User Story, Extract

NDBI046: Practical class 2

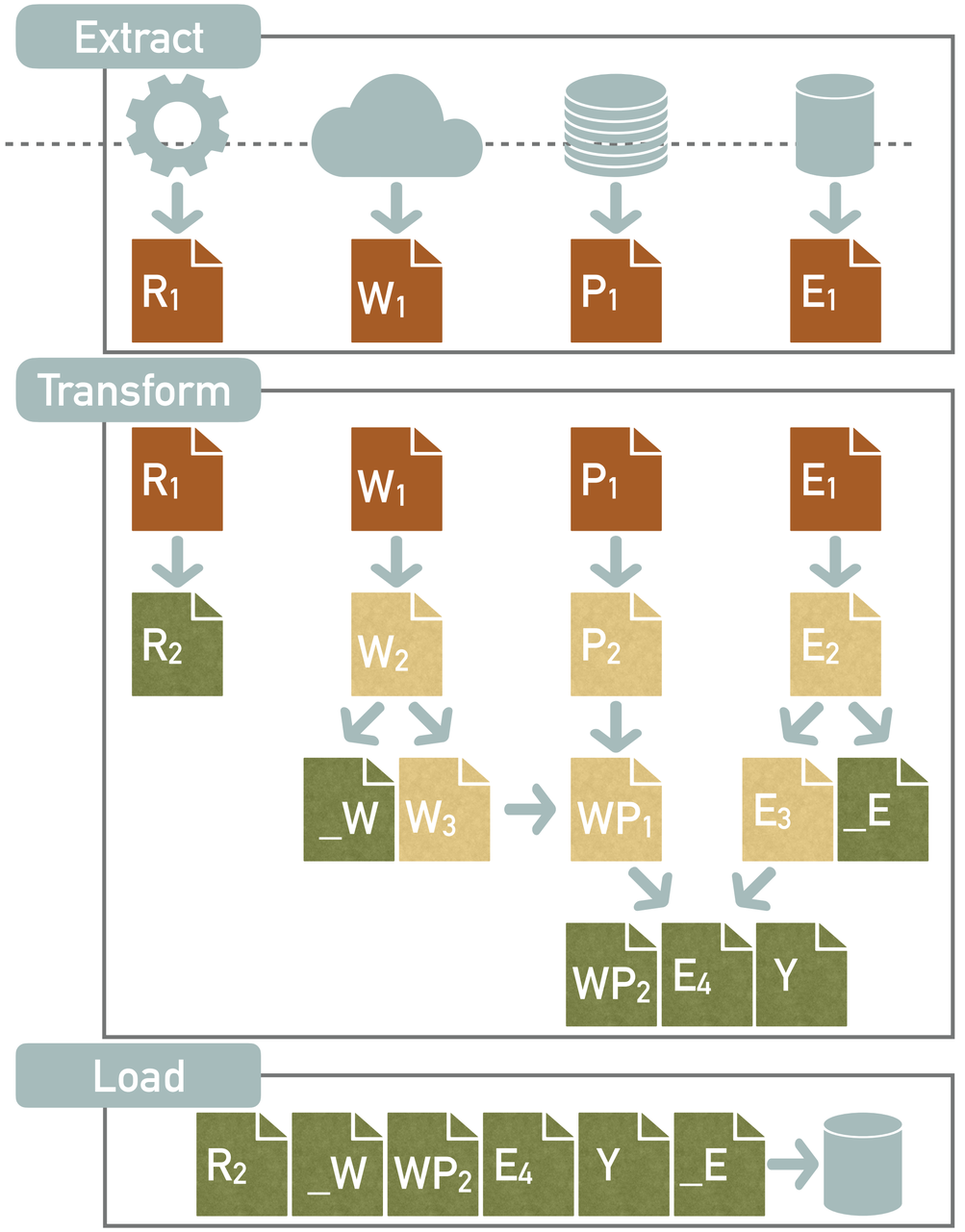
User Story

- The data analysts in our company asked us to prepare waste management datasets and load them to the data warehouse so that they could perform the required analyses
  - Specifically, they need datasets related to waste management in the Czech Republic at the level of individual regions and the extent of funds used to mitigate the environmental burden due to waste management
  - Their aim is to assess municipal and corporate waste production and address impacts, and they require that the amount of waste can be calculated per capita or per unit area
  - As a source of data, we are to use open data on waste from Czech open data portal, data published by the Czech Statistical Office and generally known facts can be extracted from Wikipedia

- **Data Engineer roles:**
  - *Extract datasets* from (various) sources
  - *Transform data* into a uniform form, detect and correct inconsistencies, etc. (see later)
  - *Load* the *data to* a *data warehouse* so that analysts can perform analyses

Extract Transform Load (ETL)

- **Data extraction** involves extracting data from homogeneous or heterogeneous sources
  - **various data sources**, e.g., *local files*, *data catalogs*, *databases*, websites, *web services*, sensors (data are all around us)
  - **various methods**, e.g., *change data capture* (CDC), *full* vs *incremental extraction*, *query-based extraction*, *web scrapping*, *event monitoring*
  - **various data formats**, e.g., Comma-Separated Values (*CSV*), JavaScript Object Notation (*JSON*), eXtensible Markup Language (*XML*), Excel Spreadsheet XML (*XLSX*), Resource Description Framework (*RDF*)
- **Data transformation** processes clean and transform data into a suitable format/structure for querying and analysis
- **Data loading** involves the insertion of data into, e.g., operational data store, data warehouse, data lake, or data mart



Prerequisite: Setting up Python (Linux, macOS)

- *Check* which *version of Python* is installed (if any)
  - If Python 3 is not installed, download the (latest) version of Python[#1] and follow the installation
- Once installed, *create* any *folder for your NDBI046 project* and navigate to it, e.g., ~/Projects/python-ndbi046
- *Create* your *Python environment*, e.g., ndbi046_env
- *Activate* you Python environment
- *Install* the required *packages*
  - Download the requirements.txt file from the practical class website
  - You may also *install additional packages*
  - You may always export the list of installed packages to a file
- Exit the Python environment after completing the practical class (not before)
  - You can return to the environment at any time by activating it

```
1  % python3 --version
2
3  % mkdir ~/Projects/python-ndbi046
4  % cd ~/Projects/python-ndbi046
5
6  % python3 -m venv ndbi046_env
7
8  % source ndbi046_env/bin/activate
9
10 (ndbi046_env) % pip install -r requirements.txt
11
12 (ndbi046_env) % pip install pandas
13
14 (ndbi046_env) % pip freeze > requirements.txt
15
16 (ndbi046_env) % deactivate
17
18 % cat requirements.txt
```

checking the installed version

creating and activating a virtual environment

installation of the required packages

export of installed packages

list installed packages

deactivating a virtual environment

#1 https://www.python.org/downloads/

Prerequisite: Setting up Python (Windows)

- *Check* which *version of Python* is installed (if any)
  - If Python 3 is not installed, download the (latest) version of Python[#1] and follow the installation

- Once installed, *create* any *folder for your NDBI046 project* and navigate to it, e.g., C:\Projects\python-ndbi046
- *Create* your *Python environment*, e.g., ndbi046_env
- *Activate* you Python environment

- *Install* the required *packages*
  - Download the requirements.txt file from the practical class website
  - You may also *install additional packages*
  - You may always export the list of installed packages to a file

- Exit the Python environment after completing the practical class (not before)
  - You can return to the environment at any time by activating it

checking the installed version

creating and activating a virtual environment

installation of the required packages

export of installed packages

list installed packages

deactivating a virtual environment

```
1  > python3 --version
2
3  > mkdir C:\Projects\python-ndbi046
4  > cd C:\Projects\python-ndbi046
5
6  > python3 -m venv ndbi046_env
7
8  > ndbi046_env\Scripts\activate.bat
9
10 (ndbi046_env) > pip install -r requirements.txt
11
12 (ndbi046_env) > pip install pandas
13
14 (ndbi046_env) > pip freeze > requirements.txt
15
16 (ndbi046_env) > deactivate
17
18 > type requirements.txt
```

#1 https://www.python.org/downloads/

Example 2.1: Extract dataset 'Production of industrial and municipal waste' (CSV)

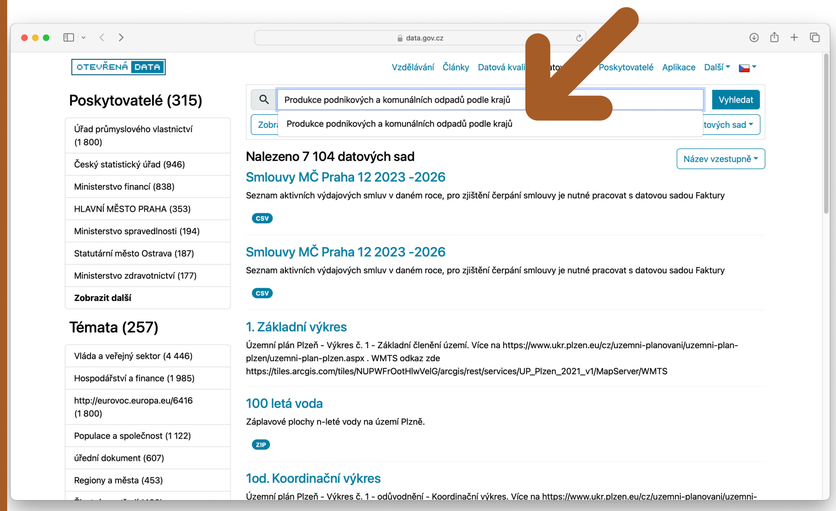
- *Extract* the *dataset* 'Produkce podnikových a komunálních odpadů podle krajů' published by the Czech Statistical Office in the Czech Open data portal[#2]
  - Write a function that allows for a *preview of the first 10 rows*
  - *Save* this *dataset into a file* named dataset_waste.csv

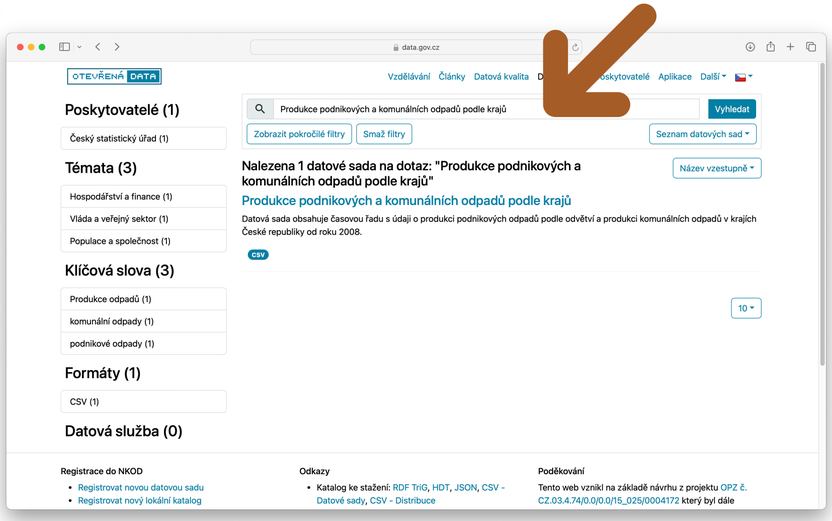
- Implement solution that *downloads data directly* from the web *using Python*

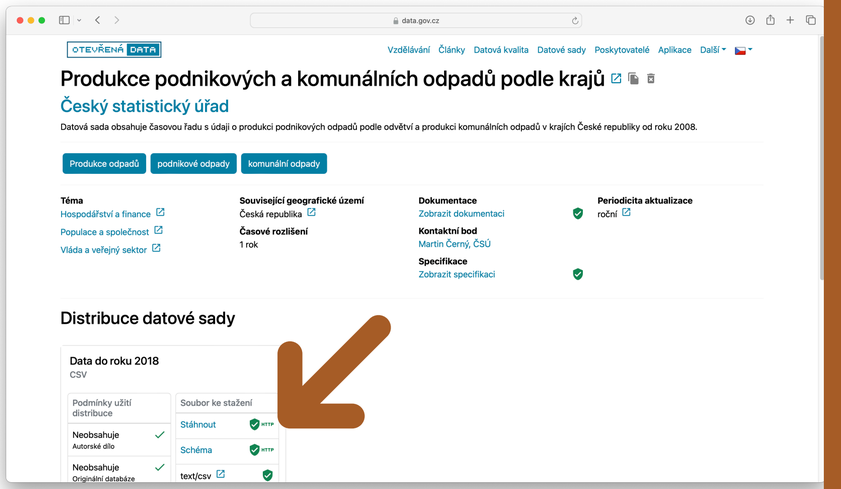
#2 *https://data.gov.cz/datové-sady*

Example 2.1: Extract dataset 'Production of industrial and municipal waste' (Solution)

- Open the data catalogue at https://data.gov.cz/datové-sady
- Search the dataset 'Produkce podnikových a komunálních odpadů podle krajů'
- Copy the link leading to dataset#3 (i.e., do not download the dataset yet)

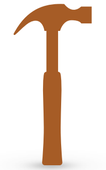






#3 https://www.czso.cz/documents/62353418/118474244/280040-19data112919.csv

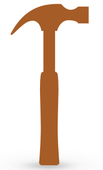
Example 2.1: Extract dataset 'Production of industrial and municipal waste' (Solution)



- Import the necessary modules (csv, logging, sys, requests)
- Configure the logging into the console from the INFO level
- Decompose the program into functions and declare function interfaces (headers) including type hints

```python
import csv
import logging
import sys

import requests

logging.basicConfig(level=logging.INFO, format="%(levelname)s: %(message)s")

def fetch_csv_content(url: str) -> bytes:
  pass

def preview_csv_content(data: bytes, num_rows: int = 10) -> None:
  pass

def save_as_csv(data: bytes, filename: str) -> None:
  pass
```

Example 2.1: Extract dataset 'Production of industrial and municipal waste' (Solution)



```python
def fetch_csv_content(url: str) -> bytes:
  try:
    response = requests.get(url)
    response.raise_for_status()  # Raise an exception if unable to download file content
    return response.content
  except requests.exceptions.RequestException as e:
    logging.error(f"Error downloading file from URL: {e}")
    raise
```

the file is returned in bytes for further processing

link validation

```python
def preview_csv_content(data: bytes, num_rows: int = 10) -> None:
  try:
    decoded_data = data.decode("utf-8")
    csv_reader = csv.DictReader(decoded_data.splitlines())

    logging.info(f"Preview of the first {num_rows} rows of the CSV file:")
    for i, row in enumerate(csv_reader):
      if i >= num_rows:
        break
      logging.info(row)
  except Exception as e:
    logging.error(f"Error previewing CSV content: {e}")
```

decode data into UTF-8 format

deserialize data as CSV

Example 2.1: Extract dataset 'Production of industrial and municipal waste' (Solution)

```
37 def save_as_csv(data: bytes, filename: str) -> None:
38   try:
39     with open(filename, "wb") as f:
40       f.write(data)
41   except Exception as e:
42     logging.error(f"Error saving data as CSV file: {e}")
43     raise
```

write bytes to the named file

```
44 if __name__ == "__main__":
45   if len(sys.argv) != 3:
46     logging.error("Usage: python script.py <url> <output_file_path>")
47     sys.exit(1)
48
49   url = sys.argv[1]
50   output_file_path = sys.argv[2]
51   try:
52     file_content = fetch_csv_content(url)
53     preview_csv_content(file_content, num_rows=10)
54     save_as_csv(file_content, output_file_path)
55     logging.info("File was successfully saved as " + output_file_path)
56   except Exception:
57     logging.error("Failed to download file content.")
```

the program accepts two arguments: (1) a file link and (2) the name of the resulting file

```
58 python3 extract_waste_csv.py \
     https://www.czso.cz/documents/62353418/118474244/280040-19data112919.csv dataset_waste.csv
```

execute program

Exercise 2.2: Extract dataset 'Costs of environmental protection' (JSON)

- *Extract* the *dataset* 'Náklady na ochranu životního prostředí a ekonomický přínos těchto aktivit' from the practical class website
  - Download data directly from the web using Python
  - Write a method that allows for a *preview of the first 10 documents*
  - Save this dataset into a file named dataset_expenses.json

Note:

- The dataset was downloaded from the open data portal in CSV format and subsequently transformed into JSON format for teaching purposes
- Link: https://data.gov.cz/datová-sada?iri=https://data.gov.cz/zdroj/datové-sady/00025593/15654858d01052b25f929597803588fe

Exercise 2.3: Web scrapping of the Regions dataset (XML)

- *Extract the table* 'Základní data o krajích' (Basic data about regions) *from* the *Wikipedia article* about Czech regions[#4]
  - Download data directly from the web using Python
  - Write a method that allows for a *preview of the first 10 rows*
  - Save extracted table into a file named dataset_regions.csv in the *CSV format*

- **Tip:** The web page is in XHTML format, hence you are encouraged to use *XPath to navigate* to elements on the page and extract only the table and its content
- **Tip:** Ideally, elements should contain a *unique identifier @id* that can be used to navigate to exact position in the document. Or, if the desired element does not contain the @id attribute, you should handle it directly, for example, using *relative positioning* or *document order*

#4 https://cs.wikipedia.org/wiki/Kraje_v_Česku

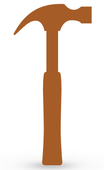
Example 2.4: Extract population dataset from multiple excel sheets (XLSX)

- *Extract population data* in the regions of the Czech Republic from the Catalog of Products of the Czech Statistical Office
  - Create a *Python script loading* a single *Excel file*, such as 'Vybrané demografické údaje podle krajů v roce 2022'[#5] (english: 'Selected demographic data by regions in the years 2022')
  - Utilize Python and the *pandas* module to *create a CSV table* with columns region, population, year
    - All of this data must be extracted from the Excel file
  - Save the result to a file named dataset_population.csv

- Subsequently, *modify the script* to accept a text file containing links to XLSX files as input, download these files, extract the data into single CSV table (i.e., *process multiple files*)

#5 *https://www.czso.cz/csu/czso/4-obyvatelstvo-b096otrb5h*

Example 2.4: Extract population dataset from multiple excel sheets (Solution)

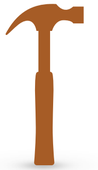


- Similarly to Example 2.1, import the modules (logging, sys, io, typing, pandas, requests), configure the logging and decompose the program into individual tasks (i.e., functions)

```
60 import logging
61 import sys
62 from io import BytesIO
63 from typing import Any, Dict, List
64 import pandas as pd
65 import requests
66
67 logging.basicConfig(level=logging.INFO, format="%(levelname)s: %(message)s")
68
69 def fetch_xlsx_content(url: str) -> BytesIO:
70   pass
71
72 def create_header() -> Dict[str, List[Any]]:
73   pass
74
75 def append_data(data: Dict[str, List[Any]], input_content: BytesIO) -> None:
76   pass
77
78 def save_as_csv(data: Dict[str, List[Any]], output_file: str) -> None:
79   pass
```

first we create the header of the CSV file and use the next function to insert individual lines

Example 2.4: Extract population dataset from multiple excel sheets (Solution)

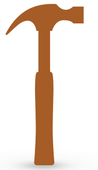


BytesIO allows reading and writing data in memory in the form of bytes

```python
def fetch_xlsx_content(url: str) -> BytesIO:
  try:
    response = requests.get(url)
    response.raise_for_status()  # Raise an exception for bad responses
    return BytesIO(response.content)
  except requests.exceptions.RequestException as e:
    logging.error(f"Error downloading Excel file from URL: {e}")
    raise
```

```python
def create_header() -> Dict[str, List[Any]]:
  return {"region": [], "population": [], "year": []}
```

Example 2.4: Extract population dataset from multiple excel sheets (Solution)



```
90 def append_data(data: Dict[str, List[Any]], input_content: BytesIO) -> None:
91   try:
92     df = pd.read_excel(input_content, header=None)
93     year = str(df.iloc[2, 0])[-4:]
94
95     df = pd.read_excel(input_content, skiprows=5)
96     for column in df.columns[2:16]:
97       region = df.iloc[0][column]
98       index_of_dash = region.find("–")
99       if index_of_dash != -1:
00         region = region[:index_of_dash] + region[index_of_dash + 2 :]
01       data["region"].append(region.strip())
02       data["population"].append(df.iloc[1][column])
03       data["year"].append(year)
04   except Exception as e:
05     logging.error(f"An error occurred while appending data: {e}")
06     raise
```

extract the year from the excel file in cell A4 (last four characters of the string)

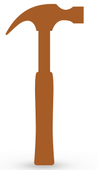
information on regions is stored in columns B to P

the region name can be split into multiple lines

```
07 def save_as_csv(data: Dict[str, List[Any]], output_file: str) -> None:
08   try:
09     df = pd.DataFrame(data)
10     df.to_csv(output_file, index=False)
11   except Exception as e:
12     logging.error(f"An error occurred while saving data to CSV: {e}")
13     raise
```

create pandas dataframe from data and write its content to csv file

Example 2.4: Extract population dataset from multiple excel sheets (Solution)



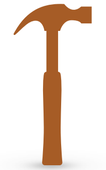
```
14 if __name__ == "__main__":
15   if len(sys.argv) != 3:
16     logging.error("Usage: python script.py <url> <output_file_path>")
17     sys.exit(1)
18
19   url = sys.argv[1]
20   output_file_path = sys.argv[2]
21
22   try:
23     data = create_header()
24
25     excel_content = fetch_xlsx_content(url)
26     append_data(data, excel_content)
27
28     save_as_csv(data, output_file_path)
29     logging.info("File was successfully saved as " + output_file_path)
30   except Exception:
31     logging.error("Failed to download file content.")
```

the program accepts two arguments: (1) a file link and (2) the name of the resulting file

```
32 python3 extract_population_excel.py https://www.czso.cz/documents/
   10180/190876467/2304101.xlsx/c8f1d7b9-6cd3-4c71-bcb7-0dc3f6e5bc9a?version=1.1
   dataset_population.csv
```

execute program

Example 2.4: Extract population dataset from multiple excel sheets (Solution)



```
35 def read_urls(urls_file: str) -> List[str]:
36   try:
37     with open(urls_file, "r") as file:
38       urls = [line.strip() for line in file.readlines()]
39     return urls
40   except Exception as e:
41     logging.error(f"An error occurred while reading URLs from the file: {e}")
42     raise
```

reading a list of links from a text file

```
43 ...
44   urls_file = sys.argv[1]
45   output_file_path = sys.argv[2]
46
47   try:
48     urls = read_urls(urls_file)
49     data = create_header()
50
51     for url in urls:
52       excel_content = fetch_xlsx_content(url)
53       append_data(data, excel_content)
54
55     save_as_csv(data, output_file_path)
56 ...
```

the modified program accepts two arguments: (1) a text file with links and (2) the name of the output file

each input file is processed and the data is appended to the output file

References

Python

- Python 3.x (LATEST) documentation: https://docs.python.org/3/
- venv documentation. https://docs.python.org/3/library/venv.html
- Python W3Schools Tutorial: https://www.w3schools.com/python/
- Pandas W3Schools Tutorial: https://www.w3schools.com/python/pandas/default.asp

XML

- XPath W3Schools Tutorial: https://www.w3schools.com/xml/xpath_intro.asp

Datasets

- Czech open data portal: https://data.gov.cz/
- Czech Statistical Office product catalog: https://www.czso.cz/csu/czso/katalog-produktu