Data Acquisition

Get started with a workflow, read data from various sources

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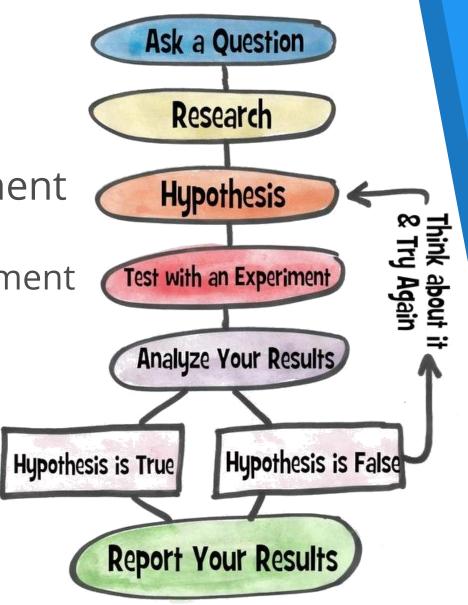
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The Scientific Method

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
 - 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

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

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: <u>AutoMPG dataset</u>
- 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: <u>these 4 books</u>
 - 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

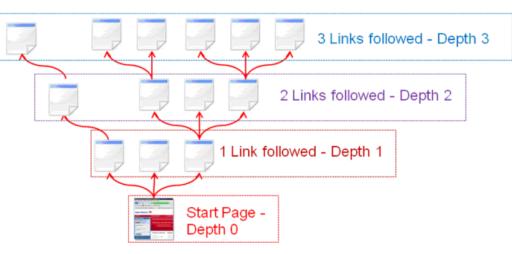
```
import pyodbc
conn = pyodbc.connect("DRIVER={SQL Server};...")
```

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?