


# Lab exercises: installing R/ Rstudio, beginning to work with data: filtering, distributions, populations, Data Frames...



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Data Analytics

ITWS-4600/ITWS-6600/MATP-4450/CSCI-4960

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Group 1, Lab 1, September 10<sup>th</sup>, 2021

# Admin information

- Class: ITWS-4600/ 6600/MATP-4450/CSCI-4960/MGMT 4962/6962/BCBP 4960
- Dates: Tuesdays/ Fridays
- Location: **Section1:** In-Person Location: SAGE 2715- Time: 10:00am -11:50am ET
- **Section2:** In-Person Location: Lally 02 - Time: 2:00pm – 3:50pm ET
- Instructor: Thilanka Munasinghe
- Instructor contact: [munast@rpi.edu](mailto:munast@rpi.edu)
- **Instructor Office Hours:** Tues/Friday 12:30pm ET – 1:30pm ET or by appointment via email OR online via WebEx (Instructor online office hours login information available on LMS)
- Instructor office location: Room 133, Amos Eaton building
- **Teaching Assistant : Mukesh Mohanty**
- **TA Office Location: Virtual (WebEx)** <https://rensselaer.webex.com/meet/mohanm3>
- **TA Office Hours: Tuesdays 1 pm ET - 2pm ET OR by Appointment (via WebEx)**
- **TA Office Hours Location: Virtual via WebEx**  
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- **TA Email Address:** [mohanm3@rpi.edu](mailto:mohanm3@rpi.edu)

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- Instructor: Thilanka Munasinghe
- Instructor contact: [munast@rpi.edu](mailto:munast@rpi.edu)
- **Website & LMS** = <http://lms.rpi.edu> and see also **Course Webpage**:
- <https://tw.rpi.edu/web/Courses/DataAnalytics/2021Fall> Schedule, lectures, syllabus, reading, assignments, etc.
  - **Location of data and R script fragments, other documents** - <http://aquarius.tw.rpi.edu/html/DA/>

# Lab tasks

- Installations
- Exploring data and their distributions
- Fitting distributions
- Data Frames in R

# Objectives for today

- Get familiar with:
  - R (Data Frames)
  - Distributions
  - Populations
  - Fitting
  - Filtering

# Creating Data Frames in R

Using the `data.frames()` in R, we can create the data frames  
Read the documentation for `data.frame` in Rstudio,  
Using the **`help(data.frame)`**

```
# Creating a dataframe
# Example: RPI Weather dataframe.

days <- c('Mon', 'Tue', 'Wed', 'Thur', 'Fri', 'Sat', 'Sun') # days
temp <- c(28, 30.5, 32, 31.2, 29.3, 27.9, 26.4) # Temperature in F' during the winter :)
snowed <- c('T', 'T', 'F', 'F', 'T', 'T', 'F') # Snowed on that day: T = TRUE, F= FALSE
help("data.frame")
RPI_Weather_Week <- data.frame(days, temp, snowed) # creating the dataframe using the data.frame() function

RPI_Weather_Week
head(RPI_Weather_Week) # head of the data frame, NOTE: it will show only 6 rows, usually head() function shows the
# first 6 rows of the dataframe, here we have only 7 rows in our dataframe.

str(RPI_Weather_Week) # we can take a look at the structure of the dataframe using the str() function.

summary(RPI_Weather_Week) # summary of the dataframe using the summary() function
```

# Data frames ...

```
RPI_Weather_Week[1,] # showing the 1st row and all the columns
RPI_Weather_Week[,1] # showing the 1st column and all the rows

RPI_Weather_Week[, 'snowed']
RPI_Weather_Week[, 'days']
RPI_Weather_Week[, 'temp']
RPI_Weather_Week[1:5, c("days", "temp")]
RPI_Weather_Week$temp
subset(RPI_Weather_Week, subset=snowed==TRUE)

sorted.snowed <- order(RPI_Weather_Week['snowed'])
sorted.snowed
RPI_Weather_Week[sorted.snowed,]
```

```
# RPI_Weather_Week[descending_snowed,]  
dec.snow <- order(-RPI_Weather_Week$temp)  
dec.snow  
# Creating Dataframes  
# creating an empty dataframe  
empty.DataFrame <- data.frame()  
v1 <- 1:10  
v1  
letters  
v2 <- letters[1:10]  
df <- data.frame(col.name.1 = v1,col.name.2 = v2)  
df  
# importing data and exporting data  
# writing to a CSV file:  
write.csv(df,file = 'saved_df1.csv')  
df2 <- read.csv('saved_df1.csv')  
df2
```

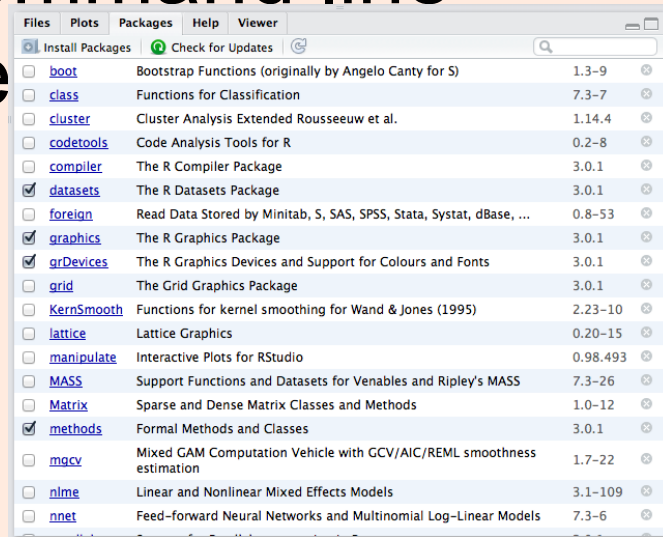


# Table: Matlab/R/scipy-numpy

- <http://hyperpolyglot.org/numerical-analysis>

# Gnu R

- <http://lib.stat.cmu.edu/R/CRAN/> - load this first
- <http://cran.r-project.org/doc/manuals/>
- <http://cran.r-project.org/doc/manuals/R-lang.html>
- R Studio = (see R-intro.html too)  
<https://www.rstudio.com/products/rstudio/>  
(desktop version)
- Manuals - Libraries – at the command line –  
library(), or select the package  
check/ uncheck as needed



# Reminder: files

- <http://aquarius.tw.rpi.edu/html/DA/>
- And some directories under this link
  - **please search before asking**
- This is where the files for assignments, lab exercises are
  - data and code fragments...

# Exercises – getting data in

- Rstudio
  - read in csv file (two ways to do this) -  
GPW3\_GRUMP\_SummaryInformation\_2010.csv
  - Read in excel file (directly or by csv convert) -  
2010EPI\_data.xls (EPI2010\_all countries or  
EPI2010\_onlyEPIcountries tabs)
  - Plot some variables
  - Commonalities among them?
- Also for other datasets, enter these in the R  
command window pannel or cmd line
  - > data()
  - > help(data)

# Files

- 2010EPI\_data.xls – with missing values changed to suit your application (EPI2010\_all countries or EPI2010\_onlyEPIcountries tabs)
- See group1/lab1\_data.R
- Get the data read in (in e.g. use “EPI\_data” for the object (in R))

```
> EPI_data <- read.csv("<path>/2010EPI_data.csv")
```

```
# Note: replace default data frame name – cannot  
start with numbers! Munging has begun
```

```
# Note: replace <path> with either a directory path or  
use setwd("<path>")
```

```
> View(EPI_data)
```

# Tips (in R)

```
> attach(EPI_data) # sets the 'default' object
> fix(EPI_data)    # launches a simple data editor – test it!
> EPI              # prints out values EPI_data$EPI
[1] NA NA 36.3 NA 71.4 NA NA 40.7 61.0 60.4 NA 69.8 65.7 78.1 59.1 43.9 58.1
[18] 39.6 47.3 44.0 62.5 42.0 NA 55.9 65.4 69.9 NA 44.3 63.4 NA 60.8 68.0 41.3 33.3
[35] 66.4 89.1 73.3 49.0 54.3 44.6 51.6 54.0 NA 76.8 NA NA 86.4 78.1 NA 56.3 71.6
[52] 73.2 60.5 NA 69.2 68.4 67.4 69.3 62.0 54.6 NA 70.6 63.8 43.1 74.7 65.9 NA 78.2
[69] NA NA 56.4 74.2 63.6 51.3 NA 44.4 NA 50.3 44.7 41.9 60.9 NA NA 54.0 NA
[86] NA 59.2 NA 49.9 68.7 39.5 69.1 44.6 NA 48.3 67.1 60.0 41.0 93.5 62.4 73.1 58.0
[103] 56.1 72.5 57.3 51.4 59.7 41.7 NA NA 57.0 51.1 59.6 57.9 NA 50.1 NA NA 63.7
[120] NA 68.3 67.8 72.5 NA 65.6 NA 58.8 49.2 65.9 67.3 NA 60.6 39.4 76.3 51.3 42.8
[137] NA 51.2 33.7 NA NA 80.6 51.4 65.0 NA 59.3 NA 37.6 NA 40.2 57.1 NA 66.4
[154] 81.1 68.2 NA 73.4 45.9 48.0 71.4 NA 69.3 65.7 NA 44.3 63.1 NA 41.8 73.0 63.5
[171] NA NA 48.9 NA 67.0 61.2 44.6 55.3 69.4 47.1 42.3 69.6 NA NA 51.1 32.1 69.1
[188] NA NA NA 57.3 68.2 74.5 65.0 86.0 54.4 NA 64.6 NA 40.8 36.4 62.2 51.3 NA
[205] 38.4 NA NA 54.2 60.6 60.4 NA NA 47.9 49.8 58.2 59.1 63.5 42.3 NA NA 62.9
[222] NA NA 59.0 NA NA NA 48.3 50.8 47.0 47.8

> tf <- is.na(EPI) # records True values if the value is NA
> E <- EPI[!tf] # filters out NA values, new array
```

# Exercise 1: exploring the distribution

```
> summary(EPI) # stats
```

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	NA's
32.10	48.60	59.20	58.37	67.60	93.50	68

```
> fivenum(EPI,na.rm=TRUE)
```

```
[1] 32.1 48.6 59.2 67.6 93.5
```

```
> stem(EPI) # stem and leaf plot
```

```
> hist(EPI)
```

```
> hist(EPI, seq(30., 95., 1.0), prob=TRUE)
```

```
> lines(density(EPI,na.rm=TRUE,bw=1.)) # or try  
bw="SJ"
```

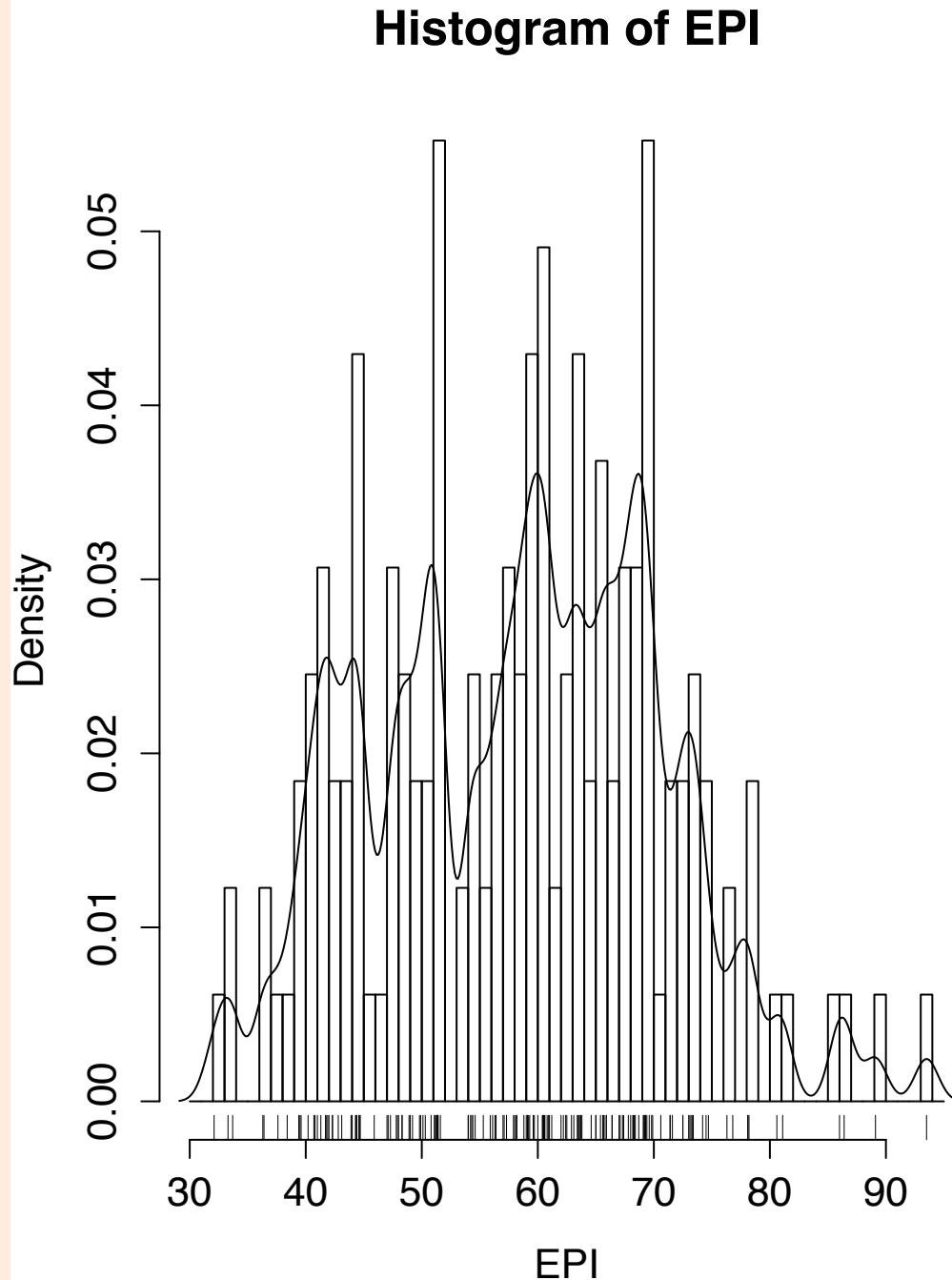
```
> rug(EPI)
```

```
#Use help(<command>), e.g. > help(stem)
```

- See group1/lab1\_summary.R

Save your  
plots, name  
them.

Save the  
commands  
you used to  
generate  
them.





# Exercise 1: fitting a distribution beyond histograms

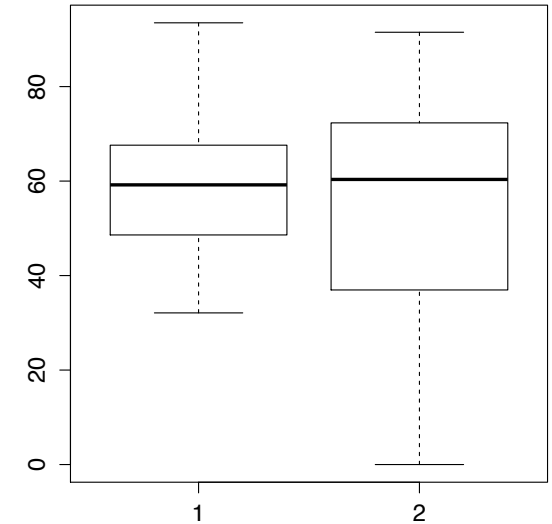
- Cumulative density function?  
    > plot(ecdf(EPI), do.points=FALSE, verticals=TRUE)
- Quantile-Quantile?  
    > par(pty="s")  
    > qqnorm(EPI); qqline(EPI)
- Make a Q-Q plot against the generating distribution  
by: `x<-seq(30,95,1)`  
    > qqplot(qt(ppoints(250), df = 5), x, xlab = "Q-Q plot for t  
    dsn")  
    > qqline(x)

# Exercise 1: fitting a distribution

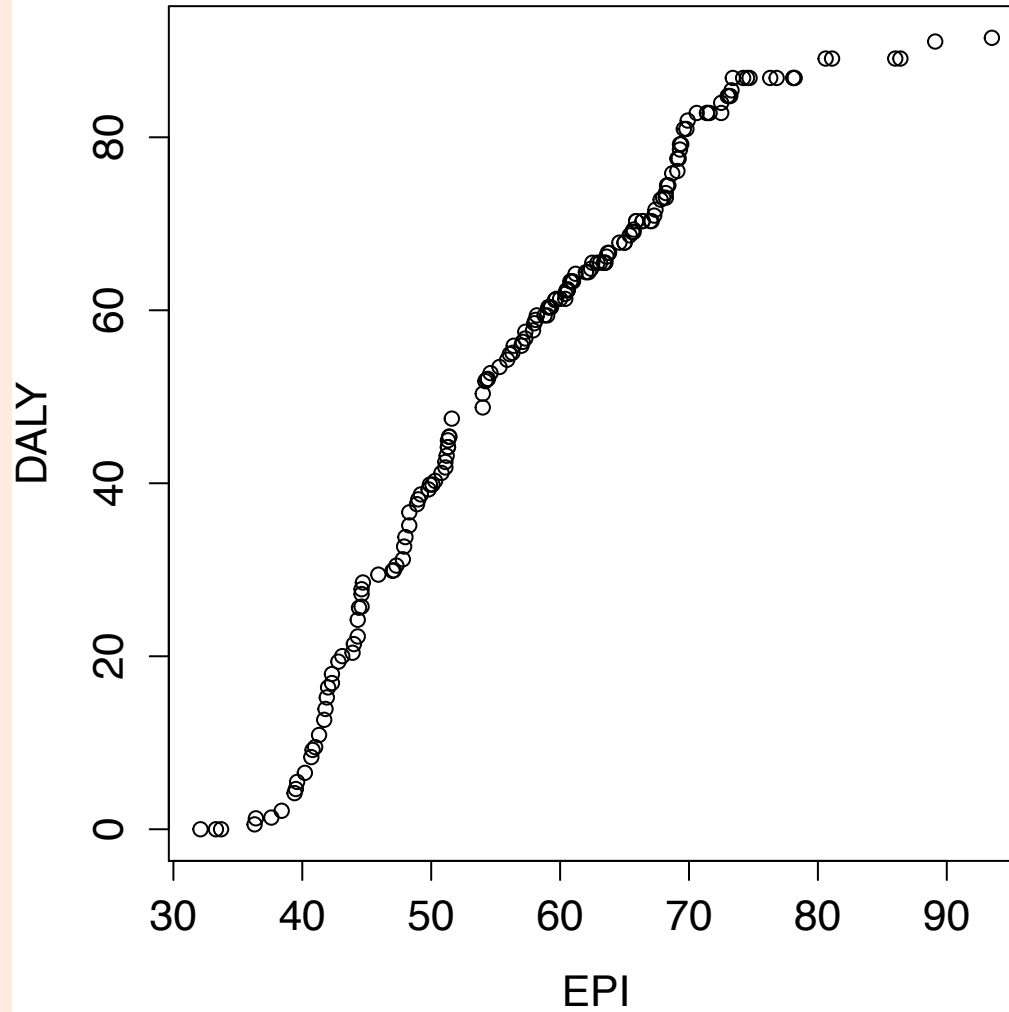
- Your exercise: do the same exploration and fitting for another 2 variables in the EPI\_data, i.e. primary variables (DALY, WATER\_H, ...)
- Try fitting other distributions – i.e. as ecdf or qq-

# Comparing distributions

```
> boxplot(EPI,DALY)
```



# qqplot(EPI,DALY)



# But there is more

- Your exercise – intercompare: EPI, ENVHEALTH, ECOSYSTEM, DALY, AIR\_H, WATER\_H, AIR\_EWATER\_E, BIODIVERSITY \*\* (subject to possible filtering...)
- Note 2010 and 2016 datasets....

# Distributions

- See archive “alldist.zip” or individual files in /distribution
  - Excel files for different distributions...
  - Expanded in the folder: e.g. lognorm.xls
- In R:  
**> help(distributions)**

# Exercise 2: filtering (populations)

- Conditional filtering:
  - > EPILand<-EPI[!Landlock]
  - > ELand <- EPILand[!is.na(EPILand)]
  - > hist(ELand)
  - > hist(ELand, seq(30., 95., 1.0), prob=TRUE)
- Repeat exercise 1...
- Also look at: No\_surface\_water, Desert and High\_Population\_Density
- Your exercise: how to filter on EPI\_regions or GEO\_subregion?
- E.g. EPI\_South\_Asia <- EPI[<what is this>]

# GPW3\_GRUMP – repeat...

- The reading in, then exploration/summary, plots, histograms, distributions, filtering



# water\_treatment

- water-treatment.csv

# Objectives for this lab are:

- Get familiar with:
  - Distributions
  - Populations
  - Fitting
  - Creating Data Frames in R.

# Your Github Repository

- Your Github Repository for this class
- Please create a Github repo for the Data Analytics class Labs
- Do not share the Assignment codes in your Data Analytics course repo, you share only your lab work and your individual project work/code.
- Email your Github repo URL to TA
- Example:  
[https://github.com/YourGithub/DataAnalyticsFall2021\\_YOUR\\_NAME](https://github.com/YourGithub/DataAnalyticsFall2021_YOUR_NAME)

# Push your Lab code to Github

- Please push your Lab1 code to Github.
- TA will collect your Github repo URLs next week.
- Example:  
[https://github.com/tYourGithub/DataAnalytics2021\\_YOUR\\_NAME](https://github.com/tYourGithub/DataAnalytics2021_YOUR_NAME)

# Assignment 1

- Reminder: Assignment 1 due today, 09/10/2021 11:59 pm ET on LMS.