Working with tabular data

Importing data

By far the most ubiquitous data format is the "comma-separated values" file format – or simply the csv file format. The csv file format can be used to store a matrix. Here is how:

1. Each row of the file contains numbers separated by commas. There must be as many entries in a row as matrix columns.
2. If you start a row with "#" it will be ignored when reading the file.

- In the directory, there is file a named `data.csv`, we can read it using `pandas` library
- The data is a thermodynamic table with saturated steam properties.

Reading data with `pandas`

```
import pandas as pd
data = pd.read_csv('data.csv', delimiter=',')
data.head(3)
```

	Absolute Pressure (bar)	Boiling Point (deg C)	Specific Volume (steam) (m3/kg)	Density (steam) (kg/m3)	Specific Enthalpy of Liquid Water (sensible heat) (kJ/kg)	Specific Enthalpy of Liquid Water (sensible heat) (kcal/kg)	Specific Enthalpy of Steam (total heat) (kJ/kg)	Specific Enthalpy of Steam (total heat) (kcal/kg)	Latent heat of Vaporization (kJ/kg)	Latent heat of Vaporization (kcal/kg)	Specific Heat (kJ/kg K)
0	0.02	17.51	67.006	0.015	73.45	17.54	2533.64	605.15	2460.19	587.61	1.8644
1	0.03	24.10	45.667	0.022	101.00	24.12	2545.64	608.02	2444.65	583.89	1.8694
2	0.04	28.98	34.802	0.029	121.41	29.00	2554.51	610.13	2433.10	581.14	1.8736

Exploratory Analysis

Exploratory Analysis

Counting missing data

- The first thing to check in a tabulated data set is if there's missing data.
- That will indicate either a problem in the data set reading or just say that these records were actually missing!

```
data.isna().sum()
```

```
Absolute Pressure (bar)                                    0
Boiling Point (oC)                                         0
Specific Volume (steam) (m3/kg)                            1
Density (steam) (kg/m3)                                    1
Specific Enthalpy of Liquid Water (sensible heat) (kJ/kg)  1
Specific Enthalpy of Liquid Water (sensible heat) (kcal/kg)1
Specific Enthalpy of Steam (total heat) (kJ/kg)            1
Specific Enthalpy of Steam (total heat) (kcal/kg)          1
Latent heat of Vaporization (kJ/kg)                        1
Latent heat of Vaporization (kcal/kg)                      1
Specific Heat (kJ/kg K)                                    2
dtype: int64
```

Summary Statistics

- When data is missing, pandas will remove the any lines with missing information when you try to calculate anything.

```
summary = data.describe()
summary
```

	Absolute Pressure (bar)	Boiling Point (deg C)	Specific Vol (steam) (m3/kg)	Density (steam) (kg/m3)	Specific Enthalpy of Liquid Water (sensible heat) (kJ/kg)	Specific Enthalpy of Liquid Water (sensible heat) (kcal/kg)	Specific Enthalpy of Steam (total heat) (kJ/kg)	Specific Enthalpy of Steam (total heat) (kcal/kg)	Latent heat of Vaporization (kJ/kg)	Latent heat of Vaporization (kcal/kg)	Specific Heat (kJ/kg K)
count	68.000000	68.000000	67.000000	67.000000	67.000000	67.000000	67.000000	67.000000	67.000000	67.000000	66.000000
mean	9.043235	137.210809	4.850761	14.638075	582.540149	139.799285	2784.580896	665.525927	2202.041791	526.351472	2.402277
std	12.242958	84.173371	11.654888	86.272047	473.605457	113.696154	263.145057	62.922357	357.318176	76.958140	0.476031
min	0.020000	0.255000	0.067000	0.015000	73.450000	17.540000	2560.370000	611.500000	1990.960000	475.900000	1.864400
25%	0.975000	95.910000	0.146000	0.562500	398.470000	95.250000	2668.310000	638.470000	1961.485000	466.105000	2.018375
50%	3.750000	136.205000	0.606000	1.908000	561.440000	134.550000	2774.660000	662.440000	2147.350000	512.890000	2.215600
75%	14.250000	192.460000	1.978000	7.351000	822.365000	200.000000	2886.605000	690.100000	2261.785000	540.220000	2.765700
max	76.000000	293.840000	67.006000	709.300000	1008.330000	241.840000	2802.270000	2055.530000	2460.190000	587.610000	3.406900

Exploratory Analysis

Actively handling missing data

- `pandas` can handle automatically missing data if you do calculations in it.
- However, if you want to do calculations using another package, errors will appear as they might not handle missing values like `pandas`

Exploratory Analysis

Actively handling missing data - Code

```
data_no_null_rows = data.dropna(axis = 0)

#Dropna drops all rows that contain at least 1 missing value
```

```
data_no_null_rows.isna().sum()
```

```
Absolute Pressure (bar)                                          0
Boiling Point (oC)                                               0
Specific Volume (steam) (m3/kg)                                  0
Density (steam) (kg/m3)                                          0
Specific Enthalpy of Liquid Water (sensible heat) (kJ/kg)        0
Specific Enthalpy of Liquid Water (sensible heat) (kcal/kg)      0
Specific Enthalpy of Steam (total heat) (kJ/kg)                  0
Specific Enthalpy of Steam (total heat) (kcal/kg)                0
Latent heat of Vaporization (kJ/kg)                              0
Latent heat of Vaporization (kcal/kg)                            0
Specific Heat (kJ/kg K)                                          0
dtype: int64
```

More options in dropna

Manipulating Data Frames

Given our clean data frame `data_no_null_rows`, we may be interested in answering some questions with it:

1. How many rows and columns my dataframe has?
2. How many data points I have for a temperature above 80 degrees celsius and less than 120?
3. What is the temperature and pressure of the record at 75% of the data set size?

Manipulating Data Frames

Question 1

- How many rows and columns my dataframe has?

```
data_no_null_rows.shape
```

```
(66, 11)
```

Question 2

- How many data points I have for a temperature above 80 degrees celsius and less than 120?

```
above_80 = data_no_null_rows["Boiling Point (oC)"] > 80.0
below_120 = data_no_null_rows["Boiling Point (oC)"] < 120.0
below_120.head(3)
```

```
0    True
1    True
2    True
Name: Boiling Point (oC), dtype: bool
```

```
a80_b120 = above_80 & below_120
data_no_null_rows[a80_b120].shape
```

```
(15, 11)
```

Question 3

- What is the temperature and pressure of the record at 75% of the data set size?

```
idx_75 = int(data_no_null_rows.shape[0]*.75)
data_no_null_rows.loc[idx_75, ["Boiling Point (oC)", "Absolute Pressure (bar)"]]
```

```
Boiling Point (oC)         187.96
Absolute Pressure (bar)     12.00
Name: 49, dtype: float64
```

Data visualization

Python has many visualization libraries. Here are some popular ones for data science:

- Matplotlib
- seaborn
- plotly

Data Visualization

2D - scatterplots

```
import matplotlib.pyplot as plt
plt.rcParams["figure.figsize"] = (5.0, 2.5)
data_no_null_rows.plot(x = "Boiling Point (oC)", y = "Absolute Pressure (bar)",
kind = "scatter")
```

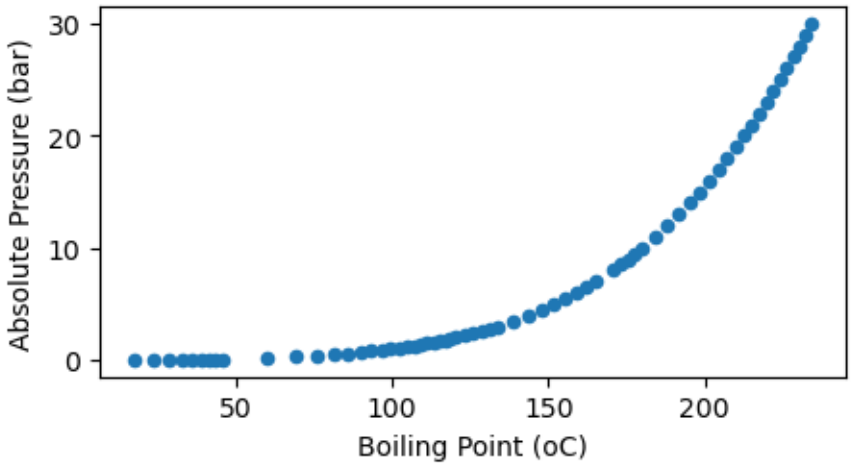
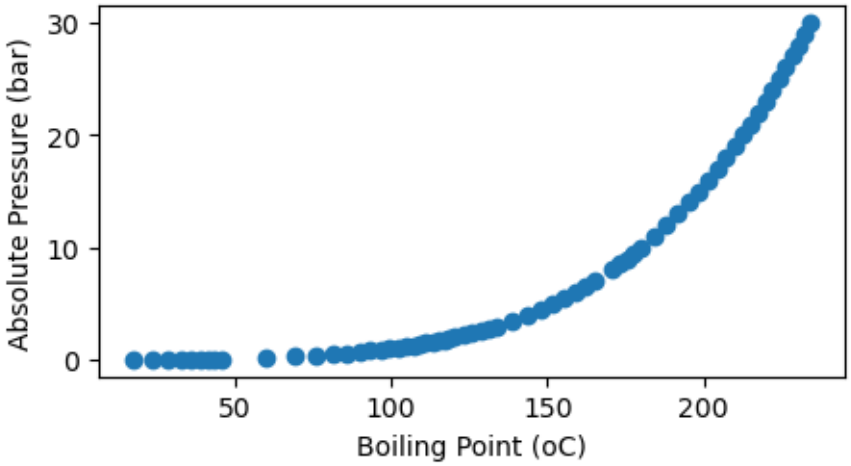


Figure 1: Temperature vs Pressure - Satured Steam

- You can also plot without using `pandas`

```
plt.scatter(data_no_null_rows["Boiling Point (oC)"],
data_no_null_rows["Absolute Pressure (bar)"])
plt.xlabel("Boiling Point (oC)")
plt.ylabel("Absolute Pressure (bar)")
```

```
Text(0, 0.5, 'Absolute Pressure (bar)')
```



2D - histograms

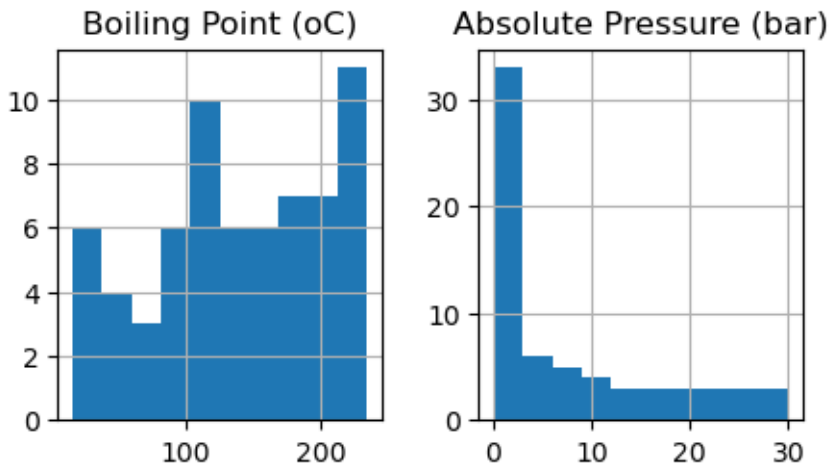
```
data_no_null_rows.hist(["Boiling Point (oC)", "Absolute Pressure (bar)"])
```

```

```

```
array([[<Axes: title={'center': 'Boiling Point (oC)'}>,
        <Axes: title={'center': 'Absolute Pressure (bar)'}>]],
      dtype=object)
```

Histograms



2D - Box plot

```
data_no_null_rows.boxplot(["Boiling Point (oC)", "Absolute Pressure (bar)"])
```

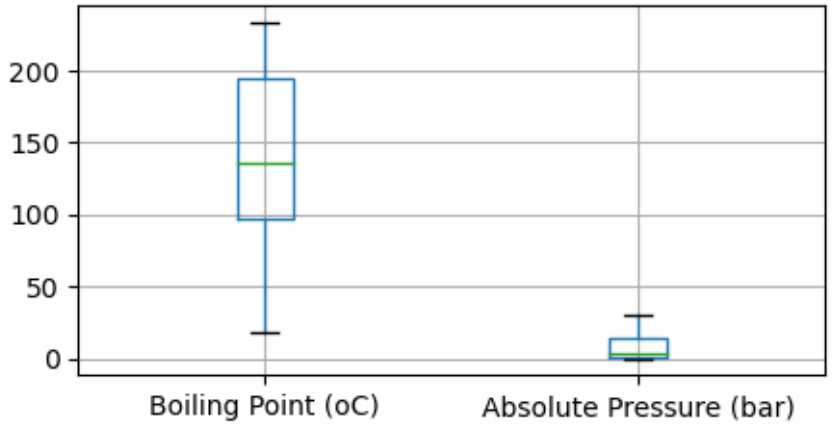


Figure 2: Boxplot