Chapter 3

Descriptive multivariate analysis

Descriptive Multivariate Analysis

Friend	Max temp	Weight	Height	Years	Gender	Company
Andrew	25	77	175	10	M	Good
Bernhard	31	110	195	12	M	Good
Carolina	15	70	172	2	F	Bad
Dennis	20	85	180	16	M	Good
Eve	10	65	168	0	F	Bad
Fred	12	75	173	6	M	Good
Gwyneth	16	75	180	3	F	Bad
Hayden	26	63	165	2	F	Bad
Irene	15	55	158	5	F	Bad
James	21	66	163	14	M	Good
Kevin	30	95	190	1	M	Bad
Lea	13	72	172	11	F	Good
Marcus	8	83	185	3	F	Bad
Nigel	12	115	192	15	M	Good

Summary

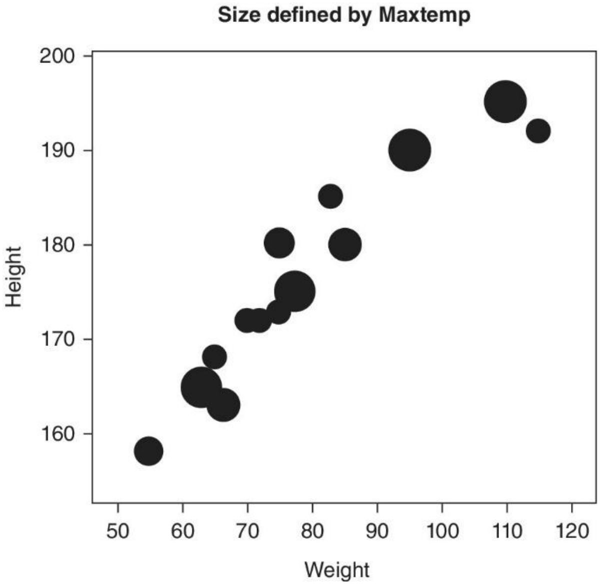
- Multivariate frequencies
- Multivariate data visualization
- Multivariate statistics
  - Location multivariate statistics
  - Dispersion multivariate statistics
- Final remarks

Multivariate frequencies

- The multivariate frequency values can be computed independently for each attribute
  - Thus, we can represent the frequency values for each attribute presenting them in a matrix like structure

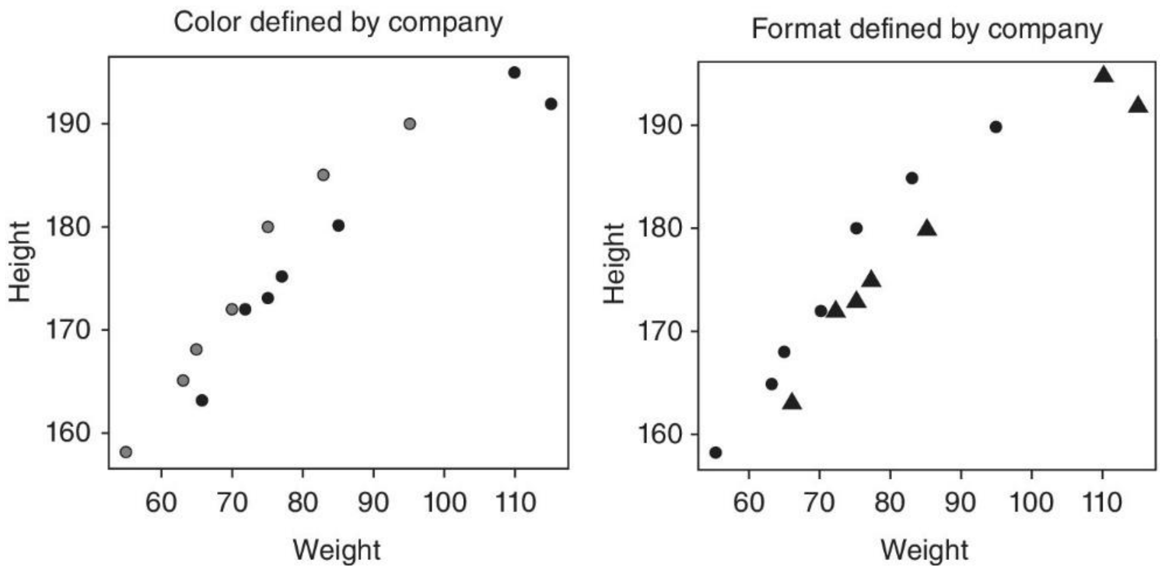
Multivariate data visualization

- When the multivariate data has **three attributes**, at least two of them quantitative, the data can still be visualized by a bivariate plot
  - This is done by associating the scale types of the values of the third attribute to how each data object is represented in the plot

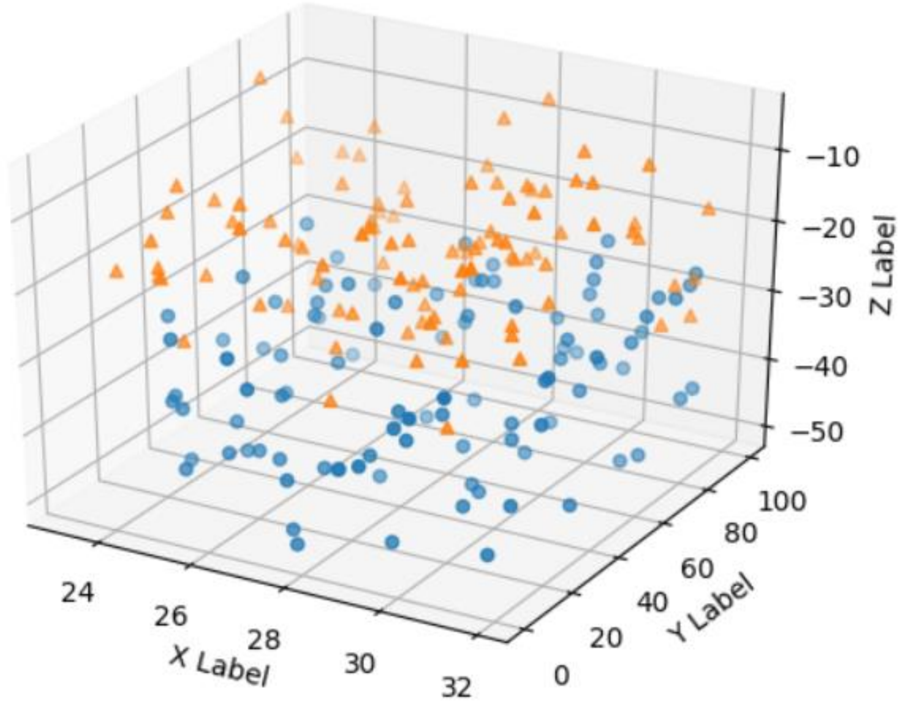


Multivariate data visualization

- If the third attribute is qualitative, its value can be represented in the plot by either the colour or by the shape of the object in the plot
  - The number of colours or shapes will be the number of values the attribute can assume



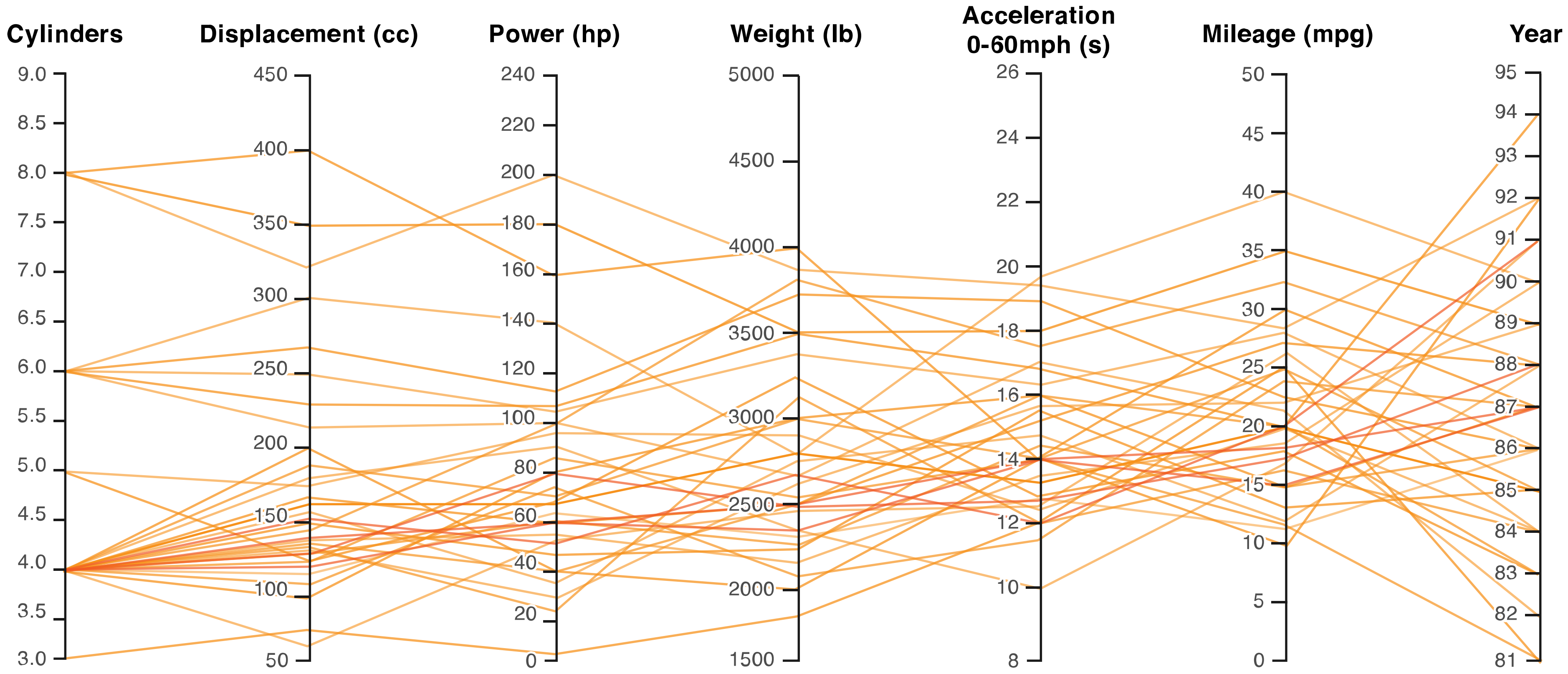
Multivariate data visualization



- Another approach to represent three attributes is to use a 3-dimensional plot
- A fourth attribute can be represented the same way a third attribute was represented in a bi-dimensional space
- We can also map a surface or wireframe on the points

Multivariate data visualization

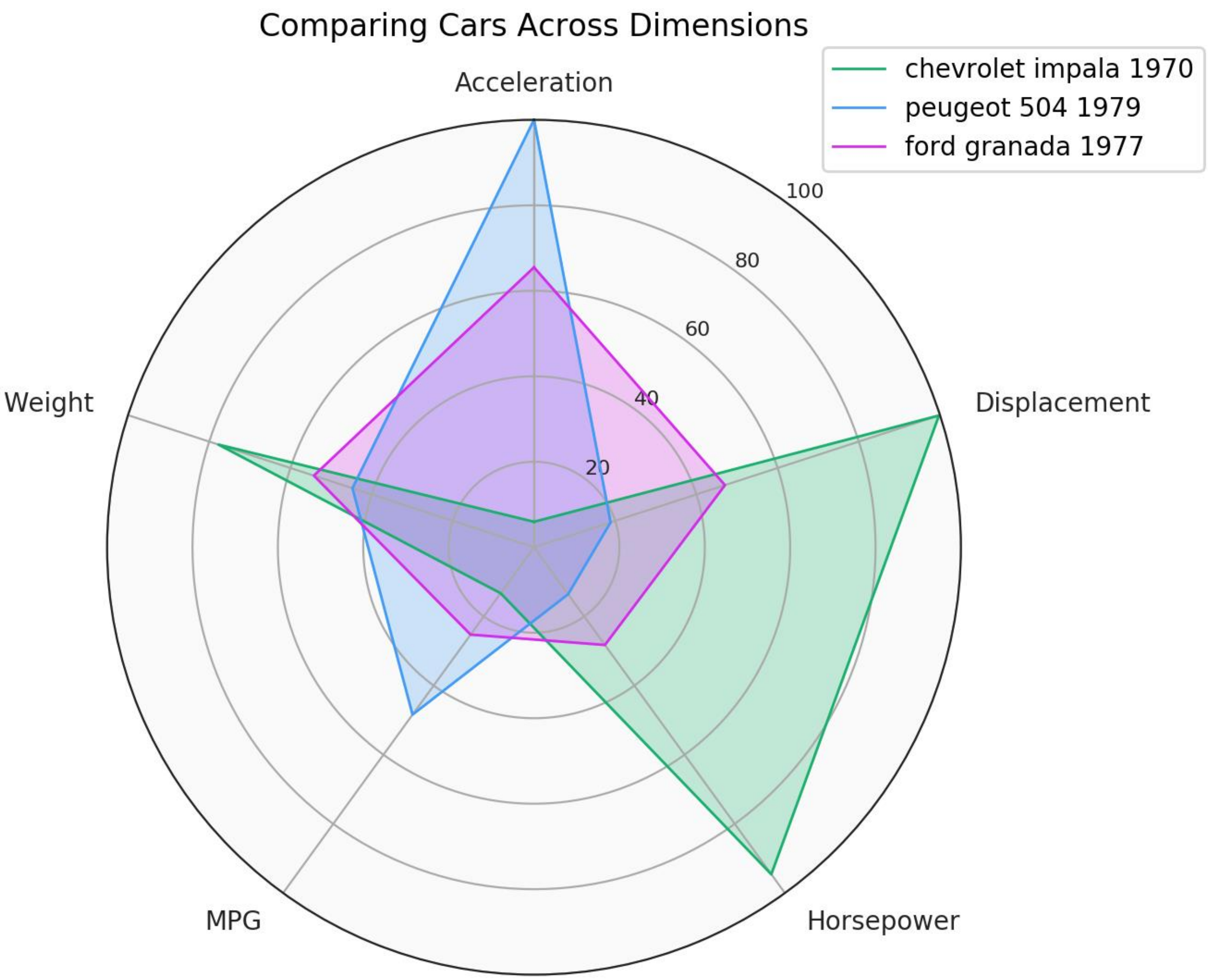
- **Parallel Coordinates**
  - Each attribute is a vector, the vectors are of the same length and ranges between min-max values of the attribute



Multivariate data visualization

Radar Chart (Spider Plot)

Same vectorization as with parallel coordinates, but instead of columns we organize the lines into a circle or polygon. Good for showing trade-offs.



Location multivariate statistics

- To measure the location statistics of several attributes we just measure the location value for each attribute
  - Thus, we can represent the location statistical values for each attribute presenting them in a matrix like structure

Location statistics	**Max temp**	**Weight**	**Height**	**Years**
min	8.00	55.00	158.00	0.00
max	31.00	115.00	195.00	16.00
average	18.14	79.00	176.29	7.14
mode	15.00	75.00	172.00	2.00
1st quartile	12.25	67.00	169.00	2.25
Median or 2nd quartile	15.50	75.00	174.00	5.50
3rd quartile	24.00	84.50	183.75	11.75

Dispersion multivariate statistics

- The extraction of some of the dispersion values for multivariate statistics, like amplitude, interquartile range, mean absolute deviation and standard deviation, can be also independently performed for each attribute

Dispersion statistics	Max temp	Weight	Height	Years
Amplitude	23.00	60.00	37.00	16.00
Interquartile range	11.75	17.50	14.75	9.50
$\overline{MAD}$	7.41	14.09	11.12	6.67
Standard deviation	7.45	17.38	11.25	5.66

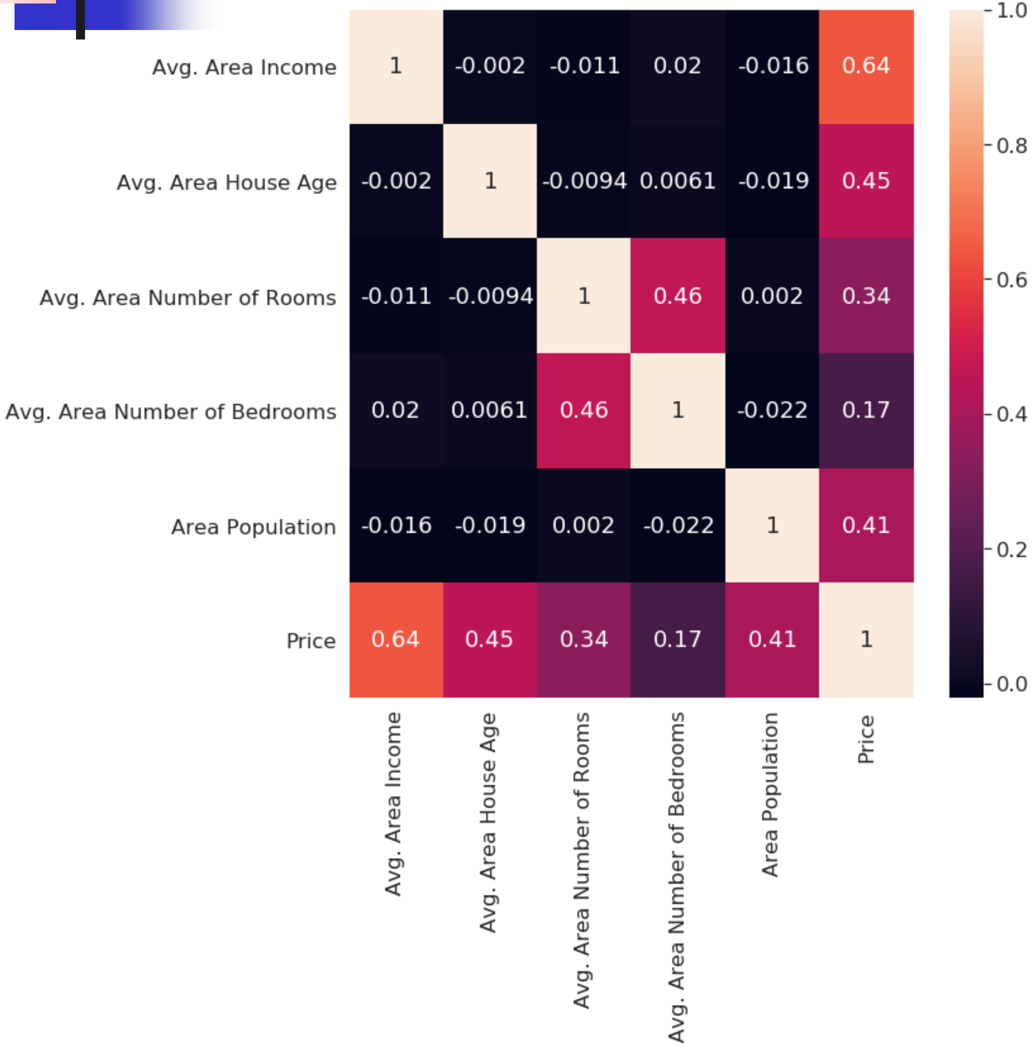
Dispersion multivariate statistics

- The relation between two attributes is evaluated using covariance or correlation measures
  - The main diagonal of the **covariance matrix** shows the variance of each attribute
  - The matrices are symmetric: the values above the main diagonal are the same as the value below the main diagonal

Covariance	Max temp	Weight	Height	Years
Max temp	55.52	34.46	20.19	5.82
Weight	34.46	302.15	184.62	42.39
Height	20.19	184.62	126.53	14.03
Years	5.82	42.39	14.03	31.98

Pearson correlation	Max temp	Weight	Height	Years
Max temp	1.00	0.27	0.24	0.14
Weight	0.27	1.00	0.94	0.43
Height	0.24	0.94	1.00	0.22
Years	0.14	0.43	0.22	1.00

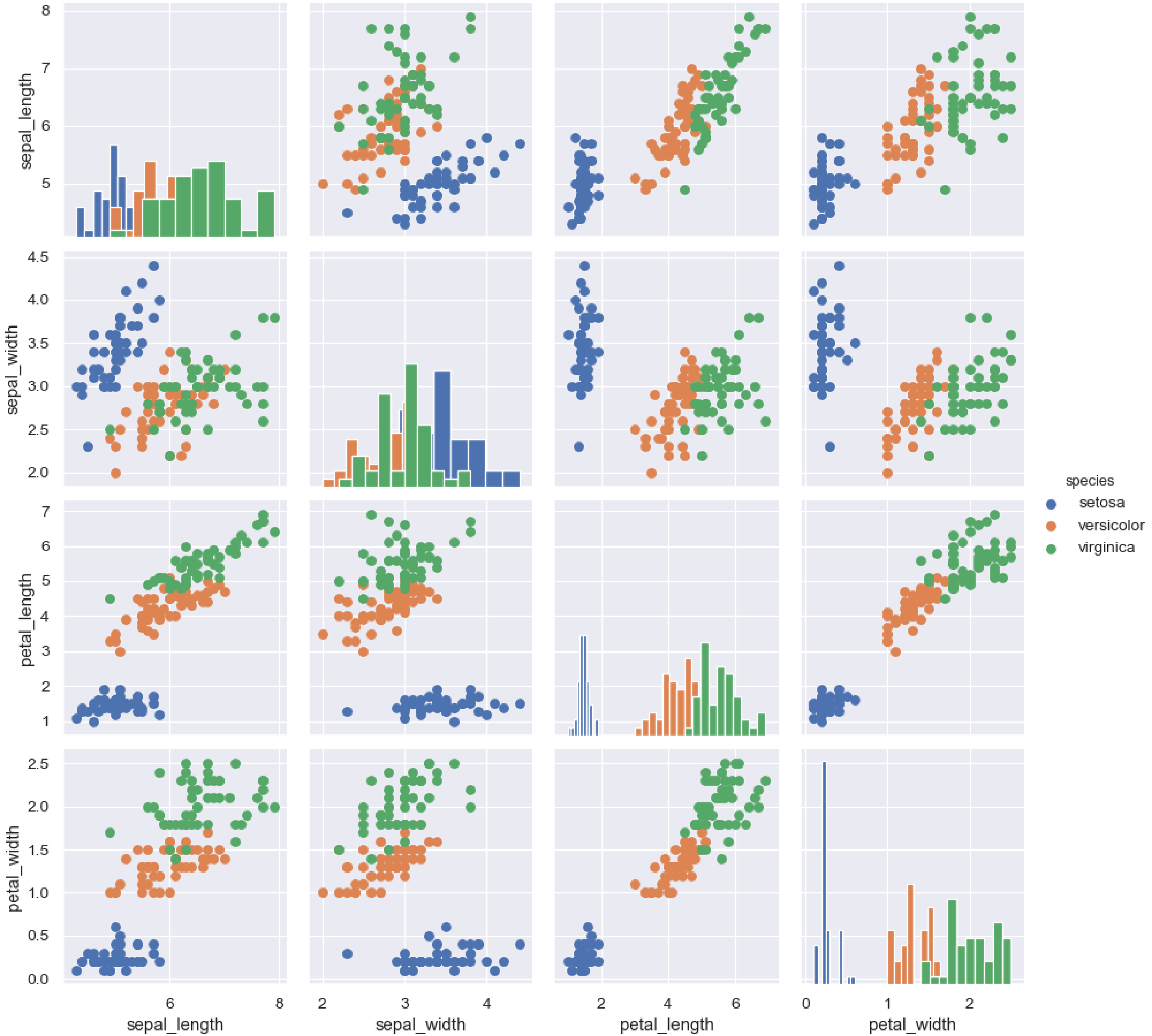
Dispersion multivariate statistics



- **Correlation Heatmap** is used to show the pairwise correlation between variables

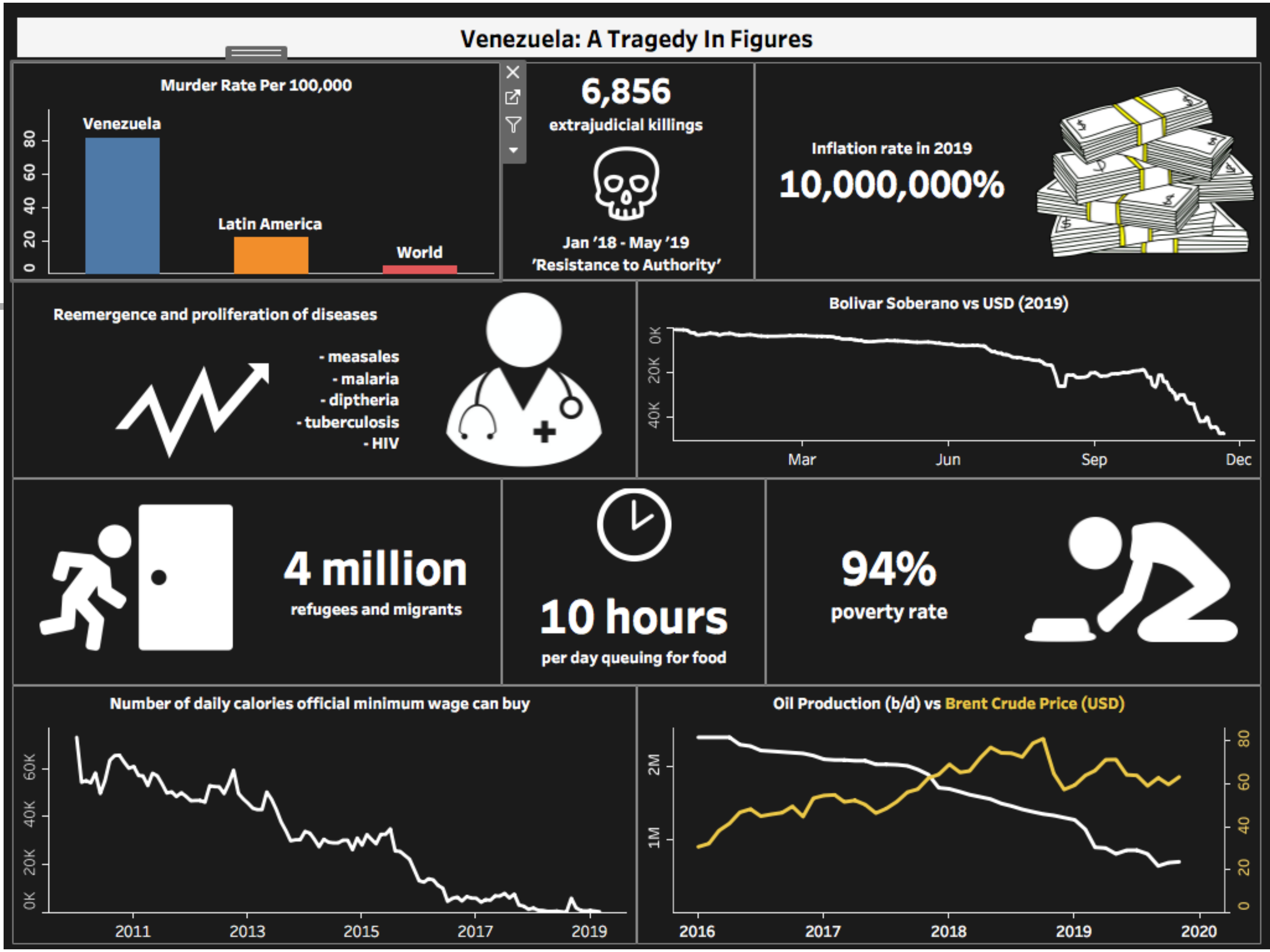
Dispersion multivariate statistics

- **Pair Plot** is used to visualize pairwise relationships between variables
  - The diagonal shows the distribution of the variables
  - As with other plots, we can increase dimensionality with colours and shapes



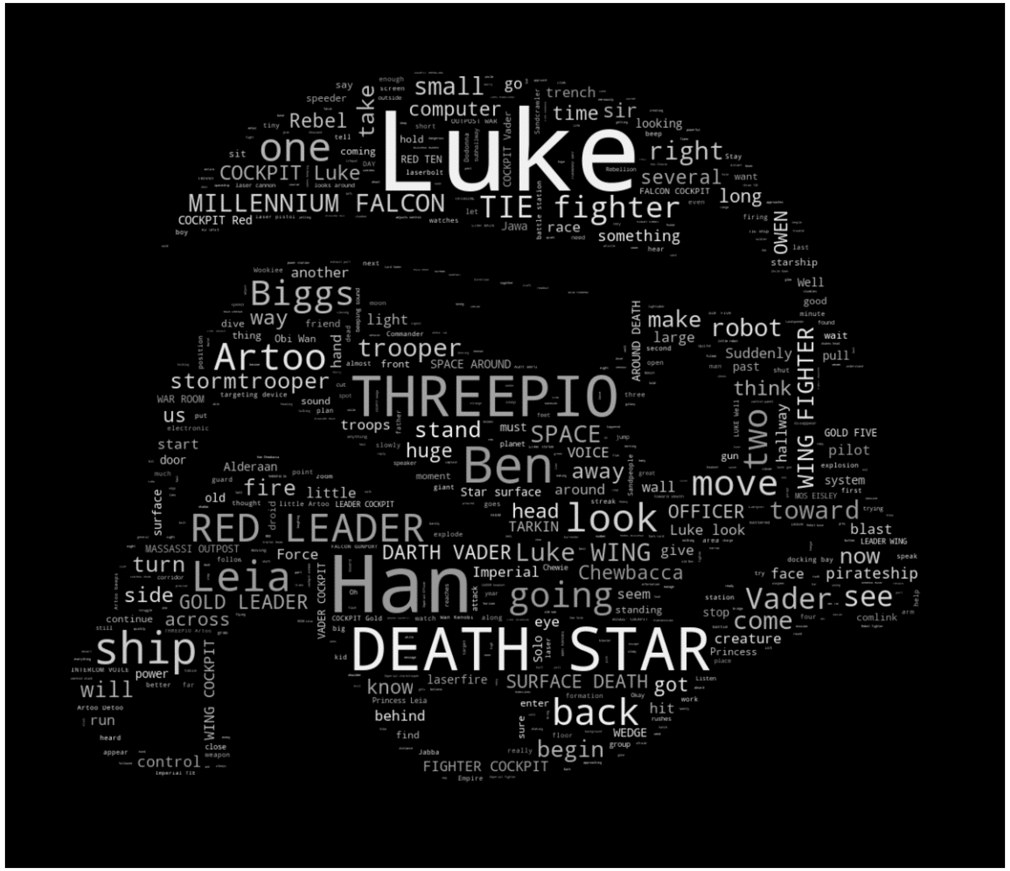
Dispersion multivariate statistics

- An **infographic** is a collection of imagery, charts, and minimal text that gives an easy-to-understand overview of a topic.
  - While data visualization is objective, automatically produced and can be applied to several data sets
  - Infographics are subjective, manually produced and customized for a particular data set



https://tinyurl.com/vrkgz86

Dispersion multivariate statistics



- A visualization tool frequently used in text mining to illustrate text data is the **word cloud**, which presents how often each word appears in a given text
  - The higher the frequency of a word in the text, the larger its size in the word cloud
  - Since articles and prepositions occur very often in a text, and numbers are not text, they are usually removed before the word cloud tool is applied to a text. For example: *a, the, is*
  - Another text process operation, stemming, which substitutes a word in a text by its stem, is also applied to the text before the word cloud tool is used. For example:*connection, connected, connections, connects -> connect*

Final remarks

- Descriptive multivariate analysis is more complex as the number of attributes increases
- It extends naturally from univariate and bivariate descriptive statistics
- The area of multivariate data visualization is an active research area

Questions?