

# Data Scientist's Toolbox Course Notes

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## CLI (Command Line Interface)

- / = root directory
- ~ = home directory
- pwd = print working directory (current directory)
- clear = clear screen
- ls = list stuff
  - -a = see all (hidden)
  - -l = details
- cd = change directory
- mkdir = make directory
- touch = creates an empty file
- cp = copy
  - cp <file> <directory> = copy a file to a directory
  - cp -r <directory> <newDirectory> = copy all documents from directory to new Directory \*
  - -r = recursive
- rm = remove
  - -r = remove entire directories (no undo)
- mv = move
  - move <file> <directory> = move file to directory
  - move <fileName> <newName> = rename file
- echo = print arguments you give/variables
- date = print current date

## GitHub

- **Workflow**
  1. make edits in workspace
  2. update index/add files
  3. commit to local repo
  4. push to remote repository
- git add . = add all new files to be tracked
- git add -u = updates tracking for files that are renamed or deleted
- git add -A = both of the above
  - *Note: add is performed before committing*
- git commit -m "message" = commit the changes you want to be saved to the local copy
- git checkout -b branchname = create new branch
- git branch = tells you what branch you are on
- git checkout master = move back to the master branch
- git pull = merge you changes into other branch/repo (pull request, sent to owner of the repo)
- git push = commit local changes to remote (GitHub)

## Markdown

- ## = signifies secondary heading (bold big font)
- ### = signifies tertiary heading (slightly smaller font than secondary, not bold)
- \* = bullet list item

## R Packages

- Primary location for R packages → CRAN
- `available.packages()` = all packages available
- `head(rownames(a), 3)` = returns first three names of a
- `install.packages("nameOfPackage")` = install single package
- `install.packages(c("nameOfPackage", "nameOfPackage", "nameOfPackage"))` = install multiple package
- Bioconductor Packages:
  - `source("https://bioconductor.org/biocLite.R")`
  - `biocLite()` = install bioconductor packages
- `library(packagename)` = load package
- `search()` = see all functions in package after loading

## Types of Data Science Questions

- in order of difficulty: *Descriptive* → *Exploratory* → *Inferential* → *Predictive* → *Causal* → *Mechanistic*
- **Descriptive analysis** = describe set of data, interpret what you see (census, Google Ngram)
- **Exploratory analysis** = discovering connections (correlation does not = causation)
- **Inferential analysis** = use data conclusions from smaller population for the broader group
- **Predictive analysis** = use data on one object to predict values for another (if X predicts Y, does not = X cause Y)
- **Causal analysis** = how does changing one variable affect another, using randomized studies, Strong assumptions, golden standard for statistical analysis
- **Mechanistic analysis** = understand exact changes in variables in other variables, modeled by empirical equations (engineering/physics)

## Data

- **Data** = values of qualitative or quantitative variables, belonging to a set of items (usually population)
- **Variables** = measurement/characteristic of an item (qualitative vs quantitative)
- **Data** = not always structured, usually raw file, different formats
- Most important thing is question, then it is data
- **Big data** = now possible to collect data cheap, but not necessarily all useful (need the right data)

## Experimental Design

- Formulate you question in advance
- **Statistical inference** = select subset, run experiment, calculate descriptive statistics, use inferential statistics to determine if results can be applied broadly
- **[Inference] Variability** = lower variability + clearer differences = decision
- **[Inference] Confounding** = underlying variable might be causing the correlation (sometimes called Spurious correlation)
  - dealing with confounding: fix variables, stratify (all options), randomize
- **[Prediction]** collection observations for different variable values, build predictive functions
  - similar problems of probability/sampling and confounding variables

- *[Prediction]* Difficult to understand where observation is from from different distributions. (size of effects important)
- *[Prediction]* Positive/negative statuses: True positive, false positive, false negative, true negative
  - **Sensitivity** =  $\Pr(\text{positive test} \mid \text{disease})$
  - **Specificity** =  $\Pr(\text{negative test} \mid \text{no disease})$
  - **Positive Predictive Value** =  $\Pr(\text{disease} \mid \text{positive test})$
  - **Negative Predictive Value** =  $\Pr(\text{no disease} \mid \text{negative test})$
  - **Accuracy** =  $\Pr(\text{correct outcome})$
- **Data dredging** = use data to fit hypothesis
- **Good experiments** = have replication, measure variability, generalize problem, transparent
- Prediction is not inference, and be ware of data dredging