Homework 1

Daniel Carpenter

August 2022

Table of contents

1 Using R: Vectors

1.1 (a)

Create a vector with 10 numbers (3, 12, 6, -5, 0, 8, 15, 1, -10, 7) and assign it to x.

```
x <- c(3, 12, 6, -5, 0, 8, 15, 1, -10, 7)
```

1.2 (b)

Using the commands seq, min, and max with one line of code create a new vector y with 10 elements ranging from the minimum value of x to the maximum value of x.

```
# Min, max of x vector
xMin = min(x)
xMax = max(x)
INCREMENT = (xMax - xMin) / (length(x) - 1) # size of each step

# Create the vector from min of x to max of x while maintaining length of 10
y = seq(min(x), max(x), INCREMENT)
y # display
```

```
 [1] -10.000000  -7.222222  -4.444444  -1.666667   1.111111   3.888889
 [7]   6.666667   9.444444  12.222222  15.000000
```

```
# Prove is 10 elements:
paste('The length of y is:', length(y) )
```

```
[1] "The length of y is: 10"
```

1.3 (c)

1.3.1 Compute the `sum`, `mean`, `standard deviation`, `variance`, `mean absolute deviation`, `quartiles`

```
# Combine x and y into single object
xAndY <- cbind(x, y)

# This is what x and y look like
head(xAndY)
```

```
     x          y
[1,]  3 -10.000000
[2,] 12  -7.222222
[3,]  6  -4.444444
[4,] -5  -1.666667
[5,]  0   1.111111
[6,]  8   3.888889
```

```
# List of all the function to calculate on x and y (excluding quintile)
vectorOfFuns      <- c('sum', 'mean', 'sd', 'var', 'mad', 'quantile')
vectorOfFunsNames <- c('sum', 'mean', 'standard deviation', 'variance', # function full na
                       'mean absolute deviation', 'quartiles')

for (funIdx in 1:length(vectorOfFuns)) {

  # Print result of the function calculation output, for x and y
  print( paste( vectorOfFunsNames[funIdx], 'of x and y:' ) )

  # Calulate using a function from `vectorOfFuns`
  output <- apply(xAndY,                          # Using X and Y
                  ncol(xAndY),                    # There are n cols in x & y
                  paste0(vectorOfFuns[funIdx]) ) # Retrieve/apply function

  print(output)
}
```

```
[1] "sum of x and y:"
 x  y
37 25
```

```
[1] "mean of x and y:"
  x   y
3.7 2.5
[1] "standard deviation of x and y:"
       x        y
7.572611 8.410140
[1] "variance of x and y:"
       x        y
57.34444 70.73045
[1] "mean absolute deviation of x and y:"
       x        y
 5.93040 10.29583
[1] "quartiles of x and y:"
          x      y
0%   -10.00 -10.00
25%    0.25  -3.75
50%    4.50   2.50
75%    7.75   8.75
100%  15.00  15.00
```

1.3.2 Compute the Quintiles

```r
# Quintile for x
quantile(x, probs = seq(0, 1, 0.20))
```

```
   0%   20%   40%   60%   80%  100%
-10.0  -1.0   2.2   6.4   8.8  15.0
```

```r
# Quintile for y
quantile(y, probs = seq(0, 1, 0.20))
```

```
           0%           20%           40%           60%           80%
-1.000000e+01 -5.000000e+00 -1.665335e-15  5.000000e+00  1.000000e+01
         100%
 1.500000e+01
```

1.4 (d)

Use sample() to create a new 7 element vector z by using R to randomly sample from x with replacement.

```
z = sample(x, size=7)

z # show value
```

```
[1]   0  12   7   8   6   3 -10
```

1.5 (e)

Use `t.test()` to compute a statistical test for differences in means between the vectors `x` and `y`.

```
t.test(x, y)
```

```
    Welch Two Sample t-test

data:  x and y
t = 0.33531, df = 17.805, p-value = 0.7413
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -6.324578  8.724578
sample estimates:
mean of x mean of y
      3.7       2.5
```

Are the differences in means significant?

No, they are not statistically significant (90%, 95%, or 99%), given

- t-value is $< \sim 1.96$
- p-value is $> 0.10, 0.05.\ 0.01$

1.6 (f)

To sort a data frame in `R`, use the `order()` function. Sort the vector `x` and re-run the t-test as a paired t-test.

```r
# Sort x
xSorted = x[order(x)]

# Run as paired t test
t.test(x, y, paired = TRUE)
```

```
    Paired t-test

data:  x and y
t = 0.30858, df = 9, p-value = 0.7647
alternative hypothesis: true mean difference is not equal to 0
95 percent confidence interval:
 -7.596943  9.996943
sample estimates:
mean difference
            1.2
```

1.7 (g)

Create a logical vector that identifies which numbers in x are negative.

```r
xThatAreNeg = x < 0

x # reminder of what x looks like
```

```
 [1]   3  12   6  -5   0   8  15   1 -10   7
```

```r
xThatAreNeg # display
```

```
 [1] FALSE FALSE FALSE  TRUE FALSE FALSE FALSE FALSE  TRUE FALSE
```

1.8 (h)

Use this logical vector to remove all entries with negative numbers from x. (Make sure to overwrite the vector x so that the new vector x has 8 elements!)

```r
x = subset(x, !xThatAreNeg)
```

```
x # display
```

```
[1]  3 12  6  0  8 15  1  7
```

2 Using R: Some missing values

2.1 (a)

2.1.1 Use the code below to create the dataframe X and

```
col1 <- c(1,2,3,NA,5)
col2 <- c(4,5,6,89,101)
col3 <- c(45,NA,66,121,201)
col4 <- c(14,NA,13,NA,27)
X <- rbind (col1,col2,col3,col4)
```

2.1.2 Then write code to display all rows in X with missing values.

```
# All rows of X that have NAs (e.g., not complete)
X[!complete.cases(X), ]
```

```
     [,1] [,2] [,3] [,4] [,5]
col1    1    2    3   NA    5
col3   45   NA   66  121  201
col4   14   NA   13   NA   27
```

2.2 (b)

Use the following vector y for this part:

```
y <- c(3,12,99,99,7,99,21)
```

2.2.1 i.

Some statistical applications and older systems sometimes code missing values with a number, e.g., 99. In order to let R know that is a missing value you need to recode it as 'NA'. Please write a line of code that will replace any 99's in the vector y with 'NA'.

```
# Replace 99 with NA values in the vector y
y[y == 99] <- NA
y
```

```
[1]  3 12 NA NA  7 NA 21
```

2.2.2 ii.

With the updated vector y, write code that will count the number of missing values in it.

```
# Number of NA values in the vector y
sum( is.na(y) )
```

```
[1] 3
```

3 Using R: Introductory data exploration

3.1 a. Read in `college.csv`

```
college <- read.csv('college.csv')
```

3.2 b. Preview data

```
# Create row names for each college
rownames(college) <- college[, 1]

# Remove the college variabl
college <- college[,-1] # get row names and store as field

# View(college)
```

3.3 c.

3.3.1 i. Stats on Data

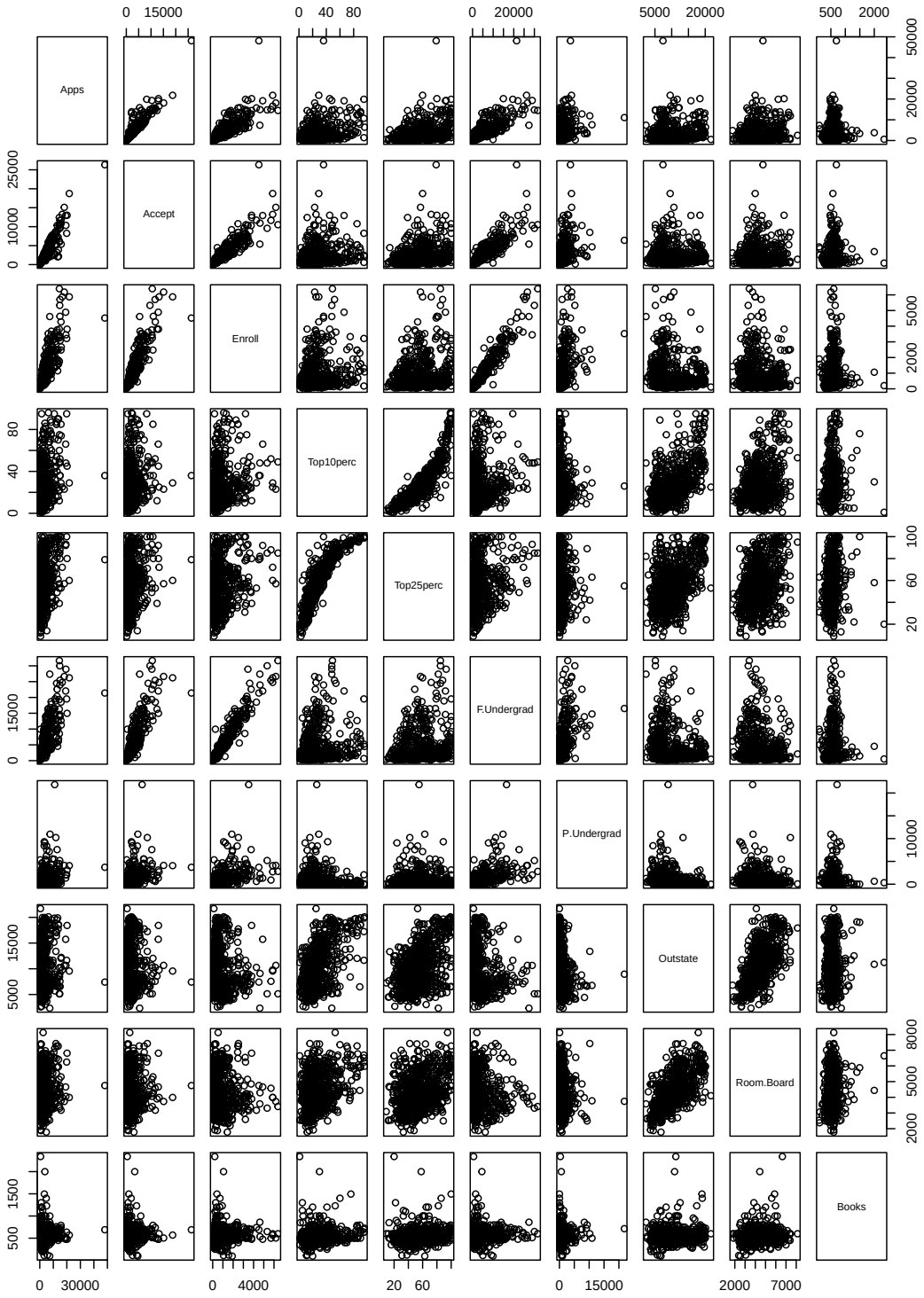
```
# summary of each variable
summary(college)
```

```
  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
```

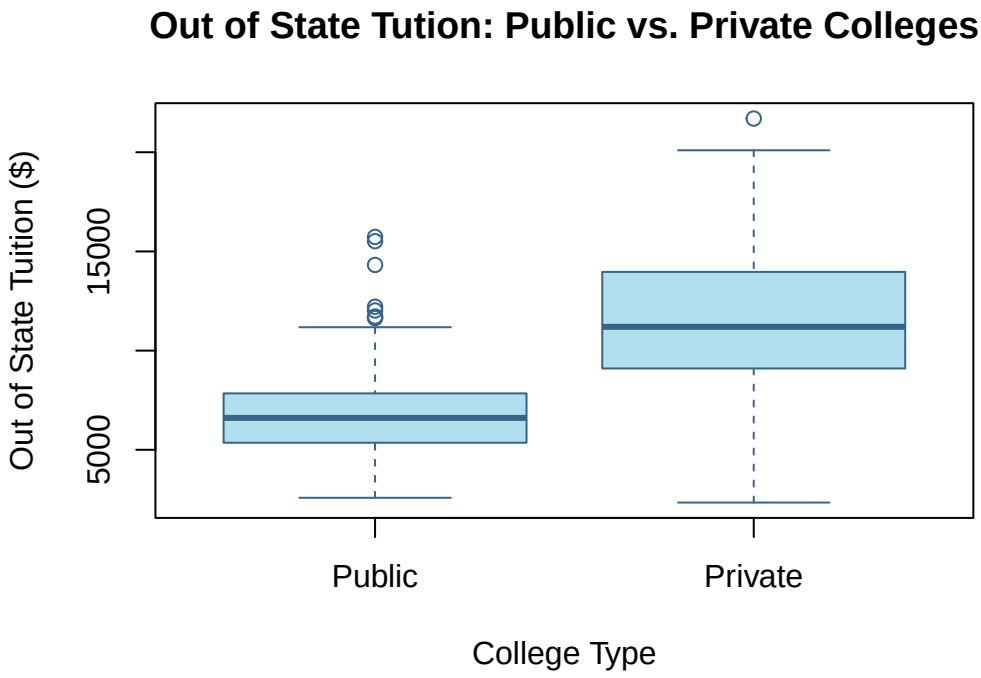
3.3.2 ii. Pairs Plots

```r
# Find package for `pairs`
# ?pairs


# Correlation between 1st 10 variables
pairs(college[, 2:11]) # 2-11 since first variable is type character
```


Apps
Accept
Enroll
Top10perc
Top25perc
F.Undergrad
P.Undergrad
Outstate
Room.Board
Books

3.3.3 iii. Boxplots: Private/Public OS Tuition

```
# Note used boxplot instead of plot since it is the de facto for base R
# Hope that choice is okay - took a judgement call
boxplot(
        # Data
        Outstate ~ Private, # Y ~ X
        data   =  college,  # Dataset

        # Aesthetics (titles & colors)
        main   = "Out of State Tution: Public vs. Private Colleges",
        names  = c('Public', 'Private'), # names of the x axis
        xlab   = "College Type",
        ylab   = "Out of State Tuition ($)",
        col    = "lightblue2",
        border = "steelblue4"
)
```



3.3.4 iv. `Elite` variable

```
# By default create and set the Elite variable to 'No'
Elite <- rep ("No", nrow(college ))

# If the college has more than 50 students from the top 10% of their class,
# Then 'Yes', the college is elite
Elite [college$Top10perc >50] <- "Yes"

# Ensure the data type is a factor
Elite <- as.factor(Elite)

# Finally add the new `Elite` variable to the college data frame
college <- data.frame(college ,Elite)
```

3.3.5 v. # of Elite Colleges

- Note there are 78 elite schools (699 that are not elite). See below.

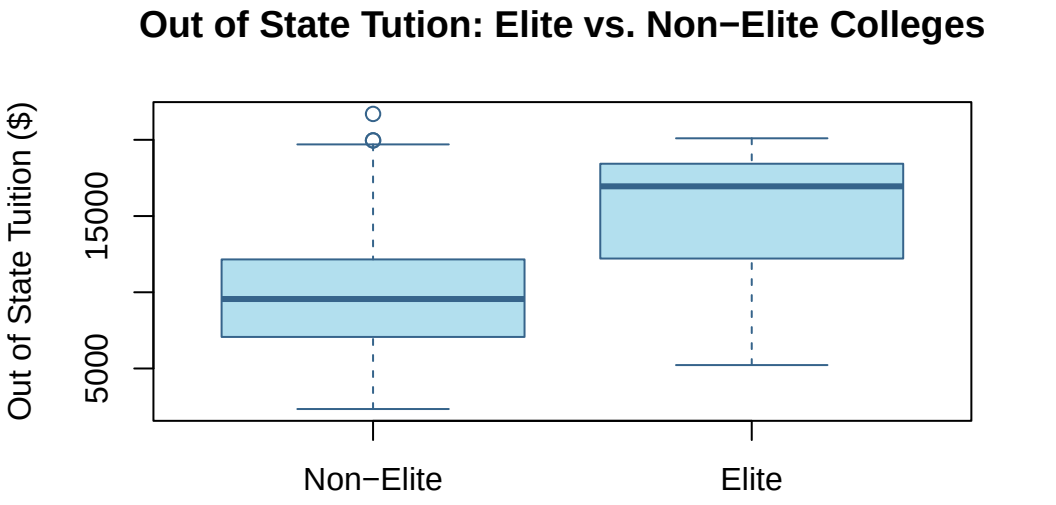
```
summary(college$Elite)
```

```
 No Yes
699  78
```

3.3.6 vi. Boxplots: Elite OS Tuition

```
boxplot(
        # Data
        Outstate ~ Elite, # Y ~ X
        data   =  college,  # Dataset

        # Aesthetics (titles & colors)
        main   = "Out of State Tution: Elite vs. Non-Elite Colleges",
        sub    = "Note 'Elite' Definition: College contains > 50 students from top 10% of
        names  = c('Non-Elite', 'Elite'), # names of the x axis
        xlab   = "Elite Status of College",
        ylab   = "Out of State Tuition ($)",
        col    = "lightblue2",
        border = "steelblue4"
```

```
)
```

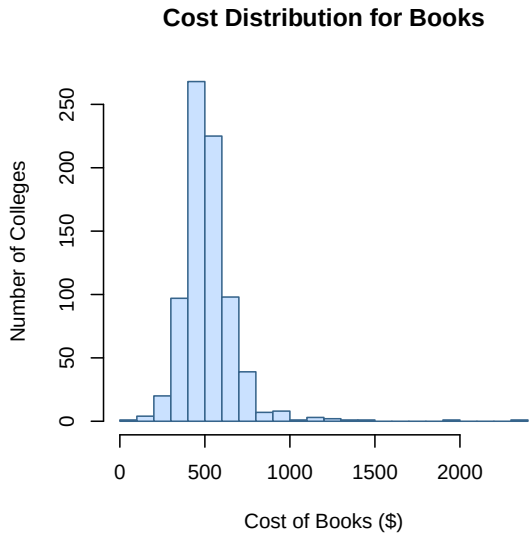


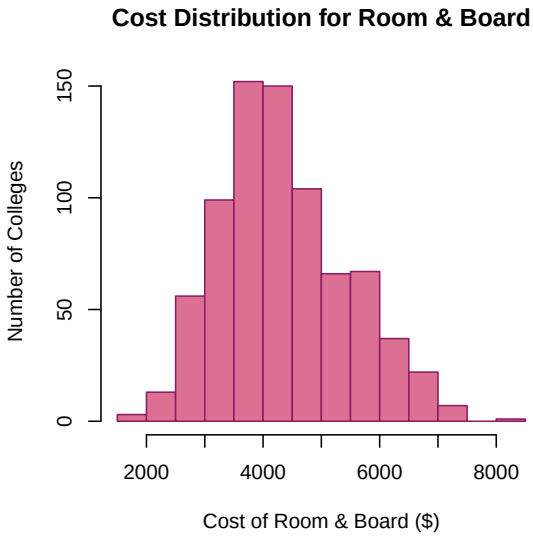
3.3.7 vii. Histograms

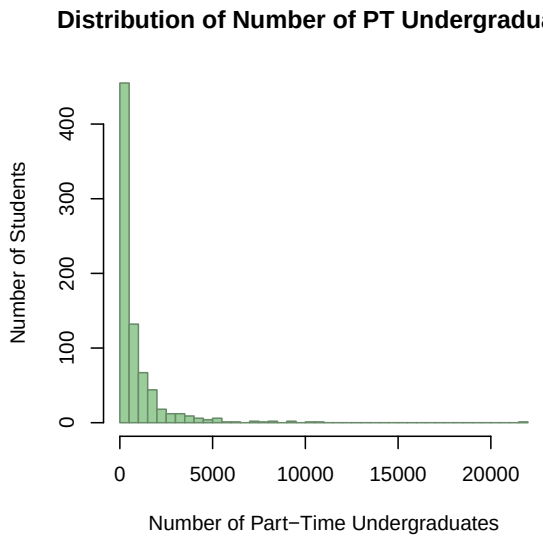
- Plot 4 numeric variables

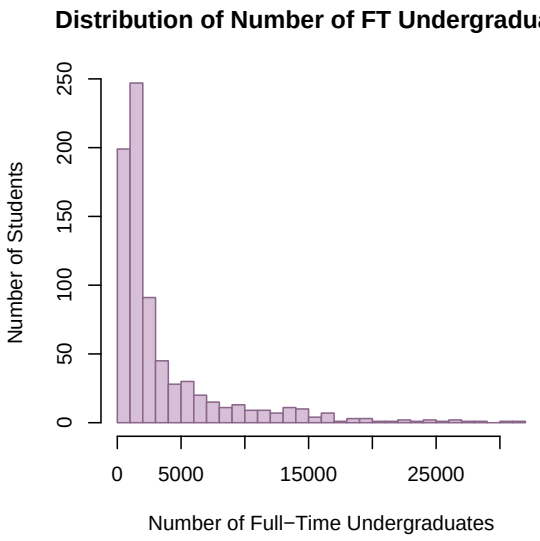
```
par(mfrow=c(2,2)) # Set up 2x2 grid for plotting

# plot histogram with some defaults
hist(x = college$Books,

     # Aesthetics (titles & colors)
     breaks = 20, # Number of bins
     main   = 'Cost Distribution for Books',
     xlab   = 'Cost of Books ($)',
     ylab   = 'Number of Colleges',
     col    = "lightsteelblue1",
     border = "steelblue4"
)

# plot histogram with some defaults
```

```r
hist(x = college$Room.Board,

     # Aesthetics (titles & colors)
     breaks = 10, # Number of bins
     main   = 'Cost Distribution for Room & Board',
     xlab   = 'Cost of Room & Board ($)',
     ylab   = 'Number of Colleges',
     col    = "palevioletred",
     border = "maroon4"
)

# plot histogram with some defaults
hist(x = college$P.Undergrad,

     # Aesthetics (titles & colors)
     breaks = 50, # Number of bins
     main   = 'Distribution of Number of PT Undergraduates',
     xlab   = 'Number of Part-Time Undergraduates',
     ylab   = 'Number of Students',
     col    = "darkseagreen3",
     border = "darkseagreen4"
)

# plot histogram with some defaults
hist(x = college$F.Undergrad,

     # Aesthetics (titles & colors)
     breaks = 30, # Number of bins
     main   = 'Distribution of Number of FT Undergraduates',
     xlab   = 'Number of Full-Time Undergraduates',
     ylab   = 'Number of Students',
     col    = "thistle",
     border = "plum4"
)
```


Cost Distribution for Books
Number of Colleges
0
50
100
150
200
250
0
500
1000
1500
2000
Cost of Books ($)


Cost Distribution for Room & Board
Number of Colleges
0
50
100
150
2000
4000
6000
8000
Cost of Room & Board ($)


Distribution of Number of PT Undergraduates
Number of Students
0
100
200
300
400
0
5000
10000
15000
20000
Number of Part−Time Undergraduates


Distribution of Number of FT Undergraduates
Number of Students
0
50
100
150
200
250
0
5000
15000
25000
Number of Full−Time Undergraduates

4 Using R: Manipulating data in data frames

- Uses `tidyverse` piping and `dplyr` functions since use of `plyr` only specified for getting `baseball` dataset

4.1 (a) Load `baseball` from `plyr`

```
if (!require(plyr)) install.packages('plyr') # get plyr package
if (!require(tidyverse)) install.packages('tidyverse') # get tidverse for piping

baseball.base <- plyr::baseball
```

4.2 (b) Data Cleanup

```
# ?baseball # get info on dataset
baseball <- baseball.base %>%

  # for players before 1954, sacrifice flies
  # (i.e. the variable sf) should be set to 0
  mutate(sf = if_else(year < 1954, 0.0, as.double(sf) ), # double because dplyr needs that

  # Hit by pitch (the variable hbp) is often missing,
  # set these missings to 0.
        hbp = if_else(is.na(hbp), 0.0, as.double(hbp) )
  ) %>%


  # Exclude all player records with fewer than 50 at bats (the variable ab).
  filter(ab < 50)

# Validation that the manipulation worked
# summary(baseball$sf)
# summary(baseball$hbp)
# summary(baseball$ab)
```

4.3 (c) Calculate the base percentage `obp`

```
baseball <- baseball %>%

  # Calculate base percent
  mutate(obp = (h + bb + hbp) / (ab + bb + hbp + sf) )
```

4.4 (d) Sort & Display

- Sort data descending on `obp`
- Display top 5 players
- *Assumes the player name is the id since name not available in dataset*

```
baseball <- baseball %>%

  # Sort data descening
  arrange(desc(obp) )

# Get package for knitting to kable table
if (!require(knitr)) install.packages('knitr')
```

```
Loading required package: knitr
```

```
NUM_PLAYERS_TO_DISPLAY = 5

knitr::kable(

  # Print top 5 players, their year, id, obp on-base percentage
  head(baseball %>% select(year, id, obp), # copy filtered data
       NUM_PLAYERS_TO_DISPLAY)             # only show 5 players
)
```

year	id	obp
1894	brownpe01	1
1913	griffcl01	1
1914	griffcl01	1
1916	davisha01	1
1918	haineje01	1