Data Acquisition

Get started with a workflow, read data from various sources

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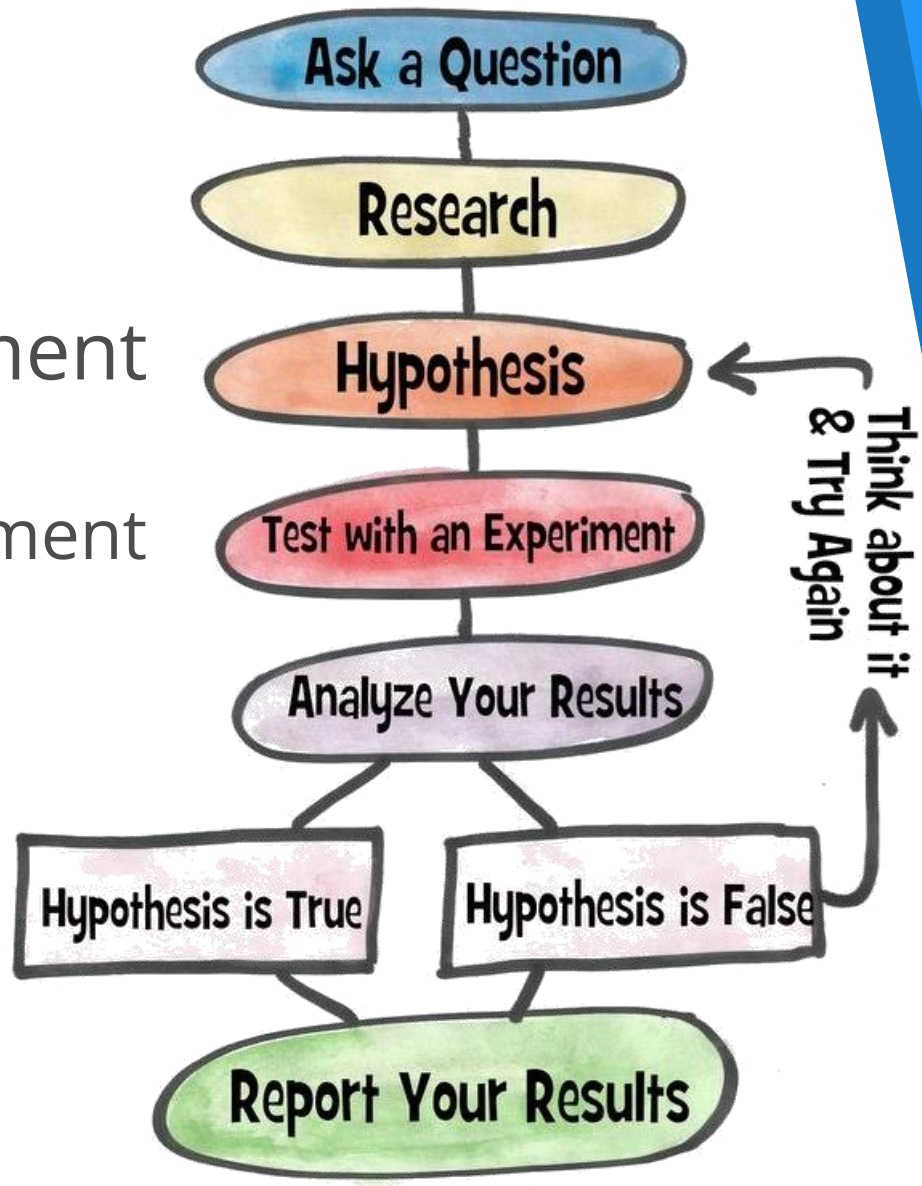
The Scientific Method

How not to get lost:
a quick reminder

The Scientific Method Steps

- Ask a question
- Do some research
- Form a hypothesis
- Test the hypothesis with an experiment
  - Experiment works ⇒ Analyze the data
  - Experiment doesn't work ⇒Fix experiment
- Results align with hypothesis ⇒ OK
- Results don't align with hypothesis ⇒ new question, new hypothesis
- Communicate the results



Getting Data

Reading data from various sources

The pandas Library

- Provides a way to read and work with data
  - Table (`DataFrame`)
    - May have many dimensions
    - We usually call this a “dataset”
  - List (`Series`)
    - One-dimensional
- Usage

```
import pandas as pd
```

- General requirements
  - Rows and columns are indexed, columns may have names
  - Each column has a fixed data type
    - Python will try to infer the best type according to the data

Data Sources

- In order to work with the data, we need to represent it in a tabular form
  - Sometimes our data is tabular – we just need to read it
  - In other cases, we need to create our tables
    - Unstructured data: data that doesn't have a **model**
      - There is some structure, it's just not very clear
      - Examples: Images, plain text, audio, web pages
- Most common sources
  - Tables in a text format such as .csv
  - Spreadsheets (such as Excel or Google Sheets)
  - Web services
  - Databases

Reading a Local File

- Let's read the file `accidents.csv`
  - Copy the file to a data folder
    - Not required, just makes working with many data files easier
  - Inspect the file (use a text editor or Excel) just to see what it contains

```
accidents_data = pd.read_csv("data/accidents.csv")
```

  - `read_csv()` docs
- You'll see that all `read_*()` functions have a lot of optional arguments
  - They make working with different formats easy, e.g.
    - Instead of "True" and "False", the table contains "Yes" and "No"
    - The actual table starts at line 30 of the file
    - There are blank / comment lines which should be skipped
    - There are no column names in the file

Exploring the Dataset

- In Python, we can print the variable

```
print(accidents_data)
```

- Even better, in Jupyter, a cell outputs its last returned value
  - This will create a nicer output

```
accidents_data
```

- We can see that
  - Rows have numerical indices starting at 0 by default
  - Columns have names taken from the first line in the .csv file
- Column names: `accidents_data.columns`
- Index values: `accidents_data.index`
- Dimensions: `accidents_data.shape`
  - Format: `(rows, columns)`

Reading Data from Other Files

- The process is very similar
- Other text-based formats
  - `pd.read_table()` is the most general function
    - All others (`read_csv()`, `read_fwf()`, etc.) just apply some settings
  - If we come across a file, we can apply our own settings
    - The point is to match the format in the best possible way
    - Example: AutoMPG dataset
- Excel
  - Read the `green_tripdata_2015-09.xls` file using `pd.read_excel()`
  - Explore the file dimensions

Reading Data from Web Services

- Web services work over the HTTP protocol and provide data in several formats
  - Most commonly used: JSON and XML
  - Some APIs to try
- Example: OpenLibrary API
  - We want information about books with ISBNs
    - Example: these 4 books
    - We can put the URL directly, `pandas` will perform a GET request
  - Function: `pd.read_json()`
    - We can provide the parameter `orient = "index"` to arrange the dataset better
      - Books should be placed by rows, their properties – by columns
      - More details on this – next time
  - More complex queries require more pre-processing

Reading Data from SQL

- Relational databases store data in tables
  - Very similar to the datasets we use
- First, install a library to connect to databases
  - From the command line: `conda install pyodbc`
- Then, import the library and connect to the database
  - **Note:** This is going to vary depending on your server settings

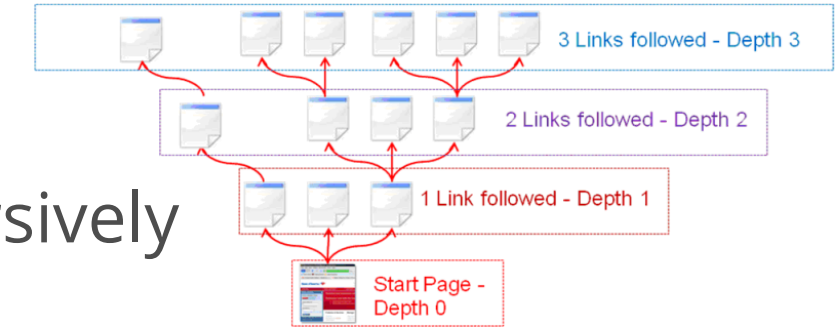
```
import pyodbc
conn = pyodbc.connect("DRIVER={SQL Server};conn_string")
```

- Perform a query

```
customer_info = pd.read_sql(
      "select * from Sales.Customer",
      conn)
```

Web Scraping

- Another method for getting data
- Sometimes combined with crawling
  - Traversing a Web page structure recursively
- Basic procedure
  - Read a Web page as HTML
  - Use the HTML to obtain the data
    - A webpage is unstructured
    - We need to create and maintain the structure
    - We usually need more libraries to do that
- Examples
  - Get all job listings from a website
  - Get user contact details from a Web page



Using Multiple Sources

Constraints and Validity

Data Guidelines

- Some queries will not be simple
  - E.g. scraping, dealing with "freeform" text, audio data, networks
  - We need to create a tabular structure from the raw data
    - How? We'll discuss this later in the course
- After we read the data, we have to ensure it's been read without errors
  - A very simple first check: check the dimensions (`dataframe.shape`) and show the first few rows (`dataframe.head()`)
  - We may need to rename columns
  - We may need to perform different manipulations to ensure the data is in a proper state
    - We'll do this in the next lectures

Merging Many Data Sources

- **Automate the process** as much as possible
  - From reading the raw data to getting the processed dataset
  - If the dataset changes or updates, you'll just re-run your code
- **Document the process**
- Create as few datasets as possible
  - I.e. merge many sources into one table if you can
    - We'll talk more about combining relations next time
- Ensure the different sources are compatible and consistent
  - If they aren't, process the raw data
    - Most common example: Mismatched IDs
- Make sure all column types are correct
  - Check: `dataframe.dtypes`
    - Example: `"str"` type for a numeric column

Summary

- Methods
  - Divide and conquer
  - Scientific method
- Setting up the environment
- Reading data from different sources
  - Text files
  - Excel
  - Web services
  - SQL databases
- Data consolidation principles

Questions?