

STAT 380: Week 1

Instructor: Murali Haran Professor of Statistics
TA: John Ensley, PhD Student

- ▶ Use the computer expressively to prepare, explore, and analyze data
- ▶ Work closely with original raw data
- ▶ Use existing software rather than build routines from the ground up.
- ▶ Focus on aspects of computing to conduct statistical analysis, NOT the computational aspects of statistical methods (For that: STAT 440, Computational Statistics)
- ▶ Book:
 - ▶ Data Technologies and Computational Reasoning by D. Nolan and D. Temple Lang (pdf files will be posted weekly).
 - ▶ Supplement: *Data Science in R: A Case Studies Approach to Computational Reasoning* by Nolan and Temple Lang.

(With thanks to Professor Nolan for lecture notes)

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What are data?

- ▶ Data are recorded/measured observations together with context.
- ▶ By context we mean the details of who, what, where, when, and/or how the observations were obtained, aka "metadata".

Tables of Numbers

Traffic on I-80



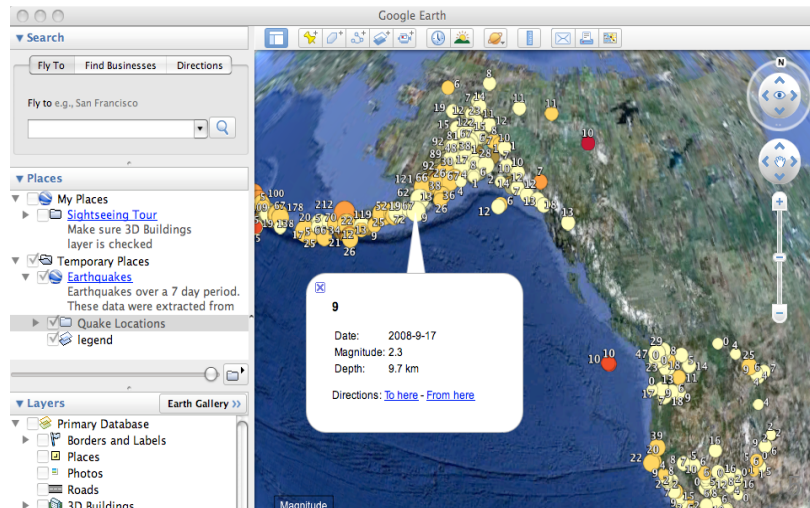
```

flow-occ-table.txt
Jcc1,F1owJcc2,F1owJcc3,F1owJ
0.017,1,0.0186,27,0.017,1,
0.0133,18,0.025,39,0.0187,25,
0.0088,12,0.018,30,0.0095,11,
0.0115,16,0.0203,33,0.0217,19
0.0069,9,0.0178,25,0.0123,13,
0.0077,11,0.0151,24,0.0092,13
0.0049,7,0.0153,22,0.0087,11
0.007,10,0.0194,33,0.0156,17,
0.0082,12,0.0146,26,0.0166,13
0.0074,11,0.0207,30,0.018,14
0.0071,10,0.0135,22,0.0074,11
0.0069,10,0.012,17,0.0074,12
0.0031,2,0.0070,13,0.0113,10
0.0038,5,0.0116,18,0.0202,11,
0.0063,8,0.0115,15,0.0123,13,
0.0034,5,0.0137,20,0.0254,17,
0.0043,5,0.0094,16,0.0133,8
0.0038,5,0.0111,18,0.0131,13,
0.0017,2,0.0121,18,0.0156,14
0.0018,3,0.0182,17,0.0269,18
0.0058,6,0.0131,19,0.0119,11,
0.0016,0.00082,11,0.0069,12
0.0013,1,0.0075,12,0.0174,18
0.0024,4,0.0094,17,0.0095,12
0.0014,2,0.017,17,0.0232,13
0.004,5,0.0079,11,0.0117,12
0.0007,2,0.0142,16
0.0015,2,0.011,15,0.0153,10
0.0013,2,0.0087,15,0.0077,8

```

Geographic Information and Time

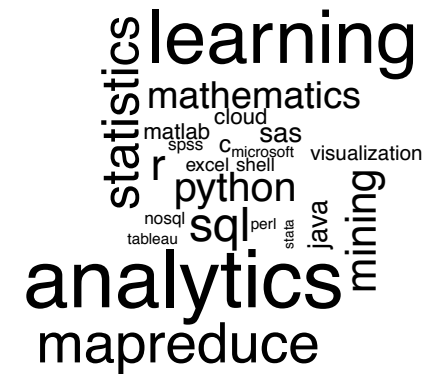
Earthquake Location, Date, and Magnitude



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Text

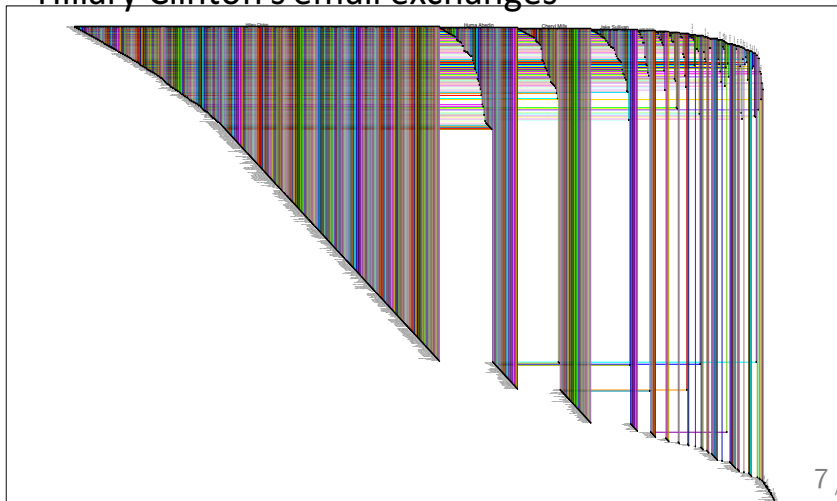
Kaggle Job Postings for a Data Scientist



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Graph

Hillary Clinton's email exchanges



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Meta-data:

Information about Spotify playlists

```
{
  "href" :
    "https://api.spotify.com/v1/users/spotify_espa%C3%B1a/playlists/21THa8j9TaSGuXYNB
    U5tsC/tracks",
  "items" : [ {
    "added_at" : "2014-08-18T20:16:08Z",
    "added_by" : {
      "external_urls" : {
        "spotify" : "http://open.spotify.com/
      },
      "href" : "https://api.spotify.com/v1/us
      "id" : "spotify-espa%C3%B1a",
      "type" : "user",
      "uri" : "spotify:user:spotify_espa%C3%B
    },
  ]
}
```

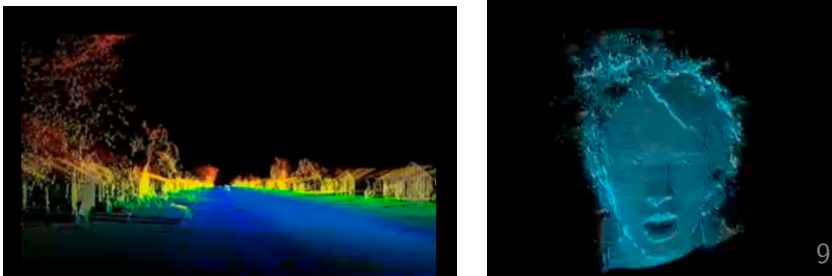


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Images, Video, or Audio

Radiohead House of Cards

Yorke: "I liked the idea of making a video of human beings and real life and time without using any cameras, just lasers, so there are just mathematical points – and how strangely emotional it ended up being."



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What Skills does a Data Scientist need?

AIG job postings on Kaggle

- ▶ Expertise in at least one modeling/machine learning platform such as R, Python, or SAS.
- ▶ Knowledge of an additional general purpose programming language such as C++ or Java.
- ▶ Advanced SQL skills and experience with No SQL technologies.
- ▶ Built several predictive models that have been put into live production.
- ▶ Obsess over sample bias, over-fitting, variable selection, missing values, etc.
- ▶ Understand the need to balance predictive power, interpretability, and ease of implementation

AIG job posting on Kaggle for senior data scientist:

- ▶ Build predictive models utilizing both traditional statistical methods and modern machine learning techniques
- ▶ Extract, clean, and manipulate large datasets (structured and unstructured) for model building.
- ▶ Communicate (written and verbal) insights from quantitative analyses to technical and non-technical audiences.
- ▶ Stay current on the latest machine learning and big data trends.
- ▶ Work with business sponsors and IT teams to implement analytic solutions.
- ▶ Serve as a technical expert on one or more domains (e.g. Time Series Analysis, Text Mining, etc.)

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Data analysis cycle

- ▶ Data ACQUISITION Input/output, regular expressions
- ▶ Data CLEANING verification, manipulation
- ▶ Data ORGANIZATION data frames, data bases, XML
- ▶ Data EXPLORATION search for interesting patterns
- ▶ Data VISUALIZATION create statistical graphs
- ▶ Data ANALYSIS fit and assess statistical models
- ▶ Data SIMULATION studies of random behavior
- ▶ Data REPORTING report findings from analysis

Statistical concepts

- ▶ Basic numeracy: Variability, Patterns, comparisons
- ▶ Exploratory Data Analysis
- ▶ Graphics: Elements and principles of graphing
- ▶ Computationally intensive methods, e.g., Classification and Regression trees, multi-dimensional scaling, nearest neighbor method
- ▶ Simulation tools: Monte Carlo, bootstrap, cross-validation

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Software

- ▶ R statistical software
- ▶ SQL structured query language for relational databases
- ▶ XML Extensible Markup Language (and HTML) and XPath
- ▶ Unix shell commands

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Computing concepts

- ▶ Programming concepts Control flow trees functions
- ▶ Regular expressions and text manipulation
- ▶ Relational databases
- ▶ Random number generation
- ▶ Representation of information in the computer

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Grading

- ▶ Homework + projects: add up to 50%. Exact proportion may change. *Tentatively:*
 - ▶ Homework = 30% + Projects = 20%
- ▶ Homework due in class. After class, before 3:30pm (in my mailbox in Thomas 326): 20% off. After that, 0 credit no matter what.
- ▶ Drop two lowest homework scores.
- ▶ Midterm: 20%
- ▶ Final: 30%

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Academic integrity

- ▶ Free to discuss course matters with instructor, TA, and fellow students
- ▶ DO NOT SHARE CODE
- ▶ Make significant contribution to your groups work
- ▶ If you are uncertain as to whether something may be a violation of the code, ask the instructor
- ▶ Writing a program is like writing a paper your code should be your original work.
- ▶ A violation will result in at least one of the following: 0 on the assignment, F for the course grade, Report to the Office of Student Conduct