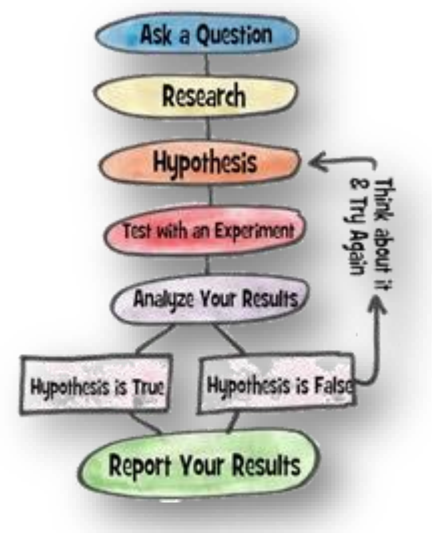
Material Summary: Data Acquisition

1. The Scientific Method

1.1The 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



2. Getting Data

2.1 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
- Usually represents a column of a table
- 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

2.2 Data Sources

- In order to work with the data, we need to represent it in 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

2.3 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

2.4 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`
- Index values: `accidents_data.index`
- Dimensions: `accidents_data.shape`
    - Format: (rows, columns)

2.5 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

2.6 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

2.7 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 sqlalchemy
```

- Then, import the library and connect to the database
  - Note: This is going to vary depending on your server settings

```
import sqlalchemy
engine = sqlalchemy.create_engine("...")
```

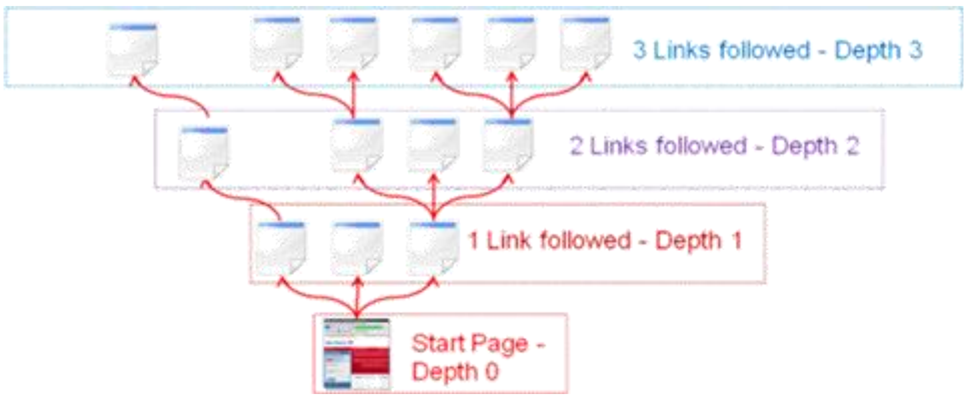
  - Perform a query

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

2.8 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


3 Links followed - Depth 3
2 Links followed - Depth 2
1 Link followed - Depth 1
Start Page - Depth 0

3. Using Multiple Sources

3.1 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

3.2 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