Problem Set - 1

Arijit Das, Roll-713

21-01-2026

PREDICTIVE ANALYTICS

Problem Set 1: An Introduction

Download “Boston” housing data from MASS library in R.

```
library("MASS")
head(Boston)

##      crim zn indus chas   nox    rm  age    dis rad tax ptratio  black lstat
## 1 0.00632 18  2.31    0 0.538 6.575 65.2 4.0900   1 296    15.3 396.90  4.98
## 2 0.02731  0  7.07    0 0.469 6.421 78.9 4.9671   2 242    17.8 396.90  9.14
## 3 0.02729  0  7.07    0 0.469 7.185 61.1 4.9671   2 242    17.8 392.83  4.03
## 4 0.03237  0  2.18    0 0.458 6.998 45.8 6.0622   3 222    18.7 394.63  2.94
## 5 0.06905  0  2.18    0 0.458 7.147 54.2 6.0622   3 222    18.7 396.90  5.33
## 6 0.02985  0  2.18    0 0.458 6.430 58.7 6.0622   3 222    18.7 394.12  5.21
##   medv
## 1 24.0
## 2 21.6
## 3 34.7
## 4 33.4
## 5 36.2
## 6 28.7

attach(Boston)
```

1. Report the “class” of the data set. How many rows and columns are in this data set? What do the rows and columns represent?

```
class(Boston)

## [1] "data.frame"

nrow(Boston)

## [1] 506

ncol(Boston)

## [1] 14
```

The “class” of the dataset is Data Frame

There are 506 rows and 14 columns in the Boston dataset.

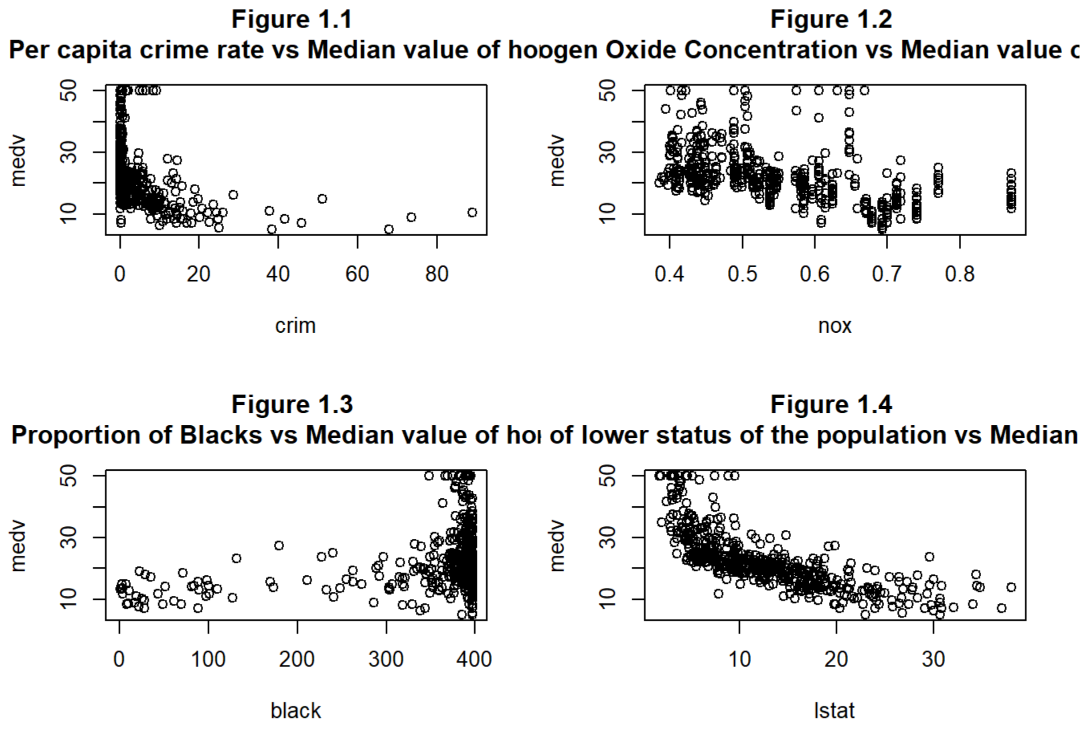
The columns represent the variables and the rows represent the values of the variables

2. Create a smaller data set with the variables median value of owner-occupied homes, per capita crime rate, nitrogen oxides concentration, proportion of blacks and percentage of lower status of the population. Choosing median value of owner occupied homes as the response and the rest as the predictors, make scatter plots of the response versus each predictor. Present the scatter plots in different panels of the same graph. Comment on your findings.

```
data=data.frame(medv,crim,nox,black,lstat)
head(data)

##   medv    crim   nox  black lstat
## 1 24.0 0.00632 0.538 396.90  4.98
## 2 21.6 0.02731 0.469 396.90  9.14
## 3 34.7 0.02729 0.469 392.83  4.03
## 4 33.4 0.03237 0.458 394.63  2.94
## 5 36.2 0.06905 0.458 396.90  5.33
## 6 28.7 0.02985 0.458 394.12  5.21

par(mfrow=c(2,2))
plot(crim,medv,main="Figure 1.1 \n Per capita crime rate vs Median value of homes")
plot(nox,medv,main="Figure 1.2 \n Nitrogen Oxide Concentration vs Median value of homes")
plot(black,medv,main="Figure 1.3 \n Proportion of Blacks vs Median value of homes")
plot(lstat,medv,main="Figure 1.4 \n Percentage of lower status of the population vs Median value of homes")
```



Comment:

Figure 1.1: Crime Rate vs Median Value

There is a negative association between per-capita crime rate (crim) and medv.High crime areas tend to have consistently lower home values. The relationship seems to be non-linear, with a large cluster near low crime that spread upward.

Figure 1.2: Nitrogen Oxide (NOX) vs Median Value

At higher NOX levels (≥0.7), house values are mostly low.Suggests environmental quality strongly affects housing prices.

Figure 1.3: Proportion of Blacks (black) vs Median Value

The plot shows no strong linear relationship, but values spread widely at higher black index values, including high medv. Hence racial composition alone isn't a direct price determinant, unlike crime or Nitrogen Oxide pollution.

Figure 1.4: Lower Status Population (lstat) vs Median Value

A strong negative relationship; as lstat increases, medv decreases sharply. Lower-status neighborhoods have consistently low home values.

3. Which suburb of Boston has lowest median value of owner-occupied homes? What are the values of the other predictors mentioned in (2), for that suburb. How do these values compare to the overall ranges for those predictors? Comment on your findings. Hint: Mention which percentile these values belong to.

```
min_index = which.min(Boston$medv)
Boston[min_index, ]
```

```
##        crim zn indus chas   nox    rm age    dis rad tax ptratio black lstat
## 399 38.3518  0  18.1    0 0.693 5.453 100 1.4896  24 666    20.2 396.9 30.59
##     medv
## 399    5
```

```
suburb=Boston[min_index, c("medv", "crim", "nox", "black", "lstat")]
suburb
```

```
##     medv    crim   nox black lstat
## 399    5 38.3518 0.693 396.9 30.59
```

```
percentile=function(x,value) ecdf(x)(value)*100

data.frame(
  Variable=c("crim", "nox", "black", "lstat"),
  Value=as.numeric(suburb[c("crim", "nox", "black", "lstat")]),
  Percentile=c(percentile(Boston$crim, suburb$crim), percentile(Boston$nox,
suburb$nox),percentile(Boston$black, suburb$black),percentile(Boston$lstat,
suburb$lstat)))
```

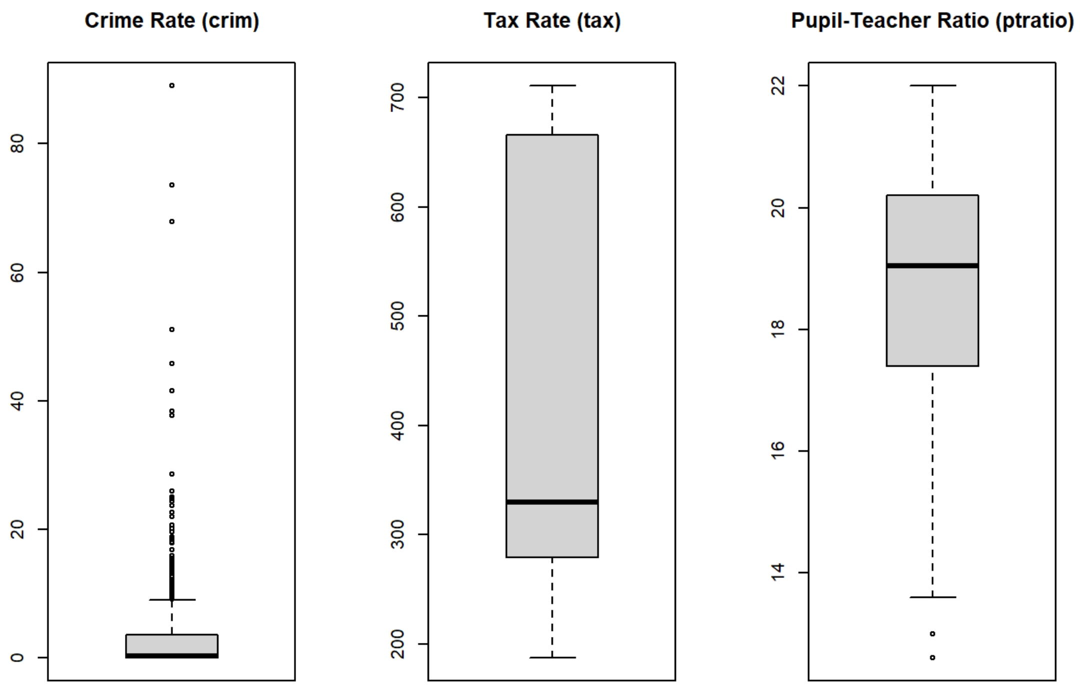
```
##   Variable    Value Percentile
## 1     crim  38.3518   98.81423
## 2      nox   0.6930   85.77075
## 3    black 396.9000  100.00000
## 4    lstat  30.5900   97.82609
```

Comment:

The suburb with the lowest median home value is characterized by extremely high crime, high pollution, and very high lower-status population, all of which are known to negatively affect housing prices. And the percentile of Black people in this suburb is 100.

4. Does any suburb of Boston stand out for having notably high crime rates,tax rates, or pupil–teacher ratios? Hint: Use a boxplot to detect any outliers. If so, identify the suburbs that show the outlier values.

```
par(mfrow=c(1,3))
boxplot(Boston$crim, main="Crime Rate (crim)")
boxplot(Boston$tax, main="Tax Rate (tax)")
boxplot(Boston$ptratio, main="Pupil-Teacher Ratio (ptratio)")
```



Comment:

Using boxplots, several suburbs are detected as outliers for crime rate and pupil–teacher ratios.

Now to find the suburbs using R:

```
get_outliers=function(x) {
  bp= boxplot.stats(x)
  which(x %in% bp$out)
}
```

The suburbs that show the Crime rate outlier values are:

```
crim_outliers=get_outliers(Boston$crim);crim_outliers

##  [1] 368 372 374 375 376 377 378 379 380 381 382 383 385 386 387 388 389 393 395
## [20] 399 400 401 402 403 404 405 406 407 408 410 411 412 413 414 415 416 417 418
## [39] 419 420 421 423 426 427 428 430 432 435 436 437 438 439 440 441 442 444 445
## [58] 446 448 449 455 469 470 478 479 480
```

The suburbs that show the Pupil-teacher ratio outlier values are:

```
ptratio_outliers=get_outliers(Boston$ptratio);ptratio_outliers

##  [1] 197 198 199 258 259 260 261 262 263 264 265 266 267 268 269
```