Section 1<

- **Online Course Layout:**
  - **Section 1 – Big Data and R**
    - **Class overview**
    - **Big Data Overview**
    - **Installing R**
    - **The IDE**
    - **Researching and best practices**
    - **R help**
    - **R Packages**
    - **Review Exercise 1**
    - **Hands on exercise**
  - **Section 2 – Data Wrangling**
  - **Section 3 – Data Visualization**
  - **Section 4 – R Markdown**
  - **Section 5 – Exploratory Data Analysis**
    - **Diamond Exercise**
    - **Bank Marketing Exercise**
  - **Section 6 – Introduction to Regression**
    - **Car Make Regression**
    - **Orange Juice Exercise**
  - **Section 7 – Introduction to Machine Learning**
    - **Titanic Kaggle Competition**
  - **Section 8 – Strategy**
    - **Big box store competitors**

https://stat.ethz.ch/R-manual/R-devel/library/base/html/Memory-limits.html

Background<

- 10+ years industry experience
  - Banking / Finance / Media / Tech
  - Cyber Security
  - Analytics
- MSBA ‘15 Stern School of Business NYU
  - Capstone: Predicted churn for members of a non-profit Arboretum

❑ DataKind

✓ Predictive Analytics to personalize Health Care

✓ 2016 Bloomberg’s Data for Good Exchange

getwd()<

- ✓ **I think, therefore I am…**

Agenda for Session 1

- **BIG DATA**
- **Industry leaders in Big Data**
- **Data Science**
- **Roles in Data Science**
- **Data Science Use Cases**
- **Data'isms**
- **Class Format**
- **R Background**
- **R Intro**
- **R Studio**

Big Data <

Big Data Leaders & Disrupters<

Company	Theme	Initiative	Launch Date
Google	Payments	Google Wallet app	2011
	Payments	Google Compare	2012
	Payments	Android Pay	2015
	Payments	Apple Wallet (previously Passbook)	2012
	Payments	Apple Pay	2015
	Payments	Messenger Payments	2015
amazon	Lending	Amazon SMB Lending	2012
	Digital Currency	Amazon Coins	2014
	Lending	Amazon Store Card & Card Comparison	2015
	Insurance	Amazon Protect (Product insurance)	2016
	Payments	Amazon Payments	2017
	Payments	Check-out by Amazon (B2B e-commerce solution)	NC

https://drive.google.com/file/d/0B18Jj7sicGWDY1VjMGM3clpNRk0/view

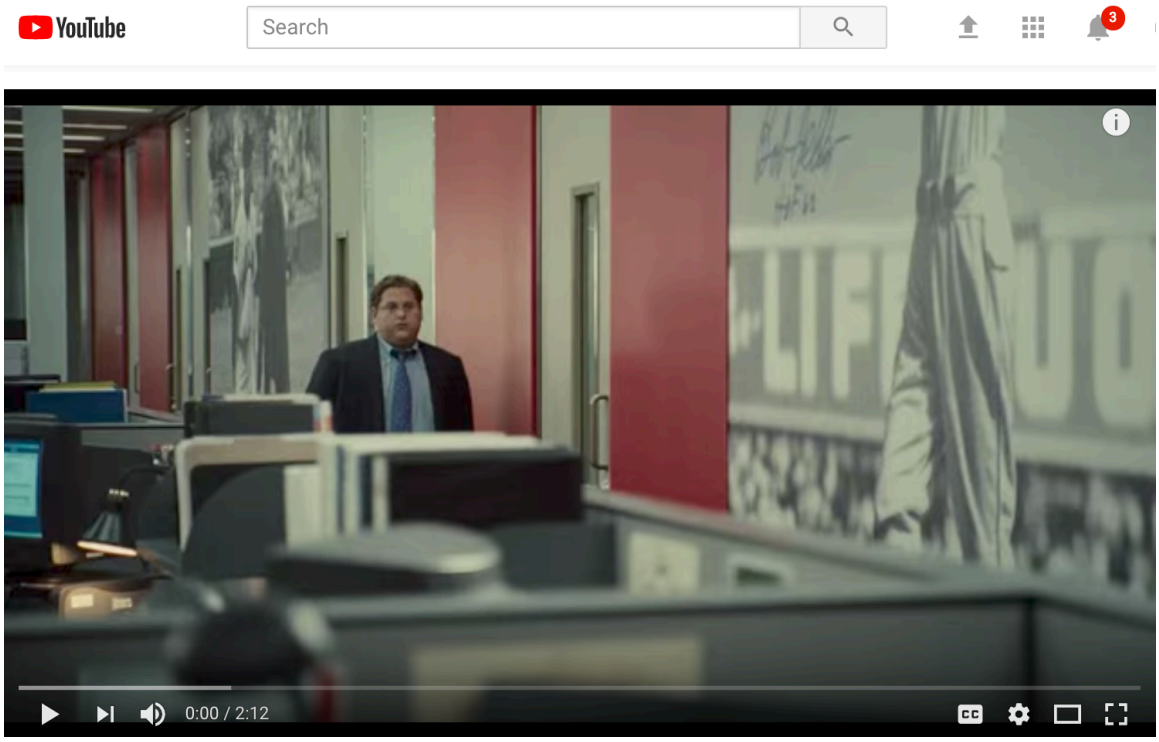
Data Science <

Data Science is the study of the generalizable extraction of knowledge from data

Business Analyst to Data Scientist <

What’s next for data science? <


MONEYBALL
Moneyball: The Art of Winning an Unfair Game is a book by Michael Lewis, published in 2003, about the Oakland Athletics baseball team and its general manager Billy Beane. Its focus is the team's analytical, evidence-based, sabermetric approach to assembling a competitive baseball team, despite Oakland's disadvantaged revenue situation. A film based on the book starring Brad Pitt and Jonah Hill was released in 2011.



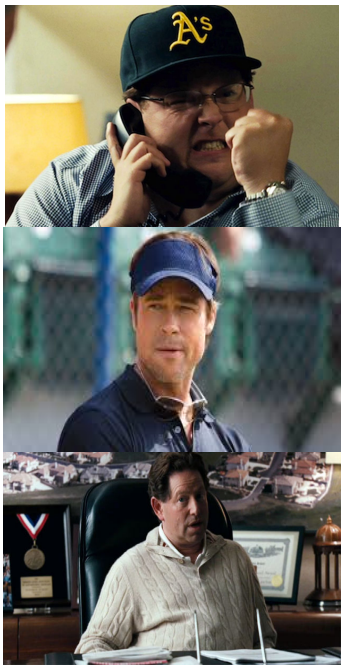
https://www.youtube.com/watch?v=TpBcwGOvO80

Roles in Data Science <

- "Data Scientist"
  - –can do the actual modeling
  - –applied statistician X computer scientist
- Collaborator in a data-centric project
  - –can transform from business problem to execution

- Manager in a data-centric company
  - –Ability to envision opportunities
  - –Ability to evaluate proposals
  - –Ability to evaluate execution
  - –Ability to interface with a broad variety of people

- Strategist, Investor, …
  - –Can envision opportunities, come up with novel ideas, design data science projects/companies conceptually, can evaluate the promise of new ideas

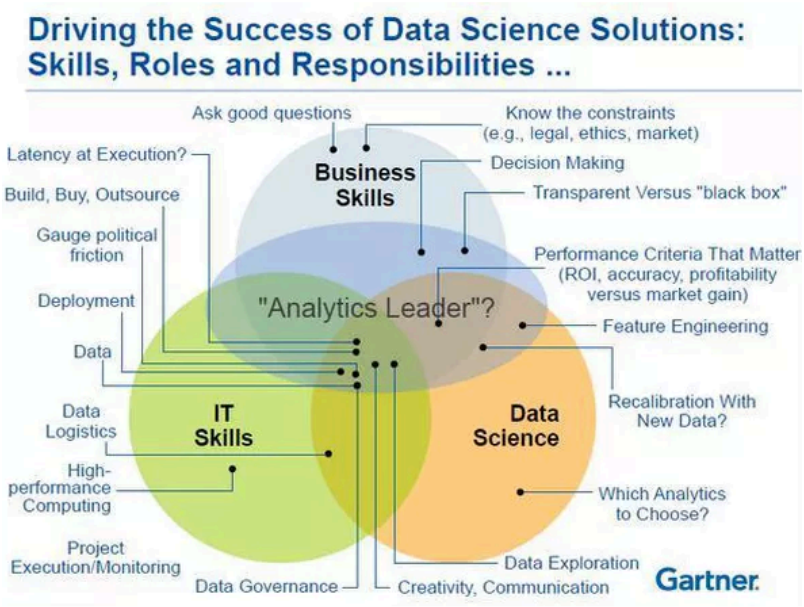


What's the secret sauce to a Data Scientist?<

Science + hacker
+ Business Knowledge
+ PATIENCE^10 =

DATA SCIENTIST

Responsibilities of a Data Scientist <

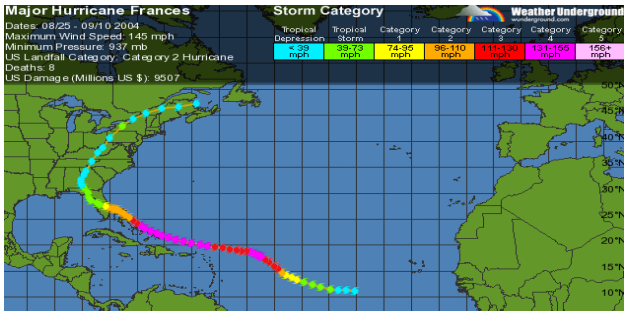


Business use cases for data science?<

- **Marketing**
  - Targeted marketing
  - online advertising
  - Recommendations for cross-selling
- **Finance**
  - Credit scoring
  - Trading
  - Fraud
  - Workforce management
  - Minimize operational expenses
- **Retail**
  - Supply chain management
- **Others????**

Business use case 1 – Walmart <

Winds: 145 mph
Date: August 24, 2004 – September 10, 2004



Walmart
Save money. Live better.

- **How can Walmart use data science to prepare the effected areas from the hurricane?**

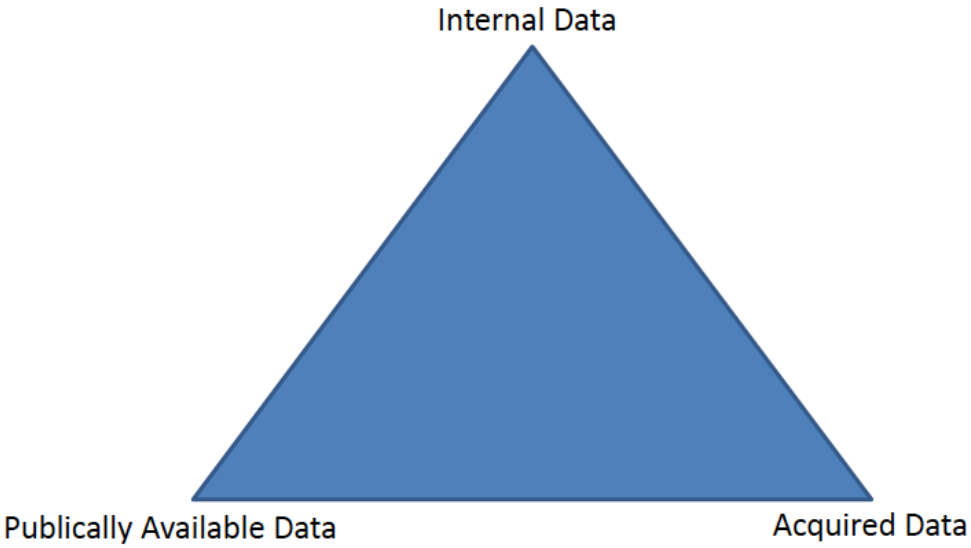
http://www.nytimes.com/2004/11/14/business/yourmoney/what-walmart-knows-about-customers-habits.html?_r=0

Business use case 2 – Target <

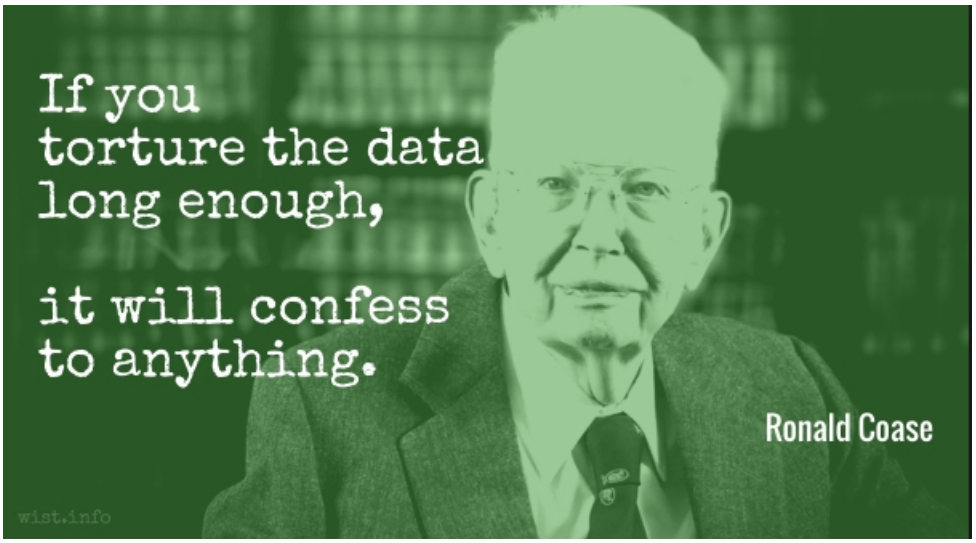
http://www.nytimes.com/2012/02/19/magazine/shopping-habits.html

- How can Target use data science to identify pregnant customers?
- Is there a risk of predicting *pregnant* customer?

The trifecta of data and knowledge extraction <



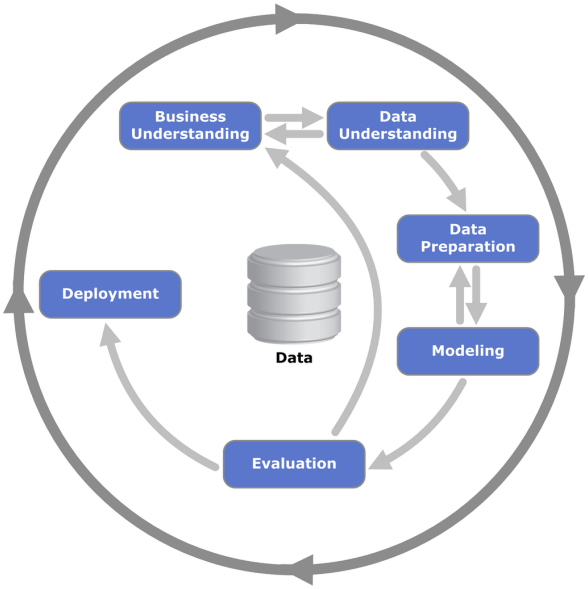
Data'isms <


If you
torture the data
long enough,
it will confess
to anything.
Ronald Coase
wist.info

How to start and finish a data science problem<

- Start with a data science problem
- Then finish with an answer to the data science problem
- Data handling is *not* the first step
- Consult a domain expert

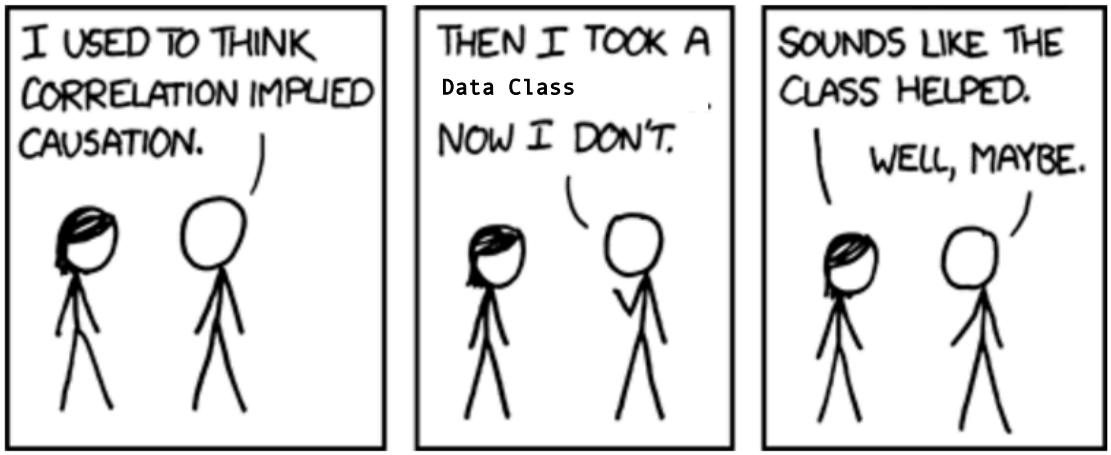
CRISP <


Business Understanding
Data Understanding
Data Preparation
Modeling
Evaluation
Deployment
Data

Correlation vs correlation <

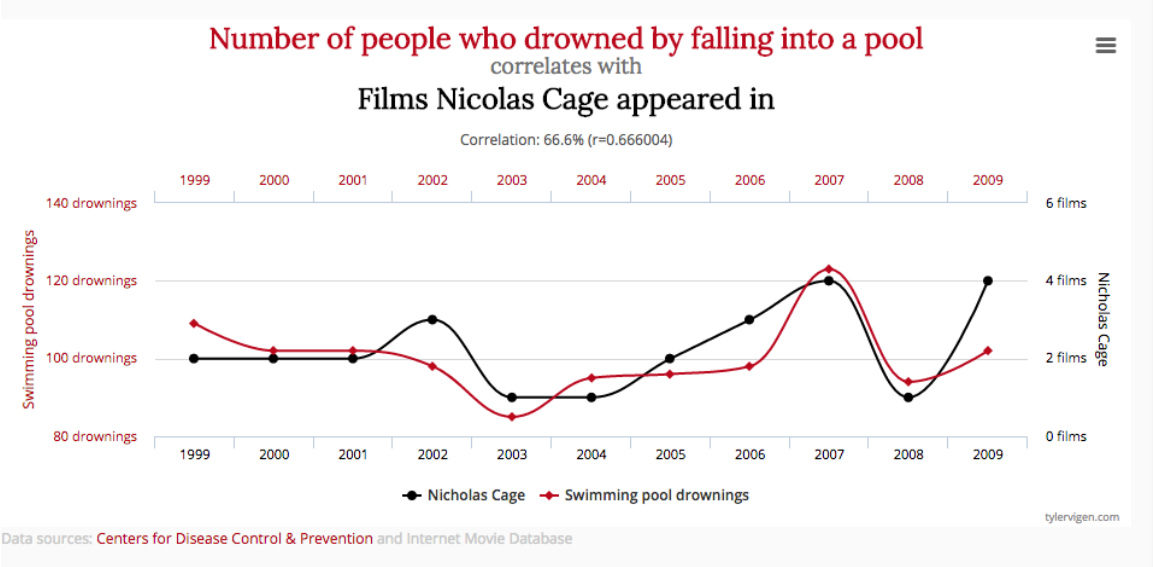
Correlation between two variables does **not** imply that one causes the other.

Correlation does not imply correlation <



One must always be wary when drawing conclusions from data! Randall Munroe, CC BY-NC

Correlation does not imply correlation Example <



R for Data Science <

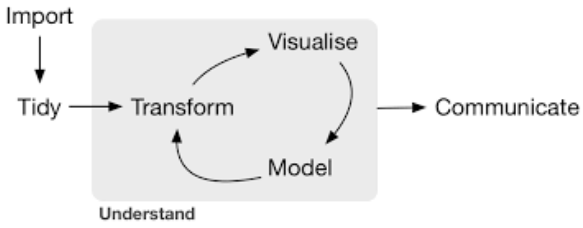
The goal for this class is to empower you to turn raw data into understanding, insight, and knowledge.

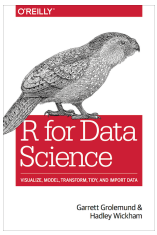
R is simply a tool that will allow you to do data science

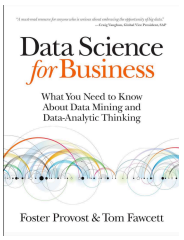
KNOWLEDGE IS POWER

Format going forward<

- **The format of the course onward will be broken out by the typical data analysis process explained by Hadley Wickham, author of "R for Data Science"**
- **Each data "problem" should be answered in this model**
- **80% of the heavy lifting in this model will be within the following sections Import->Tidy-> Transform**







http://r4ds.had.co.nz/intro.html

Import <

- **Take the data store in a file, data frame or web api and load it into a data.frame in R.**

- **If you cant get the data into R, then you cant do data science**

Tidy <

- **Cleaning the data and storing it in a consistent form that matches the semantics of the dataset with the way its stored**

Transform <

- **Narrow in on observations of interest, creating new variables that provide calculations or summary statistics**

Visualization <

- **Require human interpretation and are fundamental in describing data**

Models <

- At the surface they are a mathematical or computational tool
- Scaling the model can be difficult

Communication <

- **The ability to articulate and provide value to the end product of your data analysis**

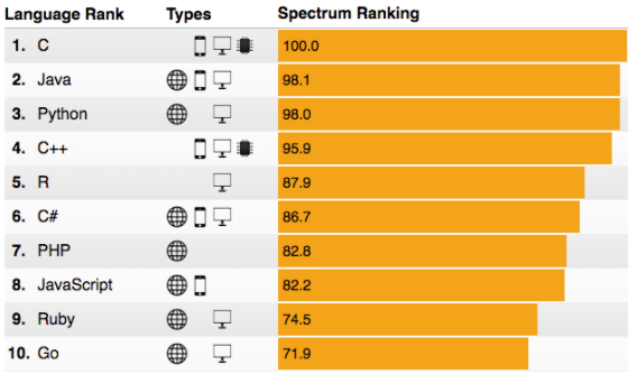
Not Data Science <

- **Data Warehousing – collection and storage of data**
- **Querying – SQL and any GUI clicking**
- **Statistical Analysis – hypothesis generation or testing. “A” “B” testing**
- **No Microsoft Excel here**

> R

History<

- The R statistical programming language is a free open source package based on the S language developed by Bell Labs. Evolved to R in 1997 with source code and packages available on CRAN and is a GNU project
- **R is** interpreted computer language used for **data manipulation, statistics, and graphics.**
- **In April of 2015 Microsoft acquired Revolution Analytics, the commercial provider of software and services for the R programming language**



R ⬆ 1 spot from 2015

http://www.datasciencecentral.com/profiles/blogs/r-moves-up-to-5th-place-in-ieee-language-rankings

R explained <

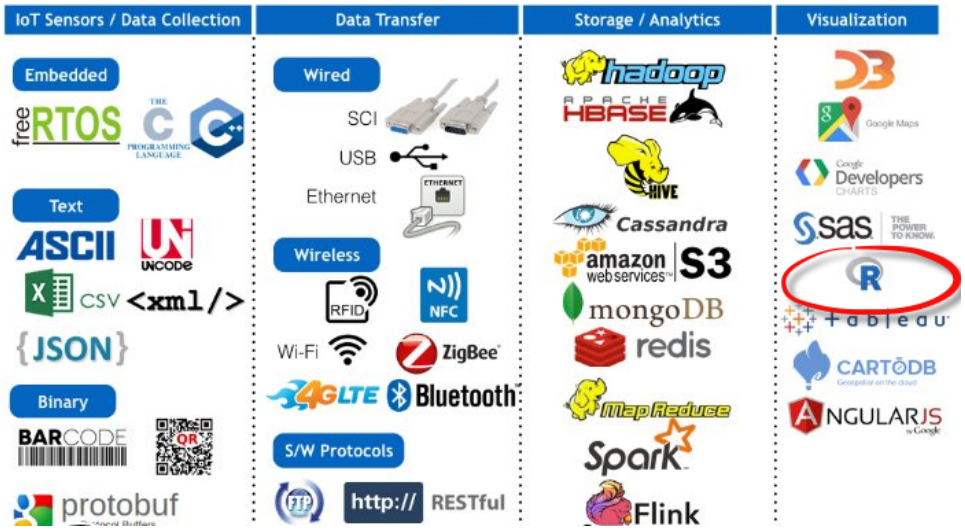
- R stores all objects in memory
- R can process 8TB of RAM on 64 bit operating systems
- R Rules of the Road
  - Can process up to 1 million records with ease
  - For > 1 million && < 1 billion records, R may struggle
  - > than 1 billion records, its best to use big data platforms that leverage map reduce and processed on big data platforms like Hadoop

https://stat.ethz.ch/R-manual/R-devel/library/base/html/Memory-limits.html

R explained part duex

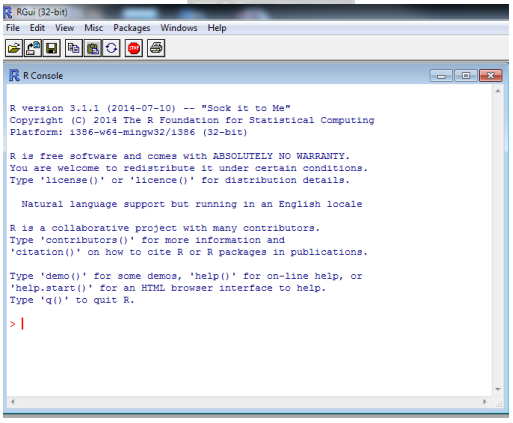
https://stat.ethz.ch/R-manual/R-devel/library/base/html/Memory-limits.html

Gartner IoT to Big Data Analytics Open Source Tech Stack



R Studio<

- For instructional purposes we will be using R Studio IDE
- Once the underlying R software is installed, RStudio can then be installed



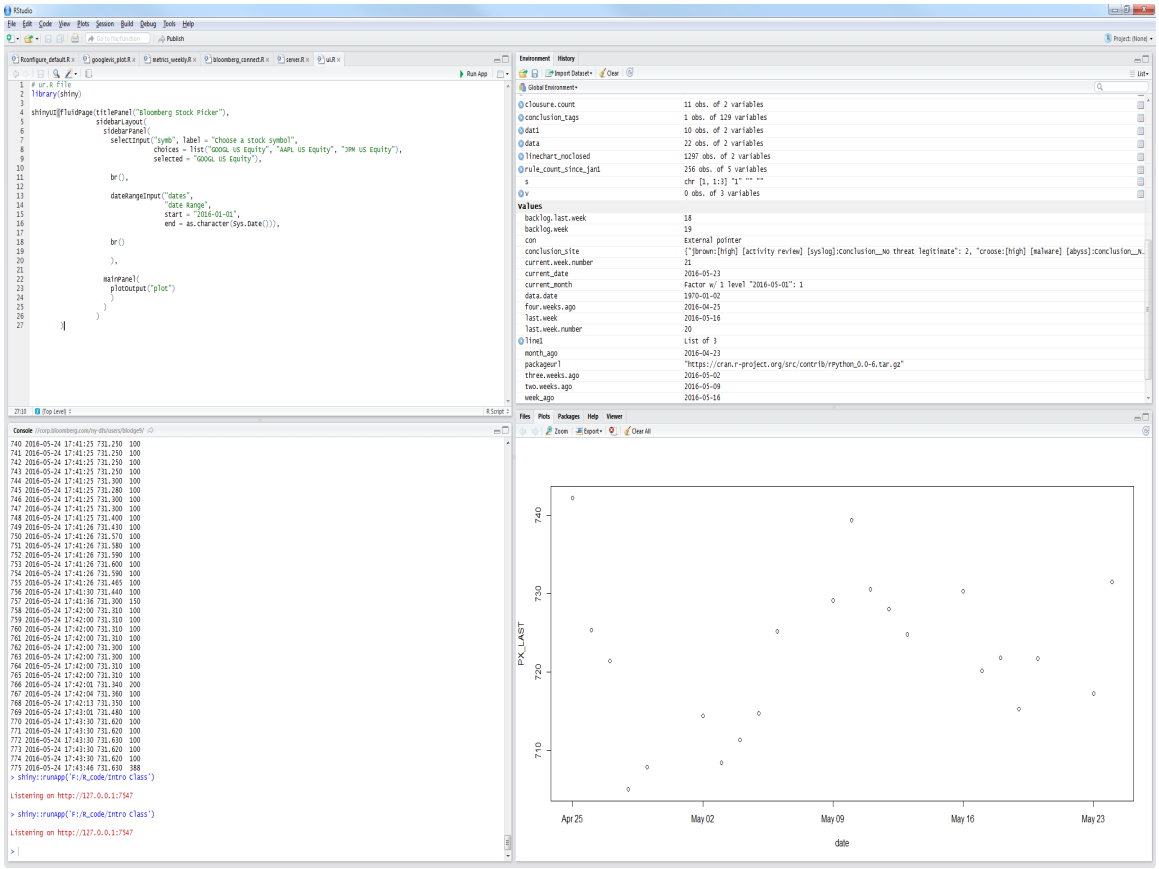
R Studio Install<

- R Class Installation Guide:
- Install R and R Studio – RStudio requires R 2.11.1 (or higher)
- You'll need admin rights to perform the install.

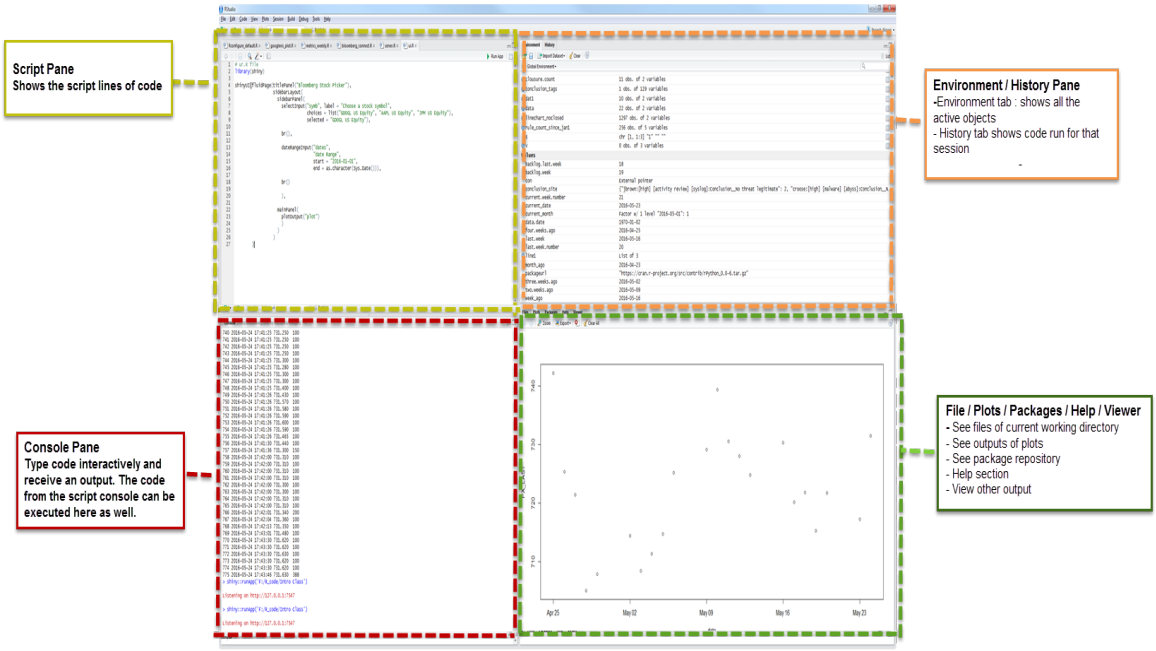
- 2 Step install R > RStudio1.

- 1. Install R here –
  - https://cran.rstudio.com/
  - Download for your OS (Linux, Mac, Windows)

- 2. Install R Studio- Install RStudio here - https://www.rstudio.com/products/rstudio/download/
- - Download the installer for your OS (Linux, Mac, Windows)


RStudio
File Edit Code View Plots Session Build Debug Tools Help
Publish
Project: (None)
Reconfigure_default.R
googleis_plot.R
metrics_weekly.R
bloomberg_connect.R
server.R
ui.R
Run App
1 # ui.R File
2 library(shiny)
3
4 shinyUI(fluidPage(titlePanel("Bloomberg Stock Picker"),
5 sidebarLayout(
6 sidebarPanel(
7 selectInput("symb", label = "choose a stock symbol",
8 choices = list("GOOGL US Equity", "AAPL US Equity", "JPM US Equity"),
9 selected = "GOOGL US Equity"),
10
11 br(),
12
13 dateRangeInput("dates",
14 "date Range",
15 start = "2016-01-01",
16 end = as.character(Sys.Date())),
17
18 br()
19
20),
21
22 mainPanel(
23 plotoutput("plot")
24)
25)
26)
27)
27:10
(Top Level)
R Script
Console
740 2016-05-24 17:41:25 731.250 100
741 2016-05-24 17:41:25 731.250 100
742 2016-05-24 17:41:25 731.250 100
743 2016-05-24 17:41:25 731.250 100
744 2016-05-24 17:41:25 731.300 100
745 2016-05-24 17:41:25 731.280 100
746 2016-05-24 17:41:25 731.300 100
747 2016-05-24 17:41:25 731.300 100
748 2016-05-24 17:41:25 731.400 100
749 2016-05-24 17:41:26 731.430 100
750 2016-05-24 17:41:26 731.570 100
751 2016-05-24 17:41:26 731.580 100
752 2016-05-24 17:41:26 731.590 100
753 2016-05-24 17:41:26 731.600 100
754 2016-05-24 17:41:26 731.590 100
755 2016-05-24 17:41:26 731.465 100
756 2016-05-24 17:41:30 731.440 100
757 2016-05-24 17:41:36 731.300 150
758 2016-05-24 17:42:00 731.310 100
759 2016-05-24 17:42:00 731.310 100
760 2016-05-24 17:42:00 731.310 100
761 2016-05-24 17:42:00 731.310 100
762 2016-05-24 17:42:00 731.300 100
763 2016-05-24 17:42:00 731.300 100
764 2016-05-24 17:42:00 731.310 100
765 2016-05-24 17:42:00 731.310 100
766 2016-05-24 17:42:01 731.340 200
767 2016-05-24 17:42:04 731.360 100
768 2016-05-24 17:42:13 731.350 100
769 2016-05-24 17:43:01 731.480 100
770 2016-05-24 17:43:30 731.620 100
771 2016-05-24 17:43:30 731.620 100
772 2016-05-24 17:43:30 731.630 100
773 2016-05-24 17:43:30 731.620 100
774 2016-05-24 17:43:30 731.620 100
775 2016-05-24 17:43:46 731.630 388
> shiny::runapp('F:/R_code/Intro Class')
Listening on http://127.0.0.1:7547
> shiny::runapp('F:/R_code/Intro Class')
Listening on http://127.0.0.1:7547
>
Environment History
Import Dataset
Clear
List
Global Environment
closure.count 11 obs. of 2 variables
conclusion_tags 1 obs. of 129 variables
dat1 10 obs. of 2 variables
data 22 obs. of 2 variables
linechart_noclosed 1297 obs. of 2 variables
rule_count_since_jan1 256 obs. of 5 variables
s chr [1, 1:3] "1" "" ""
v 0 obs. of 3 variables
Values
backlog.last.week 18
backlog.week 19
con External pointer
conclusion_site {"jbrown:[high] [activity review] [syslog]:conclusion__no threat legitimate": 2, "croose:[high] [malware] [abyss]:conclusion__N..
current.week.number 21
current_date 2016-05-23
current_month Factor w/ 1 level "2016-05-01": 1
data.date 1970-01-02
four.weeks.ago 2016-04-25
last.week 2016-05-16
last.week.number 20
line1 List of 3
month_ago 2016-04-23
packageurl "https://cran.r-project.org/src/contrib/rPython_0.0-6.tar.gz"
three.weeks.ago 2016-05-02
two.weeks.ago 2016-05-09
week_ago 2016-05-16
Files Plots Packages Help Viewer
Zoom
Export
Clear All
PX_LAST
740
730
720
710
Apr 25
May 02
May 09
May 16
May 23
date

R Studio IDE breakdown



Starting with R

- R is in fact scripting or programming
- I am expecting that you have some familiarity with scripting (Bash, Visual Basic, Perl, Python, Ruby, etc)
- Or have some experience with programming (C++, C#, Java, etc)
- We don't intend to write thousand line programs in this class but we'll show how to issue R commands

Online R Resources

- GOOGLE
- CRAN - The main R site: http://cran.r-project.org
- Stack Overflow R section

Tag Info

info newest 4 featured frequent votes active unanswered

173,698
questions tagged

Ask Question

r

About r

R is a free, open-source programming language and software environment for statistical computing, bioinformatics, and graphics. Please supplement your question with a minimal reproducible example. Use dput() for data and specify all non-base packages with library calls. For statistical questions please use http://stats.stackexchange.com.

R Programming Language

R is a free, open-source programming language and software environment for statistical computing, bioinformatics, and graphics. It is a multi-paradigm language and dynamically typed. R is an implementation of the S programming language combined with lexical scoping semantics inspired by Scheme. R was created by Ross Ihaka and Robert Gentleman and is now developed by the R Development Core Team. The R environment is easily extended through a packaging system on CRAN, the Comprehensive R Archive Network.

Scope of questions

This tag should be used for programming-related questions about R. Including a minimal reproducible example in your question will increase your chances of getting a timely, useful answer. Questions should *not* use the rstudio tag unless they relate specifically to the RStudio interface and not just the R language.

If your question is more focused on statistics or data science, use Cross Validated or Data Science, respectively. Bioinformatics-specific questions may be better received on Bioconductor Support or Biostars. General questions about R (such as requests for off-site resources or discussion questions) are unsuitable for StackOverflow and may be appropriate for one of the general, or special-interest, R mailing lists.

Please do not cross-post across multiple venues. Do research (read tag wikis, look at existing questions, or search online) to determine the most appropriate venue so that you have a better chance of receiving solutions to your question. Your question may be automatically migrated to a more appropriate StackOverflow site. If you receive **no** response to your questions after a few days, or if your question is put on-hold for being off-topic, it is then OK to post to another venue, giving a link to your StackOverflow question - but don't cross-post just because your question is down-voted or put on hold for being unclear. *Instead, work on improving your question.*

Synonyms

rstats r-language

Stats

created 8 years ago by David Locke
viewed 50017 times
active 1 month ago
editors 69

Top Answerers


akrun
242k ● 9 ● 71 ● 122


Dirk Eddelbuettel
222k ● 24 ● 405 ● 509


42-
175k ● 10 ● 173 ● 305


A5C1D2H2I1M1N2O1R2T1
124k ● 15 ● 179 ● 267

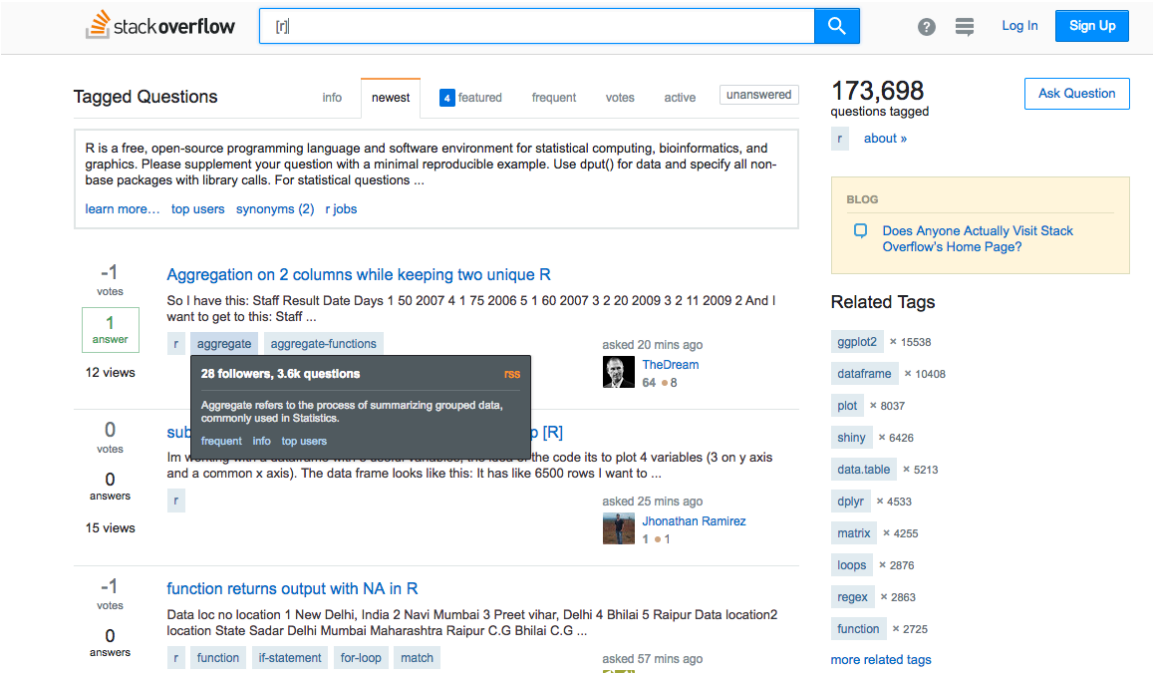

Gavin Simpson
111k ● 14 ● 230 ● 319

more »

Recent Hot Answers

R: possible truncation of >= 4GB file

How to save row names when selecting each column independently instead of row number?

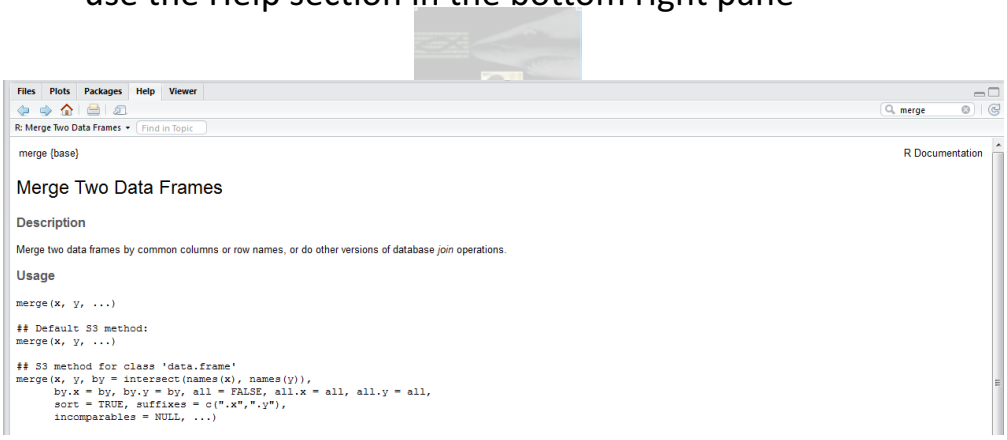

stackoverflow
[r]
Log In
Sign Up
Tagged Questions
info
newest
featured
frequent
votes
active
unanswered
173,698
questions tagged
Ask Question
r
about »
R is a free, open-source programming language and software environment for statistical computing, bioinformatics, and graphics. Please supplement your question with a minimal reproducible example. Use dput() for data and specify all non-base packages with library calls. For statistical questions ...
learn more… top users synonyms (2) r jobs
BLOG
Does Anyone Actually Visit Stack Overflow's Home Page?
-1
votes
1
answer
12 views
Aggregation on 2 columns while keeping two unique R
So I have this: Staff Result Date Days 1 50 2007 4 1 75 2006 5 1 60 2007 3 2 20 2009 3 2 11 2009 2 And I want to get to this: Staff ...
r
aggregate
aggregate-functions
asked 20 mins ago
TheDream
64 ● 8
28 followers, 3.6k questions
rss
Aggregate refers to the process of summarizing grouped data, commonly used in Statistics.
frequent info top users
0
votes
0
answers
15 views
p [R]
the code its to plot 4 variables (3 on y axis and a common x axis). The data frame looks like this: It has like 6500 rows I want to ...
r
asked 25 mins ago
Jhonathan Ramirez
1 ● 1
-1
votes
0
answers
function returns output with NA in R
Data loc no location 1 New Delhi, India 2 Navi Mumbai 3 Preet vihar, Delhi 4 Bhilai 5 Raipur Data location2 location State Sadar Delhi Mumbai Maharashtra Raipur C.G Bhilai C.G ...
r
function
if-statement
for-loop
match
asked 57 mins ago
Related Tags
ggplot2 × 15538
dataframe × 10408
plot × 8037
shiny × 6426
data.table × 5213
dplyr × 4533
matrix × 4255
loops × 2876
regex × 2863
function × 2725
more related tags

R best practices

- Ensure your code is easy to read for yourself and others
  - Use spaces
  - Variable names should be succinct, yet informative
  - Use #comments
  - Remove any code that is unnecessary or trial code
  - The more concise your code, the easier it is to understand and easier to fix

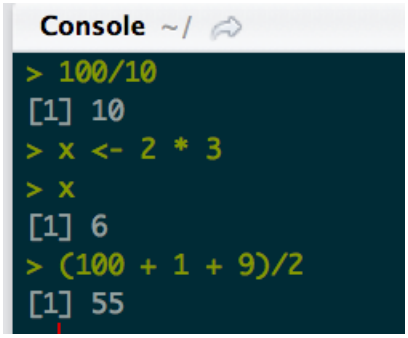
R help

- R has a very good help system built in
- If you need help on a package, function, etc use the Help section in the bottom right pane



R as a calculator

- The R console or standard out functions much like a calculator
- Assignment statements
  - Object_name < value
  - You can mentally read this aloud as “object name gets (“<”) value”
- Can use “=“ instead of “<” but it gets confusing when you begin using math formulas



R tips and tricks

- “>” the prompt
- Keyboard Shortcut [ALT-] = “<-”
- Objects
  - Must start with a letter and can only contain letters, numbers, “_” and “.”
- Code completion using [Tab] for variables, functions, packages, etc
- “+” after code generation means you are missing some syntax
  - Comma
  - Quote
  - Parenthesis
  - Press [ESC] to try again

R packages

- The fundamental units of reproducible code.
- They include
  - Reusable functions
  - Documentation

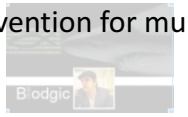
Comparisons & Boolean & NA

- <
- >
- <=
- >=
- !=
- ==
- & ”and”
- | “or”
- ! “not”
- NA “not available”
- is.na – determine if a value is missing or NA

- How do find those values that are not NA?

R - Objects

- Must start with a letter
- Can only contain letters, numbers, '_', '.'
- You'll want your object name to be explanatory and you'll need a naming convention for multiple words



I_like_to_use_this <- 1
OtherPeopleDoThis <- 1
Some.People.Do.This < 1
And_a.Few.People_will.do.THIS

This_is_a_really_long_data_object < 2.5
You can use RStudio's auto completion facility by typing "this"+[tab]
Press Cmd+CTRL+ ↑ and you'll see the last commands you've typed

R – Objects continued

- There are many types of R-objects.
  The frequently used ones are:
  - Vectors
  - Lists
  - Matrices
  - Arrays
  - Factors
  - Data Frames

Vector Object

- 6 data types of vectors
  - Logical
  - Numeric
  - Integer
  - Complex
  - Character
  - Raw

Data types

- int – integer - as.integer(3.14) = 3
- dbl – double or real number - 1, 2.5, 4.5
- chr – character vector/ string - character
- dttm – date-time – 2017-01-01
- lgl – logical – TRUE or FALSE
- fctr – factors R uses to represent categorical variables with fixed possible values
- date – dates - as.Date(as.POSIXct("2013-01-01 07:00", 'GMT')

  [1]

  "2013-01-01"

Data Type	Example	Verify

Logical	TRUE, FALSE	`v <- TRUE`
		`print(class(v))`
		it produces the following result —
		`[1] "logical"`

Numeric	12.3, 5, 999	`v <- 23.5`
		`print(class(v))`
		it produces the following result —
		`[1] "numeric"`

Integer	2L, 34L, 0L	`v <- 2L`
		`print(class(v))`
		it produces the following result —
		`[1] "integer"`

Complex	3 + 2i	`v <- 2+5i`
		`print(class(v))`
		it produces the following result —
		`[1] "complex"`

Character	'a' , '"good", "TRUE", '23.4'	`v <- "TRUE"`
		`print(class(v))`
		it produces the following result —
		`[1] "character"`

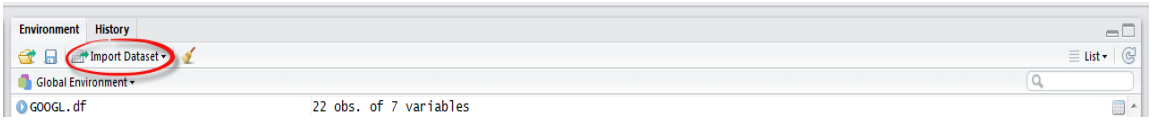
Raw	"Hello" is stored as 48 65 6c 6c 6f	`v <- charToRaw("Hello")`
		`print(class(v))`
		it produces the following result —
		`[1] "raw"`

Export & Import

Step 1: Run the code to pull googles stock price for the last 31 days (missing weekends because stocks are not traded then)

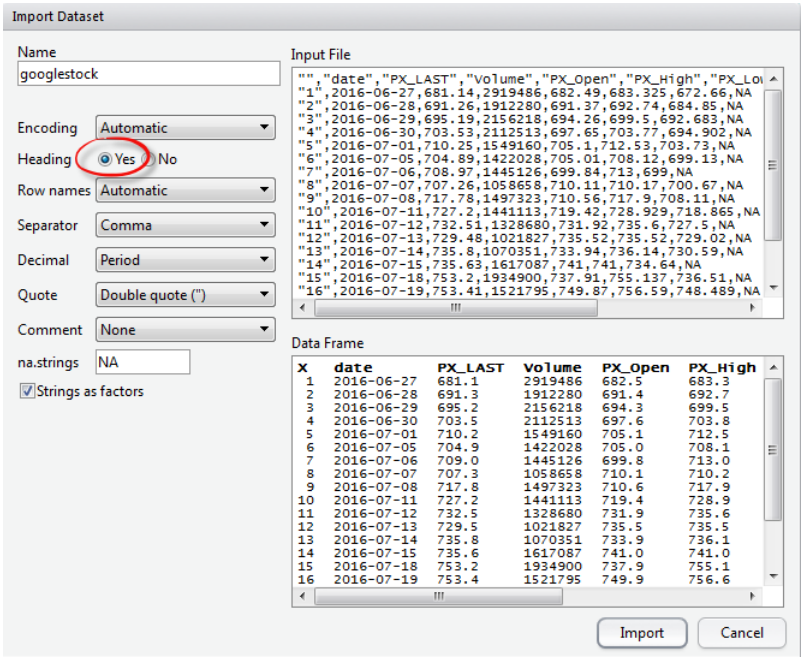
```
1  library(quantmod)
2  getSymbols("GOOGL")
3  GOOGL.2016 <- GOOGL['2016']
4  GOOGL.2016.df <- as.data.frame(GOOGL.2016)
5
6  write.csv(GOOGL.2016.df, "googlestock.csv")
```

Step 2: View the GOOGL.df data frame
Step 3: write the data frame to a csv output



Step 4: Import Dataset you just sent to csv file

Import


Import Dataset
Name
googlestock
Encoding
Automatic
Heading
Yes
No
Row names
Automatic
Separator
Comma
Decimal
Period
Quote
Double quote (")
Comment
None
na.strings
NA
Strings as factors
Input File
"","date","PX_LAST","Volume","PX_Open","PX_High","PX_Lo
"1",2016-06-27,681.14,2919486,682.49,683.325,672.66,NA
"2",2016-06-28,691.26,1912280,691.37,692.74,684.85,NA
"3",2016-06-29,695.19,2156218,694.26,699.5,692.683,NA
"4",2016-06-30,703.53,2112513,697.65,703.77,694.902,NA
"5",2016-07-01,710.25,1549160,705.1,712.53,703.73,NA
"6",2016-07-05,704.89,1422028,705.01,708.12,699.13,NA
"7",2016-07-06,708.97,1445126,699.84,713,699,NA
"8",2016-07-07,707.26,1058658,710.11,710.17,700.67,NA
"9",2016-07-08,717.78,1497323,710.56,717.9,708.11,NA
"10",2016-07-11,727.2,1441113,719.42,728.929,718.865,NA
"11",2016-07-12,732.51,1328680,731.92,735.6,727.5,NA
"12",2016-07-13,729.48,1021827,735.52,735.52,729.02,NA
"13",2016-07-14,735.8,1070351,733.94,736.14,730.59,NA
"14",2016-07-15,735.63,1617087,741,741,734.64,NA
"15",2016-07-18,753.2,1934900,737.91,755.137,736.51,NA
"16",2016-07-19,753.41,1521795,749.87,756.59,748.489,NA
Data Frame
X date PX_LAST Volume PX_Open PX_High
1 2016-06-27 681.1 2919486 682.5 683.3
2 2016-06-28 691.3 1912280 691.4 692.7
3 2016-06-29 695.2 2156218 694.3 699.5
4 2016-06-30 703.5 2112513 697.6 703.8
5 2016-07-01 710.2 1549160 705.1 712.5
6 2016-07-05 704.9 1422028 705.0 708.1
7 2016-07-06 709.0 1445126 699.8 713.0
8 2016-07-07 707.3 1058658 710.1 710.2
9 2016-07-08 717.8 1497323 710.6 717.9
10 2016-07-11 727.2 1441113 719.4 728.9
11 2016-07-12 732.5 1328680 731.9 735.6
12 2016-07-13 729.5 1021827 735.5 735.5
13 2016-07-14 735.8 1070351 733.9 736.1
14 2016-07-15 735.6 1617087 741.0 741.0
15 2016-07-18 753.2 1934900 737.9 755.1
16 2016-07-19 753.4 1521795 749.9 756.6
Import
Cancel

Hands on challenge

- **Using the library(quantmod), pick your own stock to answer the following questions:**

1. **Pick 3 fields**
2. **Write your new data frame to csv**
3. **Import that data frame to R**
4. **View the data frame in R**

Bonus

- **Remove a column of data from your data frame (use help to find remove column function)**

Hands on challenge

- **Using the library(quantmod), pick your own stock to answer the following questions:**

1. **Remove 3 fields**
2. **Write your new data frame to csv**
3. **Import that data frame to R**
4. **View the data frame in R**

Bonus

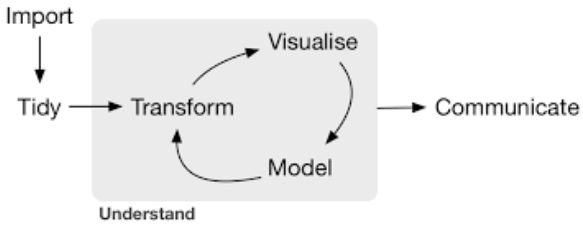
- **Find an additional column that does not come with the original dataframe.**
  - **Check out http://www.quantmod.com/examples/data/**

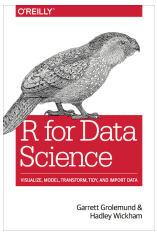
Section 2

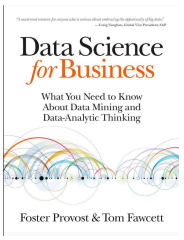
- **Online Course Layout:**
  - **Section 1 -Familiarity with R**
  - **Section 2 – Data Wrangling**
    - **API's**
    - **Data store types**
    - **Tidying**
    - **Dplyr**
    - **Data wrangling stock data**
    - **Stats wrangling**
    - **Hands-on exercise with a stock of your choice**
    - **Regular expressions**
  - **Section 3 – Data Visualization**
  - **Section 4 – R Markdown**
  - **Section 5 – Exploratory Data Analysis**
    - **Diamond Exercise**
    - **Bank Marketing Exercise**
  - **Section 6 – Introduction to Regression**
  - **Section 7 – Introduction to Machine Learning**
    - **Titanic Kaggle Competition**
  - **Section 8 – Strategy**
    - **Big box store competitors**

Format going forward<

- **The format of the course onward will be broken out by the typical data analysis process explained by Hadley Wickham, author of "R for Data Science"**
- **Each data "problem" should be answered in this model**
- **80% of the heavy lifting in this model will be within the following sections Import->Tidy-> Transform**



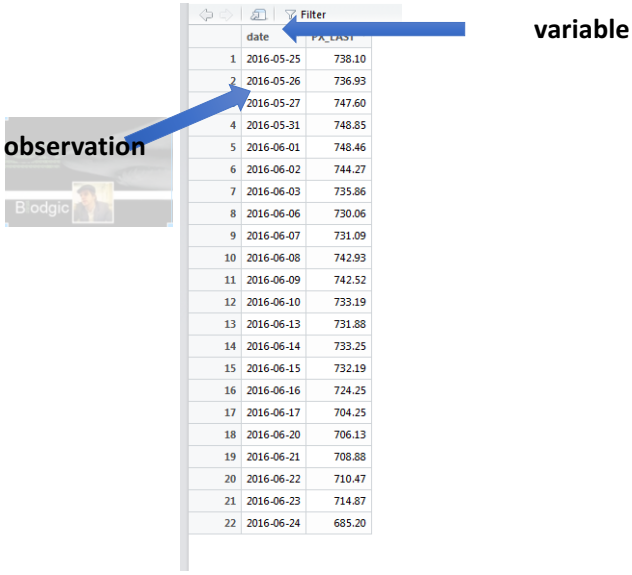




http://r4ds.had.co.nz/intro.html

Tidying

- **Getting it prepped in a standard format with variables (columns) and observations (rows)**



Dplyr Tidying

- **Filter() - pick observations by their values**
- **Arrange() – reorder the rows**
- **Select() – pick variables by their names**
- **Mutate() – create new variables with functions of existing variables**
- **Summarize() – collapse many variables down to a single summary**
- **group_by() – changes the scope of each function from operating on the entire data set to operating on it group-by-group**

Dplyr Tidying

- **Dplyr Fishery Example code**

Transformation

- **Data summaries provide overviews of key properties of the data**
- **Goal is to describe important properties of the distribution of the values across observations that were measured**
- **Implying knowledge generation against the dataset**
  - **Subset**
  - **Mathematical functions**
  - **Calculations**
  - **Summary statistics**
  - **sorting**

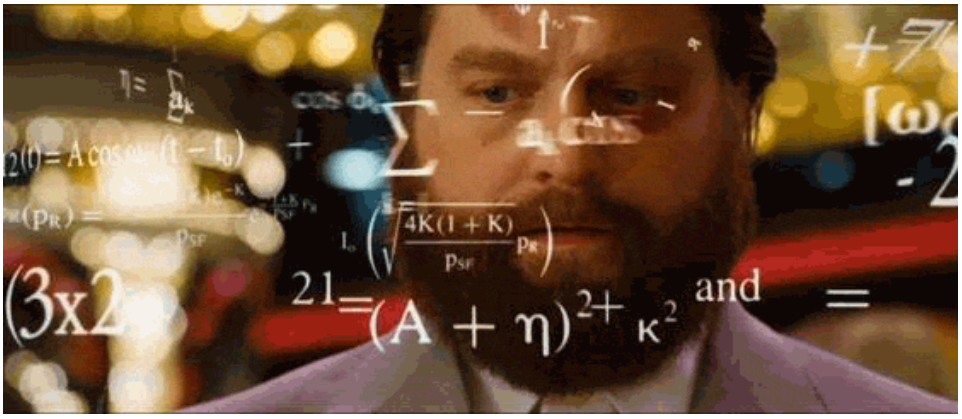
Filter

	date	PX_LAST	mean.PX_LAST
1	2016-05-25	738.10	728.6923
2	2016-05-26	736.93	728.6923
3	2016-05-27	747.60	728.6923
4	2016-05-31	748.85	728.6923
5	2016-06-01	748.46	728.6923
6	2016-06-02	744.27	728.6923
7	2016-06-03	735.86	728.6923
8	2016-06-06	730.06	728.6923
9	2016-06-07	731.09	728.6923
10	2016-06-08	742.93	728.6923
11	2016-06-09	742.52	728.6923
12	2016-06-10	733.19	728.6923
13	2016-06-13	731.88	728.6923
14	2016-06-14	733.25	728.6923
15	2016-06-15	732.19	728.6923
16	2016-06-16	724.25	728.6923
17	2016-06-17	704.25	728.6923
18	2016-06-20	706.13	728.6923
19	2016-06-21	708.88	728.6923
20	2016-06-22	710.47	728.6923
21	2016-06-23	714.87	728.6923
22	2016-06-24	685.20	728.6923

Transformation continued…

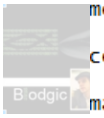
- **Mean – average**
- **Median – middle value**
- **Mode – most common value**
- **Range – difference between the largest and the smallest value**
- **Variance – numerical measure of how the data values are dispersed around the mean. The average of the squared distances from the mean**
- **Standard deviation – a measure of how spread out the numbers are**

```
subset(GOOGL.df, PX_LAST > 738)

median(GOOGL.df$PX_LAST)

centralValue(GOOGL.df$date)

max(GOOGL.df$PX_LAST)

var(GOOGL.df$PX_LAST)

sd(GOOGL.df$PX_LAST)

describe(GOOGL.df)

summary(GOOGL.df)

range(GOOGL.df$PX_LAST)

#mathisfun.com/data/standard-deviation.html
```


21=(A + η)² + κ² and =

Cheat Sheet

- **Mean – average**
- **Median – middle value**
- **Mode – most common value**
- **Range – difference between the largest and the smallest value**
- **Variance – numerical measure of how the data values are dispersed around the mean. The average of the squared distances from the mean**
- **Standard deviation – a measure of how spread out the numbers are**



```
subset(GOOGL.df, PX_LAST > 738)

median(GOOGL.df$PX_LAST)

centralvalue(GOOGL.df$date)

max(GOOGL.df$PX_LAST)

var(GOOGL.df$PX_LAST)

sd(GOOGL.df$PX_LAST)

describe(GOOGL.df)

summary(GOOGL.df)

range(GOOGL.df$PX_LAST)

#mathisfun.com/data/standard-deviation.html
```

Hands on challenge

- **Using the librcary(quantmod), pick your own stock to answer the following questions:**

1. **Select stock prices for your stock of choice for the last 31 days - library(quantmod)**
2. **Subset the data to the last 10 days and turn it into a data frame**
3. **What is the highest value and lowest value of your stock within the last 31 days?**
4. **What was the average price of your stock of choice for the last 31 days**
5. **Find the average of the squared distances from the mean for the stock prices in the last 31 days. Hint: this is a single function**
6. **Would you buy or sell your stock tomorrow? Explain why or why not.**

API's

- **API** – application Programming Interface
  - It's a means of accessing the functionality of a program from inside another program
  - Allows for flexibility and customization of the data scientist and not depend on the application for exporting on an ad-hoc basis
- API's are the driving force behind data wrangling
- They allow machines to access data programmatically through specific formatting, keys and API calls

Wrangling an API

- **Consist of a URL to a domain and a path**
  - **Example: https://api.census.gov/data/2015/acs5?get=…**
    - **Api.census.gov is the URL**
    - **After the get= is the data to retrieve**
  - **HTTP – hyper text protocol in which the web is built on**
    - **GET – command request from a client to query a server and recieves an answer**
    - **POST – sends a data payload to a server (from a client)**

API types

- **JSON – JavaScript Object Notation**
  - **Emerging as the go-to standard for API format**
  - **Less characters and no tags but brackets**

- **XML – eXtended Markup Language**
  - **Legacy format and slower with higher processing power to display characters and tags but still used**
  - **Includes HTML tags like <id> or <item> and </id> or </item> to close the tag**

JSON Example


```
"product" : {
    "id" : 15,
    "name" : "Widgets",
    "description" : "These widgets are the finest widgets ever made by anyone.",
    "options" : [
        {
            "type" : "color",
            "items" : [
                "Purple",
                "Green",
                "Orange"
            ]
        }
    ]
}
```

XML Example

```
<product>

   <id>15</id>

   <name>Widgets</name>

   <description>These widgets are the finest widgets ever made by anyone.
</description>

   <options type="color">

      <item>Purple</item>

      <item>Green</item>

      <item>Orange</item>

   </options>

</product>
```

API Exercise

- We'll now pull data from the census bureau
- The API site is here
- http://proximityone.com/zipcode_data_analytics.htm#option3
- Leverage the data dictionary provided to assign the column names
- Use transformation techniques to find interesting figures
  - Average House Hold income?
  - Sum the population of the US

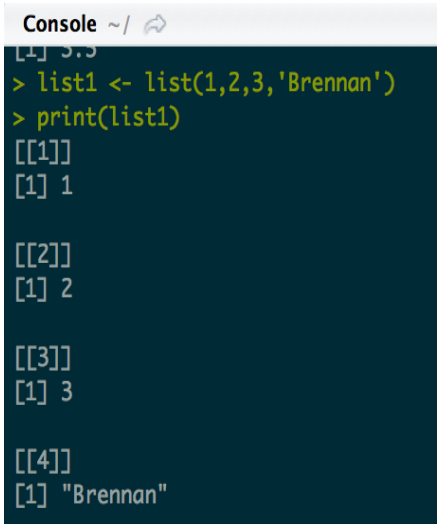
Creating multiple vectors

- When you want to create a vector with more than one element, you must use the ‘c()’ function which allows you to combine the elements into a vector

```
# Create a vector.
apple <- c('red','green',"yellow")
print(apple)

# Get the class of the vector.
print(class(apple))
```

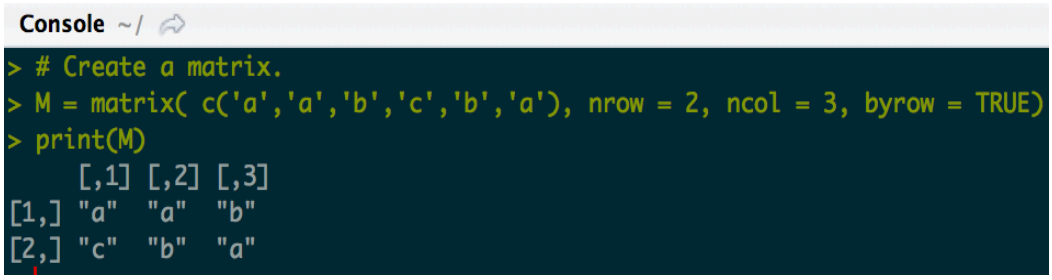
Lists

- In addition to vectors (created with the c() operator), A list is an R-object which can contain many different types of elements inside it like vectors, functions and even another list inside it
- The basic R *list* is created as the list() operator



Matrices

- Matrices are two-dimensional structures addresses by rows and columns
- It can be created using a vector input to the matrix function



Arrays

- While matrices are confined to two dimensions, arrays can be of any number of dimensions. The array functions takes a 'dim' attribute which creates the require number of dimensions. We'll create an array with two elements which are 3x3 matrices each

```
> array1 <- array(c('red','orange','yellow'), dim = c(3,3,2))
> print(array1)
, , 1

     [,1]     [,2]     [,3]
[1,] "red"    "red"    "red"
[2,] "orange" "orange" "orange"
[3,] "yellow" "yellow" "yellow"

, , 2

     [,1]     [,2]     [,3]
[1,] "red"    "red"    "red"
[2,] "orange" "orange" "orange"
[3,] "yellow" "yellow" "yellow"
```

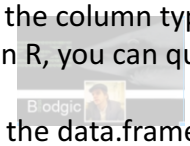
Factors

- Factors are the r-objects which are created using a vector. It stores the vector along with the distinct values of the elements in the vector as labels. The labels are always character irrespective of whether it is numeric or character or Boolean in the input vector. They are useful in statistical modeling.
- Factors are created using the **factor()** function. The **nlevels** function gives the count of levels.

```
> crayons <- c('red', 'blue', 'green', 'yellow',
+              'orange', 'violet', 'brown', 'black',
+              'red','red','yellow','brown','orange','blue')
> factor_crayons <- factor(crayons)
> print(factor_crayons)
 [1] red    blue   green  yellow orange violet brown  black  red    red
[11] yellow brown  orange blue
Levels: black blue brown green orange red violet yellow
> print(nlevels(factor_crayons))
[1] 8
>
```

data.frame

- R's central data structure is called the *data frame.* A data frame is organized into rows and columns. A data frame is a list of columns of different types. Each row has a value for each column. An R data frame is much like a database table: the column types and names are the schema and the rows are the data. In R, you can quickly create a data frame using **data.frame()** command
- Other useful functions with the data.frame
  - colnames()
  - summary()
  - dim()
- 80% of a data scientists work is figuring out how to transform data into this form



```
Console ~/
> # Create the data frame
> demographics <- data.frame(
+   gender = c('M', 'F','F'),
+   height = c(172, 121, 111),
+   weight = c(175, 124, 111),
+   Age = c(23, 24, 25)
+ )
> print(demographics)
  gender height weight Age
1      M    172    175  23
2      F    121    124  24
3      F    111    111  25
```

Example code of data structures

Regular Expressions

- The R for statistical computing provides multiple regular expression functions in its **base** package
- We can also use the **stringr** package to provide string operations
- The **grep** function takes your regex as the first argument and the input vector as the second argument.
  - If you use 'value=FALSE' then **grep** returns a new vector
  - If you use 'value = TRUE' it will return the actual matches
- Using **grepl** is similar to **grep** but it returns a logical vector (TRUE or FALSE)
- **sub** and **gsub** will perform replacement of a found regex pattern

Regular Expression syntax

- Regex's will use metacharacters that have specific meaning
  - **$ * + . ? [ ] ^ { } | ( ) **
    - **$** matches the end of the string
    - ***** matches at least 0 times
    - . matches any single character
    - **+** matches at least 1 time
    - **?** matches at most 1 time
    - […] a character list, matches any one of the characters inside the square brackets
    - **^** matches the start of string
    - **{n}** matches exactly n times
    - **| or**
    - **(…)** grouping to allow you to retrieve matches or capturing
  - **\n = newline**
  - **\r carriage return** or a control character or mechanism used to reset a device's position to the beginning of a line of text.
  - **\t** tab
  - **\b** backspace
  - **\\ backslash** or suppress the special meaning of the metacharacters

Basic Regular Expressions in R
Cheat Sheet

Character Classes

[[:digit:]] or \\d	Digits; `[0-9]`
\\D	Non-digits; `[^0-9]`
[[:lower:]]	Lower-case letters; `[a-z]`
[[:upper:]]	Upper-case letters; `[A-Z]`
[[:alpha:]]	Alphabetic characters; `[A-z]`
[[:alnum:]]	Alphanumeric characters `[A-z0-9]`
\\w	Word characters; `[A-z0-9_]`
\\W	Non-word characters
[[:xdigit:]] or \\x	Hexadec. digits; `[0-9A-Fa-f]`
[[:blank:]]	Space and tab
[[:space:]] or \\s	Space, tab, vertical tab, newline, form feed, carriage return
\\S	Not space; `[^[:space:]]`
[[:punct:]]	Punctuation characters; `!"#$%&'()*+,-./:;<=>?@[]^_`{|}~`
[[:graph:]]	Graphical char.; `[[:alnum:][:punct:]]`
[[:print:]]	Printable characters; `[[:alnum:][:punct:]\\s]`
[[:cntrl:]] or \\c	Control characters; `\n`, `\r` etc.

Special Metacharacters

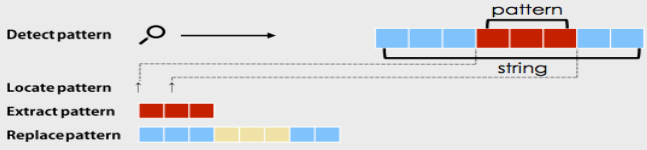
\n	New line
\r	Carriage return
\t	Tab
\v	Vertical tab
\f	Form feed

Lookaraounds and Conditionals*

(?=)	Lookahead (requires PERL = TRUE), e.g. `(?=yx)`: position followed by 'xy'
(?!)	Negative lookahead (PERL = TRUE); position NOT followed by pattern
(?<=)	Lookbehind (PERL = TRUE), e.g. `(?<=yx)`: position following 'xy'
(?<!)	Negative lookbehind (PERL = TRUE); position NOT following pattern
?(if)then	If-then-condition (PERL = TRUE); use lookaheads, optional char. etc in if-clause
?(if)then|else	If-then-else-condition (PERL = TRUE)

*see, e.g. http://www.regular-expressions.info/lookaround.html http://www.regular-expressions.info/conditional.html

Functions for Pattern Matching




```
> string <- c("Hiphopopotamus", "Rhymenoceros", "time for bottomless lyrics")
> pattern <- "t.m"
```

Detect Patterns

grep(pattern, string)
`[1] 1 3`

grep(pattern, string, value = TRUE)
`[1] "Hiphopopotamus"`
`[2] "time for bottomless lyrics"`

grepl(pattern, string)
`[1] TRUE FALSE TRUE`

stringr::str_detect(string, pattern)
`[1] TRUE FALSE TRUE`

Locate Patterns

regexpr(pattern, string)
find starting position and length of first match

gregexpr(pattern, string)
find starting position and length of all matches

stringr::**str_locate(string, pattern)**
find starting and end position of first match

stringr::**str_locate_all(string, pattern)**
find starting and end position of all matches

Split a String using a Pattern

strsplit(string, pattern) or stringr::**str_split(string, pattern)**

Extract Patterns

regmatches(string, regexpr(pattern, string))
extract first match `[1] "tam" "tim"`

regmatches(string, gregexpr(pattern, string))
extracts all matches, outputs a list
`[[1]] "tam" [[2]] character(0) [[3]] "tim" "tom"`

stringr::**str_extract(string, pattern)**
extract first match `[1] "tam" NA "tim"`

stringr::**str_extract_all(string, pattern)**
extract all matches, outputs a list

stringr::**str_extract_all(string, pattern, simplify = TRUE)**
extract all matches, outputs a matrix

stringr::**str_match(string, pattern)**
extract first match + individual character groups

stringr::**str_match_all(string, pattern)**
extract all matches + individual character groups

Replace Patterns

sub(pattern, replacement, string)
replace first match

gsub(pattern, replacement, string)
replace all matches

stringr::**str_replace(string, pattern, replacement)**
replace first match

stringr::**str_replace_all(string, pattern, replacement)**
replace all matches

Character Classes and Groups

.	Any character except \n
|	Or, e.g. (a|b)
[...]	List permitted characters, e.g. [abc]
[a-z]	Specify character ranges
[^...]	List excluded characters
(...)	Grouping, enables back referencing using \\N where N is an integer

Anchors

^	Start of the string
$	End of the string
\\b	Empty string at either edge of a word
\\B	NOT the edge of a word
\\<	Beginning of a word
\\>	End of a word

Quantifiers

*	Matches at least 0 times
+	Matches at least 1 time
?	Matches at most 1 time; optional string
{n}	Matches exactly n times
{n,}	Matches at least n times
{,n}	Matches at most n times
{n,m}	Matches between n and m times

General Modes

By default R uses *POSIX extended regular expressions*. You can switch to *PCRE regular expressions* using `PERL = TRUE` for base or by wrapping patterns with `perl()` for stringr.

All functions can be used with literal searches using `fixed = TRUE` for base or by wrapping patterns with `fixed()` for stringr.

All base functions can be made case insensitive by specifying `ignore.cases = TRUE`.

Escaping Characters

Metacharacters (`. * +` etc.) can be used as literal characters by escaping them. Characters can be escaped using `\\` or by enclosing them in `\\Q...\\E`.

Case Conversions

Regular expressions can be made case insensitive using `(?i)`. In backreferences, the strings can be converted to lower or upper case using `\\L` or `\\U` (e.g. `\\L\\1`). This requires `PERL = TRUE`.

Greedy Matching

By default the asterisk * is greedy, i.e. it always matches the longest possible string. It can be used in lazy mode by adding `?`, i.e. `*?`.

Greedy mode can be turned off using `(?U)`. This switches the syntax, so that `(?U)a*` is lazy and `(?U)a*?` is greedy.

Note

Regular expressions can conveniently be created using rex::**rex()**.

https://www.rstudio.com/wp-content/uploads/2016/09/RegExCheatsheet.pdf

Section 2 Exercise

Section 3

- **Online Course Layout:**
  - **Section 1 -Familiarity with R**
  - **Section 2 – Data Wrangling**
  - **Section 3 – Exploratory Data Analysis**
    - **Asking the right questions as a BA**
    - **Missing values**
    - **Diamond Exercise**
    - **Bank Marketing Exercise**
  - **Section 6 – Introduction to Regression**
  - **Section 7 – Introduction to Machine Learning**
    - **Titanic Kaggle Competition**

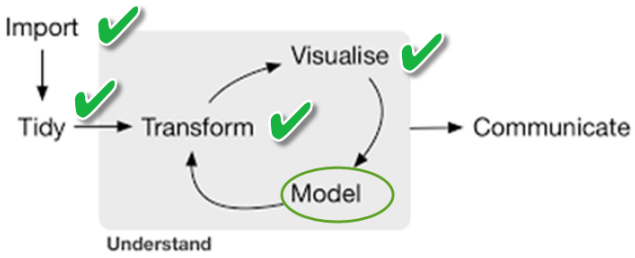
https://stat.ethz.ch/R-manual/R-devel/library/base/html/Memory-limits.html

Exploratory Data Analysis with R

Data Analysis objectives

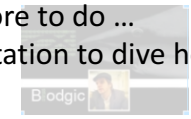
1. Generate questions about the data

2. Search for answers by performing the following
   - Visualize
   - Transform
   - Model



Data Analysis start

- How to begin
  - You've got your data in a data.frame !
    - YAY!!!
  - Wait there's a lot more to do …
    - Resist the temptation to dive head first into your data pool
    - NO DATASET IS PERFECT
      - You may be missing data "NA"
      - Some data will be dirty
      - Some data will be inconsistent
  - Address your data issues early and often
  - We've learned in previous sessions on how to do this
    - How do we address them ?

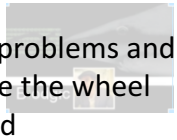


Data Analysis considerations from the start

- This is the first step in the process
- Its exploratory
- More research and development than engineering, modeling or prediction
- This initial approach is more on strategy to get you started rather than choosing software, models or outcomes
- Big difference between data engineering and data scientist
- GOALS
    - As a business analyst – recognize what sort of analytic technique is appropriate for addressing a particular problem
    - Scope
    - Reduce uncertainty

The Human Factor

- AI will *not* rule us all!
  - The human factor in data science includes the ability to decompose a data analytics problem logically
    - Break into pieces
    - Recognize familiar problems and solutions
    - No need to recreate the wheel
  - All cannot be automated
- Data Science Analysis requires the following *human* traits
  - Creativity
  - Intelligence
  - Past Experiences
  - Critical Thinking
  - Proven and working methods



Business Understanding

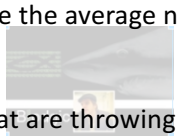
- Understanding the data also means understanding…
  - The problem
    - What are you trying to solve
    - How long will it take
    - What's the $budget$?
  - The data
    - $Cost$
    - reliability
  - The business
    - Politics
    - Subject Matter Experts
  - The Stakeholders
    - RACI
      - Responsible
      - Accountable
      - Consulted
      - Informed
  - The impact
    - psychological
    - environmental
    - ethical

Exploratory Data Analysis and beginning to understand your data

- Data Exploration
  - Summary Statistics
    - summary()
    - str()
    - nrow()
    - Means / medians
    - Variances
    - Counts
  - Visualization
    - Histograms to get distributions
    - Finding those gotcha's
    - Finding outliers
  - Joining Data
    - merge()
    - Adding additional data sources
    - Featurization

Strange and Missing Values

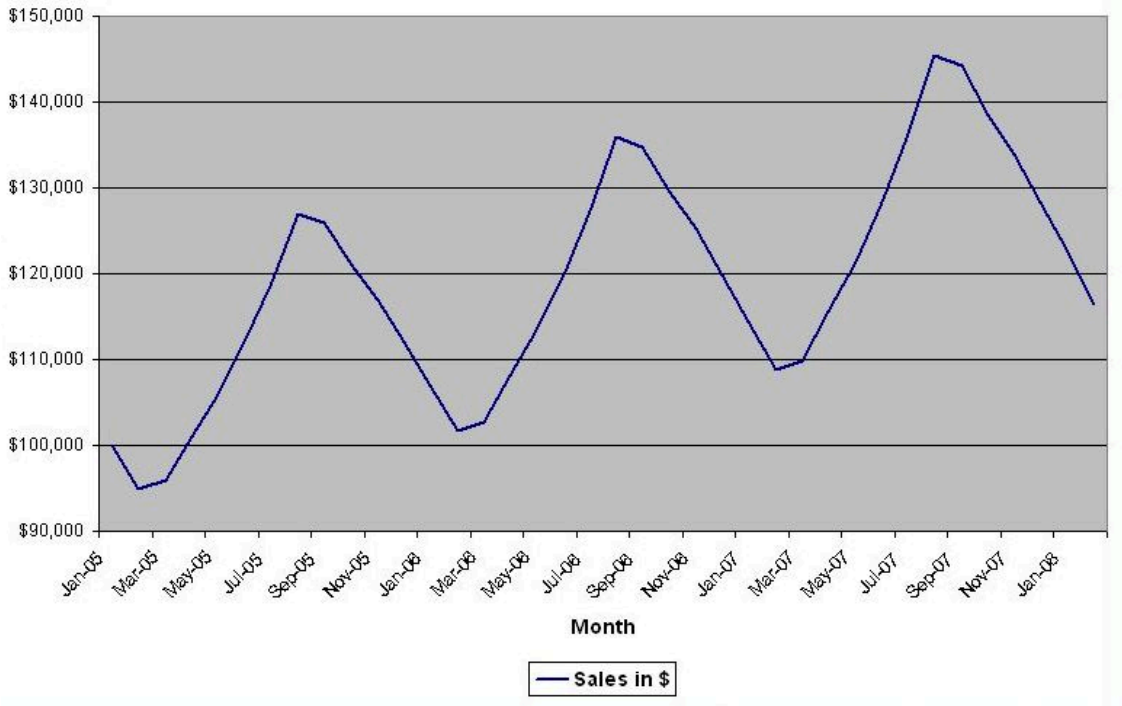
- If a particular field is immensely unpopulated then its worth finding WHY
  - You may want to drop these fields / variables / rows all together
  - Fill the NA's with zeros
  - Or take an average and use the average number smooth out the distribution



- Are there negative numbers that are throwing off the data?
  - Should a negative income be present
  - Are there outliers that shouldn't't be there
  - Are these outliers data entry errors ?
  - Are temperatures in both Celsius and Fahrenheit?
  - What is the unit of measurement?
  - Is there seasonality involved?
  - NORMALIZE, NORMALIZE, NORMALIZE

- Understand your range of values

Seasonality Example



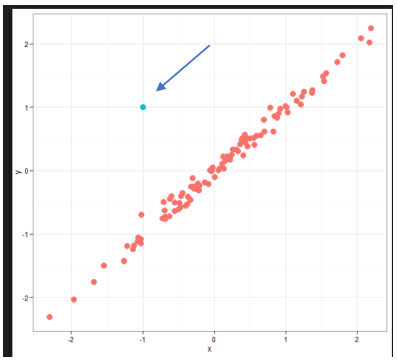
Data Analysis objectives

- Example questions to ask?

1. Which values are the most common?
2. Which values are rare
3. Can you see any unusual patterns?
4. Could this pattern be due to coincidence (random)
5. How can you describe the relationship implied by the pattern?
6. How strongly is the relationship implied by the pattern?
7. What other variables might help the relationship?
8. Clusters of similar values can suggest that subgroups, trends, commonalities or information from your data may exist

Data Analysis prep

- *Outliers* – observations that are unusual or data that stands out among the "crowd" or cluster of norm
  - Outliers could be
    - Data entry errors
    - New findings
  - Example
    - IP mapping data error by Maxmind
    - Zip codes 90210, 12345



Data Analysis prep

- *Missing values* – in R they are referred to "NA" or "not available." NA marks an unknown value

- The generic function is.na indicates which elements are missing.

- "NaN" means not a number and you may come across this in your data sets. If you see NaN as a value it could mean that there is a mix of categorical values and numerical values and R could not properly identify the value

Data Analysis prep

- Data Noise to Signal question
  - How can we segment the population with respect to something that we would like to estimate or even predict?

- *Data Mining* – finding or selecting important, informative attributes or variables of the entity described by the data

- *Information* – is a quantity that reduces uncertainty of the data

Data Analysis prep

- *Target Variable* – the attribute that will be the focus of the data problem to be solved. This manifests our perception of finding informative attributes.

    - This will lead to identifying one or more variables that reduces our uncertainty about the value of the target
    - Finding strongly related attributes that correlate with the target of interest will reduce uncertainty

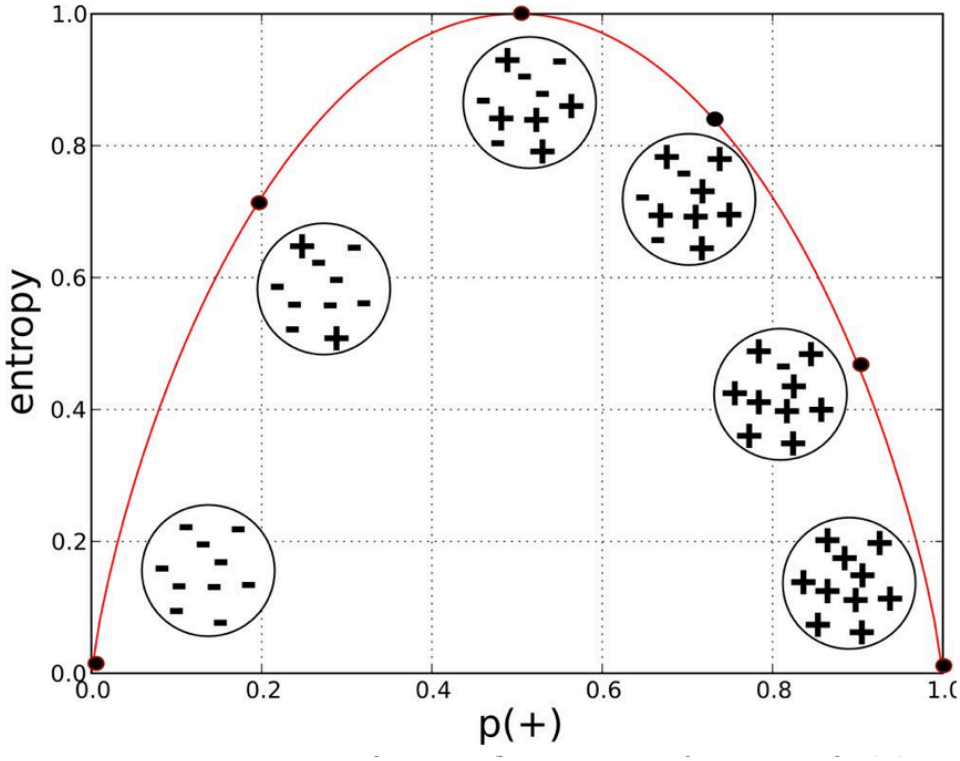
- *Descriptive Modeling* – where the primary purpose of the model is not to estimate a value but instead to gain insight into the underlying real-world relationships between factors

Data Analysis prep

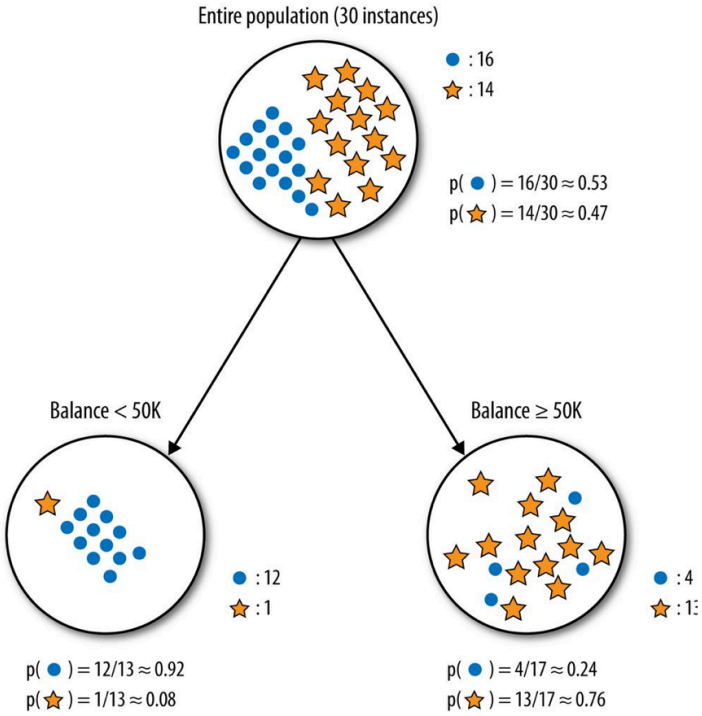
- *Entropy* – measure of disorder that can be applied to a data set such as one of our individual segments
    - Disorder – corresponds to how mixed (impure) the segment is with respect to the properties of interest
    - 1 = pure
    - 0 = impure

$$entropy = -p_1 \log(p_1) - p_2 \log(p_2) - \cdots$$

Data Analysis prep



Data Analysis prep



Data Analysis prep

- *Information Gain* – how much an attribute improves (decreases) entropy over the whole segmentation it creates
  - Measures the change in entropy due to any count of new information being added

$$IG(parent, children) = entropy(parent) - [p(c_1) \times entropy(c_1) + p(c_2) \times entropy(c_2) + \cdots$$

Data Analysis prep

- *Variance* – the natural measure of impurity for numeric values
  - If the data set has all the same values for the numeric target variable then the data set is pure and the variance is 0
  - If the numeric target values in the set are very different then the set will have high variance

Formula - The **variance** (σ^2), is defined as the sum of the squared distances of each term in the distribution from the mean (μ), divided by the number of terms in the distribution (N).

Data Science In-class Discussion Exercise

- Consider the following set of hypothetical data science project questions to determine what the approach should be?

    - What is the problem?
    - How do we solve it?

Data Science Discussion Question 1

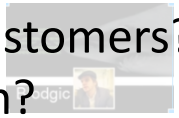
- Who are the most profitable customers?

Data Science Discussion Question 2

- What is the difference between the most profitable customers and the average customer?

Data Science Discussion Question 3

- Who are these customers? Can we characterize them?



Data Science Discussion Question 4

- Given a set criteria of customer attributes can we determine if this new customer will be profitable? How much revenue should I expect this customer to generate?

Key Takeaways

- Take the time to examine your data before diving head first into your data pool
- Summarize and understand your data first.
  - Identify data anomalies 1st

- Visualization gives you a sense of your data's distribution, relationships, outliers among all values and variables
- Visualization is an iterative process and helps answer questions about your data.
- Time spent in the data analysis phase is not time wasted.
- Data Analysis helps answer questions about the data

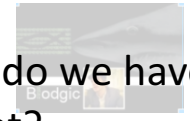
Business Analyst takeaways

- For a given project, the data analysis phase is a useful framework for analyzing a project or proposal

  - Understand whether the project is well conceived or is fundamentally flawed
  - What would make it successful from the start?
  - What would be an example of project pitfalls

Data(diamond)

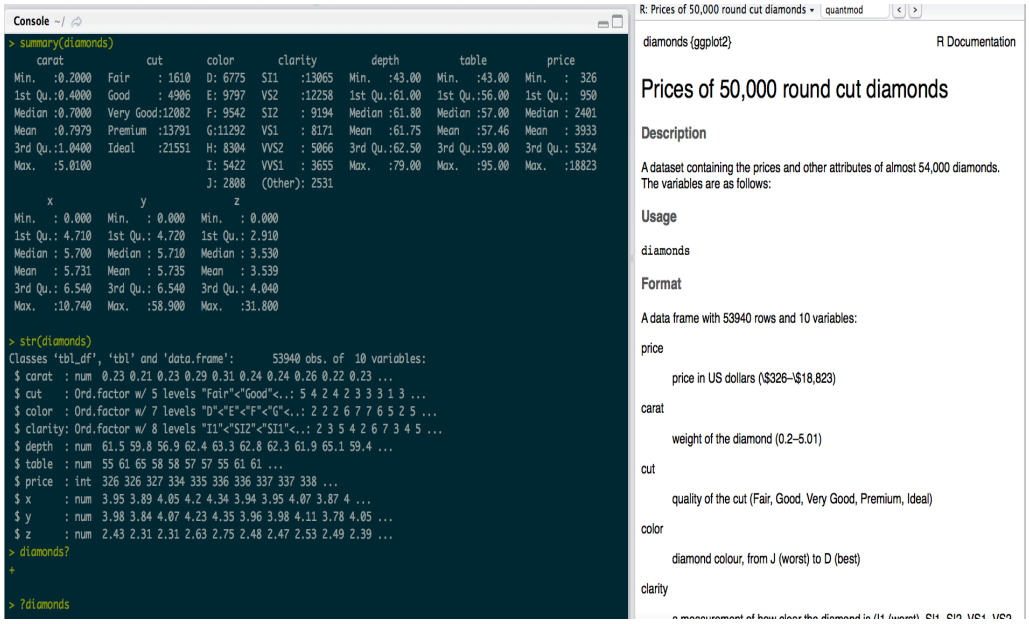
- Generate questions about the data



    - What questions do we have about the diamond data set?

        - What's the summary?
        - What are the features?
        - What type of data are we dealing with?
        - Are there any transformative features?
        - What is the structure of the data?

Data(diamond)



```
Console ~/
> summary(diamonds)
     carat               cut        color        clarity          depth      
 Min.   :0.2000   Fair      : 1610   D: 6775   SI1    :13065   Min.   :43.00  
 1st Qu.:0.4000   Good      : 4906   E: 9797   VS2    :12258   1st Qu.:61.00  
 Median :0.7000   Very Good:12082   F: 9542   SI2    : 9194   Median :61.80  
 Mean   :0.7979   Premium   :13791   G:11292   VS1    : 8171   Mean   :61.75  
 3rd Qu.:1.0400   Ideal     :21551   H: 8304   VVS2   : 5066   3rd Qu.:62.50  
 Max.   :5.0100                     I: 5422   VVS1   : 3655   Max.   :79.00  
                                    J: 2808   (Other): 2531                  
     table           price      
 Min.   :43.00   Min.   :  326  
 1st Qu.:56.00   1st Qu.:  950  
 Median :57.00   Median : 2401  
 Mean   :57.46   Mean   : 3933  
 3rd Qu.:59.00   3rd Qu.: 5324  
 Max.   :95.00   Max.   :18823  
                                
       x                y               z         
 Min.   : 0.000   Min.   : 0.000   Min.   : 0.000  
 1st Qu.: 4.710   1st Qu.: 4.720   1st Qu.: 2.910  
 Median : 5.700   Median : 5.710   Median : 3.530  
 Mean   : 5.731   Mean   : 5.735   Mean   : 3.539  
 3rd Qu.: 6.540   3rd Qu.: 6.540   3rd Qu.: 4.040  
 Max.   :10.740   Max.   :58.900   Max.   :31.800  

> str(diamonds)
Classes 'tbl_df', 'tbl' and 'data.frame':	53940 obs. of  10 variables:
 $ carat  : num  0.23 0.21 0.23 0.29 0.31 0.24 0.24 0.26 0.22 0.23 ...
 $ cut    : Ord.factor w/ 5 levels "Fair"<"Good"<..: 5 4 2 4 2 3 3 3 1 3 ...
 $ color  : Ord.factor w/ 7 levels "D"<"E"<"F"<"G"<..: 2 2 2 6 7 7 6 5 2 5 ...
 $ clarity: Ord.factor w/ 8 levels "I1"<"SI2"<"SI1"<..: 2 3 5 4 2 6 7 3 4 5 ...
 $ depth  : num  61.5 59.8 56.9 62.4 63.3 62.8 62.3 61.9 65.1 59.4 ...
 $ table  : num  55 61 65 58 58 57 57 55 61 61 ...
 $ price  : int  326 326 327 334 335 336 336 337 337 338 ...
 $ x      : num  3.95 3.89 4.05 4.2 4.34 3.94 3.95 4.07 3.87 4 ...
 $ y      : num  3.98 3.84 4.07 4.23 4.35 3.96 3.98 4.11 3.78 4.05 ...
 $ z      : num  2.43 2.31 2.31 2.63 2.75 2.48 2.47 2.53 2.49 2.39 ...
> diamonds?
+

> ?diamonds
```

R: Prices of 50,000 round cut diamonds | quantmod

diamonds {ggplot2} R Documentation

Prices of 50,000 round cut diamonds

Description

A dataset containing the prices and other attributes of almost 54,000 diamonds. The variables are as follows:

Usage

```
diamonds
```

Format

A data frame with 53940 rows and 10 variables:

price

: price in US dollars (\$326–\$18,823)

carat

: weight of the diamond (0.2–5.01)

cut

: quality of the cut (Fair, Good, Very Good, Premium, Ideal)

color

: diamond colour, from J (worst) to D (best)

clarity

: a measurement of how clear the diamond is (I1 (worst), SI1, SI2, VS1, VS2

Exploratory Data Analysis in class exercise

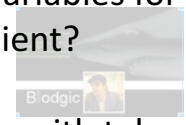
- What diamond attributes have the strongest impact on price?

We'll explore the Diamond Data set to answer this question..and more

Hands on challenge

- Bank Marketing Data Set

- What are the strongest variables for the potential banking customer to become a client?
- Identify the following:
  - Percentage of success with telemarketing currently (yes)
  - Are there NA's? How would you fill the Nas?
  - summary statistics
  - descriptive statistics
  - Outliers
- What are the ranges in education type?
- How can we improve the business given the data set



http://archive.ics.uci.edu/ml/datasets/Bank+Marketing

[Moro et al., 2014] S. Moro, P. Cortez and P. Rita. A Data-Driven Approach to Predict the Success of Bank Telemarketing. Decision Support Systems, Elsevier, 62:22-31, June 2014