content clusters. This could help in recommending movies or shows to users based on their viewing history and preferences. For instance, a user who watches a lot of action movies could be recommended more action movies or a user who watches a lot of comedies could be recommended more comedies.

Applied Questions

Exercise 8: This exercise relates to the College data set, which can be found in the file College.csv on the book website. It contains a number of variables for 777 different universities and colleges in the US. The variables are

- Private : Public/private indicator
- Apps : Number of applications received
- Accept : Number of applicants accepted
- Enroll : Number of new students enrolled
- Top10perc : New students from top 10 % of high school class
- Top25perc : New students from top 25 % of high school class
- F.Undergrad : Number of full-time undergraduates
- P.Undergrad : Number of part-time undergraduates
- Outstate : Out-of-state tuition
- Room.Board : Room and board costs
- Books : Estimated book costs
- Personal : Estimated personal spending
- PhD : Percent of faculty with Ph.D.'s
- Terminal : Percent of faculty with terminal degree
- S.F.Ratio : Student/faculty ratio
- perc.alumni : Percent of alumni who donate
- Expend : Instructional expenditure per student
- Grad.Rate : Graduation rate

Before reading the data into R, it can be viewed in Excel or a text editor.

(a) Use the read.csv() function to read the data into R. Call the loaded data college. Make sure that you have the directory set to the correct location for the data.

```r
#check curr directory
#getwd()

college <- read.csv("College.csv")
```

(b) Look at the data using the View() function. You should notice that the first column is just the name of each university. We don't really want R to treat this as data. However, it may be handy to have these names for later. Try the following commands:

rownames(college) <- college[, 1]

View(college)

```r
rownames(college) <- college[, 1]

#outputs the entire contents of colege (professor said it was okay to view just
#a subsection (since the data is large)
#View(college)

#view first ten rows in college data set, with all columns
View(college[1:10, c(1:19)])
```

You should see that there is now a row.names column with the name of each university recorded. This means that R has given each row a name corresponding to the appropriate university. R will not try to perform calculations on the row names. However, we still need to eliminate the first column in the data where the names are stored. Try

college <- college[, -1]

View(college)

```r
college <- college[, -1]
View(college)
```

Now you should see that the first data column is Private. Note that another column labeled row.names now appears before the Private column. However, this is not a data column but rather the name that R is giving to each row.

(c)

i. Use the summary() function to produce a numerical summary of the variables in the data set

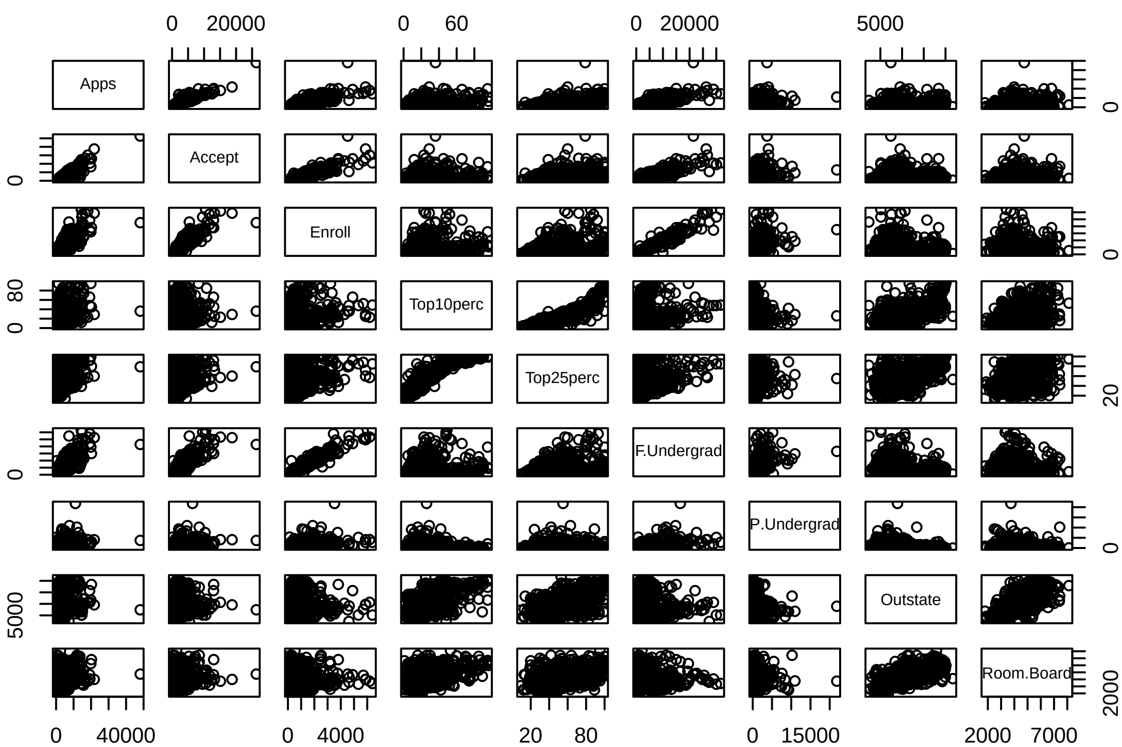
```r
summary(college)
```

```
##    Private               Apps           Accept          Enroll
##  Length:777         Min.   :   81   Min.   :   72   Min.   :  35
##  Class :character   1st Qu.:  776   1st Qu.:  604   1st Qu.: 242
##  Mode  :character   Median : 1558   Median : 1110   Median : 434
##                     Mean   : 3002   Mean   : 2019   Mean   : 780
##                     3rd Qu.: 3624   3rd Qu.: 2424   3rd Qu.: 902
##                     Max.   :48094   Max.   :26330   Max.   :6392
##    Top10perc       Top25perc      F.Undergrad     P.Undergrad
##  Min.   : 1.00   Min.   :  9.0   Min.   :  139   Min.   :    1.0
##  1st Qu.:15.00   1st Qu.: 41.0   1st Qu.:  992   1st Qu.:   95.0
##  Median :23.00   Median : 54.0   Median : 1707   Median :  353.0
##  Mean   :27.56   Mean   : 55.8   Mean   : 3700   Mean   :  855.3
##  3rd Qu.:35.00   3rd Qu.: 69.0   3rd Qu.: 4005   3rd Qu.:  967.0
##  Max.   :96.00   Max.   :100.0   Max.   :31643   Max.   :21836.0
##     Outstate       Room.Board       Books           Personal
```

```
##  Min.   : 2340   Min.   :1780   Min.   :  96.0   Min.   : 250
##  1st Qu.: 7320   1st Qu.:3597   1st Qu.: 470.0   1st Qu.: 850
##  Median : 9990   Median :4200   Median : 500.0   Median :1200
##  Mean   :10441   Mean   :4358   Mean   : 549.4   Mean   :1341
##  3rd Qu.:12925   3rd Qu.:5050   3rd Qu.: 600.0   3rd Qu.:1700
##  Max.   :21700   Max.   :8124   Max.   :2340.0   Max.   :6800
##       PhD            Terminal       S.F.Ratio      perc.alumni
##  Min.   :  8.00   Min.   : 24.0   Min.   : 2.50   Min.   : 0.00
##  1st Qu.: 62.00   1st Qu.: 71.0   1st Qu.:11.50   1st Qu.:13.00
##  Median : 75.00   Median : 82.0   Median :13.60   Median :21.00
##  Mean   : 72.66   Mean   : 79.7   Mean   :14.09   Mean   :22.74
##  3rd Qu.: 85.00   3rd Qu.: 92.0   3rd Qu.:16.50   3rd Qu.:31.00
##  Max.   :103.00   Max.   :100.0   Max.   :39.80   Max.   :64.00
##      Expend        Grad.Rate
##  Min.   : 3186   Min.   : 10.00
##  1st Qu.: 6751   1st Qu.: 53.00
##  Median : 8377   Median : 65.00
##  Mean   : 9660   Mean   : 65.46
##  3rd Qu.:10830   3rd Qu.: 78.00
##  Max.   :56233   Max.   :118.00
```

ii. Use the pairs() function to produce a scatterplot matrix of the first ten columns or variables of the data. Recall that you can reference the first ten columns of a matrix A using A[,1:10].

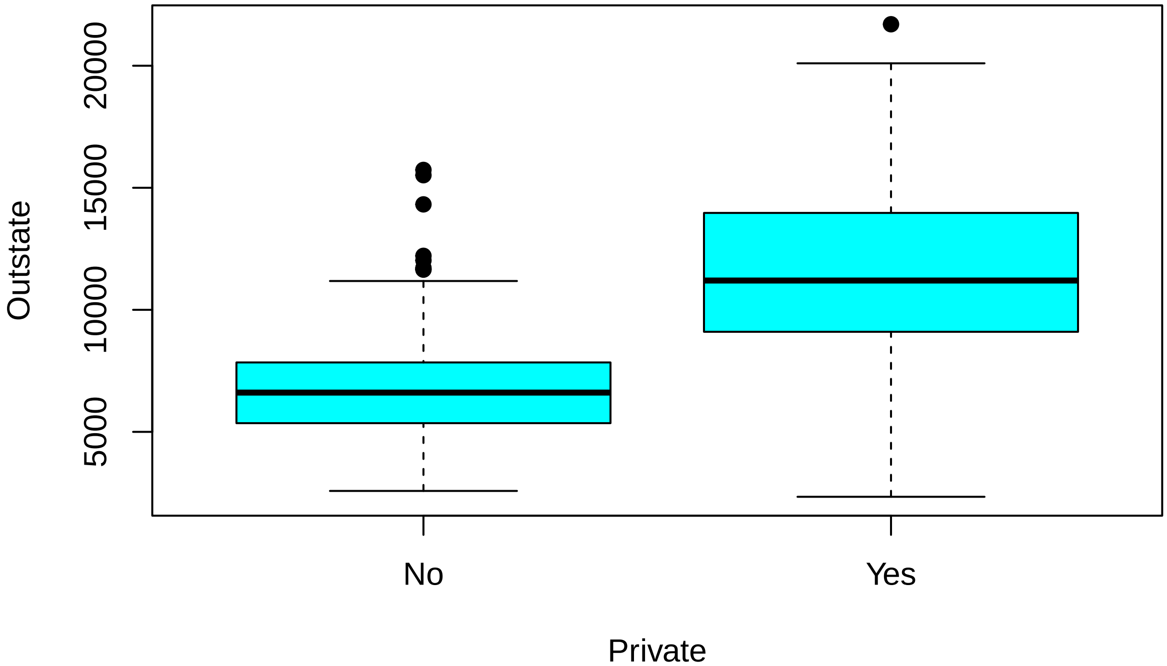
```
## passing college using [,2:10] to get the first ten col but skipping non numeric col private
pairs(college[,2:10])
```



iii. Use the plot() function to produce side-by-side boxplots of Outstate versus Private.

```
# debug chk types
# str(college$Private)  # should be a factor but was char[]
# str(college$Outstate) # int[]
```

```r
# fix type for plot()
college$Private <- as.factor(college$Private)
plot(college$Private, college$Outstate, xlab = "Private", ylab = "Outstate", col = "cyan", pch = 19)
```



iv. Create a new qualitative variable, called Elite, by binning the Top10perc variable. We are going to divide universities into two groups based on whether or not the proportion of students coming from the top 10 % of their high school classes exceeds 50 %.

Elite <- rep("No", nrow(college))

Elite[college$Top10perc > 50] <- "Yes"

Elite <- as.factor(Elite)

college <- data.frame(college , Elite)

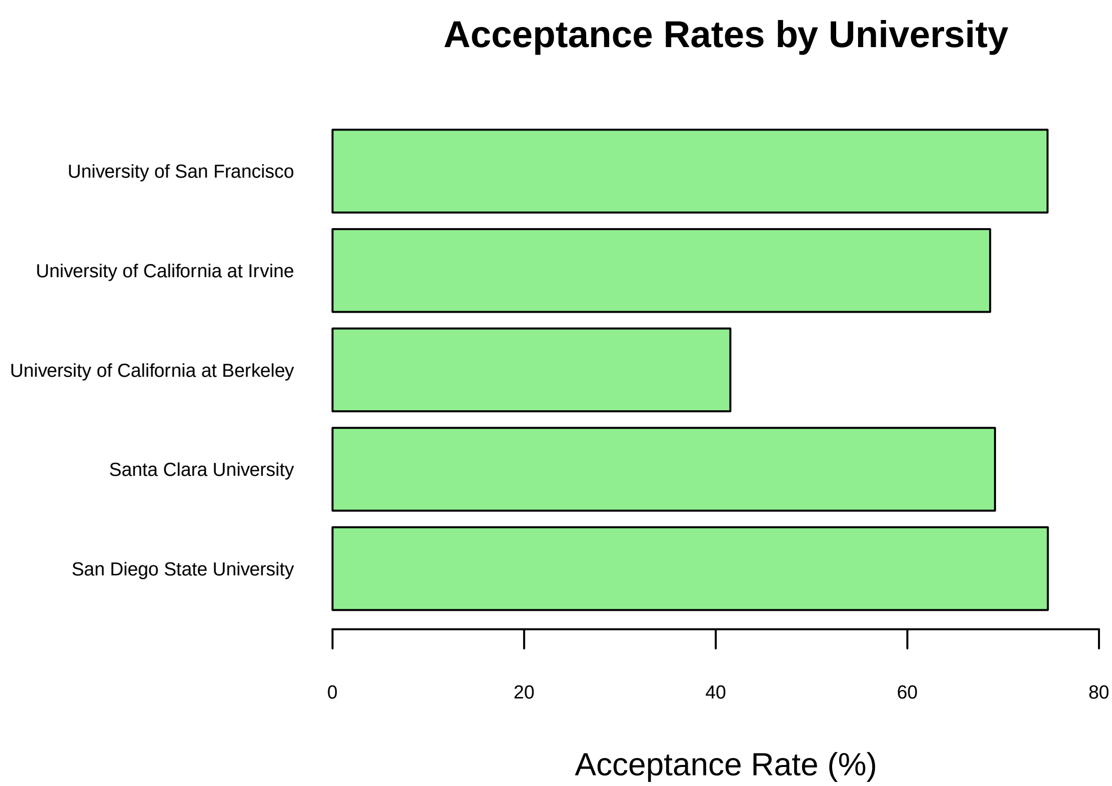
```r
Elite <- rep("No", nrow(college))
Elite[college$Top10perc > 50] <- "Yes"
Elite <- as.factor(Elite)
college <- data.frame(college , Elite)
```

Use the summary() function to see how many elite universities there are. Now use the plot() function to produce side-by-side boxplots of Outstate versus Elite. v. Use the hist() function to produce some histograms with differing numbers of bins for a few of the quantitative variables. You may find the command par(mfrow = c(2, 2)) useful: it will divide the print window into four regions so that four plots can be made simultaneously. Modifying the arguments to this function will divide the screen in other ways.

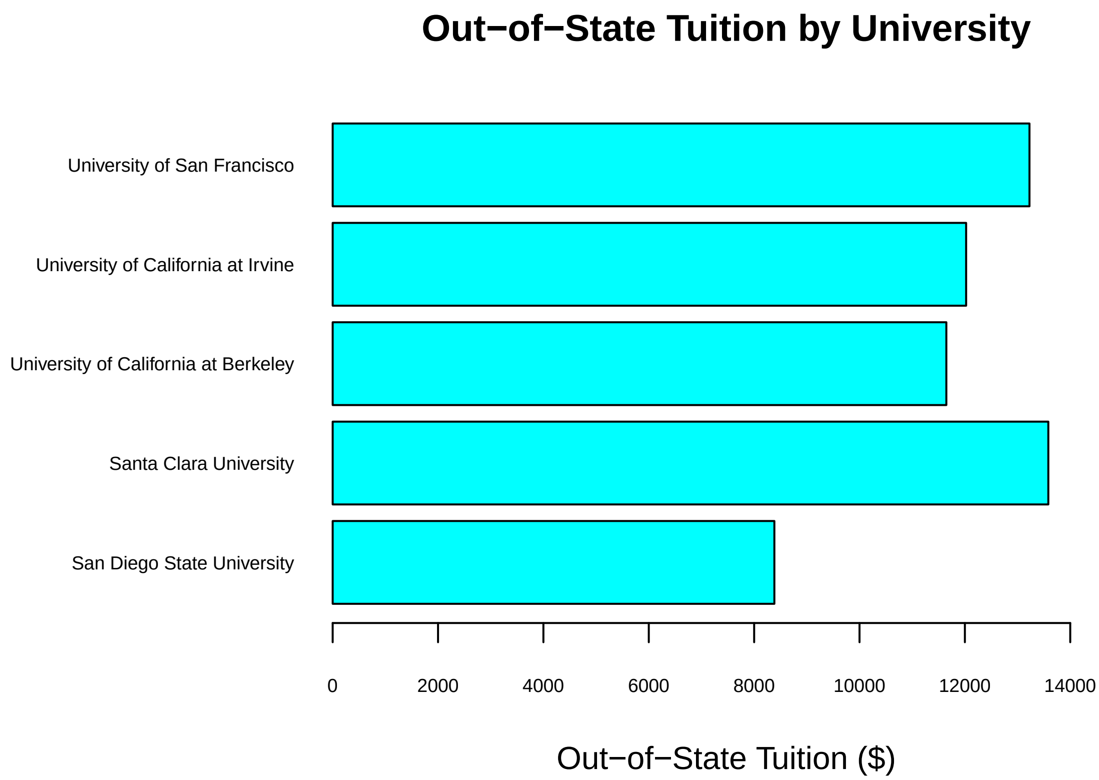
vi. Continue exploring the data, and provide a brief summary of what you discover.

```r
#college_name <- "University of California at Berkeley"
#college[rownames(college) == college_name, ]




# tmp increase margins fix for names being cut off
```

```r
par(mar = c(5, 10, 4, 2))  # Increase the left margin (10)

# list of colleges id like to search for
college_names <- c("University of California at Berkeley", "University of California at Irvine", "San Di

# conv to lower case
college_names_lower <- tolower(college_names)
rownames_lower <- tolower(rownames(college))

# collect college entries
collected_colleges<- college[rownames_lower %in% college_names_lower, ]


# get acceptance rates
collected_colleges$AcceptanceRate <- (collected_colleges$Accept / collected_colleges$Apps) * 100

# get enrollment rate
collected_colleges$EnrollmentRate <- (collected_colleges$Enroll / collected_colleges$Apps) * 100

barplot(collected_colleges$AcceptanceRate,
        names.arg = rownames(collected_colleges),
        main = "Acceptance Rates by University",
        xlab = "Acceptance Rate (%)",
        col = "lightgreen",
        horiz = TRUE,
        cex.names = 0.6,
        cex.axis = 0.6,
        las = 1,
        xlim = c(0, max(collected_colleges$AcceptanceRate) * 1.1))
```

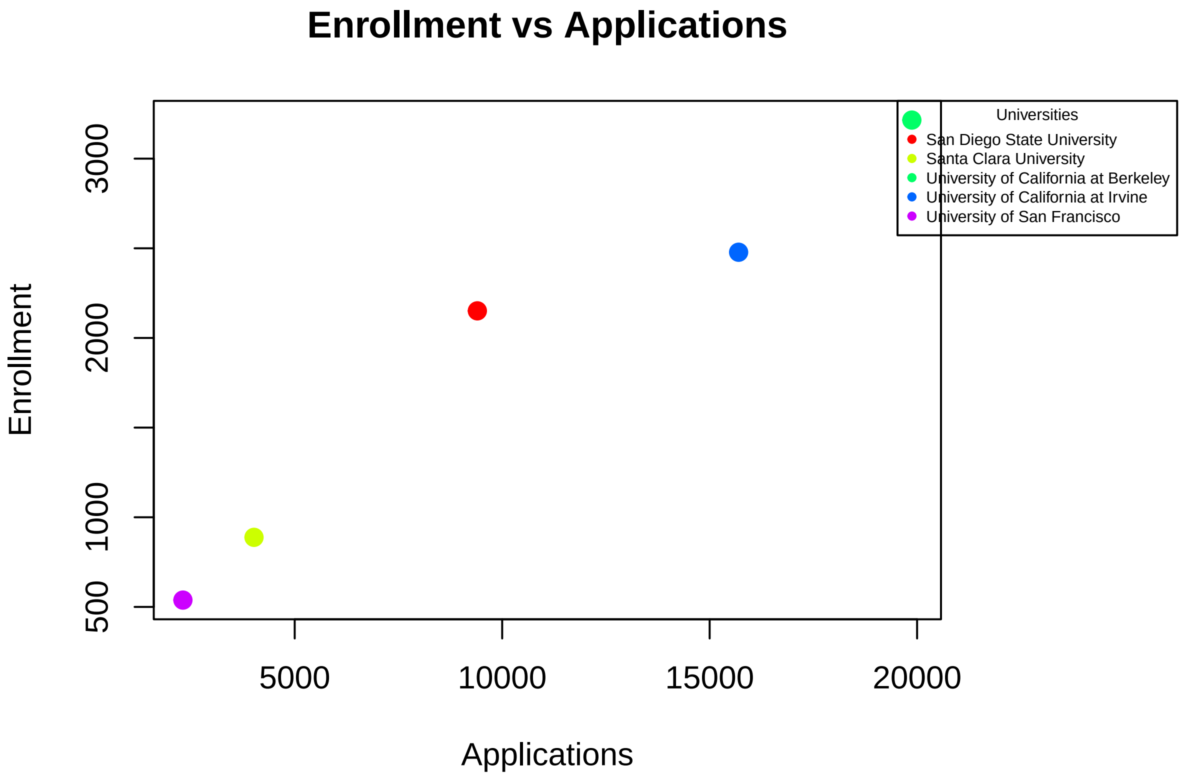


```r
barplot(collected_colleges$Outstate,
        names.arg = rownames(collected_colleges),
        main = "Out-of-State Tuition by University",
        xlab = "Out-of-State Tuition ($)",
        col = "cyan",
        horiz = TRUE,
        cex.names = 0.6,
        cex.axis = 0.6,
        las = 1,
        xlim = c(0, max(collected_colleges$Outstate) * 1.1))
```




```r
# Create a vector of colors (one per university)
n_colleges <- nrow(collected_colleges)
colors <- rainbow(n_colleges)  # or use a custom palette like c("blue", "red", "green", ...)


# Adjust plot margins to make space for the legend (bottom, left, top, right)
par(mar = c(5, 4, 4, 8), xpd = TRUE)

# Re-plot the points
plot(collected_colleges$Apps, collected_colleges$Enroll,
     main = "Enrollment vs Applications",
     xlab = "Applications",
     ylab = "Enrollment",
     pch = 19,
     col = colors,
     cex = 1.2)

# Add a legend outside the plot (adjust "inset" and "x" as needed)
```

```r
legend("topright",
       inset = c(-0.3, 0),  # Move legend outside the plot
       legend = rownames(collected_colleges),
       col = colors,
       pch = 19,
       title = "Universities",
       cex = 0.5)
```




```r
# reset to default for next ex.
par(mar = c(5, 4, 4, 2))
```

- For this portion of the exercise I wanted to compare the data for San Francisco State University , UC Berkeley, UC Santa Barbara, UC San Diego, Riverside, Santa Clara University, San Diego state and Eastbay but It seems like the data set was missing entries for San Francisco state along with other universities like UC Santa Barbara. I was able to find data for UC Berkeley, Santa Clara University, San Diego State University and University of San Francisco. I was able to calculate the acceptance rate and enrollment rate for each of these universities and then plot them along with the out of state tuition for each of these universities and I created a plot for enrollment vs applications. From the acceptance rate bar plot i saw that UC San Francisco and San Diego state gad the highest acceptance rates. From the out of state tuition bar plot I saw that Santa Clara University had the highest out of state tuition. From the enrollment vs applications plot I saw that UC Berkeley had the highest number of applications and enrollments.

Exercise 10 This exercise involves the Boston housing data set.

(a) To begin, load in the Boston data set. The Boston data set is part of the ISLR2 library.

library(ISLR2)

Now the data set is contained in the object Boston.

Boston

Read about the data set:

?Boston

How many rows are in this data set? How many columns? What do the rows and columns represent?

```r
# load the ISLR2 lib, had to install with install.packages("ISLR2")
library(ISLR2)

# load boston data set
Boston
```

```
##        crim   zn indus chas   nox    rm   age     dis rad tax ptratio lstat
## 1   0.00632 18.0  2.31    0 0.5380 6.575  65.2  4.0900   1 296    15.3  4.98
## 2   0.02731  0.0  7.07    0 0.4690 6.421  78.9  4.9671   2 242    17.8  9.14
## 3   0.02729  0.0  7.07    0 0.4690 7.185  61.1  4.9671   2 242    17.8  4.03
## 4   0.03237  0.0  2.18    0 0.4580 6.998  45.8  6.0622   3 222    18.7  2.94
## 5   0.06905  0.0  2.18    0 0.4580 7.147  54.2  6.0622   3 222    18.7  5.33
## 6   0.02985  0.0  2.18    0 0.4580 6.430  58.7  6.0622   3 222    18.7  5.21
## 7   0.08829 12.5  7.87    0 0.5240 6.012  66.6  5.5605   5 311    15.2 12.43
## 8   0.14455 12.5  7.87    0 0.5240 6.172  96.1  5.9505   5 311    15.2 19.15
## 9   0.21124 12.5  7.87    0 0.5240 5.631 100.0  6.0821   5 311    15.2 29.93
## 10  0.17004 12.5  7.87    0 0.5240 6.004  85.9  6.5921   5 311    15.2 17.10
## 11  0.22489 12.5  7.87    0 0.5240 6.377  94.3  6.3467   5 311    15.2 20.45
## 12  0.11747 12.5  7.87    0 0.5240 6.009  82.9  6.2267   5 311    15.2 13.27
## 13  0.09378 12.5  7.87    0 0.5240 5.889  39.0  5.4509   5 311    15.2 15.71
## 14  0.62976  0.0  8.14    0 0.5380 5.949  61.8  4.7075   4 307    21.0  8.26
## 15  0.63796  0.0  8.14    0 0.5380 6.096  84.5  4.4619   4 307    21.0 10.26
## 16  0.62739  0.0  8.14    0 0.5380 5.834  56.5  4.4986   4 307    21.0  8.47
## 17  1.05393  0.0  8.14    0 0.5380 5.935  29.3  4.4986   4 307    21.0  6.58
## 18  0.78420  0.0  8.14    0 0.5380 5.990  81.7  4.2579   4 307    21.0 14.67
## 19  0.80271  0.0  8.14    0 0.5380 5.456  36.6  3.7965   4 307    21.0 11.69
## 20  0.72580  0.0  8.14    0 0.5380 5.727  69.5  3.7965   4 307    21.0 11.28
## 21  1.25179  0.0  8.14    0 0.5380 5.570  98.1  3.7979   4 307    21.0 21.02
## 22  0.85204  0.0  8.14    0 0.5380 5.965  89.2  4.0123   4 307    21.0 13.83
## 23  1.23247  0.0  8.14    0 0.5380 6.142  91.7  3.9769   4 307    21.0 18.72
## 24  0.98843  0.0  8.14    0 0.5380 5.813 100.0  4.0952   4 307    21.0 19.88
## 25  0.75026  0.0  8.14    0 0.5380 5.924  94.1  4.3996   4 307    21.0 16.30
## 26  0.84054  0.0  8.14    0 0.5380 5.599  85.7  4.4546   4 307    21.0 16.51
## 27  0.67191  0.0  8.14    0 0.5380 5.813  90.3  4.6820   4 307    21.0 14.81
## 28  0.95577  0.0  8.14    0 0.5380 6.047  88.8  4.4534   4 307    21.0 17.28
## 29  0.77299  0.0  8.14    0 0.5380 6.495  94.4  4.4547   4 307    21.0 12.80
## 30  1.00245  0.0  8.14    0 0.5380 6.674  87.3  4.2390   4 307    21.0 11.98
## 31  1.13081  0.0  8.14    0 0.5380 5.713  94.1  4.2330   4 307    21.0 22.60
## 32  1.35472  0.0  8.14    0 0.5380 6.072 100.0  4.1750   4 307    21.0 13.04
## 33  1.38799  0.0  8.14    0 0.5380 5.950  82.0  3.9900   4 307    21.0 27.71
## 34  1.15172  0.0  8.14    0 0.5380 5.701  95.0  3.7872   4 307    21.0 18.35
## 35  1.61282  0.0  8.14    0 0.5380 6.096  96.9  3.7598   4 307    21.0 20.34
## 36  0.06417  0.0  5.96    0 0.4990 5.933  68.2  3.3603   5 279    19.2  9.68
## 37  0.09744  0.0  5.96    0 0.4990 5.841  61.4  3.3779   5 279    19.2 11.41
## 38  0.08014  0.0  5.96    0 0.4990 5.850  41.5  3.9342   5 279    19.2  8.77
## 39  0.17505  0.0  5.96    0 0.4990 5.966  30.2  3.8473   5 279    19.2 10.13
## 40  0.02763 75.0  2.95    0 0.4280 6.595  21.8  5.4011   3 252    18.3  4.32
## 41  0.03359 75.0  2.95    0 0.4280 7.024  15.8  5.4011   3 252    18.3  1.98
```

```
## 42   0.12744   0.0  6.91    0 0.4480 6.770   2.9  5.7209   3 233    17.9  4.84
## 43   0.14150   0.0  6.91    0 0.4480 6.169   6.6  5.7209   3 233    17.9  5.81
## 44   0.15936   0.0  6.91    0 0.4480 6.211   6.5  5.7209   3 233    17.9  7.44
## 45   0.12269   0.0  6.91    0 0.4480 6.069  40.0  5.7209   3 233    17.9  9.55
## 46   0.17142   0.0  6.91    0 0.4480 5.682  33.8  5.1004   3 233    17.9 10.21
## 47   0.18836   0.0  6.91    0 0.4480 5.786  33.3  5.1004   3 233    17.9 14.15
## 48   0.22927   0.0  6.91    0 0.4480 6.030  85.5  5.6894   3 233    17.9 18.80
## 49   0.25387   0.0  6.91    0 0.4480 5.399  95.3  5.8700   3 233    17.9 30.81
## 50   0.21977   0.0  6.91    0 0.4480 5.602  62.0  6.0877   3 233    17.9 16.20
## 51   0.08873  21.0  5.64    0 0.4390 5.963  45.7  6.8147   4 243    16.8 13.45
## 52   0.04337  21.0  5.64    0 0.4390 6.115  63.0  6.8147   4 243    16.8  9.43
## 53   0.05360  21.0  5.64    0 0.4390 6.511  21.1  6.8147   4 243    16.8  5.28
## 54   0.04981  21.0  5.64    0 0.4390 5.998  21.4  6.8147   4 243    16.8  8.43
## 55   0.01360  75.0  4.00    0 0.4100 5.888  47.6  7.3197   3 469    21.1 14.80
## 56   0.01311  90.0  1.22    0 0.4030 7.249  21.9  8.6966   5 226    17.9  4.81
## 57   0.02055  85.0  0.74    0 0.4100 6.383  35.7  9.1876   2 313    17.3  5.77
## 58   0.01432 100.0  1.32    0 0.4110 6.816  40.5  8.3248   5 256    15.1  3.95
## 59   0.15445  25.0  5.13    0 0.4530 6.145  29.2  7.8148   8 284    19.7  6.86
## 60   0.10328  25.0  5.13    0 0.4530 5.927  47.2  6.9320   8 284    19.7  9.22
## 61   0.14932  25.0  5.13    0 0.4530 5.741  66.2  7.2254   8 284    19.7 13.15
## 62   0.17171  25.0  5.13    0 0.4530 5.966  93.4  6.8185   8 284    19.7 14.44
## 63   0.11027  25.0  5.13    0 0.4530 6.456  67.8  7.2255   8 284    19.7  6.73
## 64   0.12650  25.0  5.13    0 0.4530 6.762  43.4  7.9809   8 284    19.7  9.50
## 65   0.01951  17.5  1.38    0 0.4161 7.104  59.5  9.2229   3 216    18.6  8.05
## 66   0.03584  80.0  3.37    0 0.3980 6.290  17.8  6.6115   4 337    16.1  4.67
## 67   0.04379  80.0  3.37    0 0.3980 5.787  31.1  6.6115   4 337    16.1 10.24
## 68   0.05789  12.5  6.07    0 0.4090 5.878  21.4  6.4980   4 345    18.9  8.10
## 69   0.13554  12.5  6.07    0 0.4090 5.594  36.8  6.4980   4 345    18.9 13.09
## 70   0.12816  12.5  6.07    0 0.4090 5.885  33.0  6.4980   4 345    18.9  8.79
## 71   0.08826   0.0 10.81    0 0.4130 6.417   6.6  5.2873   4 305    19.2  6.72
## 72   0.15876   0.0 10.81    0 0.4130 5.961  17.5  5.2873   4 305    19.2  9.88
## 73   0.09164   0.0 10.81    0 0.4130 6.065   7.8  5.2873   4 305    19.2  5.52
## 74   0.19539   0.0 10.81    0 0.4130 6.245   6.2  5.2873   4 305    19.2  7.54
## 75   0.07896   0.0 12.83    0 0.4370 6.273   6.0  4.2515   5 398    18.7  6.78
## 76   0.09512   0.0 12.83    0 0.4370 6.286  45.0  4.5026   5 398    18.7  8.94
## 77   0.10153   0.0 12.83    0 0.4370 6.279  74.5  4.0522   5 398    18.7 11.97
## 78   0.08707   0.0 12.83    0 0.4370 6.140  45.8  4.0905   5 398    18.7 10.27
## 79   0.05646   0.0 12.83    0 0.4370 6.232  53.7  5.0141   5 398    18.7 12.34
## 80   0.08387   0.0 12.83    0 0.4370 5.874  36.6  4.5026   5 398    18.7  9.10
## 81   0.04113  25.0  4.86    0 0.4260 6.727  33.5  5.4007   4 281    19.0  5.29
## 82   0.04462  25.0  4.86    0 0.4260 6.619  70.4  5.4007   4 281    19.0  7.22
## 83   0.03659  25.0  4.86    0 0.4260 6.302  32.2  5.4007   4 281    19.0  6.72
## 84   0.03551  25.0  4.86    0 0.4260 6.167  46.7  5.4007   4 281    19.0  7.51
## 85   0.05059   0.0  4.49    0 0.4490 6.389  48.0  4.7794   3 247    18.5  9.62
## 86   0.05735   0.0  4.49    0 0.4490 6.630  56.1  4.4377   3 247    18.5  6.53
## 87   0.05188   0.0  4.49    0 0.4490 6.015  45.1  4.4272   3 247    18.5 12.86
## 88   0.07151   0.0  4.49    0 0.4490 6.121  56.8  3.7476   3 247    18.5  8.44
## 89   0.05660   0.0  3.41    0 0.4890 7.007  86.3  3.4217   2 270    17.8  5.50
## 90   0.05302   0.0  3.41    0 0.4890 7.079  63.1  3.4145   2 270    17.8  5.70
## 91   0.04684   0.0  3.41    0 0.4890 6.417  66.1  3.0923   2 270    17.8  8.81
## 92   0.03932   0.0  3.41    0 0.4890 6.405  73.9  3.0921   2 270    17.8  8.20
## 93   0.04203  28.0 15.04    0 0.4640 6.442  53.6  3.6659   4 270    18.2  8.16
## 94   0.02875  28.0 15.04    0 0.4640 6.211  28.9  3.6659   4 270    18.2  6.21
## 95   0.04294  28.0 15.04    0 0.4640 6.249  77.3  3.6150   4 270    18.2 10.59
```

```
## 96   0.12204  0.0  2.89    0 0.4450 6.625  57.8  3.4952  2 276    18.0  6.65
## 97   0.11504  0.0  2.89    0 0.4450 6.163  69.6  3.4952  2 276    18.0 11.34
## 98   0.12083  0.0  2.89    0 0.4450 8.069  76.0  3.4952  2 276    18.0  4.21
## 99   0.08187  0.0  2.89    0 0.4450 7.820  36.9  3.4952  2 276    18.0  3.57
## 100  0.06860  0.0  2.89    0 0.4450 7.416  62.5  3.4952  2 276    18.0  6.19
## 101  0.14866  0.0  8.56    0 0.5200 6.727  79.9  2.7778  5 384    20.9  9.42
## 102  0.11432  0.0  8.56    0 0.5200 6.781  71.3  2.8561  5 384    20.9  7.67
## 103  0.22876  0.0  8.56    0 0.5200 6.405  85.4  2.7147  5 384    20.9 10.63
## 104  0.21161  0.0  8.56    0 0.5200 6.137  87.4  2.7147  5 384    20.9 13.44
## 105  0.13960  0.0  8.56    0 0.5200 6.167  90.0  2.4210  5 384    20.9 12.33
## 106  0.13262  0.0  8.56    0 0.5200 5.851  96.7  2.1069  5 384    20.9 16.47
## 107  0.17120  0.0  8.56    0 0.5200 5.836  91.9  2.2110  5 384    20.9 18.66
## 108  0.13117  0.0  8.56    0 0.5200 6.127  85.2  2.1224  5 384    20.9 14.09
## 109  0.12802  0.0  8.56    0 0.5200 6.474  97.1  2.4329  5 384    20.9 12.27
## 110  0.26363  0.0  8.56    0 0.5200 6.229  91.2  2.5451  5 384    20.9 15.55
## 111  0.10793  0.0  8.56    0 0.5200 6.195  54.4  2.7778  5 384    20.9 13.00
## 112  0.10084  0.0 10.01    0 0.5470 6.715  81.6  2.6775  6 432    17.8 10.16
## 113  0.12329  0.0 10.01    0 0.5470 5.913  92.9  2.3534  6 432    17.8 16.21
## 114  0.22212  0.0 10.01    0 0.5470 6.092  95.4  2.5480  6 432    17.8 17.09
## 115  0.14231  0.0 10.01    0 0.5470 6.254  84.2  2.2565  6 432    17.8 10.45
## 116  0.17134  0.0 10.01    0 0.5470 5.928  88.2  2.4631  6 432    17.8 15.76
## 117  0.13158  0.0 10.01    0 0.5470 6.176  72.5  2.7301  6 432    17.8 12.04
## 118  0.15098  0.0 10.01    0 0.5470 6.021  82.6  2.7474  6 432    17.8 10.30
## 119  0.13058  0.0 10.01    0 0.5470 5.872  73.1  2.4775  6 432    17.8 15.37
## 120  0.14476  0.0 10.01    0 0.5470 5.731  65.2  2.7592  6 432    17.8 13.61
## 121  0.06899  0.0 25.65    0 0.5810 5.870  69.7  2.2577  2 188    19.1 14.37
## 122  0.07165  0.0 25.65    0 0.5810 6.004  84.1  2.1974  2 188    19.1 14.27
## 123  0.09299  0.0 25.65    0 0.5810 5.961  92.9  2.0869  2 188    19.1 17.93
## 124  0.15038  0.0 25.65    0 0.5810 5.856  97.0  1.9444  2 188    19.1 25.41
## 125  0.09849  0.0 25.65    0 0.5810 5.879  95.8  2.0063  2 188    19.1 17.58
## 126  0.16902  0.0 25.65    0 0.5810 5.986  88.4  1.9929  2 188    19.1 14.81
## 127  0.38735  0.0 25.65    0 0.5810 5.613  95.6  1.7572  2 188    19.1 27.26
## 128  0.25915  0.0 21.89    0 0.6240 5.693  96.0  1.7883  4 437    21.2 17.19
## 129  0.32543  0.0 21.89    0 0.6240 6.431  98.8  1.8125  4 437    21.2 15.39
## 130  0.88125  0.0 21.89    0 0.6240 5.637  94.7  1.9799  4 437    21.2 18.34
## 131  0.34006  0.0 21.89    0 0.6240 6.458  98.9  2.1185  4 437    21.2 12.60
## 132  1.19294  0.0 21.89    0 0.6240 6.326  97.7  2.2710  4 437    21.2 12.26
## 133  0.59005  0.0 21.89    0 0.6240 6.372  97.9  2.3274  4 437    21.2 11.12
## 134  0.32982  0.0 21.89    0 0.6240 5.822  95.4  2.4699  4 437    21.2 15.03
## 135  0.97617  0.0 21.89    0 0.6240 5.757  98.4  2.3460  4 437    21.2 17.31
## 136  0.55778  0.0 21.89    0 0.6240 6.335  98.2  2.1107  4 437    21.2 16.96
## 137  0.32264  0.0 21.89    0 0.6240 5.942  93.5  1.9669  4 437    21.2 16.90
## 138  0.35233  0.0 21.89    0 0.6240 6.454  98.4  1.8498  4 437    21.2 14.59
## 139  0.24980  0.0 21.89    0 0.6240 5.857  98.2  1.6686  4 437    21.2 21.32
## 140  0.54452  0.0 21.89    0 0.6240 6.151  97.9  1.6687  4 437    21.2 18.46
## 141  0.29090  0.0 21.89    0 0.6240 6.174  93.6  1.6119  4 437    21.2 24.16
## 142  1.62864  0.0 21.89    0 0.6240 5.019 100.0  1.4394  4 437    21.2 34.41
## 143  3.32105  0.0 19.58    1 0.8710 5.403 100.0  1.3216  5 403    14.7 26.82
## 144  4.09740  0.0 19.58    0 0.8710 5.468 100.0  1.4118  5 403    14.7 26.42
## 145  2.77974  0.0 19.58    0 0.8710 4.903  97.8  1.3459  5 403    14.7 29.29
## 146  2.37934  0.0 19.58    0 0.8710 6.130 100.0  1.4191  5 403    14.7 27.80
## 147  2.15505  0.0 19.58    0 0.8710 5.628 100.0  1.5166  5 403    14.7 16.65
## 148  2.36862  0.0 19.58    0 0.8710 4.926  95.7  1.4608  5 403    14.7 29.53
## 149  2.33099  0.0 19.58    0 0.8710 5.186  93.8  1.5296  5 403    14.7 28.32
```

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## 150 2.73397  0.0 19.58    0 0.8710 5.597  94.9 1.5257   5 403    14.7 21.45
## 151 1.65660  0.0 19.58    0 0.8710 6.122  97.3 1.6180   5 403    14.7 14.10
## 152 1.49632  0.0 19.58    0 0.8710 5.404 100.0 1.5916   5 403    14.7 13.28
## 153 1.12658  0.0 19.58    1 0.8710 5.012  88.0 1.6102   5 403    14.7 12.12
## 154 2.14918  0.0 19.58    0 0.8710 5.709  98.5 1.6232   5 403    14.7 15.79
## 155 1.41385  0.0 19.58    1 0.8710 6.129  96.0 1.7494   5 403    14.7 15.12
## 156 3.53501  0.0 19.58    1 0.8710 6.152  82.6 1.7455   5 403    14.7 15.02
## 157 2.44668  0.0 19.58    0 0.8710 5.272  94.0 1.7364   5 403    14.7 16.14
## 158 1.22358  0.0 19.58    0 0.6050 6.943  97.4 1.8773   5 403    14.7  4.59
## 159 1.34284  0.0 19.58    0 0.6050 6.066 100.0 1.7573   5 403    14.7  6.43
## 160 1.42502  0.0 19.58    0 0.8710 6.510 100.0 1.7659   5 403    14.7  7.39
## 161 1.27346  0.0 19.58    1 0.6050 6.250  92.6 1.7984   5 403    14.7  5.50
## 162 1.46336  0.0 19.58    0 0.6050 7.489  90.8 1.9709   5 403    14.7  1.73
## 163 1.83377  0.0 19.58    1 0.6050 7.802  98.2 2.0407   5 403    14.7  1.92
## 164 1.51902  0.0 19.58    1 0.6050 8.375  93.9 2.1620   5 403    14.7  3.32
## 165 2.24236  0.0 19.58    0 0.6050 5.854  91.8 2.4220   5 403    14.7 11.64
## 166 2.92400  0.0 19.58    0 0.6050 6.101  93.0 2.2834   5 403    14.7  9.81
## 167 2.01019  0.0 19.58    0 0.6050 7.929  96.2 2.0459   5 403    14.7  3.70
## 168 1.80028  0.0 19.58    0 0.6050 5.877  79.2 2.4259   5 403    14.7 12.14
## 169 2.30040  0.0 19.58    0 0.6050 6.319  96.1 2.1000   5 403    14.7 11.10
## 170 2.44953  0.0 19.58    0 0.6050 6.402  95.2 2.2625   5 403    14.7 11.32
## 171 1.20742  0.0 19.58    0 0.6050 5.875  94.6 2.4259   5 403    14.7 14.43
## 172 2.31390  0.0 19.58    0 0.6050 5.880  97.3 2.3887   5 403    14.7 12.03
## 173 0.13914  0.0  4.05    0 0.5100 5.572  88.5 2.5961   5 296    16.6 14.69
## 174 0.09178  0.0  4.05    0 0.5100 6.416  84.1 2.6463   5 296    16.6  9.04
## 175 0.08447  0.0  4.05    0 0.5100 5.859  68.7 2.7019   5 296    16.6  9.64
## 176 0.06664  0.0  4.05    0 0.5100 6.546  33.1 3.1323   5 296    16.6  5.33
## 177 0.07022  0.0  4.05    0 0.5100 6.020  47.2 3.5549   5 296    16.6 10.11
## 178 0.05425  0.0  4.05    0 0.5100 6.315  73.4 3.3175   5 296    16.6  6.29
## 179 0.06642  0.0  4.05    0 0.5100 6.860  74.4 2.9153   5 296    16.6  6.92
## 180 0.05780  0.0  2.46    0 0.4880 6.980  58.4 2.8290   3 193    17.8  5.04
## 181 0.06588  0.0  2.46    0 0.4880 7.765  83.3 2.7410   3 193    17.8  7.56
## 182 0.06888  0.0  2.46    0 0.4880 6.144  62.2 2.5979   3 193    17.8  9.45
## 183 0.09103  0.0  2.46    0 0.4880 7.155  92.2 2.7006   3 193    17.8  4.82
## 184 0.10008  0.0  2.46    0 0.4880 6.563  95.6 2.8470   3 193    17.8  5.68
## 185 0.08308  0.0  2.46    0 0.4880 5.604  89.8 2.9879   3 193    17.8 13.98
## 186 0.06047  0.0  2.46    0 0.4880 6.153  68.8 3.2797   3 193    17.8 13.15
## 187 0.05602  0.0  2.46    0 0.4880 7.831  53.6 3.1992   3 193    17.8  4.45
## 188 0.07875 45.0  3.44    0 0.4370 6.782  41.1 3.7886   5 398    15.2  6.68
## 189 0.12579 45.0  3.44    0 0.4370 6.556  29.1 4.5667   5 398    15.2  4.56
## 190 0.08370 45.0  3.44    0 0.4370 7.185  38.9 4.5667   5 398    15.2  5.39
## 191 0.09068 45.0  3.44    0 0.4370 6.951  21.5 6.4798   5 398    15.2  5.10
## 192 0.06911 45.0  3.44    0 0.4370 6.739  30.8 6.4798   5 398    15.2  4.69
## 193 0.08664 45.0  3.44    0 0.4370 7.178  26.3 6.4798   5 398    15.2  2.87
## 194 0.02187 60.0  2.93    0 0.4010 6.800   9.9 6.2196   1 265    15.6  5.03
## 195 0.01439 60.0  2.93    0 0.4010 6.604  18.8 6.2196   1 265    15.6  4.38
## 196 0.01381 80.0  0.46    0 0.4220 7.875  32.0 5.6484   4 255    14.4  2.97
## 197 0.04011 80.0  1.52    0 0.4040 7.287  34.1 7.3090   2 329    12.6  4.08
## 198 0.04666 80.0  1.52    0 0.4040 7.107  36.6 7.3090   2 329    12.6  8.61
## 199 0.03768 80.0  1.52    0 0.4040 7.274  38.3 7.3090   2 329    12.6  6.62
## 200 0.03150 95.0  1.47    0 0.4030 6.975  15.3 7.6534   3 402    17.0  4.56
## 201 0.01778 95.0  1.47    0 0.4030 7.135  13.9 7.6534   3 402    17.0  4.45
## 202 0.03445 82.5  2.03    0 0.4150 6.162  38.4 6.2700   2 348    14.7  7.43
## 203 0.02177 82.5  2.03    0 0.4150 7.610  15.7 6.2700   2 348    14.7  3.11
```

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## 204  0.03510  95.0  2.68    0 0.4161 7.853  33.2  5.1180   4 224    14.7  3.81
## 205  0.02009  95.0  2.68    0 0.4161 8.034  31.9  5.1180   4 224    14.7  2.88
## 206  0.13642   0.0 10.59    0 0.4890 5.891  22.3  3.9454   4 277    18.6 10.87
## 207  0.22969   0.0 10.59    0 0.4890 6.326  52.5  4.3549   4 277    18.6 10.97
## 208  0.25199   0.0 10.59    0 0.4890 5.783  72.7  4.3549   4 277    18.6 18.06
## 209  0.13587   0.0 10.59    1 0.4890 6.064  59.1  4.2392   4 277    18.6 14.66
## 210  0.43571   0.0 10.59    1 0.4890 5.344 100.0  3.8750   4 277    18.6 23.09
## 211  0.17446   0.0 10.59    1 0.4890 5.960  92.1  3.8771   4 277    18.6 17.27
## 212  0.37578   0.0 10.59    1 0.4890 5.404  88.6  3.6650   4 277    18.6 23.98
## 213  0.21719   0.0 10.59    1 0.4890 5.807  53.8  3.6526   4 277    18.6 16.03
## 214  0.14052   0.0 10.59    0 0.4890 6.375  32.3  3.9454   4 277    18.6  9.38
## 215  0.28955   0.0 10.59    0 0.4890 5.412   9.8  3.5875   4 277    18.6 29.55
## 216  0.19802   0.0 10.59    0 0.4890 6.182  42.4  3.9454   4 277    18.6  9.47
## 217  0.04560   0.0 13.89    1 0.5500 5.888  56.0  3.1121   5 276    16.4 13.51
## 218  0.07013   0.0 13.89    0 0.5500 6.642  85.1  3.4211   5 276    16.4  9.69
## 219  0.11069   0.0 13.89    1 0.5500 5.951  93.8  2.8893   5 276    16.4 17.92
## 220  0.11425   0.0 13.89    1 0.5500 6.373  92.4  3.3633   5 276    16.4 10.50
## 221  0.35809   0.0  6.20    1 0.5070 6.951  88.5  2.8617   8 307    17.4  9.71
## 222  0.40771   0.0  6.20    1 0.5070 6.164  91.3  3.0480   8 307    17.4 21.46
## 223  0.62356   0.0  6.20    1 0.5070 6.879  77.7  3.2721   8 307    17.4  9.93
## 224  0.61470   0.0  6.20    0 0.5070 6.618  80.8  3.2721   8 307    17.4  7.60
## 225  0.31533   0.0  6.20    0 0.5040 8.266  78.3  2.8944   8 307    17.4  4.14
## 226  0.52693   0.0  6.20    0 0.5040 8.725  83.0  2.8944   8 307    17.4  4.63
## 227  0.38214   0.0  6.20    0 0.5040 8.040  86.5  3.2157   8 307    17.4  3.13
## 228  0.41238   0.0  6.20    0 0.5040 7.163  79.9  3.2157   8 307    17.4  6.36
## 229  0.29819   0.0  6.20    0 0.5040 7.686  17.0  3.3751   8 307    17.4  3.92
## 230  0.44178   0.0  6.20    0 0.5040 6.552  21.4  3.3751   8 307    17.4  3.76
## 231  0.53700   0.0  6.20    0 0.5040 5.981  68.1  3.6715   8 307    17.4 11.65
## 232  0.46296   0.0  6.20    0 0.5040 7.412  76.9  3.6715   8 307    17.4  5.25
## 233  0.57529   0.0  6.20    0 0.5070 8.337  73.3  3.8384   8 307    17.4  2.47
## 234  0.33147   0.0  6.20    0 0.5070 8.247  70.4  3.6519   8 307    17.4  3.95
## 235  0.44791   0.0  6.20    1 0.5070 6.726  66.5  3.6519   8 307    17.4  8.05
## 236  0.33045   0.0  6.20    0 0.5070 6.086  61.5  3.6519   8 307    17.4 10.88
## 237  0.52058   0.0  6.20    1 0.5070 6.631  76.5  4.1480   8 307    17.4  9.54
## 238  0.51183   0.0  6.20    0 0.5070 7.358  71.6  4.1480   8 307    17.4  4.73
## 239  0.08244  30.0  4.93    0 0.4280 6.481  18.5  6.1899   6 300    16.6  6.36
## 240  0.09252  30.0  4.93    0 0.4280 6.606  42.2  6.1899   6 300    16.6  7.37
## 241  0.11329  30.0  4.93    0 0.4280 6.897  54.3  6.3361   6 300    16.6 11.38
## 242  0.10612  30.0  4.93    0 0.4280 6.095  65.1  6.3361   6 300    16.6 12.40
## 243  0.10290  30.0  4.93    0 0.4280 6.358  52.9  7.0355   6 300    16.6 11.22
## 244  0.12757  30.0  4.93    0 0.4280 6.393   7.8  7.0355   6 300    16.6  5.19
## 245  0.20608  22.0  5.86    0 0.4310 5.593  76.5  7.9549   7 330    19.1 12.50
## 246  0.19133  22.0  5.86    0 0.4310 5.605  70.2  7.9549   7 330    19.1 18.46
## 247  0.33983  22.0  5.86    0 0.4310 6.108  34.9  8.0555   7 330    19.1  9.16
## 248  0.19657  22.0  5.86    0 0.4310 6.226  79.2  8.0555   7 330    19.1 10.15
## 249  0.16439  22.0  5.86    0 0.4310 6.433  49.1  7.8265   7 330    19.1  9.52
## 250  0.19073  22.0  5.86    0 0.4310 6.718  17.5  7.8265   7 330    19.1  6.56
## 251  0.14030  22.0  5.86    0 0.4310 6.487  13.0  7.3967   7 330    19.1  5.90
## 252  0.21409  22.0  5.86    0 0.4310 6.438   8.9  7.3967   7 330    19.1  3.59
## 253  0.08221  22.0  5.86    0 0.4310 6.957   6.8  8.9067   7 330    19.1  3.53
## 254  0.36894  22.0  5.86    0 0.4310 8.259   8.4  8.9067   7 330    19.1  3.54
## 255  0.04819  80.0  3.64    0 0.3920 6.108  32.0  9.2203   1 315    16.4  6.57
## 256  0.03548  80.0  3.64    0 0.3920 5.876  19.1  9.2203   1 315    16.4  9.25
## 257  0.01538  90.0  3.75    0 0.3940 7.454  34.2  6.3361   3 244    15.9  3.11
```

```
## 258  0.61154  20.0  3.97    0 0.6470 8.704  86.9  1.8010   5 264    13.0  5.12
## 259  0.66351  20.0  3.97    0 0.6470 7.333 100.0  1.8946   5 264    13.0  7.79
## 260  0.65665  20.0  3.97    0 0.6470 6.842 100.0  2.0107   5 264    13.0  6.90
## 261  0.54011  20.0  3.97    0 0.6470 7.203  81.8  2.1121   5 264    13.0  9.59
## 262  0.53412  20.0  3.97    0 0.6470 7.520  89.4  2.1398   5 264    13.0  7.26
## 263  0.52014  20.0  3.97    0 0.6470 8.398  91.5  2.2885   5 264    13.0  5.91
## 264  0.82526  20.0  3.97    0 0.6470 7.327  94.5  2.0788   5 264    13.0 11.25
## 265  0.55007  20.0  3.97    0 0.6470 7.206  91.6  1.9301   5 264    13.0  8.10
## 266  0.76162  20.0  3.97    0 0.6470 5.560  62.8  1.9865   5 264    13.0 10.45
## 267  0.78570  20.0  3.97    0 0.6470 7.014  84.6  2.1329   5 264    13.0 14.79
## 268  0.57834  20.0  3.97    0 0.5750 8.297  67.0  2.4216   5 264    13.0  7.44
## 269  0.54050  20.0  3.97    0 0.5750 7.470  52.6  2.8720   5 264    13.0  3.16
## 270  0.09065  20.0  6.96    1 0.4640 5.920  61.5  3.9175   3 223    18.6 13.65
## 271  0.29916  20.0  6.96    0 0.4640 5.856  42.1  4.4290   3 223    18.6 13.00
## 272  0.16211  20.0  6.96    0 0.4640 6.240  16.3  4.4290   3 223    18.6  6.59
## 273  0.11460  20.0  6.96    0 0.4640 6.538  58.7  3.9175   3 223    18.6  7.73
## 274  0.22188  20.0  6.96    1 0.4640 7.691  51.8  4.3665   3 223    18.6  6.58
## 275  0.05644  40.0  6.41    1 0.4470 6.758  32.9  4.0776   4 254    17.6  3.53
## 276  0.09604  40.0  6.41    0 0.4470 6.854  42.8  4.2673   4 254    17.6  2.98
## 277  0.10469  40.0  6.41    1 0.4470 7.267  49.0  4.7872   4 254    17.6  6.05
## 278  0.06127  40.0  6.41    1 0.4470 6.826  27.6  4.8628   4 254    17.6  4.16
## 279  0.07978  40.0  6.41    0 0.4470 6.482  32.1  4.1403   4 254    17.6  7.19
## 280  0.21038  20.0  3.33    0 0.4429 6.812  32.2  4.1007   5 216    14.9  4.85
## 281  0.03578  20.0  3.33    0 0.4429 7.820  64.5  4.6947   5 216    14.9  3.76
## 282  0.03705  20.0  3.33    0 0.4429 6.968  37.2  5.2447   5 216    14.9  4.59
## 283  0.06129  20.0  3.33    1 0.4429 7.645  49.7  5.2119   5 216    14.9  3.01
## 284  0.01501  90.0  1.21    1 0.4010 7.923  24.8  5.8850   1 198    13.6  3.16
## 285  0.00906  90.0  2.97    0 0.4000 7.088  20.8  7.3073   1 285    15.3  7.85
## 286  0.01096  55.0  2.25    0 0.3890 6.453  31.9  7.3073   1 300    15.3  8.23
## 287  0.01965  80.0  1.76    0 0.3850 6.230  31.5  9.0892   1 241    18.2 12.93
## 288  0.03871  52.5  5.32    0 0.4050 6.209  31.3  7.3172   6 293    16.6  7.14
## 289  0.04590  52.5  5.32    0 0.4050 6.315  45.6  7.3172   6 293    16.6  7.60
## 290  0.04297  52.5  5.32    0 0.4050 6.565  22.9  7.3172   6 293    16.6  9.51
## 291  0.03502  80.0  4.95    0 0.4110 6.861  27.9  5.1167   4 245    19.2  3.33
## 292  0.07886  80.0  4.95    0 0.4110 7.148  27.7  5.1167   4 245    19.2  3.56
## 293  0.03615  80.0  4.95    0 0.4110 6.630  23.4  5.1167   4 245    19.2  4.70
## 294  0.08265   0.0 13.92    0 0.4370 6.127  18.4  5.5027   4 289    16.0  8.58
## 295  0.08199   0.0 13.92    0 0.4370 6.009  42.3  5.5027   4 289    16.0 10.40
## 296  0.12932   0.0 13.92    0 0.4370 6.678  31.1  5.9604   4 289    16.0  6.27
## 297  0.05372   0.0 13.92    0 0.4370 6.549  51.0  5.9604   4 289    16.0  7.39
## 298  0.14103   0.0 13.92    0 0.4370 5.790  58.0  6.3200   4 289    16.0 15.84
## 299  0.06466  70.0  2.24    0 0.4000 6.345  20.1  7.8278   5 358    14.8  4.97
## 300  0.05561  70.0  2.24    0 0.4000 7.041  10.0  7.8278   5 358    14.8  4.74
## 301  0.04417  70.0  2.24    0 0.4000 6.871  47.4  7.8278   5 358    14.8  6.07
## 302  0.03537  34.0  6.09    0 0.4330 6.590  40.4  5.4917   7 329    16.1  9.50
## 303  0.09266  34.0  6.09    0 0.4330 6.495  18.4  5.4917   7 329    16.1  8.67
## 304  0.10000  34.0  6.09    0 0.4330 6.982  17.7  5.4917   7 329    16.1  4.86
## 305  0.05515  33.0  2.18    0 0.4720 7.236  41.1  4.0220   7 222    18.4  6.93
## 306  0.05479  33.0  2.18    0 0.4720 6.616  58.1  3.3700   7 222    18.4  8.93
## 307  0.07503  33.0  2.18    0 0.4720 7.420  71.9  3.0992   7 222    18.4  6.47
## 308  0.04932  33.0  2.18    0 0.4720 6.849  70.3  3.1827   7 222    18.4  7.53
## 309  0.49298   0.0  9.90    0 0.5440 6.635  82.5  3.3175   4 304    18.4  4.54
## 310  0.34940   0.0  9.90    0 0.5440 5.972  76.7  3.1025   4 304    18.4  9.97
## 311  2.63548   0.0  9.90    0 0.5440 4.973  37.8  2.5194   4 304    18.4 12.64
```

```
## 312  0.79041   0.0  9.90    0 0.5440 6.122  52.8  2.6403   4 304    18.4  5.98
## 313  0.26169   0.0  9.90    0 0.5440 6.023  90.4  2.8340   4 304    18.4 11.72
## 314  0.26938   0.0  9.90    0 0.5440 6.266  82.8  3.2628   4 304    18.4  7.90
## 315  0.36920   0.0  9.90    0 0.5440 6.567  87.3  3.6023   4 304    18.4  9.28
## 316  0.25356   0.0  9.90    0 0.5440 5.705  77.7  3.9450   4 304    18.4 11.50
## 317  0.31827   0.0  9.90    0 0.5440 5.914  83.2  3.9986   4 304    18.4 18.33
## 318  0.24522   0.0  9.90    0 0.5440 5.782  71.7  4.0317   4 304    18.4 15.94
## 319  0.40202   0.0  9.90    0 0.5440 6.382  67.2  3.5325   4 304    18.4 10.36
## 320  0.47547   0.0  9.90    0 0.5440 6.113  58.8  4.0019   4 304    18.4 12.73
## 321  0.16760   0.0  7.38    0 0.4930 6.426  52.3  4.5404   5 287    19.6  7.20
## 322  0.18159   0.0  7.38    0 0.4930 6.376  54.3  4.5404   5 287    19.6  6.87
## 323  0.35114   0.0  7.38    0 0.4930 6.041  49.9  4.7211   5 287    19.6  7.70
## 324  0.28392   0.0  7.38    0 0.4930 5.708  74.3  4.7211   5 287    19.6 11.74
## 325  0.34109   0.0  7.38    0 0.4930 6.415  40.1  4.7211   5 287    19.6  6.12
## 326  0.19186   0.0  7.38    0 0.4930 6.431  14.7  5.4159   5 287    19.6  5.08
## 327  0.30347   0.0  7.38    0 0.4930 6.312  28.9  5.4159   5 287    19.6  6.15
## 328  0.24103   0.0  7.38    0 0.4930 6.083  43.7  5.4159   5 287    19.6 12.79
## 329  0.06617   0.0  3.24    0 0.4600 5.868  25.8  5.2146   4 430    16.9  9.97
## 330  0.06724   0.0  3.24    0 0.4600 6.333  17.2  5.2146   4 430    16.9  7.34
## 331  0.04544   0.0  3.24    0 0.4600 6.144  32.2  5.8736   4 430    16.9  9.09
## 332  0.05023  35.0  6.06    0 0.4379 5.706  28.4  6.6407   1 304    16.9 12.43
## 333  0.03466  35.0  6.06    0 0.4379 6.031  23.3  6.6407   1 304    16.9  7.83
## 334  0.05083   0.0  5.19    0 0.5150 6.316  38.1  6.4584   5 224    20.2  5.68
## 335  0.03738   0.0  5.19    0 0.5150 6.310  38.5  6.4584   5 224    20.2  6.75
## 336  0.03961   0.0  5.19    0 0.5150 6.037  34.5  5.9853   5 224    20.2  8.01
## 337  0.03427   0.0  5.19    0 0.5150 5.869  46.3  5.2311   5 224    20.2  9.80
## 338  0.03041   0.0  5.19    0 0.5150 5.895  59.6  5.6150   5 224    20.2 10.56
## 339  0.03306   0.0  5.19    0 0.5150 6.059  37.3  4.8122   5 224    20.2  8.51
## 340  0.05497   0.0  5.19    0 0.5150 5.985  45.4  4.8122   5 224    20.2  9.74
## 341  0.06151   0.0  5.19    0 0.5150 5.968  58.5  4.8122   5 224    20.2  9.29
## 342  0.01301  35.0  1.52    0 0.4420 7.241  49.3  7.0379   1 284    15.5  5.49
## 343  0.02498   0.0  1.89    0 0.5180 6.540  59.7  6.2669   1 422    15.9  8.65
## 344  0.02543  55.0  3.78    0 0.4840 6.696  56.4  5.7321   5 370    17.6  7.18
## 345  0.03049  55.0  3.78    0 0.4840 6.874  28.1  6.4654   5 370    17.6  4.61
## 346  0.03113   0.0  4.39    0 0.4420 6.014  48.5  8.0136   3 352    18.8 10.53
## 347  0.06162   0.0  4.39    0 0.4420 5.898  52.3  8.0136   3 352    18.8 12.67
## 348  0.01870  85.0  4.15    0 0.4290 6.516  27.7  8.5353   4 351    17.9  6.36
## 349  0.01501  80.0  2.01    0 0.4350 6.635  29.7  8.3440   4 280    17.0  5.99
## 350  0.02899  40.0  1.25    0 0.4290 6.939  34.5  8.7921   1 335    19.7  5.89
## 351  0.06211  40.0  1.25    0 0.4290 6.490  44.4  8.7921   1 335    19.7  5.98
## 352  0.07950  60.0  1.69    0 0.4110 6.579  35.9 10.7103   4 411    18.3  5.49
## 353  0.07244  60.0  1.69    0 0.4110 5.884  18.5 10.7103   4 411    18.3  7.79
## 354  0.01709  90.0  2.02    0 0.4100 6.728  36.1 12.1265   5 187    17.0  4.50
## 355  0.04301  80.0  1.91    0 0.4130 5.663  21.9 10.5857   4 334    22.0  8.05
## 356  0.10659  80.0  1.91    0 0.4130 5.936  19.5 10.5857   4 334    22.0  5.57
## 357  8.98296   0.0 18.10    1 0.7700 6.212  97.4  2.1222  24 666    20.2 17.60
## 358  3.84970   0.0 18.10    1 0.7700 6.395  91.0  2.5052  24 666    20.2 13.27
## 359  5.20177   0.0 18.10    1 0.7700 6.127  83.4  2.7227  24 666    20.2 11.48
## 360  4.26131   0.0 18.10    0 0.7700 6.112  81.3  2.5091  24 666    20.2 12.67
## 361  4.54192   0.0 18.10    0 0.7700 6.398  88.0  2.5182  24 666    20.2  7.79
## 362  3.83684   0.0 18.10    0 0.7700 6.251  91.1  2.2955  24 666    20.2 14.19
## 363  3.67822   0.0 18.10    0 0.7700 5.362  96.2  2.1036  24 666    20.2 10.19
## 364  4.22239   0.0 18.10    1 0.7700 5.803  89.0  1.9047  24 666    20.2 14.64
## 365  3.47428   0.0 18.10    1 0.7180 8.780  82.9  1.9047  24 666    20.2  5.29
```

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## 366  4.55587   0.0 18.10    0 0.7180 3.561  87.9  1.6132  24 666    20.2  7.12
## 367  3.69695   0.0 18.10    0 0.7180 4.963  91.4  1.7523  24 666    20.2 14.00
## 368 13.52220   0.0 18.10    0 0.6310 3.863 100.0  1.5106  24 666    20.2 13.33
## 369  4.89822   0.0 18.10    0 0.6310 4.970 100.0  1.3325  24 666    20.2  3.26
## 370  5.66998   0.0 18.10    1 0.6310 6.683  96.8  1.3567  24 666    20.2  3.73
## 371  6.53876   0.0 18.10    1 0.6310 7.016  97.5  1.2024  24 666    20.2  2.96
## 372  9.23230   0.0 18.10    0 0.6310 6.216 100.0  1.1691  24 666    20.2  9.53
## 373  8.26725   0.0 18.10    1 0.6680 5.875  89.6  1.1296  24 666    20.2  8.88
## 374 11.10810   0.0 18.10    0 0.6680 4.906 100.0  1.1742  24 666    20.2 34.77
## 375 18.49820   0.0 18.10    0 0.6680 4.138 100.0  1.1370  24 666    20.2 37.97
## 376 19.60910   0.0 18.10    0 0.6710 7.313  97.9  1.3163  24 666    20.2 13.44
## 377 15.28800   0.0 18.10    0 0.6710 6.649  93.3  1.3449  24 666    20.2 23.24
## 378  9.82349   0.0 18.10    0 0.6710 6.794  98.8  1.3580  24 666    20.2 21.24
## 379 23.64820   0.0 18.10    0 0.6710 6.380  96.2  1.3861  24 666    20.2 23.69
## 380 17.86670   0.0 18.10    0 0.6710 6.223 100.0  1.3861  24 666    20.2 21.78
## 381 88.97620   0.0 18.10    0 0.6710 6.968  91.9  1.4165  24 666    20.2 17.21
## 382 15.87440   0.0 18.10    0 0.6710 6.545  99.1  1.5192  24 666    20.2 21.08
## 383  9.18702   0.0 18.10    0 0.7000 5.536 100.0  1.5804  24 666    20.2 23.60
## 384  7.99248   0.0 18.10    0 0.7000 5.520 100.0  1.5331  24 666    20.2 24.56
## 385 20.08490   0.0 18.10    0 0.7000 4.368  91.2  1.4395  24 666    20.2 30.63
## 386 16.81180   0.0 18.10    0 0.7000 5.277  98.1  1.4261  24 666    20.2 30.81
## 387 24.39380   0.0 18.10    0 0.7000 4.652 100.0  1.4672  24 666    20.2 28.28
## 388 22.59710   0.0 18.10    0 0.7000 5.000  89.5  1.5184  24 666    20.2 31.99
## 389 14.33370   0.0 18.10    0 0.7000 4.880 100.0  1.5895  24 666    20.2 30.62
## 390  8.15174   0.0 18.10    0 0.7000 5.390  98.9  1.7281  24 666    20.2 20.85
## 391  6.96215   0.0 18.10    0 0.7000 5.713  97.0  1.9265  24 666    20.2 17.11
## 392  5.29305   0.0 18.10    0 0.7000 6.051  82.5  2.1678  24 666    20.2 18.76
## 393 11.57790   0.0 18.10    0 0.7000 5.036  97.0  1.7700  24 666    20.2 25.68
## 394  8.64476   0.0 18.10    0 0.6930 6.193  92.6  1.7912  24 666    20.2 15.17
## 395 13.35980   0.0 18.10    0 0.6930 5.887  94.7  1.7821  24 666    20.2 16.35
## 396  8.71675   0.0 18.10    0 0.6930 6.471  98.8  1.7257  24 666    20.2 17.12
## 397  5.87205   0.0 18.10    0 0.6930 6.405  96.0  1.6768  24 666    20.2 19.37
## 398  7.67202   0.0 18.10    0 0.6930 5.747  98.9  1.6334  24 666    20.2 19.92
## 399 38.35180   0.0 18.10    0 0.6930 5.453 100.0  1.4896  24 666    20.2 30.59
## 400  9.91655   0.0 18.10    0 0.6930 5.852  77.8  1.5004  24 666    20.2 29.97
## 401 25.04610   0.0 18.10    0 0.6930 5.987 100.0  1.5888  24 666    20.2 26.77
## 402 14.23620   0.0 18.10    0 0.6930 6.343 100.0  1.5741  24 666    20.2 20.32
## 403  9.59571   0.0 18.10    0 0.6930 6.404 100.0  1.6390  24 666    20.2 20.31
## 404 24.80170   0.0 18.10    0 0.6930 5.349  96.0  1.7028  24 666    20.2 19.77
## 405 41.52920   0.0 18.10    0 0.6930 5.531  85.4  1.6074  24 666    20.2 27.38
## 406 67.92080   0.0 18.10    0 0.6930 5.683 100.0  1.4254  24 666    20.2 22.98
## 407 20.71620   0.0 18.10    0 0.6590 4.138 100.0  1.1781  24 666    20.2 23.34
## 408 11.95110   0.0 18.10    0 0.6590 5.608 100.0  1.2852  24 666    20.2 12.13
## 409  7.40389   0.0 18.10    0 0.5970 5.617  97.9  1.4547  24 666    20.2 26.40
## 410 14.43830   0.0 18.10    0 0.5970 6.852 100.0  1.4655  24 666    20.2 19.78
## 411 51.13580   0.0 18.10    0 0.5970 5.757 100.0  1.4130  24 666    20.2 10.11
## 412 14.05070   0.0 18.10    0 0.5970 6.657 100.0  1.5275  24 666    20.2 21.22
## 413 18.81100   0.0 18.10    0 0.5970 4.628 100.0  1.5539  24 666    20.2 34.37
## 414 28.65580   0.0 18.10    0 0.5970 5.155 100.0  1.5894  24 666    20.2 20.08
## 415 45.74610   0.0 18.10    0 0.6930 4.519 100.0  1.6582  24 666    20.2 36.98
## 416 18.08460   0.0 18.10    0 0.6790 6.434 100.0  1.8347  24 666    20.2 29.05
## 417 10.83420   0.0 18.10    0 0.6790 6.782  90.8  1.8195  24 666    20.2 25.79
## 418 25.94060   0.0 18.10    0 0.6790 5.304  89.1  1.6475  24 666    20.2 26.64
## 419 73.53410   0.0 18.10    0 0.6790 5.957 100.0  1.8026  24 666    20.2 20.62
```

```
## 420 11.81230   0.0 18.10    0 0.7180 6.824  76.5  1.7940  24 666    20.2 22.74
## 421 11.08740   0.0 18.10    0 0.7180 6.411 100.0  1.8589  24 666    20.2 15.02
## 422  7.02259   0.0 18.10    0 0.7180 6.006  95.3  1.8746  24 666    20.2 15.70
## 423 12.04820   0.0 18.10    0 0.6140 5.648  87.6  1.9512  24 666    20.2 14.10
## 424  7.05042   0.0 18.10    0 0.6140 6.103  85.1  2.0218  24 666    20.2 23.29
## 425  8.79212   0.0 18.10    0 0.5840 5.565  70.6  2.0635  24 666    20.2 17.16
## 426 15.86030   0.0 18.10    0 0.6790 5.896  95.4  1.9096  24 666    20.2 24.39
## 427 12.24720   0.0 18.10    0 0.5840 5.837  59.7  1.9976  24 666    20.2 15.69
## 428 37.66190   0.0 18.10    0 0.6790 6.202  78.7  1.8629  24 666    20.2 14.52
## 429  7.36711   0.0 18.10    0 0.6790 6.193  78.1  1.9356  24 666    20.2 21.52
## 430  9.33889   0.0 18.10    0 0.6790 6.380  95.6  1.9682  24 666    20.2 24.08
## 431  8.49213   0.0 18.10    0 0.5840 6.348  86.1  2.0527  24 666    20.2 17.64
## 432 10.06230   0.0 18.10    0 0.5840 6.833  94.3  2.0882  24 666    20.2 19.69
## 433  6.44405   0.0 18.10    0 0.5840 6.425  74.8  2.2004  24 666    20.2 12.03
## 434  5.58107   0.0 18.10    0 0.7130 6.436  87.9  2.3158  24 666    20.2 16.22
## 435 13.91340   0.0 18.10    0 0.7130 6.208  95.0  2.2222  24 666    20.2 15.17
## 436 11.16040   0.0 18.10    0 0.7400 6.629  94.6  2.1247  24 666    20.2 23.27
## 437 14.42080   0.0 18.10    0 0.7400 6.461  93.3  2.0026  24 666    20.2 18.05
## 438 15.17720   0.0 18.10    0 0.7400 6.152 100.0  1.9142  24 666    20.2 26.45
## 439 13.67810   0.0 18.10    0 0.7400 5.935  87.9  1.8206  24 666    20.2 34.02
## 440  9.39063   0.0 18.10    0 0.7400 5.627  93.9  1.8172  24 666    20.2 22.88
## 441 22.05110   0.0 18.10    0 0.7400 5.818  92.4  1.8662  24 666    20.2 22.11
## 442  9.72418   0.0 18.10    0 0.7400 6.406  97.2  2.0651  24 666    20.2 19.52
## 443  5.66637   0.0 18.10    0 0.7400 6.219 100.0  2.0048  24 666    20.2 16.59
## 444  9.96654   0.0 18.10    0 0.7400 6.485 100.0  1.9784  24 666    20.2 18.85
## 445 12.80230   0.0 18.10    0 0.7400 5.854  96.6  1.8956  24 666    20.2 23.79
## 446 10.67180   0.0 18.10    0 0.7400 6.459  94.8  1.9879  24 666    20.2 23.98
## 447  6.28807   0.0 18.10    0 0.7400 6.341  96.4  2.0720  24 666    20.2 17.79
## 448  9.92485   0.0 18.10    0 0.7400 6.251  96.6  2.1980  24 666    20.2 16.44
## 449  9.32909   0.0 18.10    0 0.7130 6.185  98.7  2.2616  24 666    20.2 18.13
## 450  7.52601   0.0 18.10    0 0.7130 6.417  98.3  2.1850  24 666    20.2 19.31
## 451  6.71772   0.0 18.10    0 0.7130 6.749  92.6  2.3236  24 666    20.2 17.44
## 452  5.44114   0.0 18.10    0 0.7130 6.655  98.2  2.3552  24 666    20.2 17.73
## 453  5.09017   0.0 18.10    0 0.7130 6.297  91.8  2.3682  24 666    20.2 17.27
## 454  8.24809   0.0 18.10    0 0.7130 7.393  99.3  2.4527  24 666    20.2 16.74
## 455  9.51363   0.0 18.10    0 0.7130 6.728  94.1  2.4961  24 666    20.2 18.71
## 456  4.75237   0.0 18.10    0 0.7130 6.525  86.5  2.4358  24 666    20.2 18.13
## 457  4.66883   0.0 18.10    0 0.7130 5.976  87.9  2.5806  24 666    20.2 19.01
## 458  8.20058   0.0 18.10    0 0.7130 5.936  80.3  2.7792  24 666    20.2 16.94
## 459  7.75223   0.0 18.10    0 0.7130 6.301  83.7  2.7831  24 666    20.2 16.23
## 460  6.80117   0.0 18.10    0 0.7130 6.081  84.4  2.7175  24 666    20.2 14.70
## 461  4.81213   0.0 18.10    0 0.7130 6.701  90.0  2.5975  24 666    20.2 16.42
## 462  3.69311   0.0 18.10    0 0.7130 6.376  88.4  2.5671  24 666    20.2 14.65
## 463  6.65492   0.0 18.10    0 0.7130 6.317  83.0  2.7344  24 666    20.2 13.99
## 464  5.82115   0.0 18.10    0 0.7130 6.513  89.9  2.8016  24 666    20.2 10.29
## 465  7.83932   0.0 18.10    0 0.6550 6.209  65.4  2.9634  24 666    20.2 13.22
## 466  3.16360   0.0 18.10    0 0.6550 5.759  48.2  3.0665  24 666    20.2 14.13
## 467  3.77498   0.0 18.10    0 0.6550 5.952  84.7  2.8715  24 666    20.2 17.15
## 468  4.42228   0.0 18.10    0 0.5840 6.003  94.5  2.5403  24 666    20.2 21.32
## 469 15.57570   0.0 18.10    0 0.5800 5.926  71.0  2.9084  24 666    20.2 18.13
## 470 13.07510   0.0 18.10    0 0.5800 5.713  56.7  2.8237  24 666    20.2 14.76
## 471  4.34879   0.0 18.10    0 0.5800 6.167  84.0  3.0334  24 666    20.2 16.29
## 472  4.03841   0.0 18.10    0 0.5320 6.229  90.7  3.0993  24 666    20.2 12.87
## 473  3.56868   0.0 18.10    0 0.5800 6.437  75.0  2.8965  24 666    20.2 14.36
```

```
## 474  4.64689   0.0 18.10    0 0.6140 6.980  67.6  2.5329  24 666    20.2 11.66
## 475  8.05579   0.0 18.10    0 0.5840 5.427  95.4  2.4298  24 666    20.2 18.14
## 476  6.39312   0.0 18.10    0 0.5840 6.162  97.4  2.2060  24 666    20.2 24.10
## 477  4.87141   0.0 18.10    0 0.6140 6.484  93.6  2.3053  24 666    20.2 18.68
## 478 15.02340   0.0 18.10    0 0.6140 5.304  97.3  2.1007  24 666    20.2 24.91
## 479 10.23300   0.0 18.10    0 0.6140 6.185  96.7  2.1705  24 666    20.2 18.03
## 480 14.33370   0.0 18.10    0 0.6140 6.229  88.0  1.9512  24 666    20.2 13.11
## 481  5.82401   0.0 18.10    0 0.5320 6.242  64.7  3.4242  24 666    20.2 10.74
## 482  5.70818   0.0 18.10    0 0.5320 6.750  74.9  3.3317  24 666    20.2  7.74
## 483  5.73116   0.0 18.10    0 0.5320 7.061  77.0  3.4106  24 666    20.2  7.01
## 484  2.81838   0.0 18.10    0 0.5320 5.762  40.3  4.0983  24 666    20.2 10.42
## 485  2.37857   0.0 18.10    0 0.5830 5.871  41.9  3.7240  24 666    20.2 13.34
## 486  3.67367   0.0 18.10    0 0.5830 6.312  51.9  3.9917  24 666    20.2 10.58
## 487  5.69175   0.0 18.10    0 0.5830 6.114  79.8  3.5459  24 666    20.2 14.98
## 488  4.83567   0.0 18.10    0 0.5830 5.905  53.2  3.1523  24 666    20.2 11.45
## 489  0.15086   0.0 27.74    0 0.6090 5.454  92.7  1.8209   4 711    20.1 18.06
## 490  0.18337   0.0 27.74    0 0.6090 5.414  98.3  1.7554   4 711    20.1 23.97
## 491  0.20746   0.0 27.74    0 0.6090 5.093  98.0  1.8226   4 711    20.1 29.68
## 492  0.10574   0.0 27.74    0 0.6090 5.983  98.8  1.8681   4 711    20.1 18.07
## 493  0.11132   0.0 27.74    0 0.6090 5.983  83.5  2.1099   4 711    20.1 13.35
## 494  0.17331   0.0  9.69    0 0.5850 5.707  54.0  2.3817   6 391    19.2 12.01
## 495  0.27957   0.0  9.69    0 0.5850 5.926  42.6  2.3817   6 391    19.2 13.59
## 496  0.17899   0.0  9.69    0 0.5850 5.670  28.8  2.7986   6 391    19.2 17.60
## 497  0.28960   0.0  9.69    0 0.5850 5.390  72.9  2.7986   6 391    19.2 21.14
## 498  0.26838   0.0  9.69    0 0.5850 5.794  70.6  2.8927   6 391    19.2 14.10
## 499  0.23912   0.0  9.69    0 0.5850 6.019  65.3  2.4091   6 391    19.2 12.92
## 500  0.17783   0.0  9.69    0 0.5850 5.569  73.5  2.3999   6 391    19.2 15.10
## 501  0.22438   0.0  9.69    0 0.5850 6.027  79.7  2.4982   6 391    19.2 14.33
## 502  0.06263   0.0 11.93    0 0.5730 6.593  69.1  2.4786   1 273    21.0  9.67
## 503  0.04527   0.0 11.93    0 0.5730 6.120  76.7  2.2875   1 273    21.0  9.08
## 504  0.06076   0.0 11.93    0 0.5730 6.976  91.0  2.1675   1 273    21.0  5.64
## 505  0.10959   0.0 11.93    0 0.5730 6.794  89.3  2.3889   1 273    21.0  6.48
## 506  0.04741   0.0 11.93    0 0.5730 6.030  80.8  2.5050   1 273    21.0  7.88
##     medv
## 1   24.0
## 2   21.6
## 3   34.7
## 4   33.4
## 5   36.2
## 6   28.7
## 7   22.9
## 8   27.1
## 9   16.5
## 10  18.9
## 11  15.0
## 12  18.9
## 13  21.7
## 14  20.4
## 15  18.2
## 16  19.9
## 17  23.1
## 18  17.5
## 19  20.2
## 20  18.2
```

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## 21  13.6
## 22  19.6
## 23  15.2
## 24  14.5
## 25  15.6
## 26  13.9
## 27  16.6
## 28  14.8
## 29  18.4
## 30  21.0
## 31  12.7
## 32  14.5
## 33  13.2
## 34  13.1
## 35  13.5
## 36  18.9
## 37  20.0
## 38  21.0
## 39  24.7
## 40  30.8
## 41  34.9
## 42  26.6
## 43  25.3
## 44  24.7
## 45  21.2
## 46  19.3
## 47  20.0
## 48  16.6
## 49  14.4
## 50  19.4
## 51  19.7
## 52  20.5
## 53  25.0
## 54  23.4
## 55  18.9
## 56  35.4
## 57  24.7
## 58  31.6
## 59  23.3
## 60  19.6
## 61  18.7
## 62  16.0
## 63  22.2
## 64  25.0
## 65  33.0
## 66  23.5
## 67  19.4
## 68  22.0
## 69  17.4
## 70  20.9
## 71  24.2
## 72  21.7
## 73  22.8
## 74  23.4
```

```
## 75  24.1
## 76  21.4
## 77  20.0
## 78  20.8
## 79  21.2
## 80  20.3
## 81  28.0
## 82  23.9
## 83  24.8
## 84  22.9
## 85  23.9
## 86  26.6
## 87  22.5
## 88  22.2
## 89  23.6
## 90  28.7
## 91  22.6
## 92  22.0
## 93  22.9
## 94  25.0
## 95  20.6
## 96  28.4
## 97  21.4
## 98  38.7
## 99  43.8
## 100 33.2
## 101 27.5
## 102 26.5
## 103 18.6
## 104 19.3
## 105 20.1
## 106 19.5
## 107 19.5
## 108 20.4
## 109 19.8
## 110 19.4
## 111 21.7
## 112 22.8
## 113 18.8
## 114 18.7
## 115 18.5
## 116 18.3
## 117 21.2
## 118 19.2
## 119 20.4
## 120 19.3
## 121 22.0
## 122 20.3
## 123 20.5
## 124 17.3
## 125 18.8
## 126 21.4
## 127 15.7
## 128 16.2
```

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## 129 18.0
## 130 14.3
## 131 19.2
## 132 19.6
## 133 23.0
## 134 18.4
## 135 15.6
## 136 18.1
## 137 17.4
## 138 17.1
## 139 13.3
## 140 17.8
## 141 14.0
## 142 14.4
## 143 13.4
## 144 15.6
## 145 11.8
## 146 13.8
## 147 15.6
## 148 14.6
## 149 17.8
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## 151 21.5
## 152 19.6
## 153 15.3
## 154 19.4
## 155 17.0
## 156 15.6
## 157 13.1
## 158 41.3
## 159 24.3
## 160 23.3
## 161 27.0
## 162 50.0
## 163 50.0
## 164 50.0
## 165 22.7
## 166 25.0
## 167 50.0
## 168 23.8
## 169 23.8
## 170 22.3
## 171 17.4
## 172 19.1
## 173 23.1
## 174 23.6
## 175 22.6
## 176 29.4
## 177 23.2
## 178 24.6
## 179 29.9
## 180 37.2
## 181 39.8
## 182 36.2
```

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## 183 37.9
## 184 32.5
## 185 26.4
## 186 29.6
## 187 50.0
## 188 32.0
## 189 29.8
## 190 34.9
## 191 37.0
## 192 30.5
## 193 36.4
## 194 31.1
## 195 29.1
## 196 50.0
## 197 33.3
## 198 30.3
## 199 34.6
## 200 34.9
## 201 32.9
## 202 24.1
## 203 42.3
## 204 48.5
## 205 50.0
## 206 22.6
## 207 24.4
## 208 22.5
## 209 24.4
## 210 20.0
## 211 21.7
## 212 19.3
## 213 22.4
## 214 28.1
## 215 23.7
## 216 25.0
## 217 23.3
## 218 28.7
## 219 21.5
## 220 23.0
## 221 26.7
## 222 21.7
## 223 27.5
## 224 30.1
## 225 44.8
## 226 50.0
## 227 37.6
## 228 31.6
## 229 46.7
## 230 31.5
## 231 24.3
## 232 31.7
## 233 41.7
## 234 48.3
## 235 29.0
## 236 24.0
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```
## 237 25.1
## 238 31.5
## 239 23.7
## 240 23.3
## 241 22.0
## 242 20.1
## 243 22.2
## 244 23.7
## 245 17.6
## 246 18.5
## 247 24.3
## 248 20.5
## 249 24.5
## 250 26.2
## 251 24.4
## 252 24.8
## 253 29.6
## 254 42.8
## 255 21.9
## 256 20.9
## 257 44.0
## 258 50.0
## 259 36.0
## 260 30.1
## 261 33.8
## 262 43.1
## 263 48.8
## 264 31.0
## 265 36.5
## 266 22.8
## 267 30.7
## 268 50.0
## 269 43.5
## 270 20.7
## 271 21.1
## 272 25.2
## 273 24.4
## 274 35.2
## 275 32.4
## 276 32.0
## 277 33.2
## 278 33.1
## 279 29.1
## 280 35.1
## 281 45.4
## 282 35.4
## 283 46.0
## 284 50.0
## 285 32.2
## 286 22.0
## 287 20.1
## 288 23.2
## 289 22.3
## 290 24.8
```

```
## 291 28.5
## 292 37.3
## 293 27.9
## 294 23.9
## 295 21.7
## 296 28.6
## 297 27.1
## 298 20.3
## 299 22.5
## 300 29.0
## 301 24.8
## 302 22.0
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## 304 33.1
## 305 36.1
## 306 28.4
## 307 33.4
## 308 28.2
## 309 22.8
## 310 20.3
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## 312 22.1
## 313 19.4
## 314 21.6
## 315 23.8
## 316 16.2
## 317 17.8
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## 321 23.8
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## 324 18.5
## 325 25.0
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## 334 22.2
## 335 20.7
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## 337 19.5
## 338 18.5
## 339 20.6
## 340 19.0
## 341 18.7
## 342 32.7
## 343 16.5
## 344 23.9
```

```
## 345 31.2
## 346 17.5
## 347 17.2
## 348 23.1
## 349 24.5
## 350 26.6
## 351 22.9
## 352 24.1
## 353 18.6
## 354 30.1
## 355 18.2
## 356 20.6
## 357 17.8
## 358 21.7
## 359 22.7
## 360 22.6
## 361 25.0
## 362 19.9
## 363 20.8
## 364 16.8
## 365 21.9
## 366 27.5
## 367 21.9
## 368 23.1
## 369 50.0
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## 374 13.8
## 375 13.8
## 376 15.0
## 377 13.9
## 378 13.3
## 379 13.1
## 380 10.2
## 381 10.4
## 382 10.9
## 383 11.3
## 384 12.3
## 385  8.8
## 386  7.2
## 387 10.5
## 388  7.4
## 389 10.2
## 390 11.5
## 391 15.1
## 392 23.2
## 393  9.7
## 394 13.8
## 395 12.7
## 396 13.1
## 397 12.5
## 398  8.5
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```
## 399  5.0
## 400  6.3
## 401  5.6
## 402  7.2
## 403 12.1
## 404  8.3
## 405  8.5
## 406  5.0
## 407 11.9
## 408 27.9
## 409 17.2
## 410 27.5
## 411 15.0
## 412 17.2
## 413 17.9
## 414 16.3
## 415  7.0
## 416  7.2
## 417  7.5
## 418 10.4
## 419  8.8
## 420  8.4
## 421 16.7
## 422 14.2
## 423 20.8
## 424 13.4
## 425 11.7
## 426  8.3
## 427 10.2
## 428 10.9
## 429 11.0
## 430  9.5
## 431 14.5
## 432 14.1
## 433 16.1
## 434 14.3
## 435 11.7
## 436 13.4
## 437  9.6
## 438  8.7
## 439  8.4
## 440 12.8
## 441 10.5
## 442 17.1
## 443 18.4
## 444 15.4
## 445 10.8
## 446 11.8
## 447 14.9
## 448 12.6
## 449 14.1
## 450 13.0
## 451 13.4
## 452 15.2
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## 453 16.1
## 454 17.8
## 455 14.9
## 456 14.1
## 457 12.7
## 458 13.5
## 459 14.9
## 460 20.0
## 461 16.4
## 462 17.7
## 463 19.5
## 464 20.2
## 465 21.4
## 466 19.9
## 467 19.0
## 468 19.1
## 469 19.1
## 470 20.1
## 471 19.9
## 472 19.6
## 473 23.2
## 474 29.8
## 475 13.8
## 476 13.3
## 477 16.7
## 478 12.0
## 479 14.6
## 480 21.4
## 481 23.0
## 482 23.7
## 483 25.0
## 484 21.8
## 485 20.6
## 486 21.2
## 487 19.1
## 488 20.6
## 489 15.2
## 490  7.0
## 491  8.1
## 492 13.6
## 493 20.1
## 494 21.8
## 495 24.5
## 496 23.1
## 497 19.7
## 498 18.3
## 499 21.2
## 500 17.5
## 501 16.8
## 502 22.4
## 503 20.6
## 504 23.9
## 505 22.0
## 506 11.9
```

```
?Boston
dim(Boston)
```

```
## [1] 506  13
```

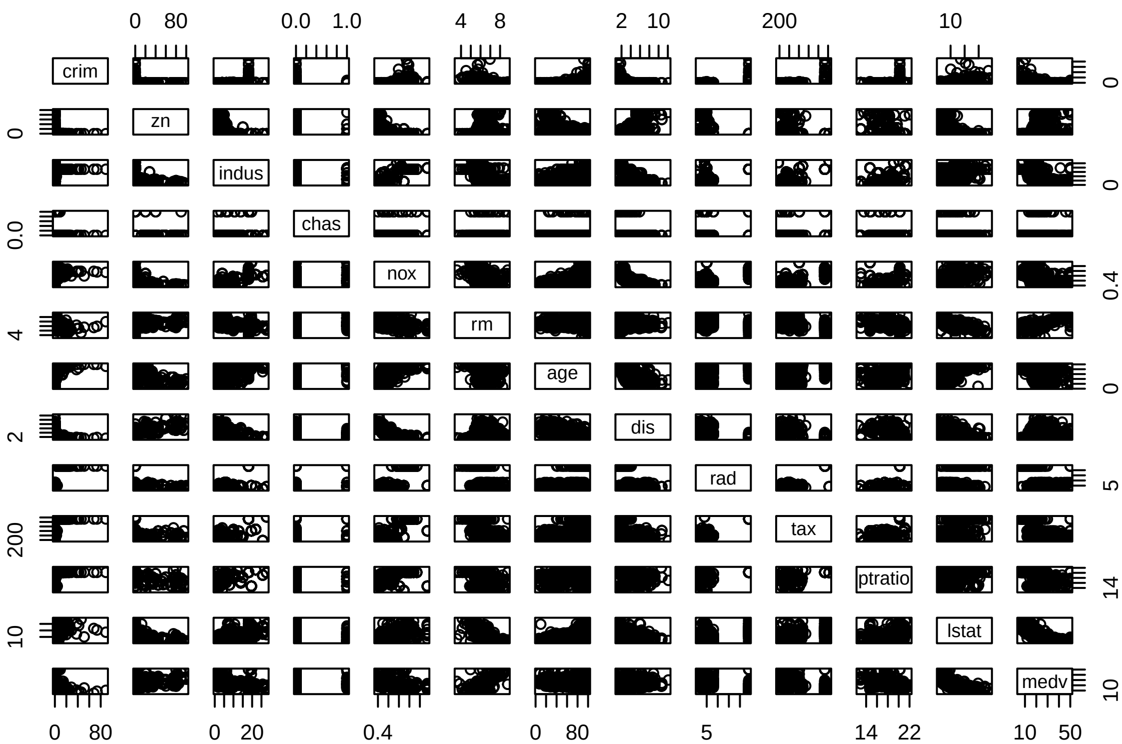
```
colnames(Boston)
```

```
##  [1] "crim"    "zn"      "indus"   "chas"    "nox"     "rm"      "age"
##  [8] "dis"     "rad"     "tax"     "ptratio" "lstat"   "medv"
```

- The Boston data set has 506 rows and 13 columns. The rows represent the census tracts / neighborhoods in Boston. The columns represent different attributes of each neighborhood

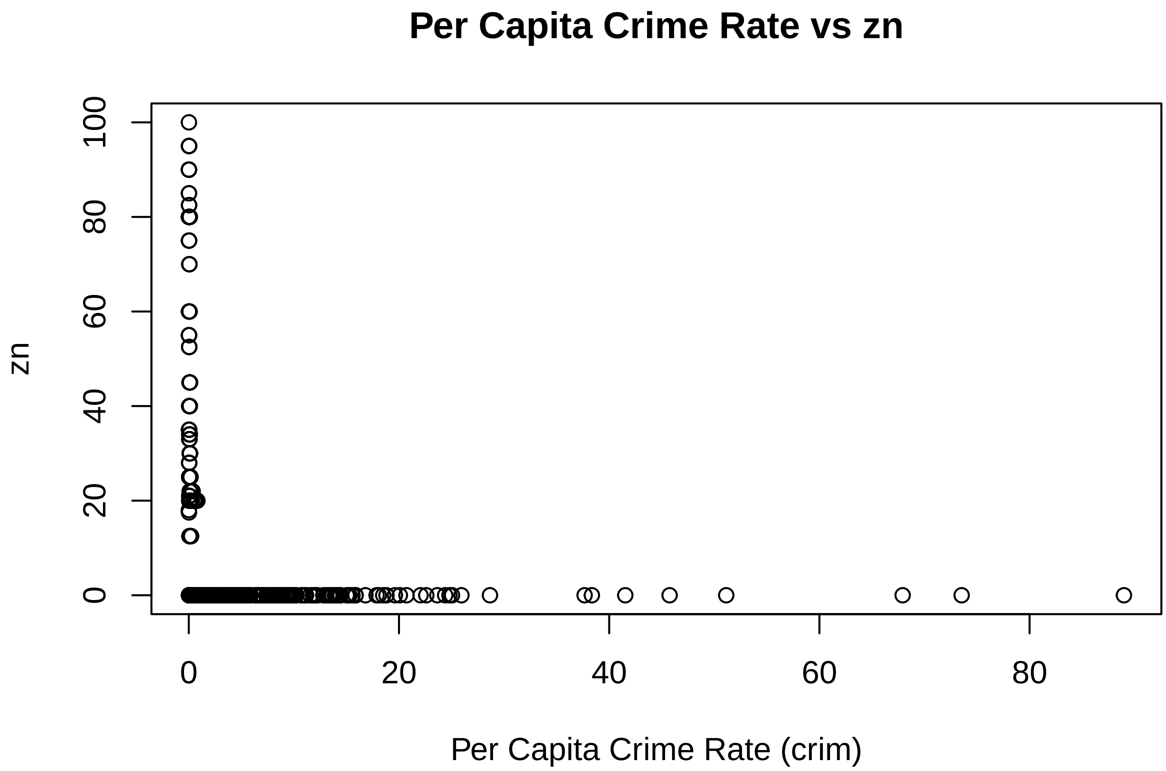
(b) Make some pairwise scatterplots of the predictors (columns) in this data set. Describe your findings.

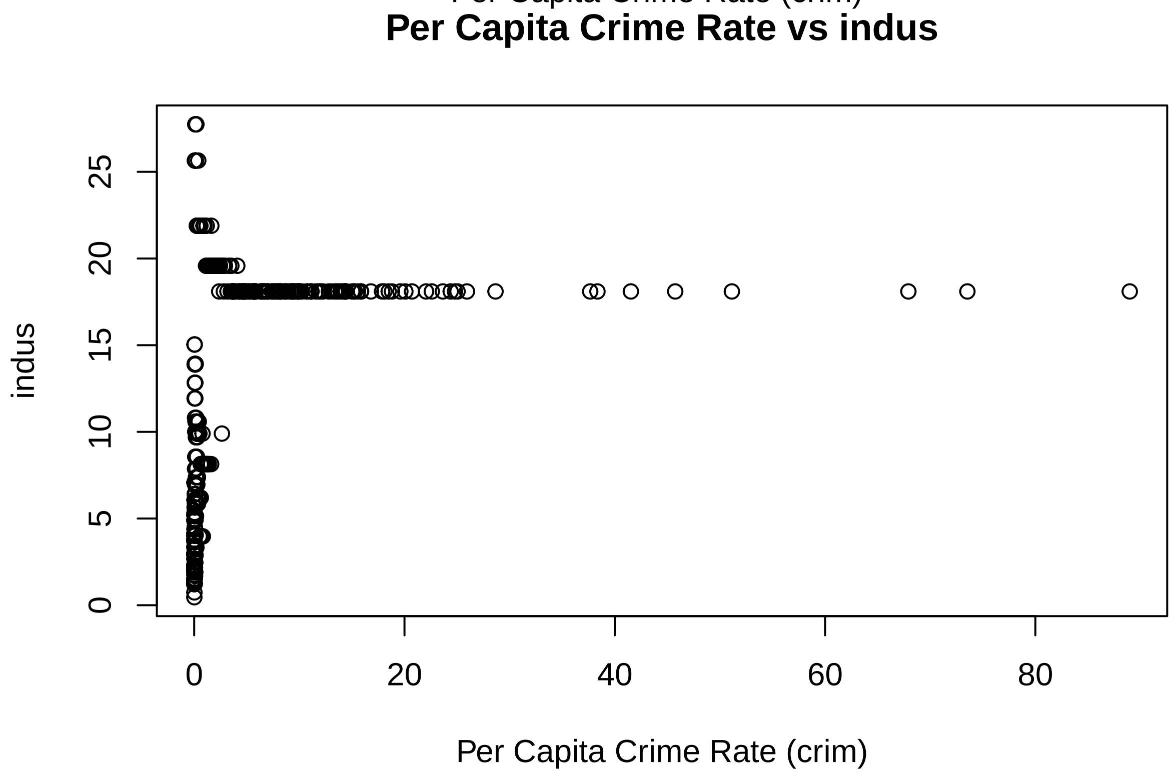
```
pairs(Boston)
```

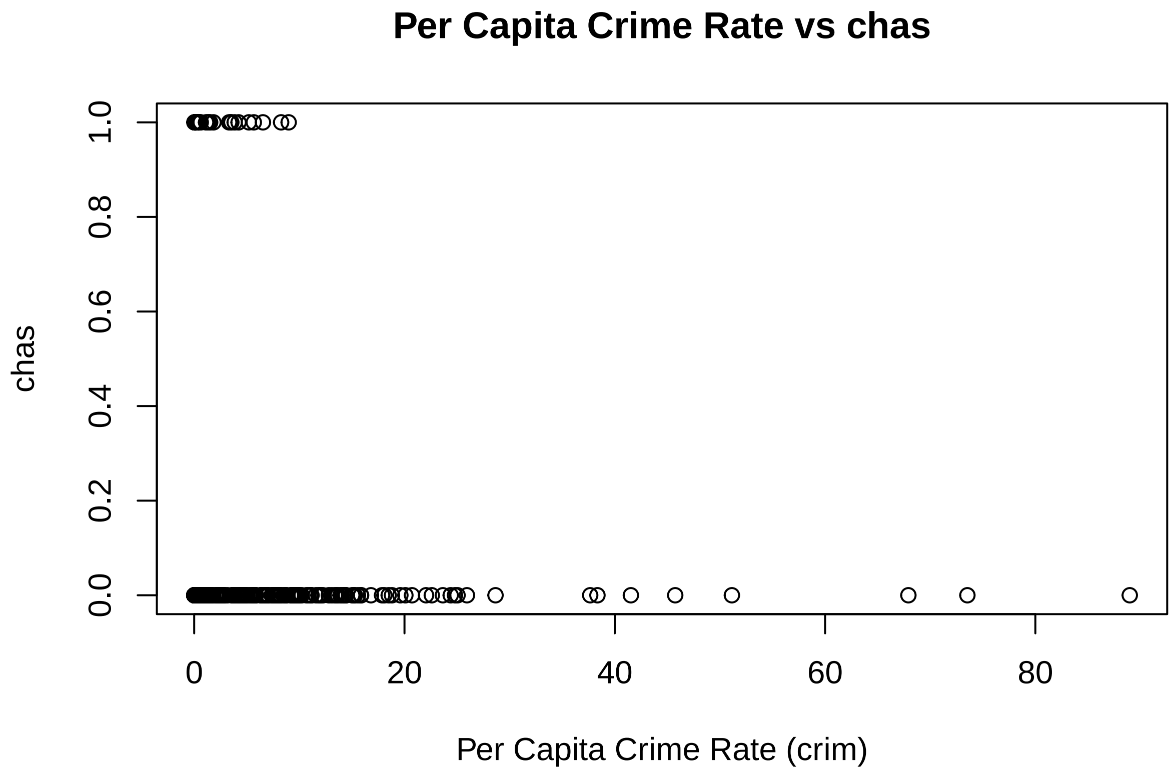


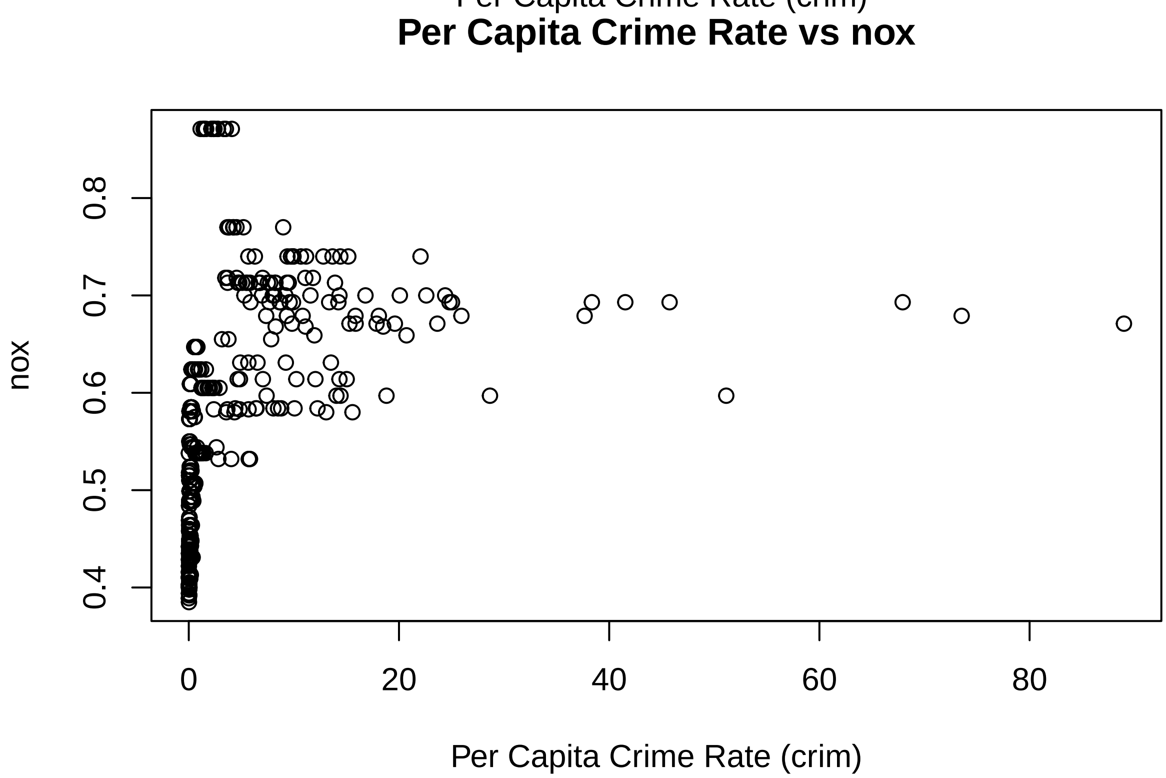
(c) Are any of the predictors associated with per capita crime rate? If so, explain the relationship.

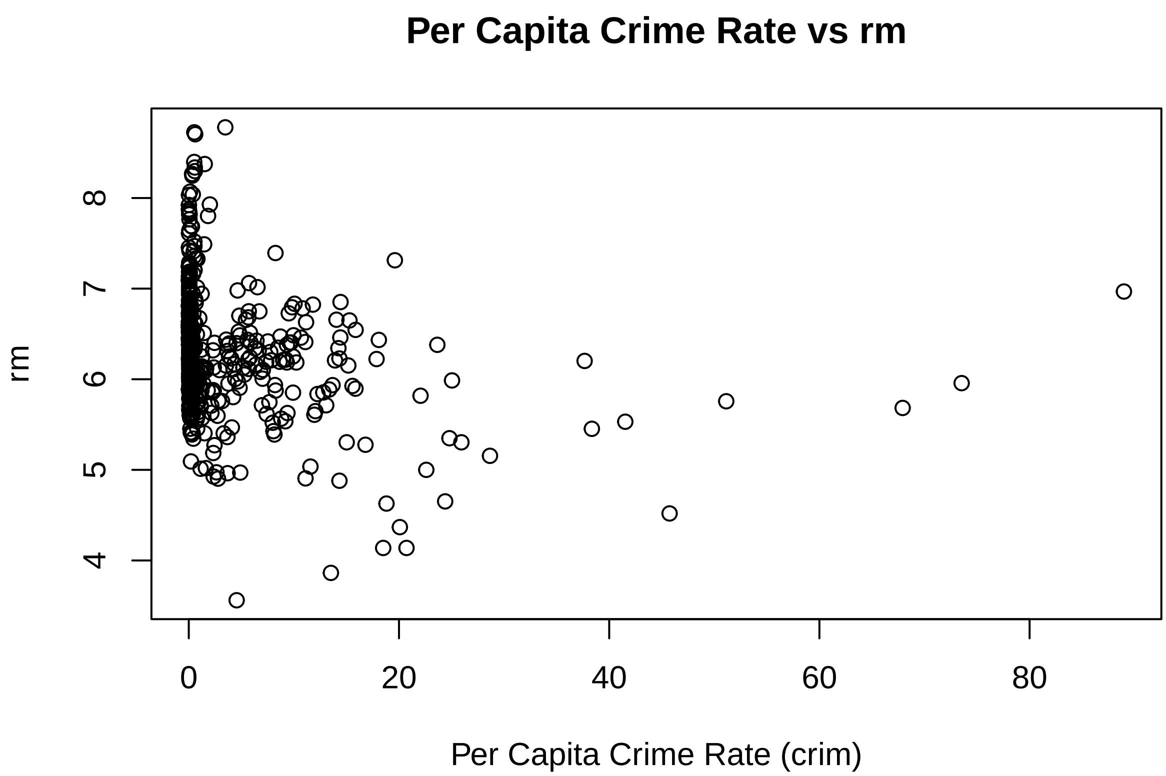
```
for (i in 1:ncol(Boston)) {
    if (colnames(Boston)[i] != "crim") {
        plot(
            Boston$crim,
            Boston[, i],
            xlab = "Per Capita Crime Rate (crim)",
            ylab = colnames(Boston)[i],
            main = paste("Per Capita Crime Rate vs", colnames(Boston)[i])
        )
    }
}
```

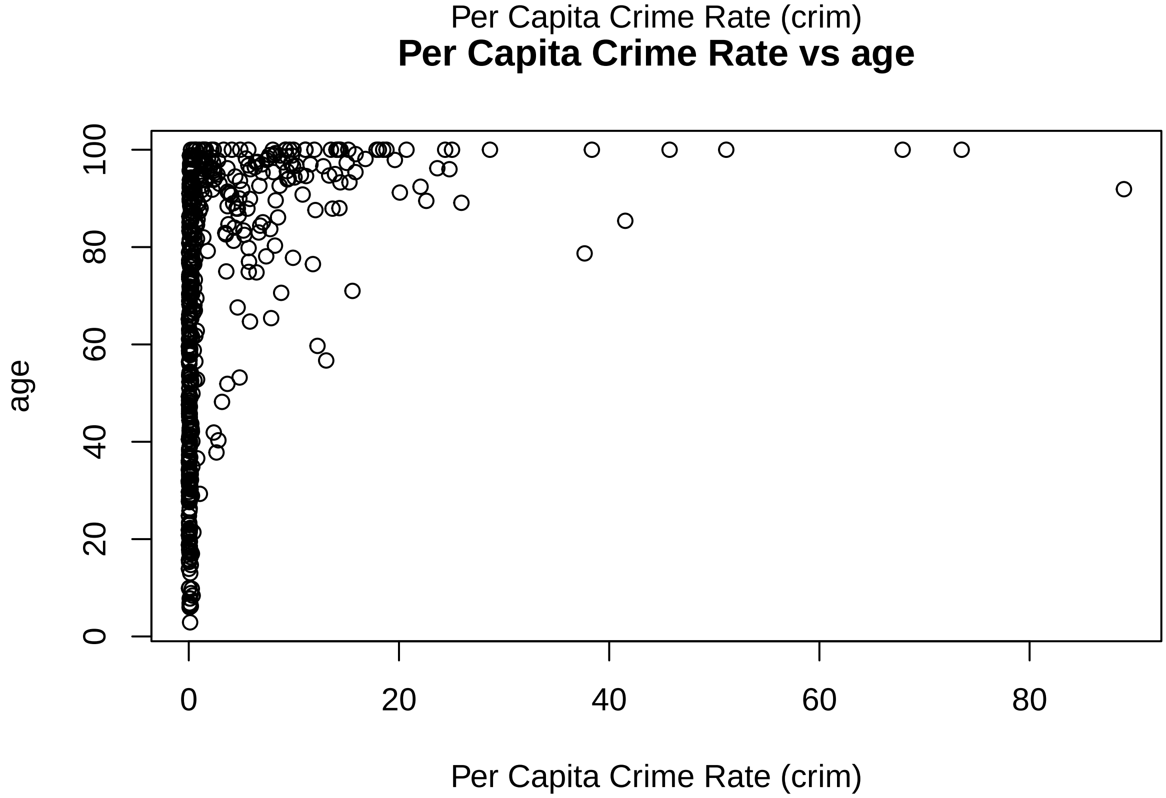

Per Capita Crime Rate vs zn
zn
0
20
40
60
80
100
0
20
40
60
80
Per Capita Crime Rate (crim)

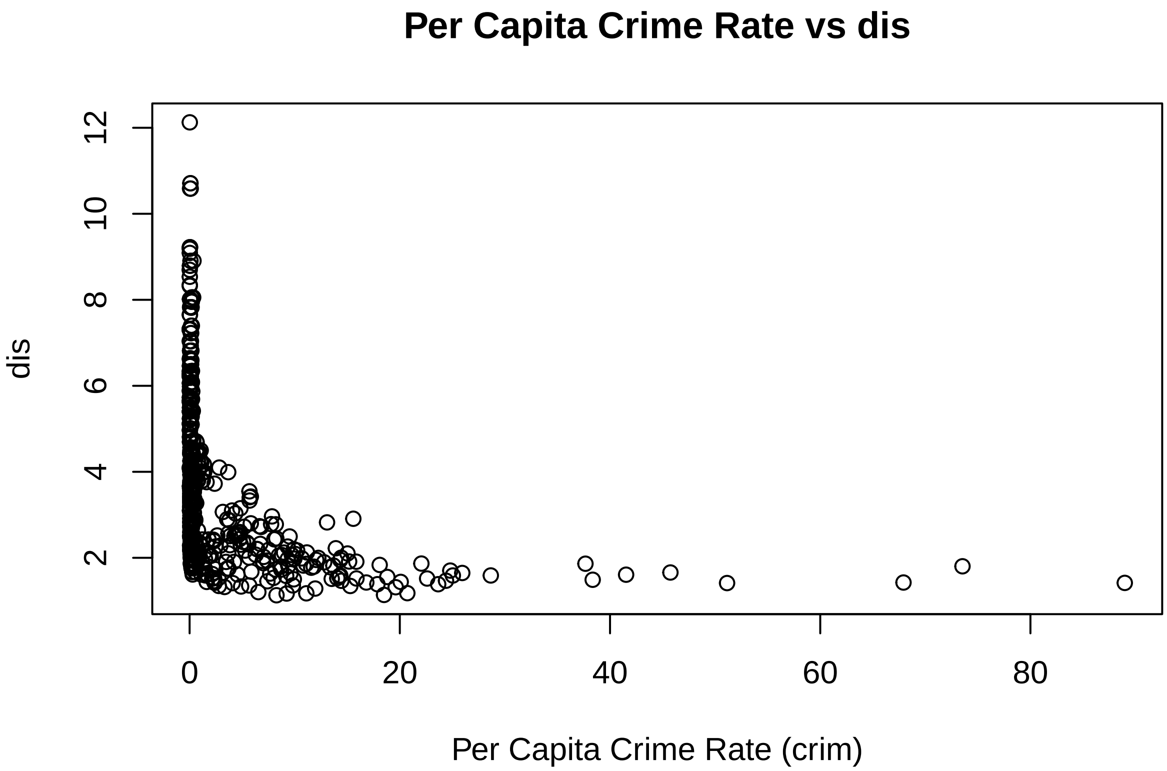

Per Capita Crime Rate vs indus
indus
0
5
10
15
20
25
0
20
40
60
80
Per Capita Crime Rate (crim)

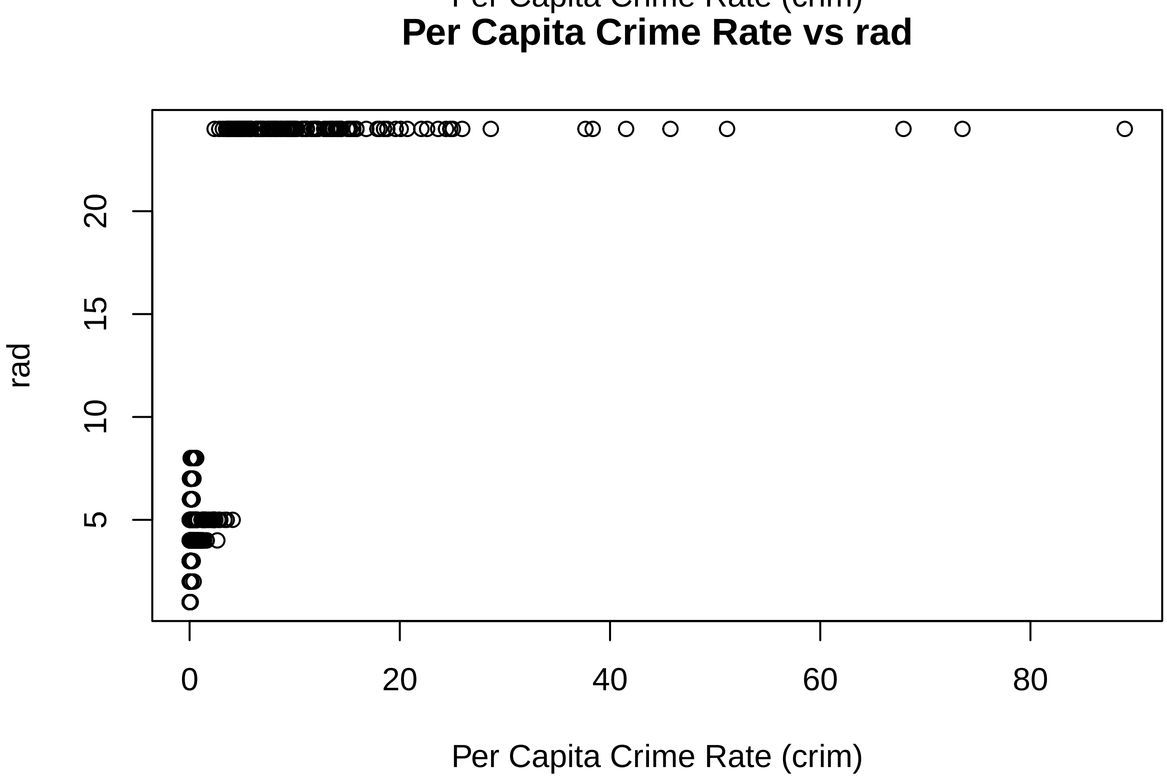

Per Capita Crime Rate vs chas
chas
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
Per Capita Crime Rate (crim)

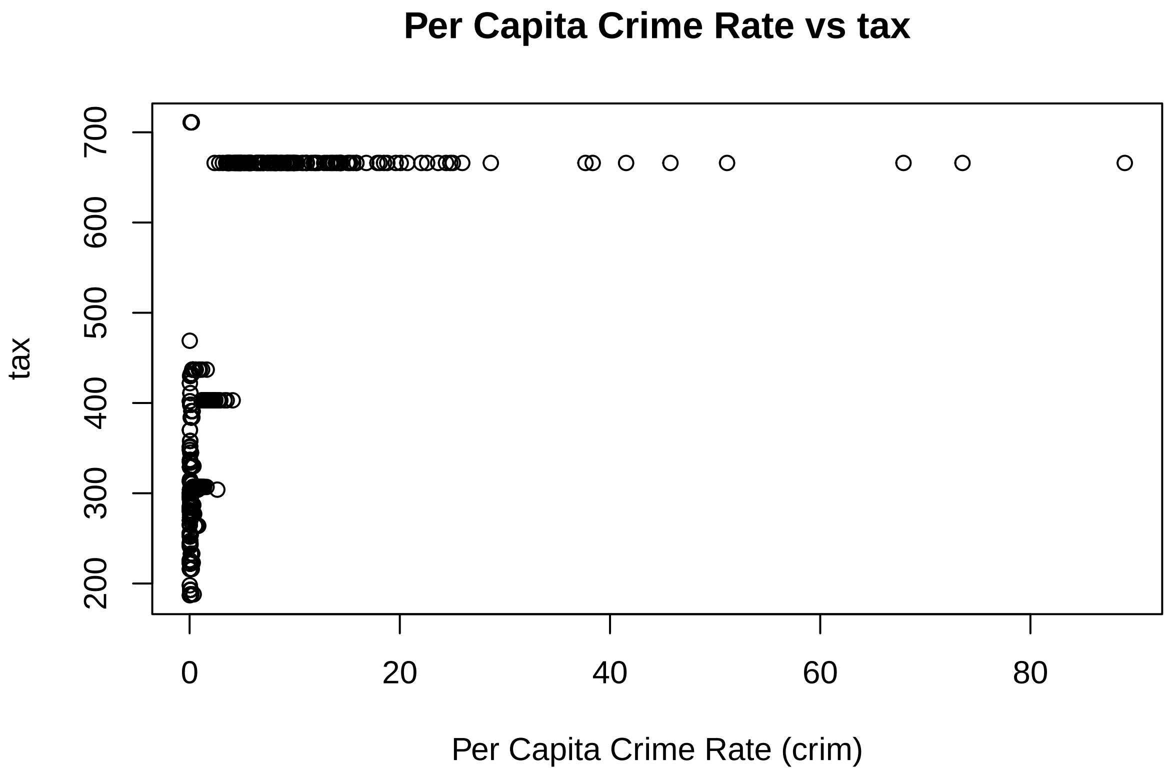

Per Capita Crime Rate vs nox
nox
0.4
0.5
0.6
0.7
0.8
0
20
40
60
80
Per Capita Crime Rate (crim)

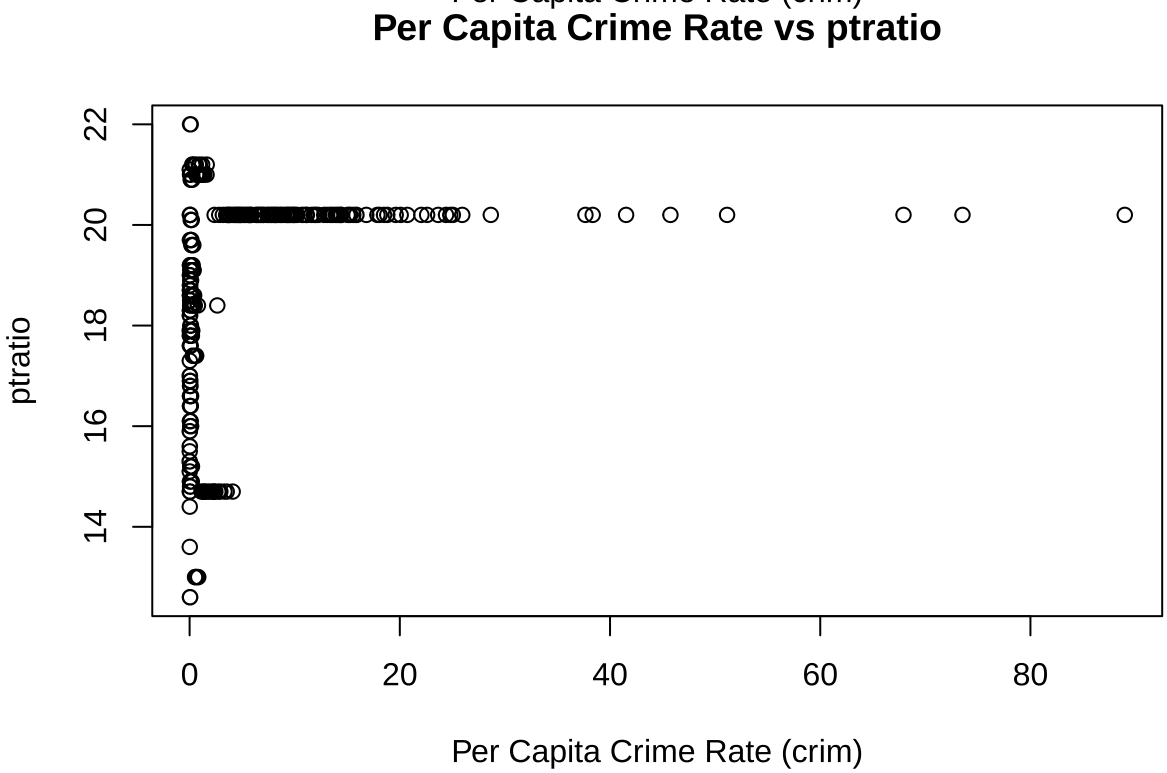

Per Capita Crime Rate vs rm
rm
4
5
6
7
8
0
20
40
60
80
Per Capita Crime Rate (crim)

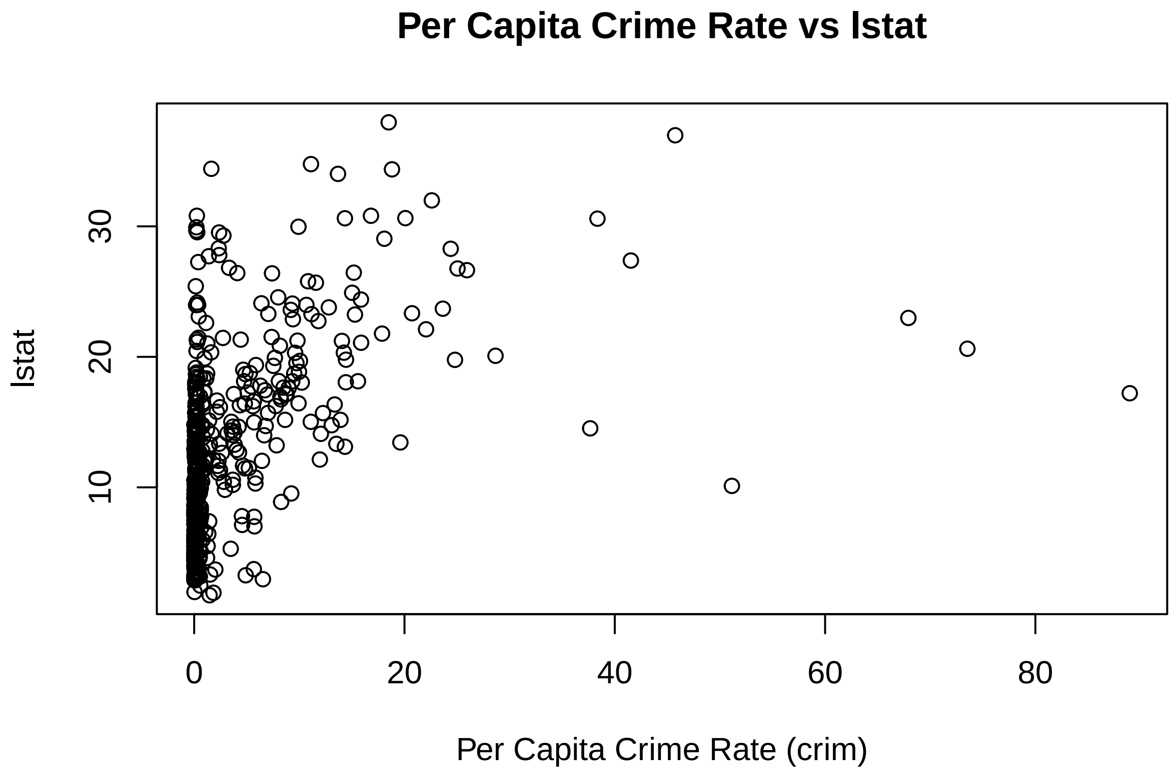

Per Capita Crime Rate vs age
age
0
20
40
60
80
100
0
20
40
60
80
Per Capita Crime Rate (crim)

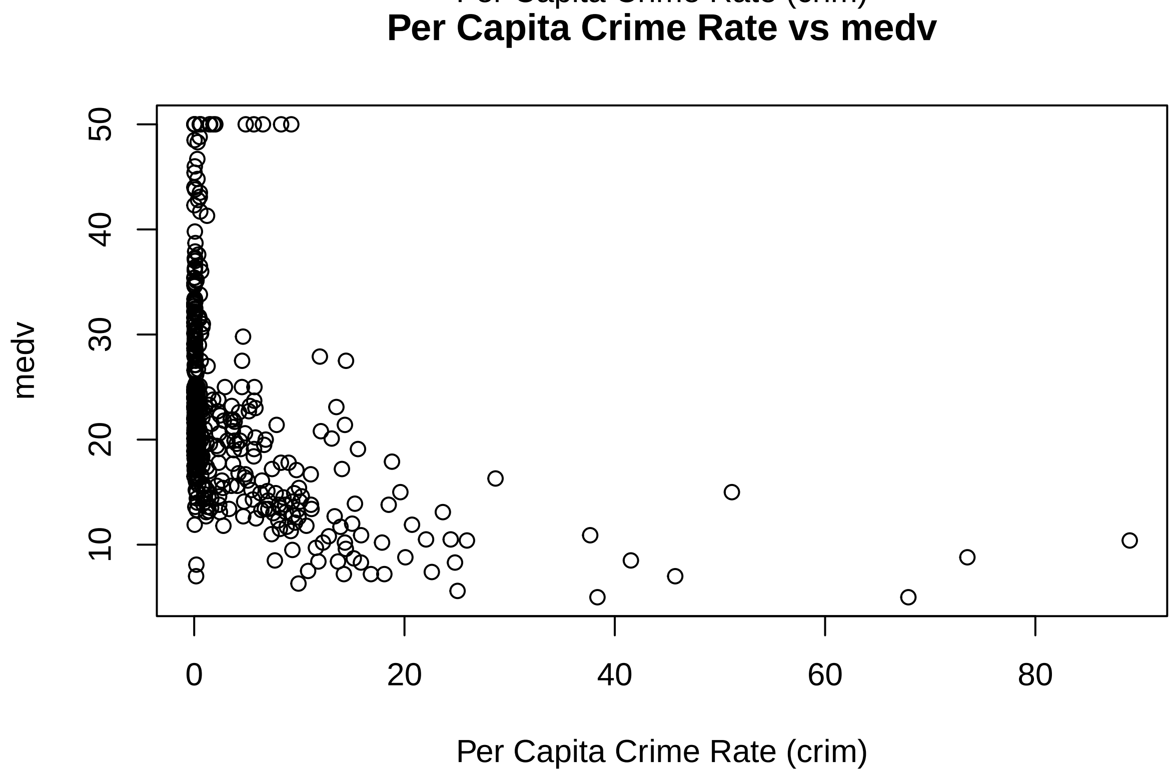

Per Capita Crime Rate vs dis
dis
12
10
8
6
4
2
0
20
40
60
80
Per Capita Crime Rate (crim)


Per Capita Crime Rate vs rad
rad
20
15
10
5
0
20
40
60
80
Per Capita Crime Rate (crim)


Per Capita Crime Rate vs tax
tax
200
300
400
500
600
700
0
20
40
60
80
Per Capita Crime Rate (crim)


Per Capita Crime Rate vs ptratio
ptratio
14
16
18
20
22
0
20
40
60
80
Per Capita Crime Rate (crim)






```r
cor(Boston)
```

```
##                crim          zn       indus         chas         nox
## crim     1.00000000 -0.20046922  0.40658341 -0.055891582  0.42097171
## zn      -0.20046922  1.00000000 -0.53382819 -0.042696719 -0.51660371
## indus    0.40658341 -0.53382819  1.00000000  0.062938027  0.76365145
```

```
## chas    -0.05589158 -0.04269672  0.06293803  1.000000000  0.09120281
## nox      0.42097171 -0.51660371  0.76365145  0.091202807  1.00000000
## rm      -0.21924670  0.31199059 -0.39167585  0.091251225 -0.30218819
## age      0.35273425 -0.56953734  0.64477851  0.086517774  0.73147010
## dis     -0.37967009  0.66440822 -0.70802699 -0.099175780 -0.76923011
## rad      0.62550515 -0.31194783  0.59512927 -0.007368241  0.61144056
## tax      0.58276431 -0.31456332  0.72076018 -0.035586518  0.66802320
## ptratio  0.28994558 -0.39167855  0.38324756 -0.121515174  0.18893268
## lstat    0.45562148 -0.41299457  0.60379972 -0.053929298  0.59087892
## medv    -0.38830461  0.36044534 -0.48372516  0.175260177 -0.42732077
##                  rm         age         dis          rad         tax    ptratio
## crim    -0.21924670  0.35273425 -0.37967009  0.625505145  0.58276431  0.2899456
## zn       0.31199059 -0.56953734  0.66440822 -0.311947826 -0.31456332 -0.3916785
## indus   -0.39167585  0.64477851 -0.70802699  0.595129275  0.72076018  0.3832476
## chas     0.09125123  0.08651777 -0.09917578 -0.007368241 -0.03558652 -0.1215152
## nox     -0.30218819  0.73147010 -0.76923011  0.611440563  0.66802320  0.1889327
## rm       1.00000000 -0.24026493  0.20524621 -0.209846668 -0.29204783 -0.3555015
## age     -0.24026493  1.00000000 -0.74788054  0.456022452  0.50645559  0.2615150
## dis      0.20524621 -0.74788054  1.00000000 -0.494587930 -0.53443158 -0.2324705
## rad     -0.20984667  0.45602245 -0.49458793  1.000000000  0.91022819  0.4647412
## tax     -0.29204783  0.50645559 -0.53443158  0.910228189  1.00000000  0.4608530
## ptratio -0.35550149  0.26151501 -0.23247054  0.464741179  0.46085304  1.0000000
## lstat   -0.61380827  0.60233853 -0.49699583  0.488676335  0.54399341  0.3740443
## medv     0.69535995 -0.37695457  0.24992873 -0.381626231 -0.46853593 -0.5077867
##              lstat       medv
## crim     0.4556215 -0.3883046
## zn      -0.4129946  0.3604453
## indus    0.6037997 -0.4837252
## chas    -0.0539293  0.1752602
## nox      0.5908789 -0.4273208
## rm      -0.6138083  0.6953599
## age      0.6023385 -0.3769546
## dis     -0.4969958  0.2499287
## rad      0.4886763 -0.3816262
## tax      0.5439934 -0.4685359
## ptratio  0.3740443 -0.5077867
## lstat    1.0000000 -0.7376627
## medv    -0.7376627  1.0000000
```

- Yes, from the output plots it seems that crime correlates to several predictors such as age, dis, medv,rad, indus and tax. For instance, the per capita crime rate seems to increase with the age of the house, the distance to employment centers, the median value of owner-occupied homes, the index of accessibility to radial highways, the proportion of non-retail business acres per town and the full-value property-tax rate per $10,000. These can be seen from inspecting their respective plots.

(d) Do any of the census tracts of Boston appear to have particularly high crime rates? Tax rates? Pupil-teacher ratios? Comment on the range of each predictor.

```r
# get the census tracts with the highest crime rates
high_crim <- Boston[Boston$crim > 20, ]
high_crim
```

```
##        crim zn indus chas   nox    rm  age    dis rad tax ptratio lstat medv
## 379 23.6482  0  18.1    0 0.671 6.380 96.2 1.3861  24 666    20.2 23.69 13.1
## 381 88.9762  0  18.1    0 0.671 6.968 91.9 1.4165  24 666    20.2 17.21 10.4
## 385 20.0849  0  18.1    0 0.700 4.368 91.2 1.4395  24 666    20.2 30.63  8.8
```

```
## 387 24.3938  0  18.1    0 0.700 4.652 100.0 1.4672  24 666    20.2 28.28 10.5
## 388 22.5971  0  18.1    0 0.700 5.000  89.5 1.5184  24 666    20.2 31.99  7.4
## 399 38.3518  0  18.1    0 0.693 5.453 100.0 1.4896  24 666    20.2 30.59  5.0
## 401 25.0461  0  18.1    0 0.693 5.987 100.0 1.5888  24 666    20.2 26.77  5.6
## 404 24.8017  0  18.1    0 0.693 5.349  96.0 1.7028  24 666    20.2 19.77  8.3
## 405 41.5292  0  18.1    0 0.693 5.531  85.4 1.6074  24 666    20.2 27.38  8.5
## 406 67.9208  0  18.1    0 0.693 5.683 100.0 1.4254  24 666    20.2 22.98  5.0
## 407 20.7162  0  18.1    0 0.659 4.138 100.0 1.1781  24 666    20.2 23.34 11.9
## 411 51.1358  0  18.1    0 0.597 5.757 100.0 1.4130  24 666    20.2 10.11 15.0
## 414 28.6558  0  18.1    0 0.597 5.155 100.0 1.5894  24 666    20.2 20.08 16.3
## 415 45.7461  0  18.1    0 0.693 4.519 100.0 1.6582  24 666    20.2 36.98  7.0
## 418 25.9406  0  18.1    0 0.679 5.304  89.1 1.6475  24 666    20.2 26.64 10.4
## 419 73.5341  0  18.1    0 0.679 5.957 100.0 1.8026  24 666    20.2 20.62  8.8
## 428 37.6619  0  18.1    0 0.679 6.202  78.7 1.8629  24 666    20.2 14.52 10.9
## 441 22.0511  0  18.1    0 0.740 5.818  92.4 1.8662  24 666    20.2 22.11 10.5
```

```
# get the census tracts with the highest tax rates
high_tax <- Boston[Boston$tax > 600, ]
high_tax
```

```
##         crim zn indus chas   nox    rm   age    dis rad tax ptratio lstat medv
## 357  8.98296  0 18.10    1 0.770 6.212  97.4 2.1222  24 666    20.2 17.60 17.8
## 358  3.84970  0 18.10    1 0.770 6.395  91.0 2.5052  24 666    20.2 13.27 21.7
## 359  5.20177  0 18.10    1 0.770 6.127  83.4 2.7227  24 666    20.2 11.48 22.7
## 360  4.26131  0 18.10    0 0.770 6.112  81.3 2.5091  24 666    20.2 12.67 22.6
## 361  4.54192  0 18.10    0 0.770 6.398  88.0 2.5182  24 666    20.2  7.79 25.0
## 362  3.83684  0 18.10    0 0.770 6.251  91.1 2.2955  24 666    20.2 14.19 19.9
## 363  3.67822  0 18.10    0 0.770 5.362  96.2 2.1036  24 666    20.2 10.19 20.8
## 364  4.22239  0 18.10    1 0.770 5.803  89.0 1.9047  24 666    20.2 14.64 16.8
## 365  3.47428  0 18.10    1 0.718 8.780  82.9 1.9047  24 666    20.2  5.29 21.9
## 366  4.55587  0 18.10    0 0.718 3.561  87.9 1.6132  24 666    20.2  7.12 27.5
## 367  3.69695  0 18.10    0 0.718 4.963  91.4 1.7523  24 666    20.2 14.00 21.9
## 368 13.52220  0 18.10    0 0.631 3.863 100.0 1.5106  24 666    20.2 13.33 23.1
## 369  4.89822  0 18.10    0 0.631 4.970 100.0 1.3325  24 666    20.2  3.26 50.0
## 370  5.66998  0 18.10    1 0.631 6.683  96.8 1.3567  24 666    20.2  3.73 50.0
## 371  6.53876  0 18.10    1 0.631 7.016  97.5 1.2024  24 666    20.2  2.96 50.0
## 372  9.23230  0 18.10    0 0.631 6.216 100.0 1.1691  24 666    20.2  9.53 50.0
## 373  8.26725  0 18.10    1 0.668 5.875  89.6 1.1296  24 666    20.2  8.88 50.0
## 374 11.10810  0 18.10    0 0.668 4.906 100.0 1.1742  24 666    20.2 34.77 13.8
## 375 18.49820  0 18.10    0 0.668 4.138 100.0 1.1370  24 666    20.2 37.97 13.8
## 376 19.60910  0 18.10    0 0.671 7.313  97.9 1.3163  24 666    20.2 13.44 15.0
## 377 15.28800  0 18.10    0 0.671 6.649  93.3 1.3449  24 666    20.2 23.24 13.9
## 378  9.82349  0 18.10    0 0.671 6.794  98.8 1.3580  24 666    20.2 21.24 13.3
## 379 23.64820  0 18.10    0 0.671 6.380  96.2 1.3861  24 666    20.2 23.69 13.1
## 380 17.86670  0 18.10    0 0.671 6.223 100.0 1.3861  24 666    20.2 21.78 10.2
## 381 88.97620  0 18.10    0 0.671 6.968  91.9 1.4165  24 666    20.2 17.21 10.4
## 382 15.87440  0 18.10    0 0.671 6.545  99.1 1.5192  24 666    20.2 21.08 10.9
## 383  9.18702  0 18.10    0 0.700 5.536 100.0 1.5804  24 666    20.2 23.60 11.3
## 384  7.99248  0 18.10    0 0.700 5.520 100.0 1.5331  24 666    20.2 24.56 12.3
## 385 20.08490  0 18.10    0 0.700 4.368  91.2 1.4395  24 666    20.2 30.63  8.8
## 386 16.81180  0 18.10    0 0.700 5.277  98.1 1.4261  24 666    20.2 30.81  7.2
## 387 24.39380  0 18.10    0 0.700 4.652 100.0 1.4672  24 666    20.2 28.28 10.5
## 388 22.59710  0 18.10    0 0.700 5.000  89.5 1.5184  24 666    20.2 31.99  7.4
## 389 14.33370  0 18.10    0 0.700 4.880 100.0 1.5895  24 666    20.2 30.62 10.2
## 390  8.15174  0 18.10    0 0.700 5.390  98.9 1.7281  24 666    20.2 20.85 11.5
```

```
## 391  6.96215  0 18.10    0 0.700 5.713  97.0 1.9265  24 666    20.2 17.11 15.1
## 392  5.29305  0 18.10    0 0.700 6.051  82.5 2.1678  24 666    20.2 18.76 23.2
## 393 11.57790  0 18.10    0 0.700 5.036  97.0 1.7700  24 666    20.2 25.68  9.7
## 394  8.64476  0 18.10    0 0.693 6.193  92.6 1.7912  24 666    20.2 15.17 13.8
## 395 13.35980  0 18.10    0 0.693 5.887  94.7 1.7821  24 666    20.2 16.35 12.7
## 396  8.71675  0 18.10    0 0.693 6.471  98.8 1.7257  24 666    20.2 17.12 13.1
## 397  5.87205  0 18.10    0 0.693 6.405  96.0 1.6768  24 666    20.2 19.37 12.5
## 398  7.67202  0 18.10    0 0.693 5.747  98.9 1.6334  24 666    20.2 19.92  8.5
## 399 38.35180  0 18.10    0 0.693 5.453 100.0 1.4896  24 666    20.2 30.59  5.0
## 400  9.91655  0 18.10    0 0.693 5.852  77.8 1.5004  24 666    20.2 29.97  6.3
## 401 25.04610  0 18.10    0 0.693 5.987 100.0 1.5888  24 666    20.2 26.77  5.6
## 402 14.23620  0 18.10    0 0.693 6.343 100.0 1.5741  24 666    20.2 20.32  7.2
## 403  9.59571  0 18.10    0 0.693 6.404 100.0 1.6390  24 666    20.2 20.31 12.1
## 404 24.80170  0 18.10    0 0.693 5.349  96.0 1.7028  24 666    20.2 19.77  8.3
## 405 41.52920  0 18.10    0 0.693 5.531  85.4 1.6074  24 666    20.2 27.38  8.5
## 406 67.92080  0 18.10    0 0.693 5.683 100.0 1.4254  24 666    20.2 22.98  5.0
## 407 20.71620  0 18.10    0 0.659 4.138 100.0 1.1781  24 666    20.2 23.34 11.9
## 408 11.95110  0 18.10    0 0.659 5.608 100.0 1.2852  24 666    20.2 12.13 27.9
## 409  7.40389  0 18.10    0 0.597 5.617  97.9 1.4547  24 666    20.2 26.40 17.2
## 410 14.43830  0 18.10    0 0.597 6.852 100.0 1.4655  24 666    20.2 19.78 27.5
## 411 51.13580  0 18.10    0 0.597 5.757 100.0 1.4130  24 666    20.2 10.11 15.0
## 412 14.05070  0 18.10    0 0.597 6.657 100.0 1.5275  24 666    20.2 21.22 17.2
## 413 18.81100  0 18.10    0 0.597 4.628 100.0 1.5539  24 666    20.2 34.37 17.9
## 414 28.65580  0 18.10    0 0.597 5.155 100.0 1.5894  24 666    20.2 20.08 16.3
## 415 45.74610  0 18.10    0 0.693 4.519 100.0 1.6582  24 666    20.2 36.98  7.0
## 416 18.08460  0 18.10    0 0.679 6.434 100.0 1.8347  24 666    20.2 29.05  7.2
## 417 10.83420  0 18.10    0 0.679 6.782  90.8 1.8195  24 666    20.2 25.79  7.5
## 418 25.94060  0 18.10    0 0.679 5.304  89.1 1.6475  24 666    20.2 26.64 10.4
## 419 73.53410  0 18.10    0 0.679 5.957 100.0 1.8026  24 666    20.2 20.62  8.8
## 420 11.81230  0 18.10    0 0.718 6.824  76.5 1.7940  24 666    20.2 22.74  8.4
## 421 11.08740  0 18.10    0 0.718 6.411 100.0 1.8589  24 666    20.2 15.02 16.7
## 422  7.02259  0 18.10    0 0.718 6.006  95.3 1.8746  24 666    20.2 15.70 14.2
## 423 12.04820  0 18.10    0 0.614 5.648  87.6 1.9512  24 666    20.2 14.10 20.8
## 424  7.05042  0 18.10    0 0.614 6.103  85.1 2.0218  24 666    20.2 23.29 13.4
## 425  8.79212  0 18.10    0 0.584 5.565  70.6 2.0635  24 666    20.2 17.16 11.7
## 426 15.86030  0 18.10    0 0.679 5.896  95.4 1.9096  24 666    20.2 24.39  8.3
## 427 12.24720  0 18.10    0 0.584 5.837  59.7 1.9976  24 666    20.2 15.69 10.2
## 428 37.66190  0 18.10    0 0.679 6.202  78.7 1.8629  24 666    20.2 14.52 10.9
## 429  7.36711  0 18.10    0 0.679 6.193  78.1 1.9356  24 666    20.2 21.52 11.0
## 430  9.33889  0 18.10    0 0.679 6.380  95.6 1.9682  24 666    20.2 24.08  9.5
## 431  8.49213  0 18.10    0 0.584 6.348  86.1 2.0527  24 666    20.2 17.64 14.5
## 432 10.06230  0 18.10    0 0.584 6.833  94.3 2.0882  24 666    20.2 19.69 14.1
## 433  6.44405  0 18.10    0 0.584 6.425  74.8 2.2004  24 666    20.2 12.03 16.1
## 434  5.58107  0 18.10    0 0.713 6.436  87.9 2.3158  24 666    20.2 16.22 14.3
## 435 13.91340  0 18.10    0 0.713 6.208  95.0 2.2222  24 666    20.2 15.17 11.7
## 436 11.16040  0 18.10    0 0.740 6.629  94.6 2.1247  24 666    20.2 23.27 13.4
## 437 14.42080  0 18.10    0 0.740 6.461  93.3 2.0026  24 666    20.2 18.05  9.6
## 438 15.17720  0 18.10    0 0.740 6.152 100.0 1.9142  24 666    20.2 26.45  8.7
## 439 13.67810  0 18.10    0 0.740 5.935  87.9 1.8206  24 666    20.2 34.02  8.4
## 440  9.39063  0 18.10    0 0.740 5.627  93.9 1.8172  24 666    20.2 22.88 12.8
## 441 22.05110  0 18.10    0 0.740 5.818  92.4 1.8662  24 666    20.2 22.11 10.5
## 442  9.72418  0 18.10    0 0.740 6.406  97.2 2.0651  24 666    20.2 19.52 17.1
## 443  5.66637  0 18.10    0 0.740 6.219 100.0 2.0048  24 666    20.2 16.59 18.4
## 444  9.96654  0 18.10    0 0.740 6.485 100.0 1.9784  24 666    20.2 18.85 15.4
```

```
## 445 12.80230  0 18.10    0 0.740 5.854  96.6 1.8956  24 666    20.2 23.79 10.8
## 446 10.67180  0 18.10    0 0.740 6.459  94.8 1.9879  24 666    20.2 23.98 11.8
## 447  6.28807  0 18.10    0 0.740 6.341  96.4 2.0720  24 666    20.2 17.79 14.9
## 448  9.92485  0 18.10    0 0.740 6.251  96.6 2.1980  24 666    20.2 16.44 12.6
## 449  9.32909  0 18.10    0 0.713 6.185  98.7 2.2616  24 666    20.2 18.13 14.1
## 450  7.52601  0 18.10    0 0.713 6.417  98.3 2.1850  24 666    20.2 19.31 13.0
## 451  6.71772  0 18.10    0 0.713 6.749  92.6 2.3236  24 666    20.2 17.44 13.4
## 452  5.44114  0 18.10    0 0.713 6.655  98.2 2.3552  24 666    20.2 17.73 15.2
## 453  5.09017  0 18.10    0 0.713 6.297  91.8 2.3682  24 666    20.2 17.27 16.1
## 454  8.24809  0 18.10    0 0.713 7.393  99.3 2.4527  24 666    20.2 16.74 17.8
## 455  9.51363  0 18.10    0 0.713 6.728  94.1 2.4961  24 666    20.2 18.71 14.9
## 456  4.75237  0 18.10    0 0.713 6.525  86.5 2.4358  24 666    20.2 18.13 14.1
## 457  4.66883  0 18.10    0 0.713 5.976  87.9 2.5806  24 666    20.2 19.01 12.7
## 458  8.20058  0 18.10    0 0.713 5.936  80.3 2.7792  24 666    20.2 16.94 13.5
## 459  7.75223  0 18.10    0 0.713 6.301  83.7 2.7831  24 666    20.2 16.23 14.9
## 460  6.80117  0 18.10    0 0.713 6.081  84.4 2.7175  24 666    20.2 14.70 20.0
## 461  4.81213  0 18.10    0 0.713 6.701  90.0 2.5975  24 666    20.2 16.42 16.4
## 462  3.69311  0 18.10    0 0.713 6.376  88.4 2.5671  24 666    20.2 14.65 17.7
## 463  6.65492  0 18.10    0 0.713 6.317  83.0 2.7344  24 666    20.2 13.99 19.5
## 464  5.82115  0 18.10    0 0.713 6.513  89.9 2.8016  24 666    20.2 10.29 20.2
## 465  7.83932  0 18.10    0 0.655 6.209  65.4 2.9634  24 666    20.2 13.22 21.4
## 466  3.16360  0 18.10    0 0.655 5.759  48.2 3.0665  24 666    20.2 14.13 19.9
## 467  3.77498  0 18.10    0 0.655 5.952  84.7 2.8715  24 666    20.2 17.15 19.0
## 468  4.42228  0 18.10    0 0.584 6.003  94.5 2.5403  24 666    20.2 21.32 19.1
## 469 15.57570  0 18.10    0 0.580 5.926  71.0 2.9084  24 666    20.2 18.13 19.1
## 470 13.07510  0 18.10    0 0.580 5.713  56.7 2.8237  24 666    20.2 14.76 20.1
## 471  4.34879  0 18.10    0 0.580 6.167  84.0 3.0334  24 666    20.2 16.29 19.9
## 472  4.03841  0 18.10    0 0.532 6.229  90.7 3.0993  24 666    20.2 12.87 19.6
## 473  3.56868  0 18.10    0 0.580 6.437  75.0 2.8965  24 666    20.2 14.36 23.2
## 474  4.64689  0 18.10    0 0.614 6.980  67.6 2.5329  24 666    20.2 11.66 29.8
## 475  8.05579  0 18.10    0 0.584 5.427  95.4 2.4298  24 666    20.2 18.14 13.8
## 476  6.39312  0 18.10    0 0.584 6.162  97.4 2.2060  24 666    20.2 24.10 13.3
## 477  4.87141  0 18.10    0 0.614 6.484  93.6 2.3053  24 666    20.2 18.68 16.7
## 478 15.02340  0 18.10    0 0.614 5.304  97.3 2.1007  24 666    20.2 24.91 12.0
## 479 10.23300  0 18.10    0 0.614 6.185  96.7 2.1705  24 666    20.2 18.03 14.6
## 480 14.33370  0 18.10    0 0.614 6.229  88.0 1.9512  24 666    20.2 13.11 21.4
## 481  5.82401  0 18.10    0 0.532 6.242  64.7 3.4242  24 666    20.2 10.74 23.0
## 482  5.70818  0 18.10    0 0.532 6.750  74.9 3.3317  24 666    20.2  7.74 23.7
## 483  5.73116  0 18.10    0 0.532 7.061  77.0 3.4106  24 666    20.2  7.01 25.0
## 484  2.81838  0 18.10    0 0.532 5.762  40.3 4.0983  24 666    20.2 10.42 21.8
## 485  2.37857  0 18.10    0 0.583 5.871  41.9 3.7240  24 666    20.2 13.34 20.6
## 486  3.67367  0 18.10    0 0.583 6.312  51.9 3.9917  24 666    20.2 10.58 21.2
## 487  5.69175  0 18.10    0 0.583 6.114  79.8 3.5459  24 666    20.2 14.98 19.1
## 488  4.83567  0 18.10    0 0.583 5.905  53.2 3.1523  24 666    20.2 11.45 20.6
## 489  0.15086  0 27.74    0 0.609 5.454  92.7 1.8209   4 711    20.1 18.06 15.2
## 490  0.18337  0 27.74    0 0.609 5.414  98.3 1.7554   4 711    20.1 23.97  7.0
## 491  0.20746  0 27.74    0 0.609 5.093  98.0 1.8226   4 711    20.1 29.68  8.1
## 492  0.10574  0 27.74    0 0.609 5.983  98.8 1.8681   4 711    20.1 18.07 13.6
## 493  0.11132  0 27.74    0 0.609 5.983  83.5 2.1099   4 711    20.1 13.35 20.1
```

```r
# get the census tracts with the highest pupil-teacher ratios
high_ptratio <- Boston[Boston$ptratio > 20, ]
high_ptratio
```

```
##         crim zn indus chas   nox    rm   age     dis rad tax ptratio lstat medv
```

```
## 14   0.62976  0  8.14    0 0.538 5.949  61.8  4.7075   4 307    21.0  8.26 20.4
## 15   0.63796  0  8.14    0 0.538 6.096  84.5  4.4619   4 307    21.0 10.26 18.2
## 16   0.62739  0  8.14    0 0.538 5.834  56.5  4.4986   4 307    21.0  8.47 19.9
## 17   1.05393  0  8.14    0 0.538 5.935  29.3  4.4986   4 307    21.0  6.58 23.1
## 18   0.78420  0  8.14    0 0.538 5.990  81.7  4.2579   4 307    21.0 14.67 17.5
## 19   0.80271  0  8.14    0 0.538 5.456  36.6  3.7965   4 307    21.0 11.69 20.2
## 20   0.72580  0  8.14    0 0.538 5.727  69.5  3.7965   4 307    21.0 11.28 18.2
## 21   1.25179  0  8.14    0 0.538 5.570  98.1  3.7979   4 307    21.0 21.02 13.6
## 22   0.85204  0  8.14    0 0.538 5.965  89.2  4.0123   4 307    21.0 13.83 19.6
## 23   1.23247  0  8.14    0 0.538 6.142  91.7  3.9769   4 307    21.0 18.72 15.2
## 24   0.98843  0  8.14    0 0.538 5.813 100.0  4.0952   4 307    21.0 19.88 14.5
## 25   0.75026  0  8.14    0 0.538 5.924  94.1  4.3996   4 307    21.0 16.30 15.6
## 26   0.84054  0  8.14    0 0.538 5.599  85.7  4.4546   4 307    21.0 16.51 13.9
## 27   0.67191  0  8.14    0 0.538 5.813  90.3  4.6820   4 307    21.0 14.81 16.6
## 28   0.95577  0  8.14    0 0.538 6.047  88.8  4.4534   4 307    21.0 17.28 14.8
## 29   0.77299  0  8.14    0 0.538 6.495  94.4  4.4547   4 307    21.0 12.80 18.4
## 30   1.00245  0  8.14    0 0.538 6.674  87.3  4.2390   4 307    21.0 11.98 21.0
## 31   1.13081  0  8.14    0 0.538 5.713  94.1  4.2330   4 307    21.0 22.60 12.7
## 32   1.35472  0  8.14    0 0.538 6.072 100.0  4.1750   4 307    21.0 13.04 14.5
## 33   1.38799  0  8.14    0 0.538 5.950  82.0  3.9900   4 307    21.0 27.71 13.2
## 34   1.15172  0  8.14    0 0.538 5.701  95.0  3.7872   4 307    21.0 18.35 13.1
## 35   1.61282  0  8.14    0 0.538 6.096  96.9  3.7598   4 307    21.0 20.34 13.5
## 55   0.01360 75  4.00    0 0.410 5.888  47.6  7.3197   3 469    21.1 14.80 18.9
## 101  0.14866  0  8.56    0 0.520 6.727  79.9  2.7778   5 384    20.9  9.42 27.5
## 102  0.11432  0  8.56    0 0.520 6.781  71.3  2.8561   5 384    20.9  7.67 26.5
## 103  0.22876  0  8.56    0 0.520 6.405  85.4  2.7147   5 384    20.9 10.63 18.6
## 104  0.21161  0  8.56    0 0.520 6.137  87.4  2.7147   5 384    20.9 13.44 19.3
## 105  0.13960  0  8.56    0 0.520 6.167  90.0  2.4210   5 384    20.9 12.33 20.1
## 106  0.13262  0  8.56    0 0.520 5.851  96.7  2.1069   5 384    20.9 16.47 19.5
## 107  0.17120  0  8.56    0 0.520 5.836  91.9  2.2110   5 384    20.9 18.66 19.5
## 108  0.13117  0  8.56    0 0.520 6.127  85.2  2.1224   5 384    20.9 14.09 20.4
## 109  0.12802  0  8.56    0 0.520 6.474  97.1  2.4329   5 384    20.9 12.27 19.8
## 110  0.26363  0  8.56    0 0.520 6.229  91.2  2.5451   5 384    20.9 15.55 19.4
## 111  0.10793  0  8.56    0 0.520 6.195  54.4  2.7778   5 384    20.9 13.00 21.7
## 128  0.25915  0 21.89    0 0.624 5.693  96.0  1.7883   4 437    21.2 17.19 16.2
## 129  0.32543  0 21.89    0 0.624 6.431  98.8  1.8125   4 437    21.2 15.39 18.0
## 130  0.88125  0 21.89    0 0.624 5.637  94.7  1.9799   4 437    21.2 18.34 14.3
## 131  0.34006  0 21.89    0 0.624 6.458  98.9  2.1185   4 437    21.2 12.60 19.2
## 132  1.19294  0 21.89    0 0.624 6.326  97.7  2.2710   4 437    21.2 12.26 19.6
## 133  0.59005  0 21.89    0 0.624 6.372  97.9  2.3274   4 437    21.2 11.12 23.0
## 134  0.32982  0 21.89    0 0.624 5.822  95.4  2.4699   4 437    21.2 15.03 18.4
## 135  0.97617  0 21.89    0 0.624 5.757  98.4  2.3460   4 437    21.2 17.31 15.6
## 136  0.55778  0 21.89    0 0.624 6.335  98.2  2.1107   4 437    21.2 16.96 18.1
## 137  0.32264  0 21.89    0 0.624 5.942  93.5  1.9669   4 437    21.2 16.90 17.4
## 138  0.35233  0 21.89    0 0.624 6.454  98.4  1.8498   4 437    21.2 14.59 17.1
## 139  0.24980  0 21.89    0 0.624 5.857  98.2  1.6686   4 437    21.2 21.32 13.3
## 140  0.54452  0 21.89    0 0.624 6.151  97.9  1.6687   4 437    21.2 18.46 17.8
## 141  0.29090  0 21.89    0 0.624 6.174  93.6  1.6119   4 437    21.2 24.16 14.0
## 142  1.62864  0 21.89    0 0.624 5.019 100.0  1.4394   4 437    21.2 34.41 14.4
## 334  0.05083  0  5.19    0 0.515 6.316  38.1  6.4584   5 224    20.2  5.68 22.2
## 335  0.03738  0  5.19    0 0.515 6.310  38.5  6.4584   5 224    20.2  6.75 20.7
## 336  0.03961  0  5.19    0 0.515 6.037  34.5  5.9853   5 224    20.2  8.01 21.1
## 337  0.03427  0  5.19    0 0.515 5.869  46.3  5.2311   5 224    20.2  9.80 19.5
## 338  0.03041  0  5.19    0 0.515 5.895  59.6  5.6150   5 224    20.2 10.56 18.5
```

```
## 339  0.03306  0  5.19    0 0.515 6.059  37.3  4.8122   5 224    20.2  8.51 20.6
## 340  0.05497  0  5.19    0 0.515 5.985  45.4  4.8122   5 224    20.2  9.74 19.0
## 341  0.06151  0  5.19    0 0.515 5.968  58.5  4.8122   5 224    20.2  9.29 18.7
## 355  0.04301 80  1.91    0 0.413 5.663  21.9 10.5857   4 334    22.0  8.05 18.2
## 356  0.10659 80  1.91    0 0.413 5.936  19.5 10.5857   4 334    22.0  5.57 20.6
## 357  8.98296  0 18.10    1 0.770 6.212  97.4  2.1222  24 666    20.2 17.60 17.8
## 358  3.84970  0 18.10    1 0.770 6.395  91.0  2.5052  24 666    20.2 13.27 21.7
## 359  5.20177  0 18.10    1 0.770 6.127  83.4  2.7227  24 666    20.2 11.48 22.7
## 360  4.26131  0 18.10    0 0.770 6.112  81.3  2.5091  24 666    20.2 12.67 22.6
## 361  4.54192  0 18.10    0 0.770 6.398  88.0  2.5182  24 666    20.2  7.79 25.0
## 362  3.83684  0 18.10    0 0.770 6.251  91.1  2.2955  24 666    20.2 14.19 19.9
## 363  3.67822  0 18.10    0 0.770 5.362  96.2  2.1036  24 666    20.2 10.19 20.8
## 364  4.22239  0 18.10    1 0.770 5.803  89.0  1.9047  24 666    20.2 14.64 16.8
## 365  3.47428  0 18.10    1 0.718 8.780  82.9  1.9047  24 666    20.2  5.29 21.9
## 366  4.55587  0 18.10    0 0.718 3.561  87.9  1.6132  24 666    20.2  7.12 27.5
## 367  3.69695  0 18.10    0 0.718 4.963  91.4  1.7523  24 666    20.2 14.00 21.9
## 368 13.52220  0 18.10    0 0.631 3.863 100.0  1.5106  24 666    20.2 13.33 23.1
## 369  4.89822  0 18.10    0 0.631 4.970 100.0  1.3325  24 666    20.2  3.26 50.0
## 370  5.66998  0 18.10    1 0.631 6.683  96.8  1.3567  24 666    20.2  3.73 50.0
## 371  6.53876  0 18.10    1 0.631 7.016  97.5  1.2024  24 666    20.2  2.96 50.0
## 372  9.23230  0 18.10    0 0.631 6.216 100.0  1.1691  24 666    20.2  9.53 50.0
## 373  8.26725  0 18.10    1 0.668 5.875  89.6  1.1296  24 666    20.2  8.88 50.0
## 374 11.10810  0 18.10    0 0.668 4.906 100.0  1.1742  24 666    20.2 34.77 13.8
## 375 18.49820  0 18.10    0 0.668 4.138 100.0  1.1370  24 666    20.2 37.97 13.8
## 376 19.60910  0 18.10    0 0.671 7.313  97.9  1.3163  24 666    20.2 13.44 15.0
## 377 15.28800  0 18.10    0 0.671 6.649  93.3  1.3449  24 666    20.2 23.24 13.9
## 378  9.82349  0 18.10    0 0.671 6.794  98.8  1.3580  24 666    20.2 21.24 13.3
## 379 23.64820  0 18.10    0 0.671 6.380  96.2  1.3861  24 666    20.2 23.69 13.1
## 380 17.86670  0 18.10    0 0.671 6.223 100.0  1.3861  24 666    20.2 21.78 10.2
## 381 88.97620  0 18.10    0 0.671 6.968  91.9  1.4165  24 666    20.2 17.21 10.4
## 382 15.87440  0 18.10    0 0.671 6.545  99.1  1.5192  24 666    20.2 21.08 10.9
## 383  9.18702  0 18.10    0 0.700 5.536 100.0  1.5804  24 666    20.2 23.60 11.3
## 384  7.99248  0 18.10    0 0.700 5.520 100.0  1.5331  24 666    20.2 24.56 12.3
## 385 20.08490  0 18.10    0 0.700 4.368  91.2  1.4395  24 666    20.2 30.63  8.8
## 386 16.81180  0 18.10    0 0.700 5.277  98.1  1.4261  24 666    20.2 30.81  7.2
## 387 24.39380  0 18.10    0 0.700 4.652 100.0  1.4672  24 666    20.2 28.28 10.5
## 388 22.59710  0 18.10    0 0.700 5.000  89.5  1.5184  24 666    20.2 31.99  7.4
## 389 14.33370  0 18.10    0 0.700 4.880 100.0  1.5895  24 666    20.2 30.62 10.2
## 390  8.15174  0 18.10    0 0.700 5.390  98.9  1.7281  24 666    20.2 20.85 11.5
## 391  6.96215  0 18.10    0 0.700 5.713  97.0  1.9265  24 666    20.2 17.11 15.1
## 392  5.29305  0 18.10    0 0.700 6.051  82.5  2.1678  24 666    20.2 18.76 23.2
## 393 11.57790  0 18.10    0 0.700 5.036  97.0  1.7700  24 666    20.2 25.68  9.7
## 394  8.64476  0 18.10    0 0.693 6.193  92.6  1.7912  24 666    20.2 15.17 13.8
## 395 13.35980  0 18.10    0 0.693 5.887  94.7  1.7821  24 666    20.2 16.35 12.7
## 396  8.71675  0 18.10    0 0.693 6.471  98.8  1.7257  24 666    20.2 17.12 13.1
## 397  5.87205  0 18.10    0 0.693 6.405  96.0  1.6768  24 666    20.2 19.37 12.5
## 398  7.67202  0 18.10    0 0.693 5.747  98.9  1.6334  24 666    20.2 19.92  8.5
## 399 38.35180  0 18.10    0 0.693 5.453 100.0  1.4896  24 666    20.2 30.59  5.0
## 400  9.91655  0 18.10    0 0.693 5.852  77.8  1.5004  24 666    20.2 29.97  6.3
## 401 25.04610  0 18.10    0 0.693 5.987 100.0  1.5888  24 666    20.2 26.77  5.6
## 402 14.23620  0 18.10    0 0.693 6.343 100.0  1.5741  24 666    20.2 20.32  7.2
## 403  9.59571  0 18.10    0 0.693 6.404 100.0  1.6390  24 666    20.2 20.31 12.1
## 404 24.80170  0 18.10    0 0.693 5.349  96.0  1.7028  24 666    20.2 19.77  8.3
## 405 41.52920  0 18.10    0 0.693 5.531  85.4  1.6074  24 666    20.2 27.38  8.5
```

```
## 406 67.92080  0 18.10    0 0.693 5.683 100.0  1.4254  24 666    20.2 22.98  5.0
## 407 20.71620  0 18.10    0 0.659 4.138 100.0  1.1781  24 666    20.2 23.34 11.9
## 408 11.95110  0 18.10    0 0.659 5.608 100.0  1.2852  24 666    20.2 12.13 27.9
## 409  7.40389  0 18.10    0 0.597 5.617  97.9  1.4547  24 666    20.2 26.40 17.2
## 410 14.43830  0 18.10    0 0.597 6.852 100.0  1.4655  24 666    20.2 19.78 27.5
## 411 51.13580  0 18.10    0 0.597 5.757 100.0  1.4130  24 666    20.2 10.11 15.0
## 412 14.05070  0 18.10    0 0.597 6.657 100.0  1.5275  24 666    20.2 21.22 17.2
## 413 18.81100  0 18.10    0 0.597 4.628 100.0  1.5539  24 666    20.2 34.37 17.9
## 414 28.65580  0 18.10    0 0.597 5.155 100.0  1.5894  24 666    20.2 20.08 16.3
## 415 45.74610  0 18.10    0 0.693 4.519 100.0  1.6582  24 666    20.2 36.98  7.0
## 416 18.08460  0 18.10    0 0.679 6.434 100.0  1.8347  24 666    20.2 29.05  7.2
## 417 10.83420  0 18.10    0 0.679 6.782  90.8  1.8195  24 666    20.2 25.79  7.5
## 418 25.94060  0 18.10    0 0.679 5.304  89.1  1.6475  24 666    20.2 26.64 10.4
## 419 73.53410  0 18.10    0 0.679 5.957 100.0  1.8026  24 666    20.2 20.62  8.8
## 420 11.81230  0 18.10    0 0.718 6.824  76.5  1.7940  24 666    20.2 22.74  8.4
## 421 11.08740  0 18.10    0 0.718 6.411 100.0  1.8589  24 666    20.2 15.02 16.7
## 422  7.02259  0 18.10    0 0.718 6.006  95.3  1.8746  24 666    20.2 15.70 14.2
## 423 12.04820  0 18.10    0 0.614 5.648  87.6  1.9512  24 666    20.2 14.10 20.8
## 424  7.05042  0 18.10    0 0.614 6.103  85.1  2.0218  24 666    20.2 23.29 13.4
## 425  8.79212  0 18.10    0 0.584 5.565  70.6  2.0635  24 666    20.2 17.16 11.7
## 426 15.86030  0 18.10    0 0.679 5.896  95.4  1.9096  24 666    20.2 24.39  8.3
## 427 12.24720  0 18.10    0 0.584 5.837  59.7  1.9976  24 666    20.2 15.69 10.2
## 428 37.66190  0 18.10    0 0.679 6.202  78.7  1.8629  24 666    20.2 14.52 10.9
## 429  7.36711  0 18.10    0 0.679 6.193  78.1  1.9356  24 666    20.2 21.52 11.0
## 430  9.33889  0 18.10    0 0.679 6.380  95.6  1.9682  24 666    20.2 24.08  9.5
## 431  8.49213  0 18.10    0 0.584 6.348  86.1  2.0527  24 666    20.2 17.64 14.5
## 432 10.06230  0 18.10    0 0.584 6.833  94.3  2.0882  24 666    20.2 19.69 14.1
## 433  6.44405  0 18.10    0 0.584 6.425  74.8  2.2004  24 666    20.2 12.03 16.1
## 434  5.58107  0 18.10    0 0.713 6.436  87.9  2.3158  24 666    20.2 16.22 14.3
## 435 13.91340  0 18.10    0 0.713 6.208  95.0  2.2222  24 666    20.2 15.17 11.7
## 436 11.16040  0 18.10    0 0.740 6.629  94.6  2.1247  24 666    20.2 23.27 13.4
## 437 14.42080  0 18.10    0 0.740 6.461  93.3  2.0026  24 666    20.2 18.05  9.6
## 438 15.17720  0 18.10    0 0.740 6.152 100.0  1.9142  24 666    20.2 26.45  8.7
## 439 13.67810  0 18.10    0 0.740 5.935  87.9  1.8206  24 666    20.2 34.02  8.4
## 440  9.39063  0 18.10    0 0.740 5.627  93.9  1.8172  24 666    20.2 22.88 12.8
## 441 22.05110  0 18.10    0 0.740 5.818  92.4  1.8662  24 666    20.2 22.11 10.5
## 442  9.72418  0 18.10    0 0.740 6.406  97.2  2.0651  24 666    20.2 19.52 17.1
## 443  5.66637  0 18.10    0 0.740 6.219 100.0  2.0048  24 666    20.2 16.59 18.4
## 444  9.96654  0 18.10    0 0.740 6.485 100.0  1.9784  24 666    20.2 18.85 15.4
## 445 12.80230  0 18.10    0 0.740 5.854  96.6  1.8956  24 666    20.2 23.79 10.8
## 446 10.67180  0 18.10    0 0.740 6.459  94.8  1.9879  24 666    20.2 23.98 11.8
## 447  6.28807  0 18.10    0 0.740 6.341  96.4  2.0720  24 666    20.2 17.79 14.9
## 448  9.92485  0 18.10    0 0.740 6.251  96.6  2.1980  24 666    20.2 16.44 12.6
## 449  9.32909  0 18.10    0 0.713 6.185  98.7  2.2616  24 666    20.2 18.13 14.1
## 450  7.52601  0 18.10    0 0.713 6.417  98.3  2.1850  24 666    20.2 19.31 13.0
## 451  6.71772  0 18.10    0 0.713 6.749  92.6  2.3236  24 666    20.2 17.44 13.4
## 452  5.44114  0 18.10    0 0.713 6.655  98.2  2.3552  24 666    20.2 17.73 15.2
## 453  5.09017  0 18.10    0 0.713 6.297  91.8  2.3682  24 666    20.2 17.27 16.1
## 454  8.24809  0 18.10    0 0.713 7.393  99.3  2.4527  24 666    20.2 16.74 17.8
## 455  9.51363  0 18.10    0 0.713 6.728  94.1  2.4961  24 666    20.2 18.71 14.9
## 456  4.75237  0 18.10    0 0.713 6.525  86.5  2.4358  24 666    20.2 18.13 14.1
## 457  4.66883  0 18.10    0 0.713 5.976  87.9  2.5806  24 666    20.2 19.01 12.7
## 458  8.20058  0 18.10    0 0.713 5.936  80.3  2.7792  24 666    20.2 16.94 13.5
## 459  7.75223  0 18.10    0 0.713 6.301  83.7  2.7831  24 666    20.2 16.23 14.9
```

```
## 460  6.80117  0 18.10    0 0.713 6.081  84.4  2.7175  24 666    20.2 14.70 20.0
## 461  4.81213  0 18.10    0 0.713 6.701  90.0  2.5975  24 666    20.2 16.42 16.4
## 462  3.69311  0 18.10    0 0.713 6.376  88.4  2.5671  24 666    20.2 14.65 17.7
## 463  6.65492  0 18.10    0 0.713 6.317  83.0  2.7344  24 666    20.2 13.99 19.5
## 464  5.82115  0 18.10    0 0.713 6.513  89.9  2.8016  24 666    20.2 10.29 20.2
## 465  7.83932  0 18.10    0 0.655 6.209  65.4  2.9634  24 666    20.2 13.22 21.4
## 466  3.16360  0 18.10    0 0.655 5.759  48.2  3.0665  24 666    20.2 14.13 19.9
## 467  3.77498  0 18.10    0 0.655 5.952  84.7  2.8715  24 666    20.2 17.15 19.0
## 468  4.42228  0 18.10    0 0.584 6.003  94.5  2.5403  24 666    20.2 21.32 19.1
## 469 15.57570  0 18.10    0 0.580 5.926  71.0  2.9084  24 666    20.2 18.13 19.1
## 470 13.07510  0 18.10    0 0.580 5.713  56.7  2.8237  24 666    20.2 14.76 20.1
## 471  4.34879  0 18.10    0 0.580 6.167  84.0  3.0334  24 666    20.2 16.29 19.9
## 472  4.03841  0 18.10    0 0.532 6.229  90.7  3.0993  24 666    20.2 12.87 19.6
## 473  3.56868  0 18.10    0 0.580 6.437  75.0  2.8965  24 666    20.2 14.36 23.2
## 474  4.64689  0 18.10    0 0.614 6.980  67.6  2.5329  24 666    20.2 11.66 29.8
## 475  8.05579  0 18.10    0 0.584 5.427  95.4  2.4298  24 666    20.2 18.14 13.8
## 476  6.39312  0 18.10    0 0.584 6.162  97.4  2.2060  24 666    20.2 24.10 13.3
## 477  4.87141  0 18.10    0 0.614 6.484  93.6  2.3053  24 666    20.2 18.68 16.7
## 478 15.02340  0 18.10    0 0.614 5.304  97.3  2.1007  24 666    20.2 24.91 12.0
## 479 10.23300  0 18.10    0 0.614 6.185  96.7  2.1705  24 666    20.2 18.03 14.6
## 480 14.33370  0 18.10    0 0.614 6.229  88.0  1.9512  24 666    20.2 13.11 21.4
## 481  5.82401  0 18.10    0 0.532 6.242  64.7  3.4242  24 666    20.2 10.74 23.0
## 482  5.70818  0 18.10    0 0.532 6.750  74.9  3.3317  24 666    20.2  7.74 23.7
## 483  5.73116  0 18.10    0 0.532 7.061  77.0  3.4106  24 666    20.2  7.01 25.0
## 484  2.81838  0 18.10    0 0.532 5.762  40.3  4.0983  24 666    20.2 10.42 21.8
## 485  2.37857  0 18.10    0 0.583 5.871  41.9  3.7240  24 666    20.2 13.34 20.6
## 486  3.67367  0 18.10    0 0.583 6.312  51.9  3.9917  24 666    20.2 10.58 21.2
## 487  5.69175  0 18.10    0 0.583 6.114  79.8  3.5459  24 666    20.2 14.98 19.1
## 488  4.83567  0 18.10    0 0.583 5.905  53.2  3.1523  24 666    20.2 11.45 20.6
## 489  0.15086  0 27.74    0 0.609 5.454  92.7  1.8209   4 711    20.1 18.06 15.2
## 490  0.18337  0 27.74    0 0.609 5.414  98.3  1.7554   4 711    20.1 23.97  7.0
## 491  0.20746  0 27.74    0 0.609 5.093  98.0  1.8226   4 711    20.1 29.68  8.1
## 492  0.10574  0 27.74    0 0.609 5.983  98.8  1.8681   4 711    20.1 18.07 13.6
## 493  0.11132  0 27.74    0 0.609 5.983  83.5  2.1099   4 711    20.1 13.35 20.1
## 502  0.06263  0 11.93    0 0.573 6.593  69.1  2.4786   1 273    21.0  9.67 22.4
## 503  0.04527  0 11.93    0 0.573 6.120  76.7  2.2875   1 273    21.0  9.08 20.6
## 504  0.06076  0 11.93    0 0.573 6.976  91.0  2.1675   1 273    21.0  5.64 23.9
## 505  0.10959  0 11.93    0 0.573 6.794  89.3  2.3889   1 273    21.0  6.48 22.0
## 506  0.04741  0 11.93    0 0.573 6.030  80.8  2.5050   1 273    21.0  7.88 11.9
```

```r
# get the range of each predictor
range(Boston$crim)
```

```
## [1]  0.00632 88.97620
```

```r
range(Boston$tax)
```

```
## [1] 187 711
```

```r
range(Boston$ptratio)
```

```
## [1] 12.6 22.0
```

- Yes, there are census tracts with particularly high crime rates, tax rates and pupil-teacher ratios. For instance, census tracts with crime rates greater than 20 have particularly high crime rates. Census tracts with tax rates greater than 600 have particularly high tax rates. Census tracts with pupil-teacher ratios greater than 20 have particularly high pupil-teacher ratios. The range of each predictor is as follows: the per capita crime rate ranges from 0 to 89.0, the full-value property-tax rate per $10,000 ranges from 187 to 711, and the pupil-teacher ratio by town ranges from 12.6 to 22.0.

(e) How many of the census tracts in this data set bound the Charles river?

```
# selecting tract which bound the river , i.e chas == 1 .
#Boston[Boston$chas == 1,]

# the num of such tracts
num_tracts_river <- length(Boston[Boston$chas == 1,]$chas)
```

(f) What is the median pupil-teacher ratio among the towns in this data set?

```
median_ptratio <- median(Boston$ptratio)
print(median_ptratio)
```

```
## [1] 19.05
```

(g) Which census tract of Boston has lowest median value of owner-occupied homes? What are the values of the other predictors for that census tract, and how do those values compare to the overall ranges for those predictors? Comment on your findings.

```
# get the census tract with the lowest median value of owner-occupied homes
low_medv <- Boston[Boston$medv == min(Boston$medv), ]
low_medv
```

```
##        crim zn indus chas   nox    rm age    dis rad tax ptratio lstat medv
## 399 38.3518  0  18.1    0 0.693 5.453 100 1.4896  24 666    20.2 30.59    5
## 406 67.9208  0  18.1    0 0.693 5.683 100 1.4254  24 666    20.2 22.98    5
```

(h) In this data set, how many of the census tracts average more than seven rooms per dwelling? More than eight rooms per dwelling? Comment on the census tracts that average more than eight rooms per dwelling.

```
# get the num of census tracts that average more than seven rooms per dwelling
num_tracts_seven <- length(Boston[Boston$rm > 7, ]$rm)

# get the census tracts that average more than eight rooms per dwelling
tracts_eight <- Boston[Boston$rm > 8, ]
tracts_eight
```

```
##        crim zn indus chas    nox    rm  age    dis rad tax ptratio lstat medv
## 98  0.12083  0  2.89    0 0.4450 8.069 76.0 3.4952   2 276    18.0  4.21 38.7
## 164 1.51902  0 19.58    1 0.6050 8.375 93.9 2.1620   5 403    14.7  3.32 50.0
## 205 0.02009 95  2.68    0 0.4161 8.034 31.9 5.1180   4 224    14.7  2.88 50.0
## 225 0.31533  0  6.20    0 0.5040 8.266 78.3 2.8944   8 307    17.4  4.14 44.8
## 226 0.52693  0  6.20    0 0.5040 8.725 83.0 2.8944   8 307    17.4  4.63 50.0
## 227 0.38214  0  6.20    0 0.5040 8.040 86.5 3.2157   8 307    17.4  3.13 37.6
## 233 0.57529  0  6.20    0 0.5070 8.337 73.3 3.8384   8 307    17.4  2.47 41.7
## 234 0.33147  0  6.20    0 0.5070 8.247 70.4 3.6519   8 307    17.4  3.95 48.3
## 254 0.36894 22  5.86    0 0.4310 8.259  8.4 8.9067   7 330    19.1  3.54 42.8
## 258 0.61154 20  3.97    0 0.6470 8.704 86.9 1.8010   5 264    13.0  5.12 50.0
## 263 0.52014 20  3.97    0 0.6470 8.398 91.5 2.2885   5 264    13.0  5.91 48.8
## 268 0.57834 20  3.97    0 0.5750 8.297 67.0 2.4216   5 264    13.0  7.44 50.0
## 365 3.47428  0 18.10    1 0.7180 8.780 82.9 1.9047  24 666    20.2  5.29 21.9
```