Software Engineering for Data Scientists

Course Introduction

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University of Washington

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What's the class about? Who are we?

- Objectives
  - Teach how to create and collaborate on data- and computation-intensive research projects
  - Provide practical software skills for data analysis in research & industry.
  - Elevate coding in science to the level of technical writing.
- Instructor introductions

Student Introductions

Prepare For Team Formation During Break

- What to say
  - What data you analyze (generically)
    - Analyze numbers/text/images?
  - Programming experience
    - if-statements? for-statements? functions? modules?
    - python? matplotlib? pandas?
    - Size of biggest project (lines of code or files)
  - What you want to learn from the class
    - Programming? Engineering (design, testing)? Software collaboration techniques?

2 minutes max!

Pre-req Check

- Individual laptops
- Access to the open Internet from your laptop
- Github accounts
- Software stack
  - Git, bash shell, text editor, python 3.5 or later, pandas, matplotlib, numpy, ipython (jupyter) notebook, (scipy)

Agenda

- Why data science?
- Course overview
- Pronto data
- Getting data with shell scripts

Why Data Science?

Data Science

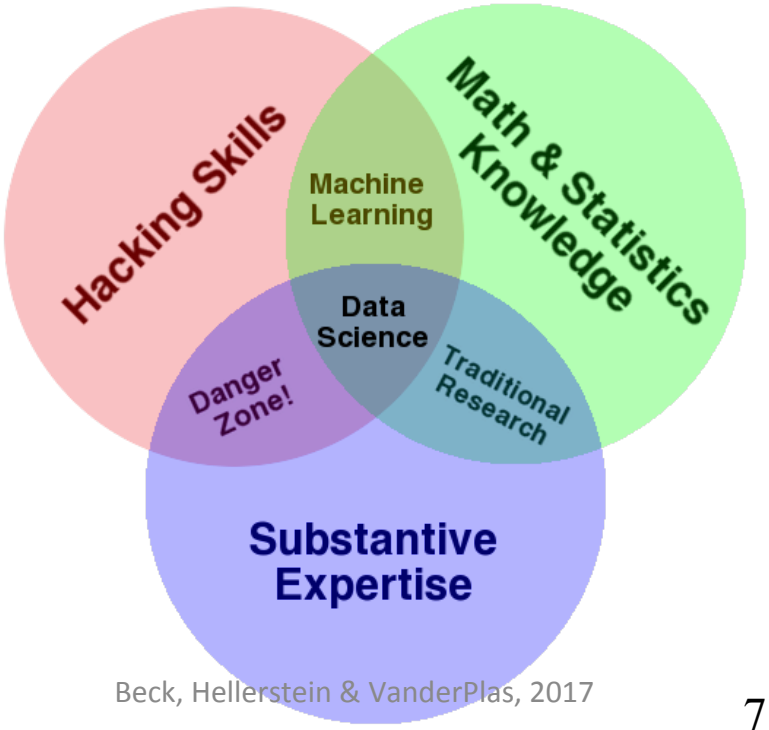
Forbes / Tech

MAY 28, 2013 @ 09:09 AM 103,702 VIEWS

A Very Short History Of Data Science

Gil Press
CONTRIBUTOR

The story of how data scientists became sexy is mostly the story of the coupling of the mature discipline of statistics with a very young one–computer science. The term "Data Science" has emerged only recently to specifically designate a new profession that is expected to make sense of the vast stores of big data. But making sense of data has a long history and has been discussed by scientists, statisticians, librarians, computer scientists and others for years. The following timeline traces the evolution of the term "Data Science" and its use, attempts to define it, and related terms.



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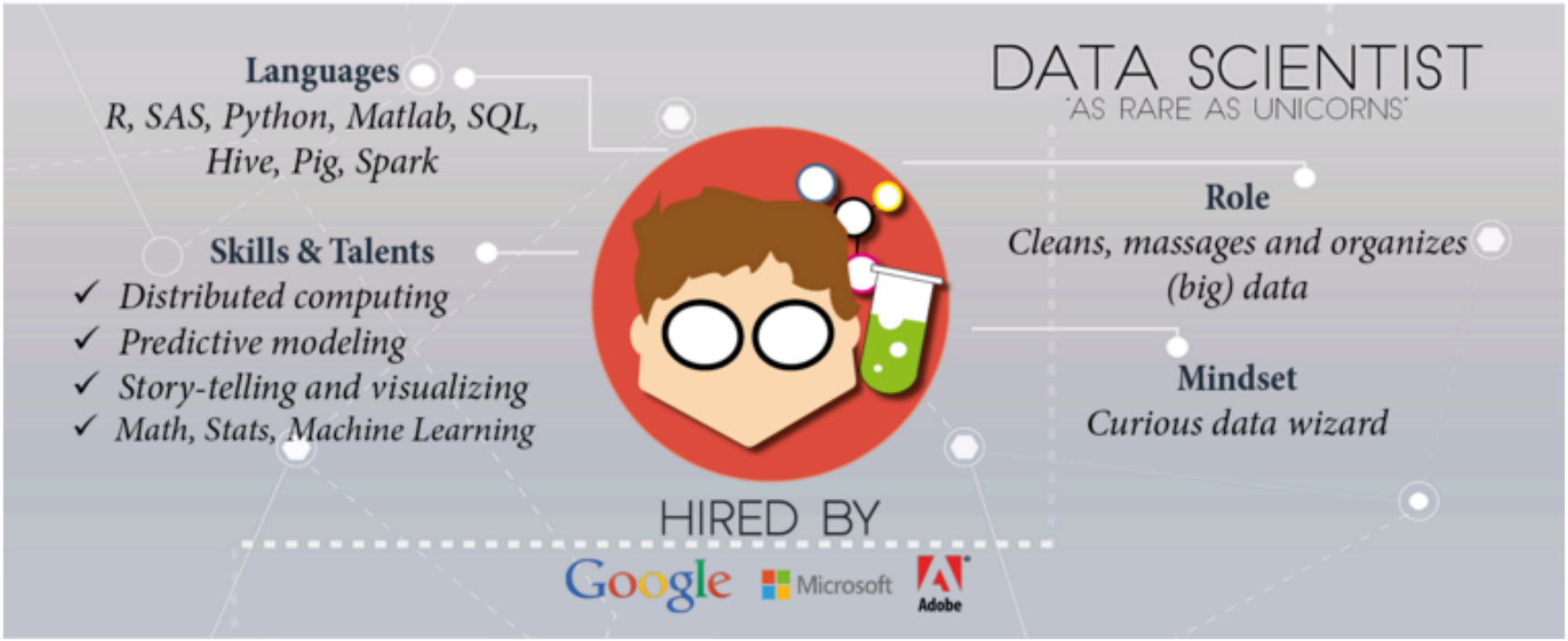
Data Scientist – Industry Perspective



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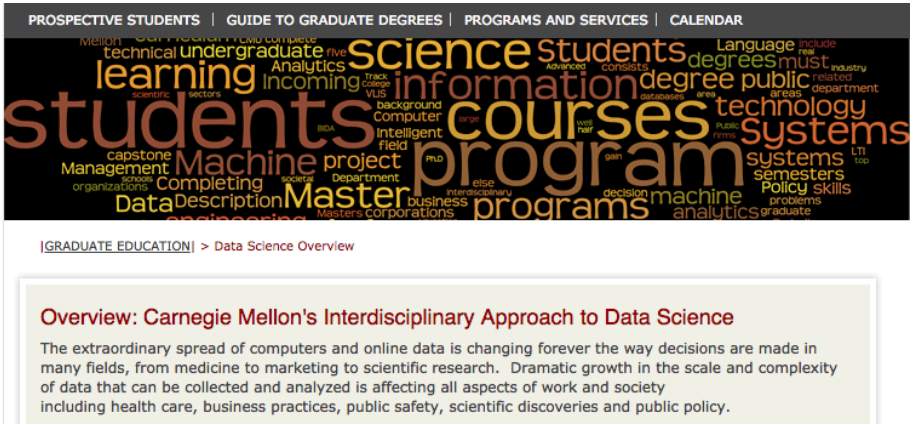
Degrees in Data Science

Approved by the UW Department of Computer Science & Engineering and developed under the guidance of the eScience Institute



Data Science at UC Berkeley

As the world becomes increasingly digital, new approaches to aggregating and analyzing data will bring huge benefits to fields as diverse as health care,

UC Berkeley's scientific impact across the natural and social science domains reflects revolutionary techniques to collect, mine, and analyze unprecedented volumes and velocities of data. These achievements are augmented by our faculty's groundbreaking

Course Overview

Skills Taught

- Program in python using the Python scientific stack, including numpy, pandas, and matplotlib.
- Search, evaluate, and integrate into a project externally developed Python packages; create your own Python packages.
- Develop unit tests that validate important aspects of the project implementation.
- Develop software that it can be used by others including: shared code on github, documentation, installing packages, setup, and running computational studies.
- Create technical specifications for what a program should do and how this is accomplished.

Assumptions On Student Background

Question	Response
Years of programming?	Mostly > 1 yr
Years of python?	< 1 yr
Experience with a text editor	Mostly "Yes"
Comfort with if-statements?	Yes
Comfort with for-statements?	Yes
Comfort with functions?	Mostly "Yes"
Python packages (scipy, pandas, ...)	Mostly "No"
Experience with iPython?	Very little
Experience with github?	Very little

Course Structure

- Programming basics
- Version control, python, data manipulation
- Software development
  - Debugging, documentation, design, collaboration
- Software engineering practicum

Class syllabus

Programming vs. Software Engineering

Analogy: What is the difference between the following kinds of writing:

1. Note to yourself
2. An article in the NY Times

Relating Writing to Software

How Learn Skills

Reporter	SW Eng
Writing quality	Code quality
Content	Features
Structure	Design
Review	Testing

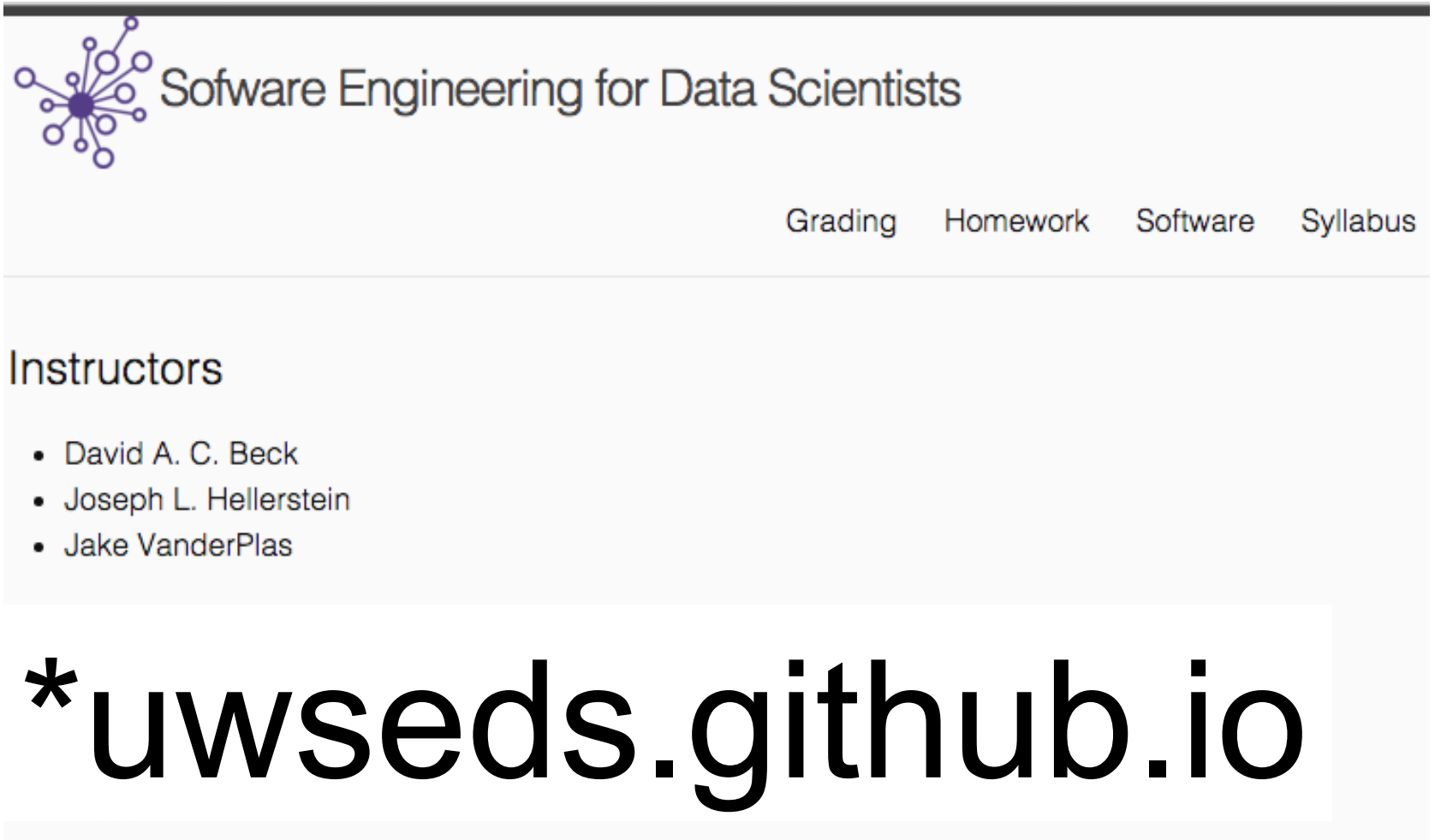
Freshman English

Programming class

Composition & literature classes, professional writer

Computer Science degree, Collaborate on a big project

Course Web Page*



Pronto Data

https://www.prontocycleshare.com/datachallenge

Open Data

Here you'll find Pronto's trip data for public use. Whether you're a designer, developer, or just plain curious, feel free to bring it to life!

The Data

Each trip is anonymized and includes:

- Bike number
- Trip start day & time
- Trip end day & time
- Trip start station
- Trip end station
- Rider Type: Annual Member or Short-Term (24-Hour or 3-Day) Pass Holder
- Annual Member trips will also include the member's gender and year of birth

The data set also includes:

- Weather information per day (using 98101 zip code)
- Bike and dock availability per minute per station

Click the buttons on the right side of the page to download the available data sets. Additionally, you can always use our live JSON feed.

Fields in Pronto Data

Variable	Data Type	Units
trip_id	Int64	
starttime	datetime64	
stoptime	datetime64	
bikeid	string	Coded (e.g., "SEA00298")
tripduration	float	Seconds
from_station_name	string	Address
to_station_name	string	Address
from_station_id	string	Coded (e.g., "PS-04")
to_station_id	string	Coded (e.g., "PS-04")
usertype	string	Coded (e.g., "Annual Member")
gender	string	Coded (e.g., "Male")

Data Considerations

Variable	Data Type	Units
trip_id	Int64	
starttime	datetime64	
stoptime	datetime64	
bikeid	string	Coded (e.g., "SEA00298")
tripduration	float	Seconds
from_station_name	string	Address
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from_station_id	string	Coded (e.g., "PS-04")
to_station_id	string	Coded (e.g., "PS-04")
usertype	string	Coded (e.g., "Annual Member")
gender	string	Coded (e.g., "Male")

- Do similar fields have the same data type and/or code (e.g., `from_station_id`, `to_station_id`)?
- Do coded data have useful information hidden in the codes (e.g., "PS-04")?
- How merge with other data (e.g., weather)?

Data Schema

Variable	Data Type	Units
trip_id	Int64	
starttime	datetime64	
stoptime	datetime64	
bikeid	string	Coded (e.g., "SEA00298")
tripduration	float	Seconds
from_station_name	string	Address
to_station_name	string	Address
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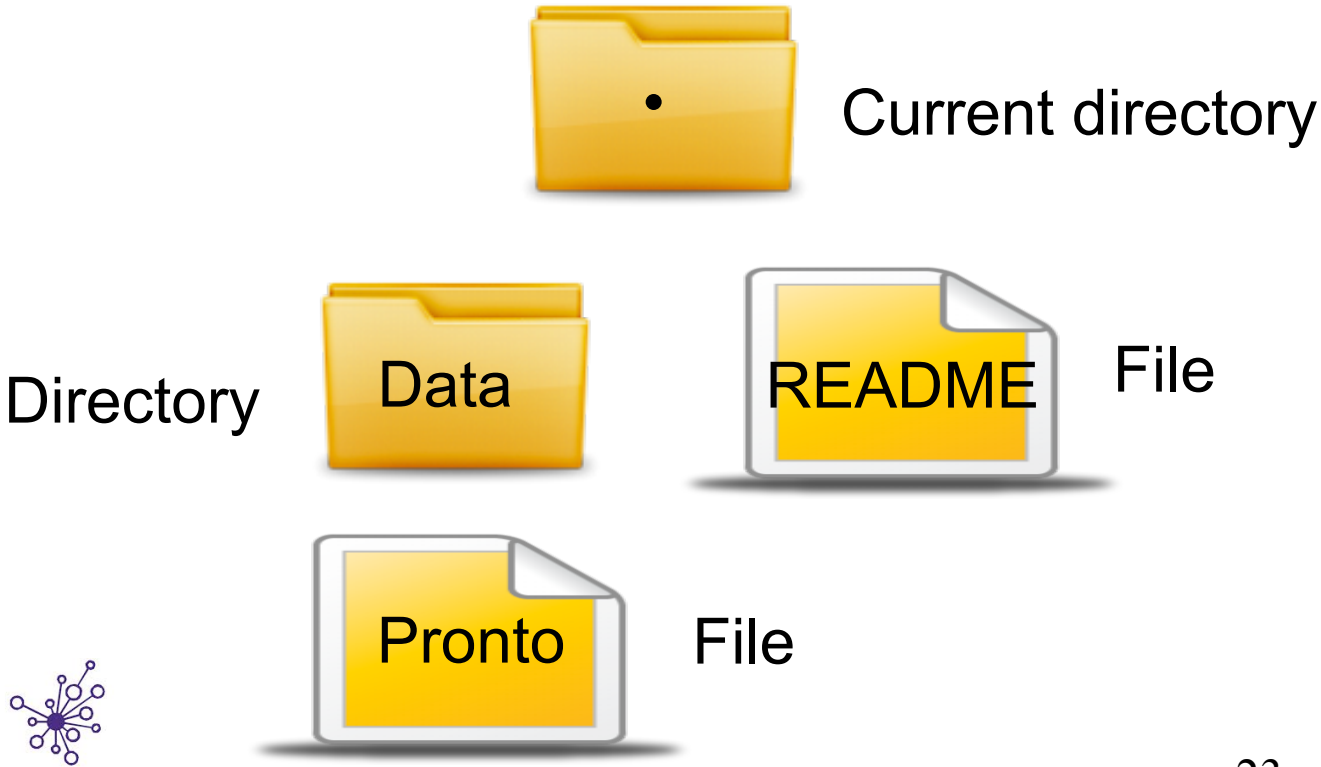
- "Meta data" – describes the data
  - data types
  - units
  - "keys" (how relate one data set to another)

Getting Data With Shell Scripts

File System Basics

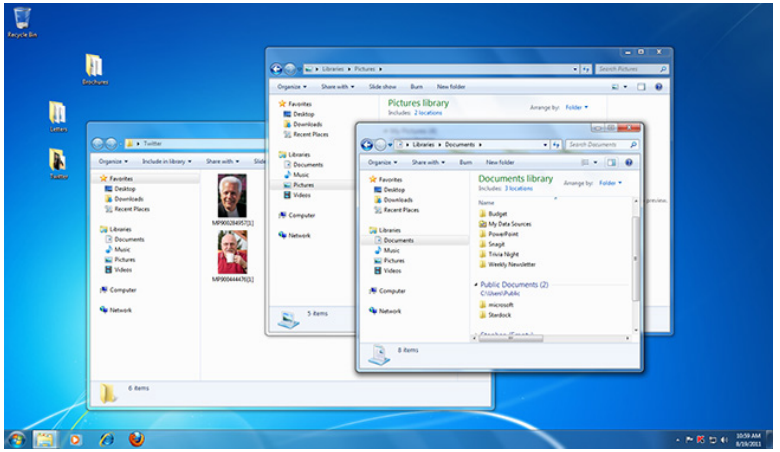
- File – container of data
- Directory – container of files and directories

Directories are organized into a tree

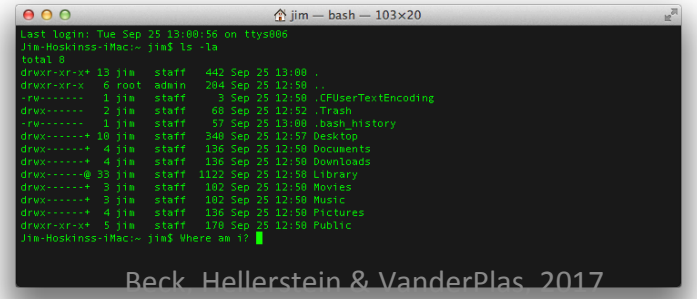


Command Line Tools

Graphical User Interface (GUI)



Command Line Interface (CLI)



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Command Line Tools

What is the command line?

- Also known as a 'shell'
- Most common is `bash` (what we will use)
  - Bourne Again Shell
  - Reimplementation of a shell from 1977
  - Every OS/X Mac
  - Every Linux
  - Every supercomputer
- For later…
  - Programming language itself!

Command Line Tools

Where is the command line?

Mac (pre-installed)

Applications -> Utilities -> Terminal

Windows (after install Git / Bash)

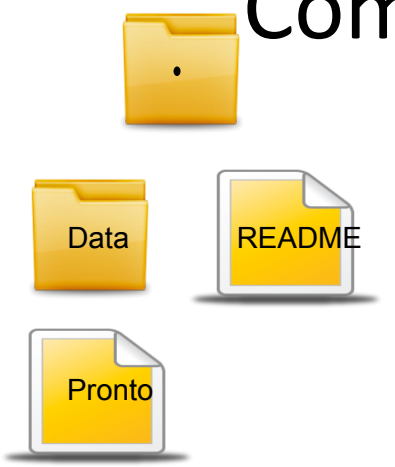
Start -> Git -> Git Bash

(See the "software" tab of the course web page to install Gitbash.)

Command Line Tools

- Commands take arguments (stuff after cmd.)
  - Arguments alter the function of commands, e.g.
    - Specify what file to use as input
  - Many commands accept the special argument to return help, usually one of
    - `--help`
    - `-help`
    - `-h`
- Tab completion is your friend!
  - When entering file arguments
  - Hitting tab key will autocomplete the filename

Commands for Files & Directories



- By category
  - Create
    - Directory: `mkdir`
    - File: various (e.g., `cp`)
  - View contents
    - Directory: `ls`
    - File: `cat`
  - Remove
    - Directory: `rmdir`
    - File: `rm`

Demo

1. Create the project directory structure and README
2. Get the pronto data from the Internet
3. Unpack the data

   Comma separated variable (CSV) files
4. Automate the workflow using a shell script

Useful Shell Commands

Command	Task	Example usage
ls	List files	`ls`
cp	Copy files	`cp original_file new_file`
mv	Move / rename files	`mv original_file new_file`
rm	Remove / delete files	`rm original_file`
cd	Change directory	`cd some_directory`
pwd	Print working / current directory	`pwd`
mkdir	Create directory	`mkdir some_directory`
rmdir	Remove / delete directory	`rmdir some_directory`
cat	View files	`cat some_file`
head	View begining of file	`head some_file`
tail	View end of file	`tail some_file`
grep	Search file for matching lines	`grep search.text some_file`
sort	Sort lines	`sort some_file`
uniq	Print unique lines	`uniq some_file`
diff	Compare to files	`diff original_file new_file`
unzip	Uncompress a file	`unzip compressed_file.zip`
curl	Download a file using its URL	`curl some URL`

Also see http://www.pixelbeat.org/cmdline.html

Also search shell + <cmd name>

Lecture Review: Data Essentials

- Structure of data
  - Schema
  - File format (CSV)
- File systems (directories, files)
- Terminal sessions
- Shell commands
  - File system operations (create, view, delete)
  - Data access (download URL, decompress)