# ISE 5103 Intelligent Data Analytics
# Homework #1

Instructor: Charles Nicholson

See course website for due date

**Learning objective:** Learn the basics of R programming.
**Submission notes:**

1. Clearly identify each problem (e.g. Problem 1a, Problem 2b, etc.)
2. All *relevant* computer output should be provided unless noted otherwise.
3. The R code itself is part of your solution – make sure to *provide comments* on what your code is doing. Keep it clean and clear!
4. You will submit your complete R script. Note: include `library` commands to load *all* packages that are used in the completion of the assignment. Place these statements at the top of your script.
5. Use "R Markdown" to produce a PDF document as your submission.
6. Do not zip your files for submission. Submit exactly two files. Name the files "LastName-HW1" with the appropriate file extension (that is, .R, .pdf, .docx, or .html)

Note: it is very helpful to create a "New Project" using RStudio for each homework assignment. This allows for easier management of script files and data.

## 1 Using R: Vectors

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

(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`.

(c) Compute the sum, mean, standard deviation, variance, mean absolute deviation, quartiles, and quintiles for `x` and `y`.

(d) Create a new 7 element vector `z` by using R to randomly sample from `x` *with* replacement.

(e) Find a package (or packages) that provide the statistical measures skewness and kurtosis. Use the appropriate functions from the package to calculate the skewness and kurtosis of `x`.

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

(g) Sort the vector `x` and re-run the t-test as a paired t-test.

(h) Create a logical vector that identifies which numbers in `x` are negative.

(i) 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!)

## 2 Using R: Introductory data exploration

This exercise relates to the College data set, which can be found in the file "College.csv" in D2L. The file 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
- `Top25perc` : New students from top 25
- `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 a data frame in R. Call the data frame `college`. Make sure that you have the directory set to the correct location for the data (or that the data is in the same directory as the RStudio project).

(b) Look at the data using RStudio. You should notice that the first column is just the name of each university. We dont 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 )
```

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]
```

and then view the data (either with the `View` command or clicking on the `college` data frame in the RStudio workspace window) Now you should see that the first data column is `Private`.

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

ii. Access help for the `pairs` function and then use `pairs` to produce a scatterplot matrix of the *first ten columns*. Recall that you can reference the first ten columns of a matrix `A` using `A[,1:10]`.

iii. Use the `plot()` function to produce side-by-side boxplots of Outstate versus Private. Label the axes and main title appropriately.

iv. Using the following bit of code you will create a new qualitative variable, called `Elite` by binning the `Top10perc` variable. That is, `Elite` will classify the 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%.

   Add comments to each line below explaining what the corresponding code is doing and then run the code.

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

v. Use the `summary()` function to see how many elite universities there are.

vi. Now use the `plot()` function to produce side-by-side boxplots of `Outstate` versus `Elite`. Label the axes and main title appropriately.

vii. 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.

## 3 Using R: Manipulating data in data frames

(a) Load the data frame `baseball` in the `plyr` package. Use `?baseball` to get information about the data set and definitions for the variables.

(b) You will calculate the *on base percentage* for each player, but first clean up the data:

- Before 1954, sacrifice flies were counted as part of sacrifice hits, so for players before 1954, sacrifice flies (i.e. the variable `sf`) should be set to 0.
- *Hit by pitch* (the variable `hbp`) is often missing – set these missings to 0.
- Exclude all player records with fewer than 50 *at bats* (the variable `ab`).

(c) Compute *on base percentage* in the variable `obp` according to the formula:

$$\texttt{obp} = \frac{\texttt{h} + \texttt{bb} + \texttt{hbp}}{\texttt{ab} + \texttt{bb} + \texttt{hbp} + \texttt{sf}}$$

(d) Sort the data based on the computed `obp` and print the year, player name, and on base percentage for the top five records based on this value.

## 4 Using R: `aggregate()` function

The `aggregate` function is very useful method in R and allows you to easily compute statistics (such as the mean) for different groupings, e.g. if you have a set of data for students which contains both demographic and grade information; to compute the mean class grade *by* gender, you could use the `aggregate` command.

To complete this problem, you will need to look up information on how to use `aggregate`. You can use the built-in R documentation, look for help online, or both.

(a) Load the `quakes` data from the `datasets` package.

(b) Plot the recorded earthquake magnitude against the earthquake depth using the `plot` command.

(c) Use `aggregate` to compute the average earthquake depth for each magnitude level. Store these results in a new data frame named `quakeAvgDepth`.

(d) Rename the variables in `quakeAvgDepth` to something meaningful.

(e) Plot the magnitude vs. the average depth.

(f) From the two plots, do you think there is a relationship between earthquake depth and magnitude?