JANUARY 2018

TEXAS
The University of Texas at Austin

APPLIED ENGINEERING DATA ANALYSIS, OPTIMIZATION AND VISUALIZATION

Basic R

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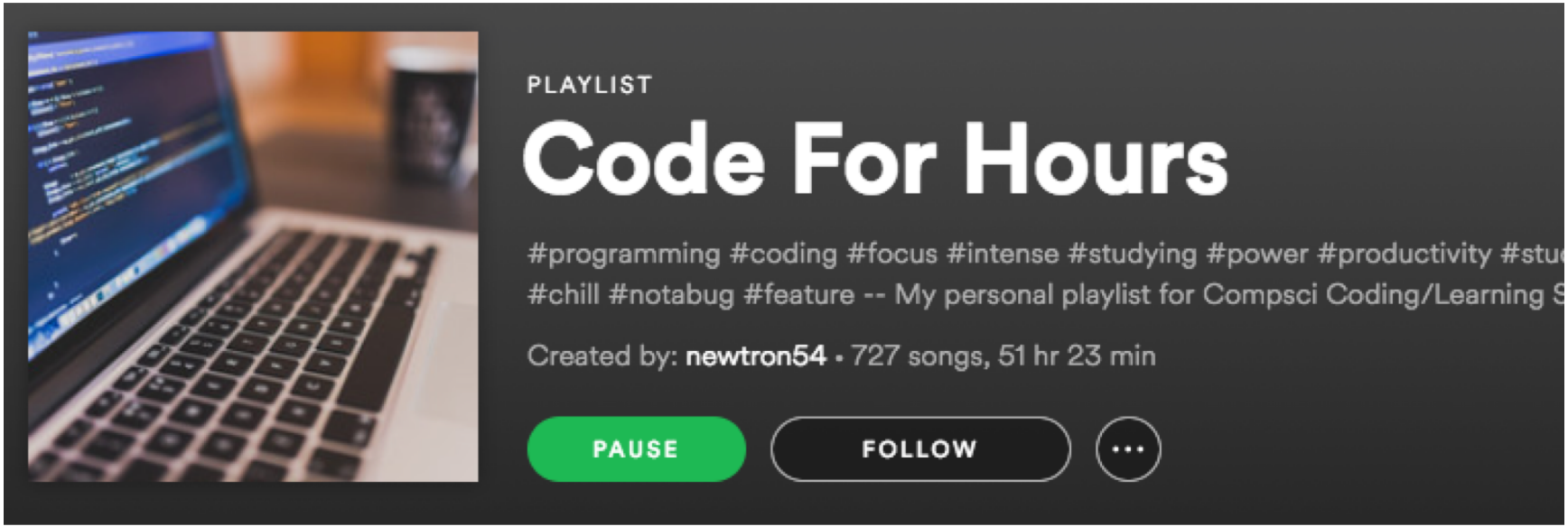
What is R?

Git* ready

*more on this later

Recommended playlist for coding*



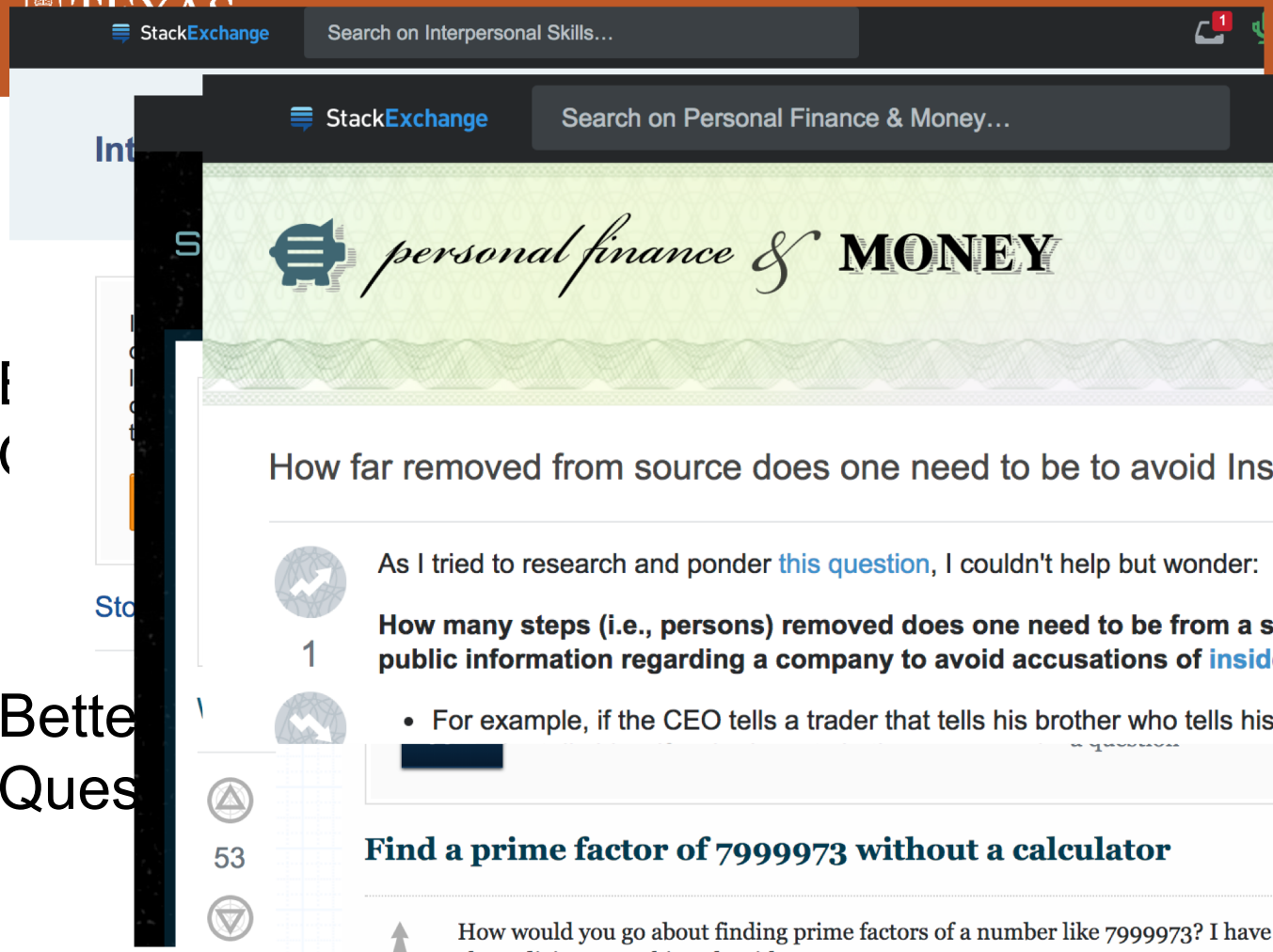
*optional

R you done? (yes)

- R is a system for statistical computation and graphics. It consists of a language plus a run-time environment with graphics, a debugger, access to certain system functions, and the ability to run programs stored in script files.
- FAQ: https://cran.r-project.org/doc/FAQ/R-FAQ.html#What-is-R_003f

R is a computer language that I find to be *easy* to learn/use

- Runs on all platforms
- Free
- Open source and well documented
- Lots of TACC support
- Good data visualization
- https://stackoverflow.com/questions/tagged/r


StackExchange
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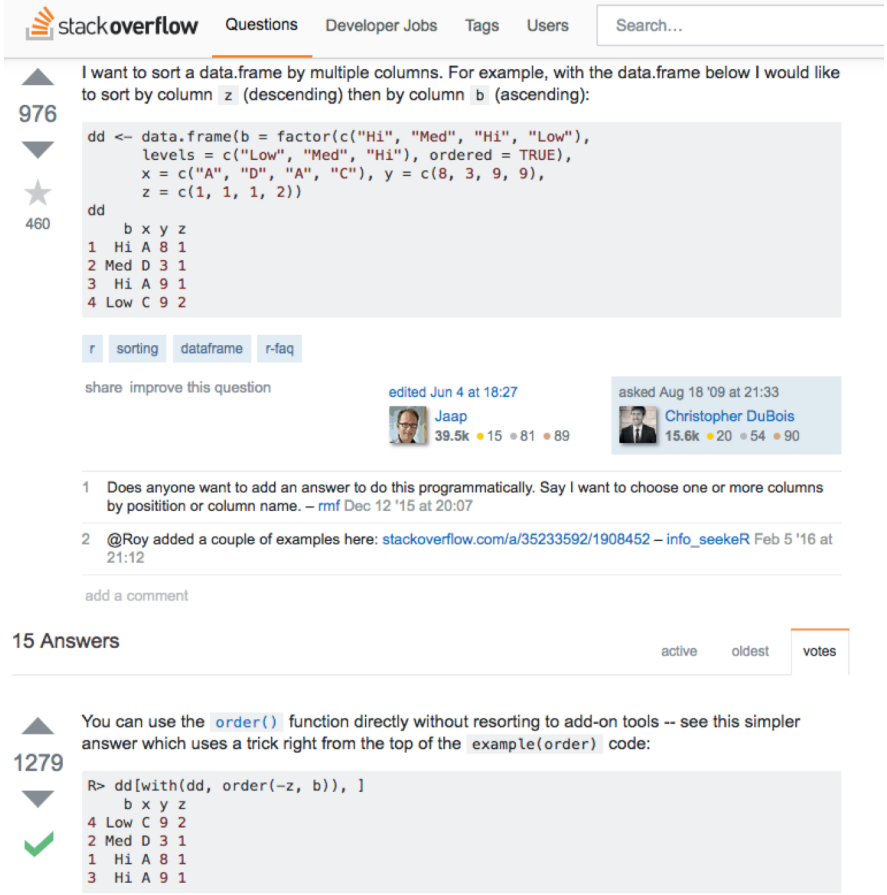
StackExchange
Search on Personal Finance & Money…
personal finance & MONEY
QUESTIONS
TAGS
US
How far removed from source does one need to be to avoid Insider Trading?
As I tried to research and ponder this question, I couldn't help but wonder:
How many steps (i.e., persons) removed does one need to be from a source of material/non-public information regarding a company to avoid accusations of insider trading?
For example, if the CEO tells a trader that tells his brother who tells his barber who tells his
1
53
Find a prime factor of 7999973 without a calculator
How would you go about finding prime factors of a number like 7999973? I have trivial knowledge about divisor-searching algorithms.
asked
viewed

Answers usually contain the code you need you just might have to Google it multiple times



stackoverflow Questions Developer Jobs Tags Users Search...

976

460

I want to sort a data.frame by multiple columns. For example, with the data.frame below I would like to sort by column `z` (descending) then by column `b` (ascending):

```
dd <- data.frame(b = factor(c("Hi", "Med", "Hi", "Low"),
      levels = c("Low", "Med", "Hi"), ordered = TRUE),
      x = c("A", "D", "A", "C"), y = c(8, 3, 9, 9),
      z = c(1, 1, 1, 2))
dd
    b x y z
1  Hi A 8 1
2 Med D 3 1
3  Hi A 9 1
4 Low C 9 2
```

r sorting dataframe r-faq

share improve this question

edited Jun 4 at 18:27 Jaap 39.5k ● 15 ● 81 ● 89

asked Aug 18 '09 at 21:33 Christopher DuBois 15.6k ● 20 ● 54 ● 90

1 Does anyone want to add an answer to do this programmatically. Say I want to choose one or more columns by position or column name. – rmf Dec 12 '15 at 20:07

2 @Roy added a couple of examples here: stackoverflow.com/a/35233592/1908452 – info_seekeR Feb 5 '16 at 21:12

add a comment

15 Answers active oldest votes

1279

You can use the `order()` function directly without resorting to add-on tools -- see this simpler answer which uses a trick right from the top of the `example(order)` code:

```
R> dd[with(dd, order(-z, b)), ]
    b x y z
4 Low C 9 2
2 Med D 3 1
1  Hi A 8 1
3  Hi A 9 1
```

I recommend using the RStudio platform

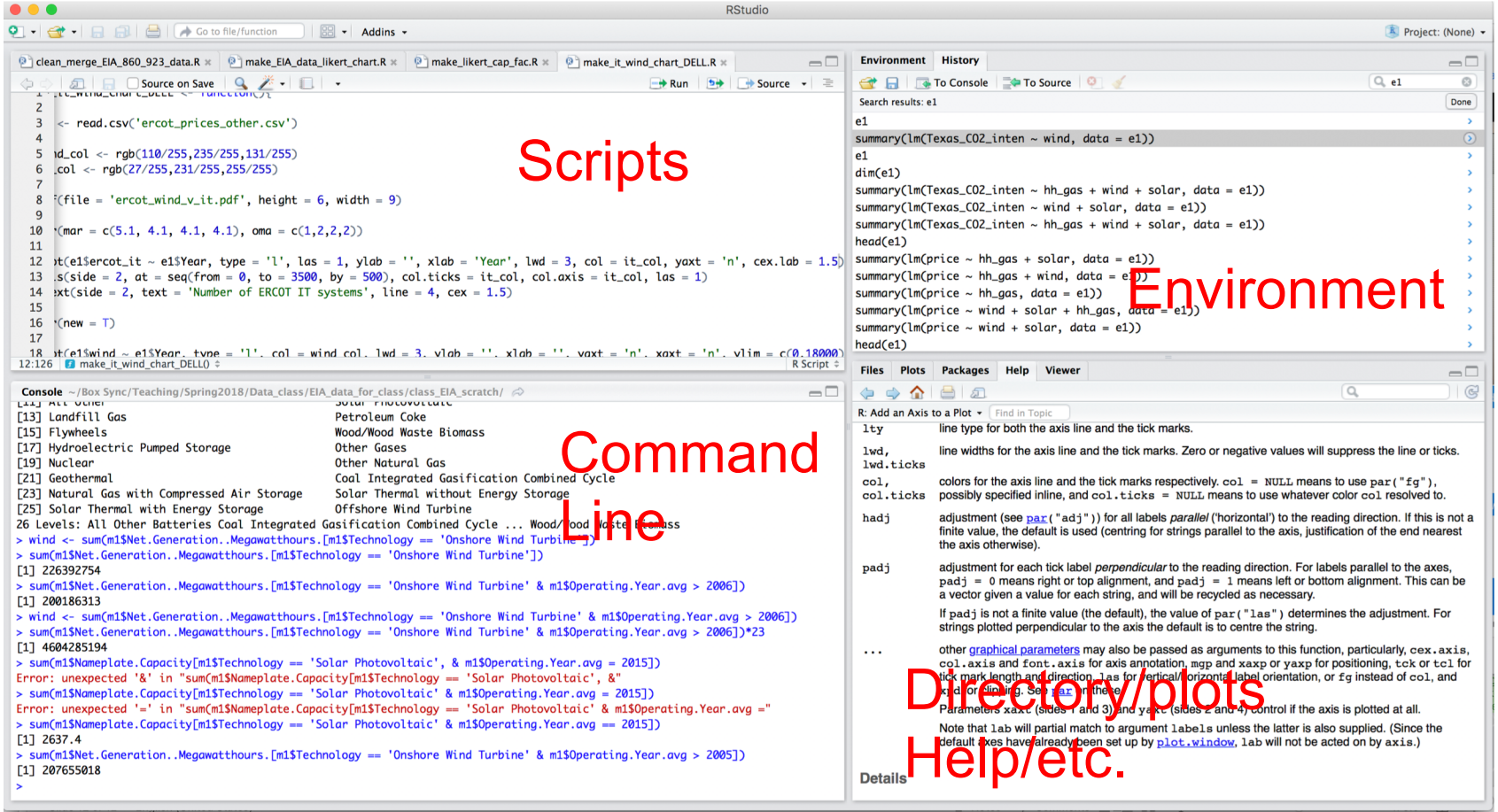
- The free version is good for this class
  - And likely for your research
- Get it here: https://www.rstudio.com/

Crash course in programming using R

- Essentially a lot of engineering coding looks like this:
  - Read in some stuff from a file
  - Clean, sort, merge data
  - Do some analysis (business calls this “value add”)
  - Learn
  - Visualize the data
  - Write some other file

It rarely (never) goes that smooth the first time

- Many intermediate steps
  - Data cleaning
  - Data aggregation
  - Intermediate visualization


RStudio
clean_merge_EIA_860_923_data.R
make_EIA_data_likert_chart.R
make_likert_cap_fac.R
make_it_wind_chart_DELL.R
Scripts
Environment
History
Command Line
Console
Files
Plots
Packages
Help
Viewer
Discovery/plots
Help/etc.

Reading in some data

- A lot of data we use comes from excel files or CSV files
- There are others (non-exhaustive list):
  - Tab delimited
  - JSON (web)
  - XML (Extensible Markup Language, structured)
  - HTML (Hypertext Markup Language, web, structured)

R also has packages to read in data stored in other software formats

Package 'foreign'

June 21, 2017

Priority recommended

Version 0.8-69

Date 2017-06-21

Title Read Data Stored by 'Minitab', 'S', 'SAS', 'SPSS', 'Stata', 'Systat', 'Weka', 'dBase', ...

rplexos v1.1.11 Other versions

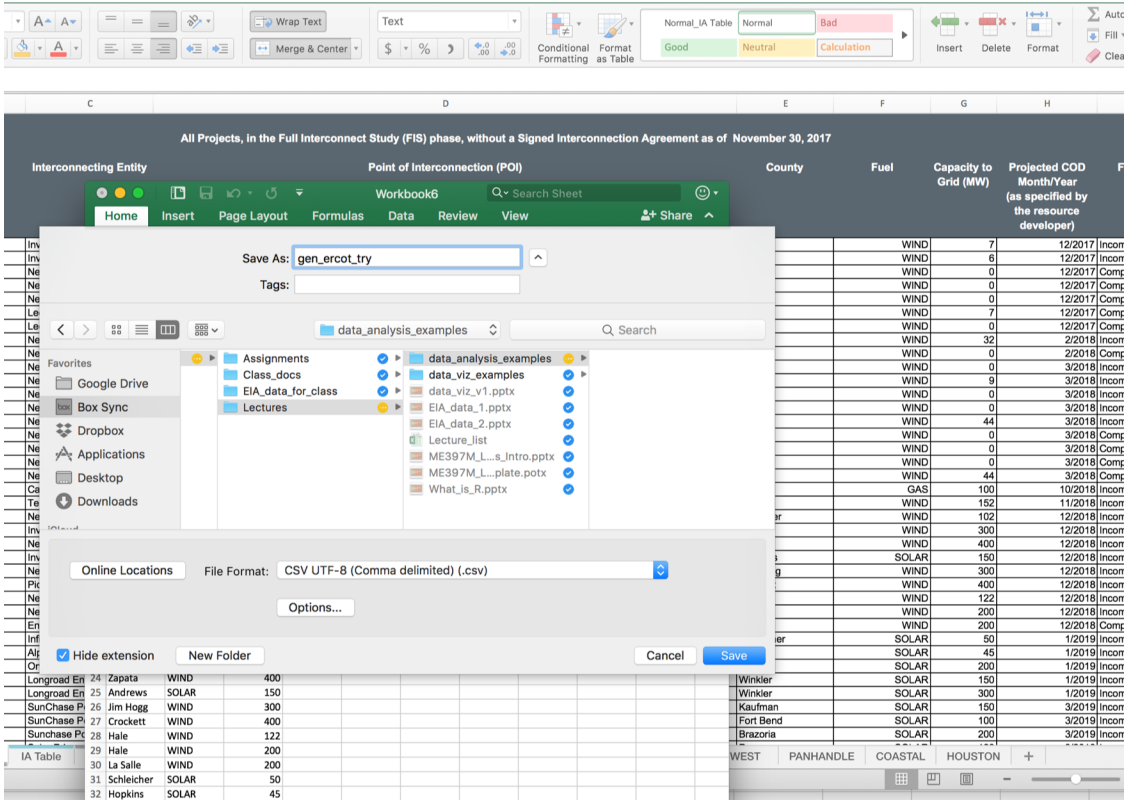
by Jef Daniels

Read and Analyze 'PLEXOS' Solutions

Efficiently read and analyze 'PLEXOS' solutions by converting them into 'SQLite' databases t
divided into different time partitions, as well as the comparison across different scenarios.
Energy Exemplar (see <http://energyexemplar.com/software/plexos-desktop-edition> for n

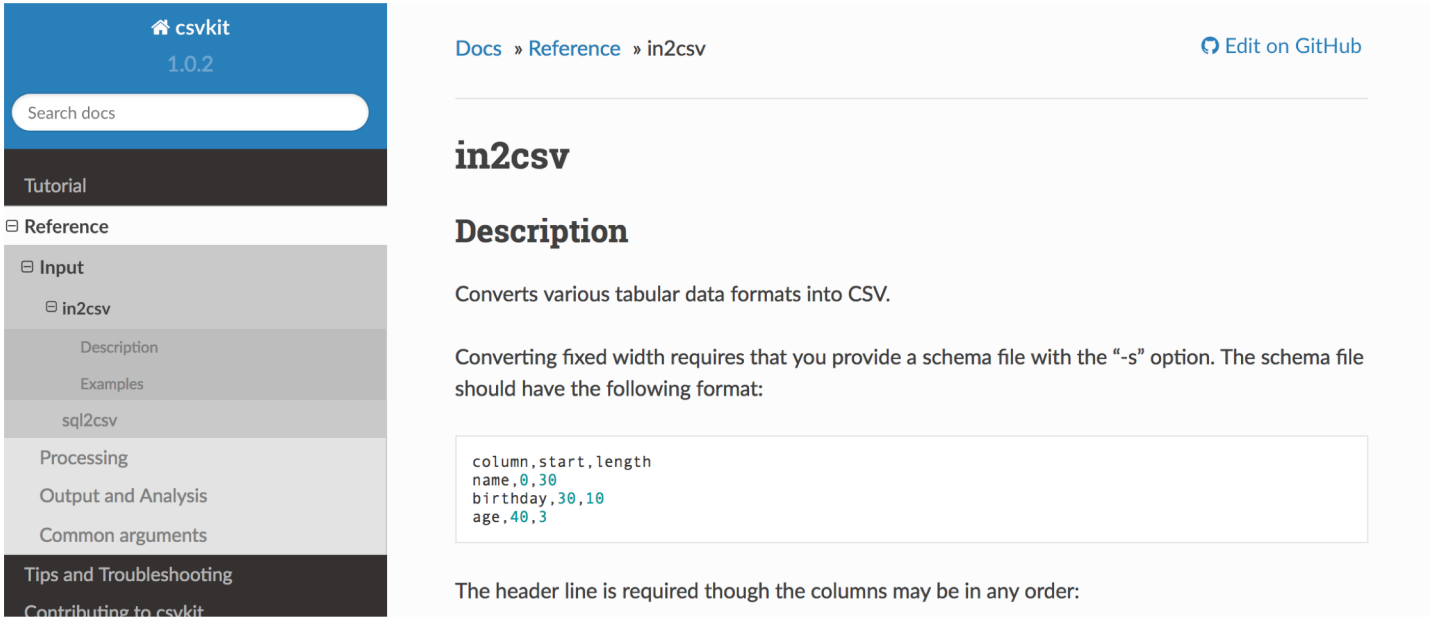
I find that 90% of my work is CSV, or Excel -> CSV

- Let's use an (I think) interesting example*
- Open Excel, grab some columns, save as CSV
- "gen_ercot_try.csv" file on box/board/whatever



* http://www.ercot.com/gridinfo/resource

Aside: there are command line (& R) packages that can auto convert Excel to CSV if you need to do that (be careful)



Another aside on file/folder/directory hygiene

- NEVER use spaces in directory or file names
- my awesome file.csv -> my_awesome_file.csv
- Some systems (TACC) have trouble with spaces
- This will save you hours of headaches
  - You're welcome

REMINDER: On file names – VERY IMPORTANT!!!!

- If you send me (turn in a file named) this:
  - assignment.doc, or hwk3.csv
  - I will NOT even open it, you get 0%
- Always name files so you (and I) know what they are
  - RHODES_HWK3.pdf OR
  - RHODES_midterm_dataset.csv
- This way, I know who it is from and what it is w/o opening it

Navigate to folder with “gen_ercot_try.csv” file

```
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> setwd('/Users/jdr2823/Box Sync/Teaching/Spring2018/Data_class/Lectures/data_analysis_examples')
> dir()
[1] "gen_ercot_try.csv"
>
```

setwd(‘you/are/here’) = set working directory to wherever you want to be

Reading in CSV data

```
> setwd('/Users/jdr2823/Box Sync/Teaching/Spring2018/Data_class/Lectures/data_analysis_examples')
> dir()
[1] "gen_ercot_try.csv"
> gen <- read.csv("gen_ercot_try.csv")
> head(gen)
  County Fuel cap_MW
1  Pecos WIND      7
2  Nolan WIND      6
3   Coke WIND      0
4 Taylor WIND      0
5 Taylor WIND      0
6  Nolan WIND      7
>
```

- head(x, n = 5) is a function that shows you the first n (5 is default) rows of something
- tail(x) shows the last

There are other ways to read in data

- read.table – the actual call being made (read.csv is a wrapper, but helpful)
- fread = ‘fast read’ from package(data.table)
- If read.csv takes too long, look at faster options – they exist

“data” is plural

- Datum or dataset is singular
  - Correct: The data are
  - Incorrect: The data is
- The latter is akin to saying “the apples is”
  - Not correct, don’t do it

You should know your data, or at least have an idea of what your data are

- This dataset shows how much capacity of each type of power plant is trying to connect the to the grid in each county in Texas (ERCOT)
- 3 rows, different types
  - County = string
  - FUEL = string
  - Cap_MW = integer

```
> setwd('/Users/jdr2823/Box Sync/Teaching/
> dir()
[1] "gen_ercot_try.csv"
> gen <- read.csv("gen_ercot_try.csv")
> head(gen)
  County Fuel cap_MW
1  Pecos WIND      7
2  Nolan WIND      6
3   Coke WIND      0
4 Taylor WIND      0
5 Taylor WIND      0
6  Nolan WIND      7
>
```

Code: summary(x) is a good way to look at your data quickly

```
> summary(gen)
      County        Fuel         cap_MW       
 Pecos   :  9   GAS  :10   Min.   : -27.0  
 Nolan   :  8   SOLAR:84   1st Qu.:  90.0  
 Castro  :  7   WIND :93   Median : 180.0  
 Hidalgo :  7              Mean   : 179.4  
 Taylor  :  7              3rd Qu.: 202.0  
 Crockett:  6              Max.   :1156.0  
 (Other) :143                              
> 
```

Wait, -27 MW? That doesn't seem to make sense… Go back and check, it does!

64	20INR0030	Rustler Solar	Cypress Creek Renewables	tap 138kV 5827 Moore - 5895 Pearsall	Frio	SOLAR	113	6/2020 Incomplete
65	20INR0002	Lake Spring Solar	8 Minute Energy	79501 Ogallala 345kV	Castro	SOLAR	400	6/2020 Incomplete
66	19INR0030	San Bernard Solar	Sunchase Power	43340 Tx Gulf Sulphur 138kV	Wharton	SOLAR	100	6/2020 Incomplete
67	20INR0025	Is 195	Innovative Solar	tap 138kV 5225 Hondo - 5813 Pearson	Medina	SOLAR	30	7/2020 Incomplete
68	20INR0024	Is 177	Innovative Solar	5817 FerrisSw 69kV	Uvalde	SOLAR	25	7/2020 Incomplete
69	20INR0021	Is 341	Innovative Solar	tap 69kV 3648 Granger - 3649 Taylor	Williamson	SOLAR	20	7/2020 Incomplete
70	**20INR0019**	**Trinity Hills Wind repowering**	**Bp**	**150751 & 150752 Trinity Hills 34.5kV**	**Young**	**WIND**	**-27**	**7/2020 Incomplete**
71	20INR0041	Watusi Solar	Cypress Creek Renewables		Menard	SOLAR	195	8/2020 Incomplete
72	20INR0036	Stillwater Solar	Cypress Creek Renewables	tap 345kV 8455 LONHILL - 8955 NEDIN	Nueces	SOLAR	216	8/2020 Incomplete
73	20INR0035	Angus Solar	Cypress Creek Renewables	tap 138kV 177 Bosque - 181 Cayote	Bosque	SOLAR	188	8/2020 Incomplete
74	20INR0034	Cargil Solar	Cypress Creek Renewables	tap 69kV 8231 Uvalde - 8672 LaPryor	Zavala	SOLAR	98	8/2020 Incomplete
75	20INR0023	Is 207	Innovative Solar	1906 Venus S 345kV	Ellis	SOLAR	60	8/2020 Incomplete
76	20INR0022	Is 305	Innovative Solar	tap 138kV 6135 Paducah - 6320 Tardis	Cottle	SOLAR	30	8/2020 Incomplete
77	20INR0016	Is 165	Innovative Solar	tap one 345kV 60501 Tesla - 60500 Edith Clark	Hardeman	SOLAR	45	8/2020 Incomplete
78	20INR0015	Is 145	Innovative Solar	Tap 138kV 6135 Paducah Clare - 6117 E Munda	Cottle	SOLAR	45	8/2020 Incomplete
79	20INR0014	Is 144	Innovative Solar	6131 Padr 69kV	Cottle	SOLAR	60	8/2020 Incomplete
80	20INR0013	Is 137	Innovative Solar	tap 138kV 8234 Uvalde - 8241 Razorback	Uvalde	SOLAR	20	8/2020 Incomplete
81	20INR0012	Is 75	Innovative Solar	Tap 138kV 6161 Paint Creek - 6200 Ft Phantom	Haskell	SOLAR	40	8/2020 Incomplete
82	19INR0099b	Kontiki Wind	TriGlobal	59903 Bearkat 345kV	Glasscock	WIND	255	9/2020 Incomplete

Always be checking your data as you go

- If you make a mistake or your data are bad (not what you thought) they will propagate through your analysis
- Or you will realize it later and have wasted time
- Just check in every once in a while

In R we use data.frames a lot

- Fast and easy for most applications
- Data stored in RAM, so size limitations
  - "big data" packages for large size issues
  - Or figure out how to get code working with sample and use TACC's TBs of RAM
- read.csv automatically creates a dataframe
  - For some applications you might want lists, matrices, ect.

You call a specific column of a data frame using the '$' operator: dataframe$column

```
> summary(gen$County)
    Andrews   Armstrong      Baylor         Bee      Borden      Bosque     Brazoria     Brewster      Briscoe
          4           1           1           1           4           1           4           5           2
     Brooks      Calhoun    Callahan     Cameron      Castro    Cherokee   Childress        Clay        Coke
          1           1           1           3           7           1           3           2           1
     Concho      Cottle       Crane    Crockett      Crosby   Culberson  Deaf Smith     Dickens    Eastland
          1           3           3           6           2           1           2           1           1
      Ector       Ellis      Fannin      Foard   Fort Bend       Frio   Glasscock        Gray     Grayson
          1           1           1           1           2           1           2           2           1
       Hale        Hall   Hardeman      Harris     Haskell     Hidalgo        Hill     Hopkins        Hunt
          2           1           4           1           1           7           1           1           1
      Irion     Jackson    Jim Hogg  Jim Wells     Kaufman      Kenedy        Kent        Knox   La Salle
          1           1           1           1           2           1           2           3           1
  Limestone   Matagorda    Maverick      Medina      Menard       Mills    Mitchell       Nolan      Nueces
          2           1           1           1           3           1           1           8           1
      Pecos     Randall     Reeves     Refugio     Runnels San Patricio  Schleicher      Scurry       Starr
          9           2           1           1           1           3           1           2           2
   Sterling      Taylor       Upton      Uvalde   Val Verde    Victoria        Webb     Wharton   Wilbarger
          5           7           3           2           1           3           1           2           1
    Willacy   Williamson      Winkler       Young      Zapata      Zavala
          4           1           3           1           2           3
>
```

```
          4           1           3           1           2           3
> max(gen$County)
Error in Summary.factor(c(64L, 62L, 18L, 74L, 74L, 62L, 62L, 73L, 5L,  :
  'max' not meaningful for factors
> max(gen$cap_MW)
[1] 1156
>
```

Some helpful ways to slice ‘n dice data

```
> max(gen$cap_MW)
[1] 1156
> min(gen$cap_MW)
[1] -27
> mean(gen$cap_MW)
[1] 179.4011
> gen[gen$County == 'Menard',]
    County  Fuel cap_MW
98  Menard  WIND    200
133 Menard  WIND    250
168 Menard SOLAR    195
> aggregate(x = gen$cap_MW, by = list(gen$Fuel), FUN = sum)
  Group.1     x
1     GAS  3554
2   SOLAR 13619
3    WIND 16375
> ?aggregate
> aggregate(x = gen[gen$County == 'Menard',], by = list(gen$Fuel), FUN = sum)
Error in aggregate.data.frame(x = gen[gen$County == "Menard", ], by = list(gen$Fuel),  :
  arguments must have same length
> aggregate(x = gen[gen$County == 'Menard',], by = list(gen[gen$County == 'Menard',]$Fuel), FUN = sum)
Error in Summary.factor(59L, na.rm = FALSE) :
  ‘sum’ not meaningful for factors
> aggregate(x = gen[gen$County == 'Menard',]$cap_MW, by = list(gen[gen$County == 'Menard',]$Fuel), FUN = sum)
  Group.1   x
1   SOLAR 195
2    WIND 450
> Menard <- gen[gen$County == 'Menard',]
> aggregate(x = Menard$cap_MW, by = list(Menard$Fuel), FUN = sum)
  Group.1   x
1   SOLAR 195
2    WIND 450
>
```

R: Compute Summary Statistics of Data Subsets — Find in Topic

aggregate {stats}

Compute Summary Statistics of Data Subsets

Description

Splits the data into subsets, computes summary statistics for each, and returns the result in a

Usage

```
aggregate(x, ...)

## Default S3 method:
aggregate(x, ...)

## S3 method for class 'data.frame'
aggregate(x, by, FUN, ..., simplify = TRUE, drop = TRUE)

## S3 method for class 'formula'
aggregate(formula, data, FUN, ...,
          subset, na.action = na.omit)

## S3 method for class 'ts'
aggregate(x, nfrequency = 1, FUN = sum, ndeltat = 1,
          ts.eps = getOption("ts.eps"), ...)
```

Arguments

x	an R object.
by	a list of grouping elements, each as long as the variables in the data frame x before use.

read.csv can also scrape web data

```
> data <- read.csv('https://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=KTXAUSTI942&month=1&day=16&year=2018&format=1', row.names = NULL)
> head(data)
          row.names Time TemperatureF DewpointF PressureIn WindDirection WindDirectionDegrees WindSpeedMPH
1 2018-01-16 00:08:00 36.9         33.7     30.48        ESE           113                   4            9
2               <br>   NA           NA        NA                      NA                  NA           NA
3 2018-01-16 00:13:00 36.7         33.2     30.49        ESE           113                   8           10
4               <br>   NA           NA        NA                      NA                  NA           NA
5 2018-01-16 00:26:00 36.5         33.3     30.50        SSE           158                   9            9
6               <br>   NA           NA        NA                      NA                  NA           NA
  WindSpeedGustMPH Humidity HourlyPrecipIn Conditions Clouds dailyrainin        SoftwareType DateUTC.br.
1               88     0.06             NA         NA   0.00   myAcuRite 2018-01-16 06:08:00          NA
2               NA       NA             NA         NA     NA                                        NA
3               87     0.05             NA         NA   0.00   myAcuRite 2018-01-16 06:13:00          NA
4               NA       NA             NA         NA     NA                                        NA
5               88     0.06             NA         NA   0.02   myAcuRite 2018-01-16 06:26:00          NA
6               NA       NA             NA         NA     NA                                        NA
>
```

I find the best way to code in R is to write function scripts

R markdowns and notebooks are cool, but won't work on TACC