



Welcome to this session Skills Bootcamp:

Data Visualisation Techniques (Theory)

The session will start shortly...

Questions? Drop them in the chat.
We'll have dedicated moderators
answering questions.



Safeguarding & Welfare

We are committed to all our students and staff feeling safe and happy; we want to make sure there is always someone you can turn to if you are worried about anything.

If you are feeling upset or unsafe, are worried about a friend, student or family member, or you feel like something isn't right, speak to our safeguarding team:



Ian Wyles
Designated Safeguarding
Lead



Simone Botes



Nurhaan Snyman



Rafiq Manan



Ronald Munodawafa



Tevin Pitts

**Scan to report a
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or email the Designated
Safeguarding Lead:
Ian Wyles
safeguarding@hyperiondev.com

Skills Bootcamp Full Stack Web Development

- The use of disrespectful language is prohibited in the questions, this is a supportive, learning environment for all - please engage accordingly. (**Fundamental British Values: Mutual Respect and Tolerance**)
- No question is daft or silly - **ask them!**
- There are **Q&A sessions** midway and at the end of the session, should you wish to ask any follow-up questions. We will be answering questions as the session progresses as well.
- If you have any questions outside of this lecture, or that are not answered during this lecture, please do submit these for upcoming Academic Sessions. You can submit these questions here: **Questions**

Skills Bootcamp Cloud Web Development

- For all **non-academic questions**, please submit a query:
www.hyperiondev.com/support
- **Report a safeguarding incident:** **www.hyperiondev.com/safeguardreporting**
- We would love your feedback on lectures: **Feedback on Lectures.**
- Find all the lecture **content** in your **Lecture Backpack** on GitHub.
- If you are hearing impaired, kindly use your computer's function through Google chrome to enable captions.

Skills Bootcamp

Progression Overview

✓ Criterion 1 - Initial Requirements

Specific achievements **within the first two weeks of the program.**

To meet this criterion, students need to, by no later than **01 December 2024 (C11)** or **22 December 2024 (C12)**:

- **Guided Learning Hours (GLH):** Attend a minimum of **7-8 GLH per week** (lectures, workshops, or mentor calls) for a total minimum of **15 GLH**.
- **Task Completion:** Successfully complete the **first 4 of the assigned tasks**.

✓ Criterion 2 - Mid-Course Progress

Progress through the successful completion of tasks **within the first half of the program.**

To meet this criterion, students should, by no later than **12 January 2025 (C11)** or **02 February 2025 (C12)**:

- **Guided Learning Hours (GLH):** Complete at least **60 GLH**.
- **Task Completion :** Successfully complete the **first 13 of the assigned tasks**.

Skills Bootcamp Progression Overview

✓ Criterion 3 – End-Course Progress

Showcasing students' progress nearing the completion of the course.

To meet this criterion, students should:

- **Guided Learning Hours (GLH)**: Complete the **total minimum required GLH**, by the **support end date**.
- **Task Completion** : **Complete all mandatory tasks**, including any necessary resubmissions, by the end of the bootcamp, **09 March 2025 (C11)** or **30 March 2025 (C12)**.

✓ Criterion 4 - Employability

Demonstrating progress to find employment.

To meet this criterion, students should:

- **Record an Interview Invite**: Students are required to record proof of invitation to an interview by **30 March 2025 (C11)** or **04 May 2025 (C12)**.
 - **South Holland Students** are required to proof and interview by **17 March 2025**.
- **Record a Final Job Outcome** : Within 12 weeks post-graduation, students are required to record a job outcome.

Stay Safe Series:

Mastering Online Safety One week at a Time

While the digital world can be a wonderful place to make education and learning accessible to all, it is unfortunately also a space where harmful threats like online radicalization, extremist propaganda, phishing scams, online blackmail and hackers can flourish.

As a component of this BootCamp the **Stay Safe Series** will guide you through essential measures in order to protect yourself & your community from online dangers, whether they target your privacy, personal information or even attempt to manipulate your beliefs.

Download with Caution: Avoiding Dangerous Files

- Use Trusted Sources Only
- Look for HTTPS
- Avoid Clicking on Pop-ups
- Scan Downloads with Antivirus
- Keep Software Updated
- Beware of Free Downloads
- Check File Extensions



Why is data cleaning important in data analysis?

- A. To save storage space
- B. To ensure accurate and reliable insights
- C. To make data visually appealing
- D. To remove unused data

What is a common issue when working with datasets?

- A. Missing values
- B. Overly clear formats
- C. Consistently structured data
- D. Homogeneous datasets

Learning Outcomes

- ❖ Discuss the importance of data visualisation
- ❖ Explain how to use the Matplotlib library and Seaborn
- ❖ Analyse and interpret visualisations

Lecture Overview

- Data Visualisation
- Basic Visualisation
- Break
- Advanced Visualisation
- Q&A

Data Visualisation

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Key Goals of Data Visualisation

- ❖ Expose **underlying trends, outliers, and relationships within data**
- ❖ Support **intuitive exploration and rapid insight generation**
- ❖ Depending on what **information we want** from the dataset, we use the data to **answer the questions through visualisations**
- ❖ Create **appropriate, easily read visual narratives** that resonate with your audience.

COVID-19 cases, country level trends

Sort by latest value

Sort by percent change

Align axis scales

Russian Federation

Reported COVID-19 cases



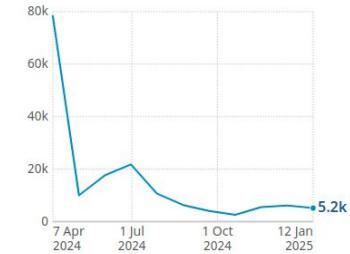
Greece

Reported COVID-19 cases



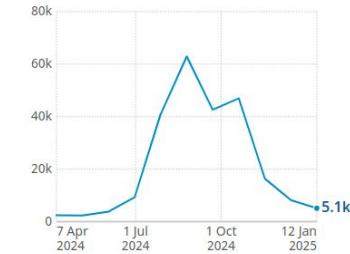
New Zealand

Reported COVID-19 cases



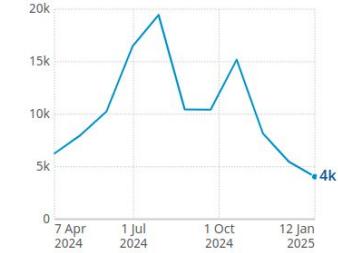
Italy

Reported COVID-19 cases



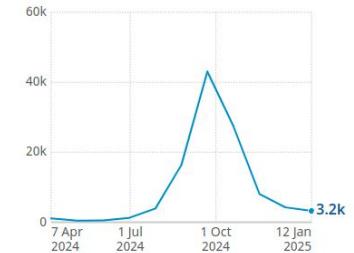
United Kingdom of Great Britain And Northern Ireland

Reported COVID-19 cases



Poland

Reported COVID-19 cases



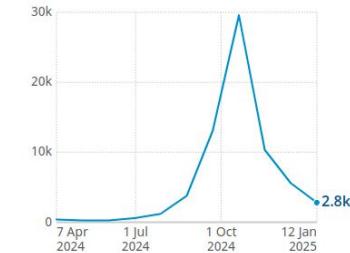
France

Reported COVID-19 cases



Czechia

Reported COVID-19 cases



Percent change based on previous 28 days

Source: World Health Organization

Types of Data



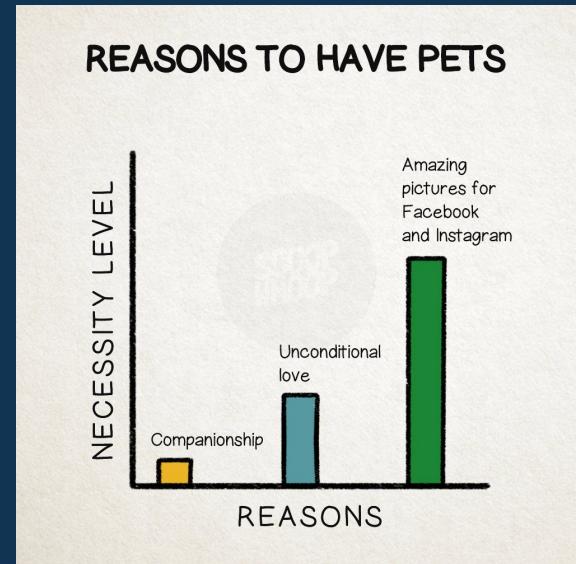
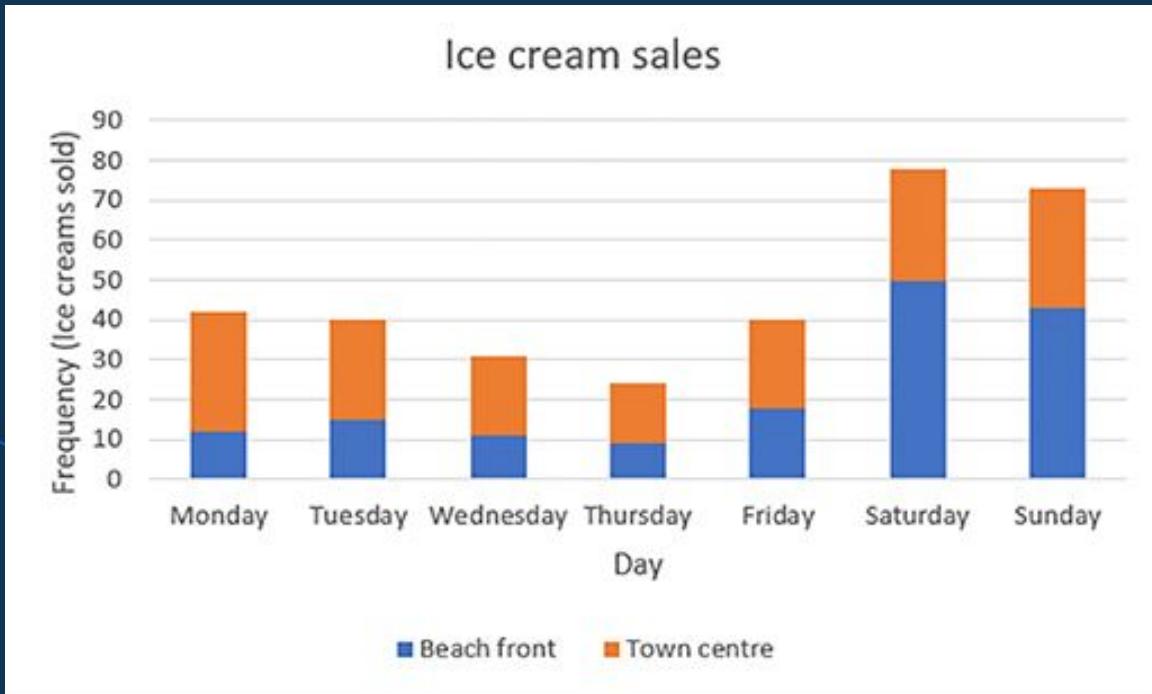
Types of Data

- ❖ **Discrete data:** Can take specific values, with an infinite range, e.g :
[1, 2, 3, 4, 5, ...]
- ❖ **Categorical data:** Can take specific values, with a limited range, e.g.
[Dog, Cat, Hamster, Fish]
- ❖ **Continuous data:** Available values in a spectrum, there are an infinite number of values, e.g. temperature or distance
- ❖ **Time series data:** Data changes along with some form of time-related progression

Basic Visualisations

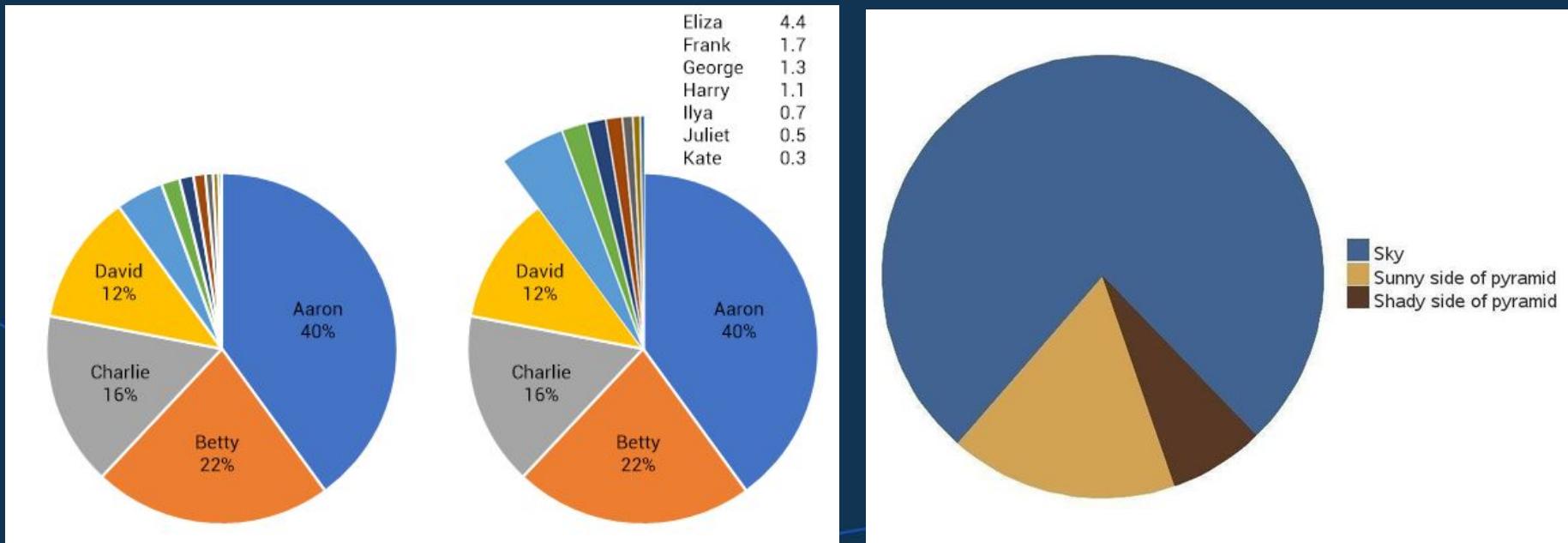
Barplot (Bar chart)

Good for plotting Categorical vs. Continuous /Discrete data



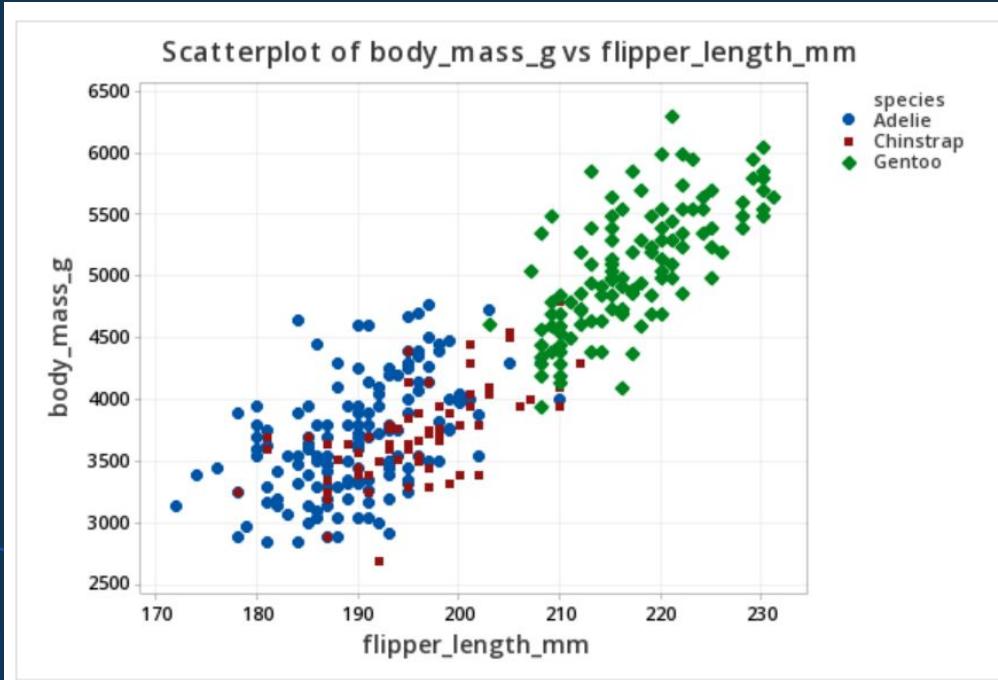
Pie chart

Good for plotting Categorical vs. Discrete data. Also great for getting a sense of proportions



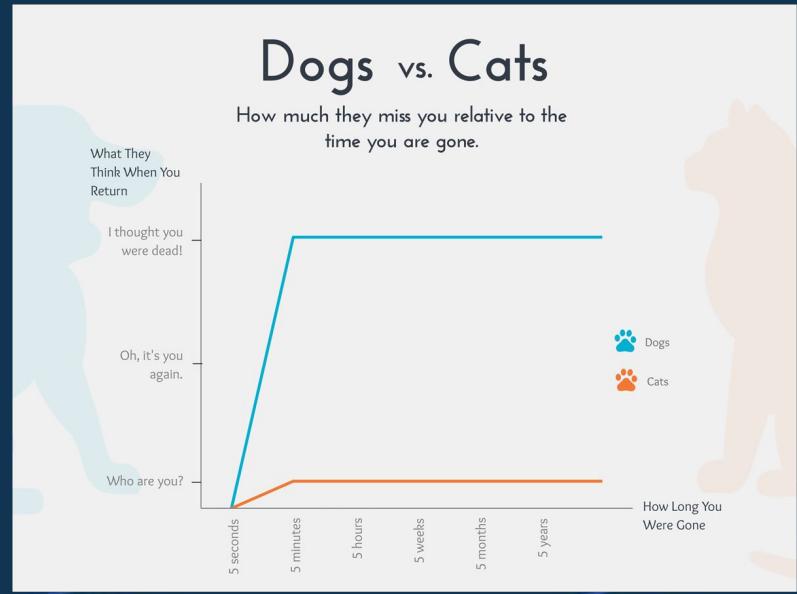
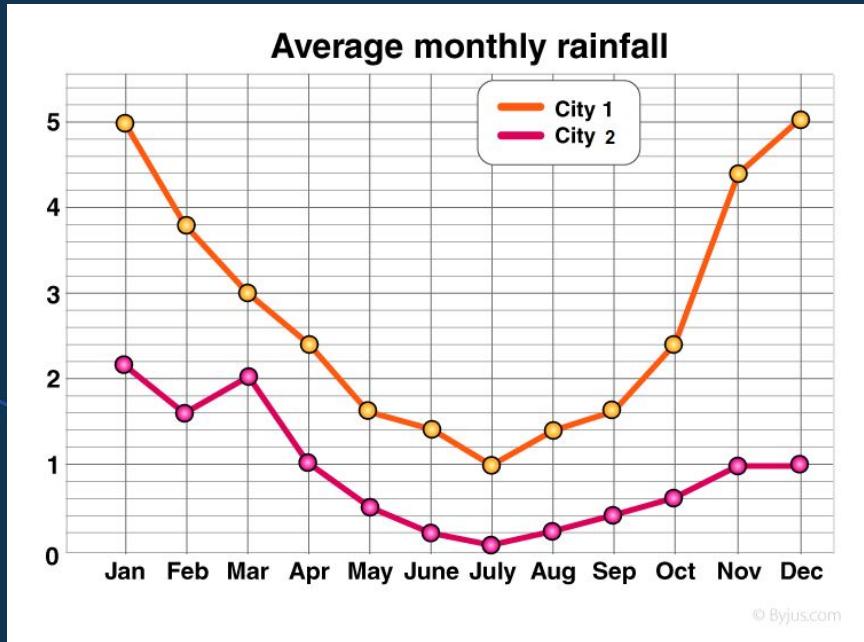
Scatterplots

Great for plotting Discrete vs. Discrete data or Continuous vs. Continuous data. Useful for finding relationships between variables.



Line graphs

Good for plotting Discrete / Continuous vs. Discrete / Continuous data or comparing with a Time Series.



Matplotlib

CoGrammar



Matplotlib

Installation

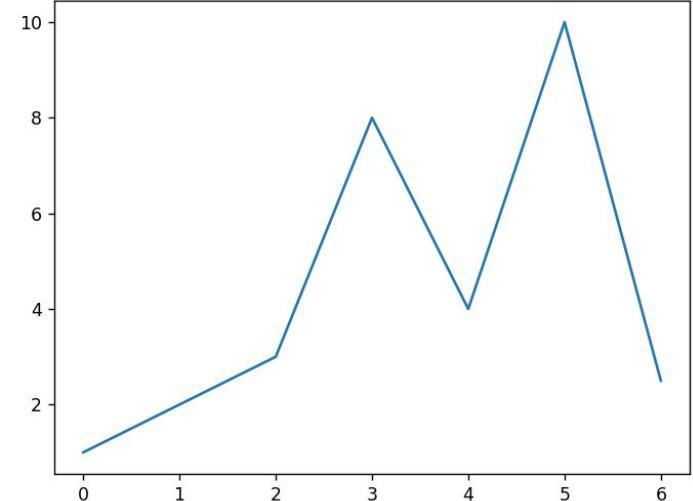
```
pip install matplotlib
```

Importing

```
import matplotlib.pyplot as plt
```

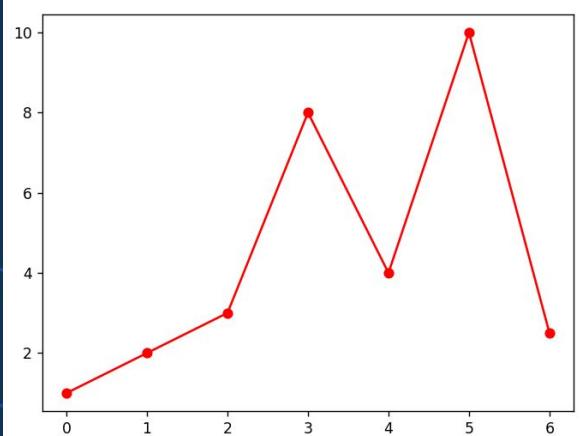
```
import matplotlib.pyplot as plt  
import numpy as np  
  
y whole points = np.array([1, 2, 3, 8, 4, 10, 2.5])  
  
plt.plot(y whole points)  
plt.show()
```

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Matplotlib

```
import matplotlib.pyplot as plt  
import numpy as np  
  
y whole points = np.array([1, 2, 3, 8, 4, 10, 2.5])  
  
plt.plot(y whole points, 'o-r')  
  
plt.show()
```



Markers

o = Circle, * = Star,
. = Point, x = Cross,
s = Square, d = diamond

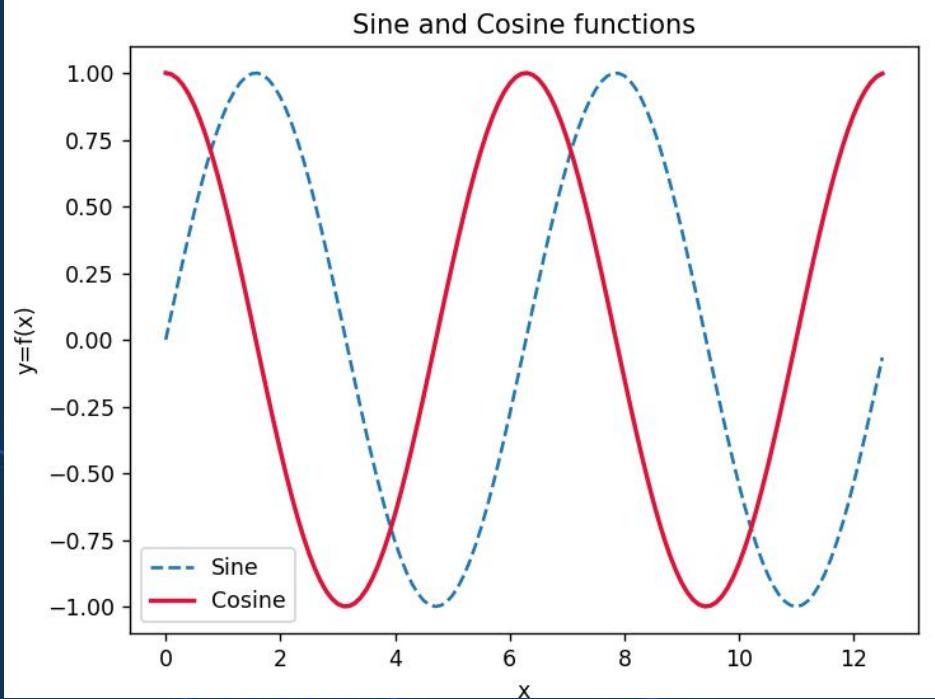
Linestyle ls

- Solid line
- : Dotted line
- Dashed line
- . Dashed/dotted line

Colour

List of colours
b = Blue, r = Red, g = Green,
c = Cyan, m = Magenta, y =
Yellow, k = Black, w = White

Matplotlib



```
import matplotlib.pyplot as plt
import numpy as np

pi = np.pi
# Creating x axis with range
#and y axis with sine/cosine
x = np.arange(0, 4*pi, 0.1)
y1 = np.sin(x)
y2 = np.cos(x)

#Plotting sine/cosine on the same plot
plt.plot(x,y1, label='Sine', ls='--')
plt.plot(x,y2, label='Cosine', lw=2, c='crimson')

#x-axis, y-axis Label, and plot title
plt.xlabel('x')
plt.ylabel('y=f(x)')
plt.title('Sine and Cosine functions')

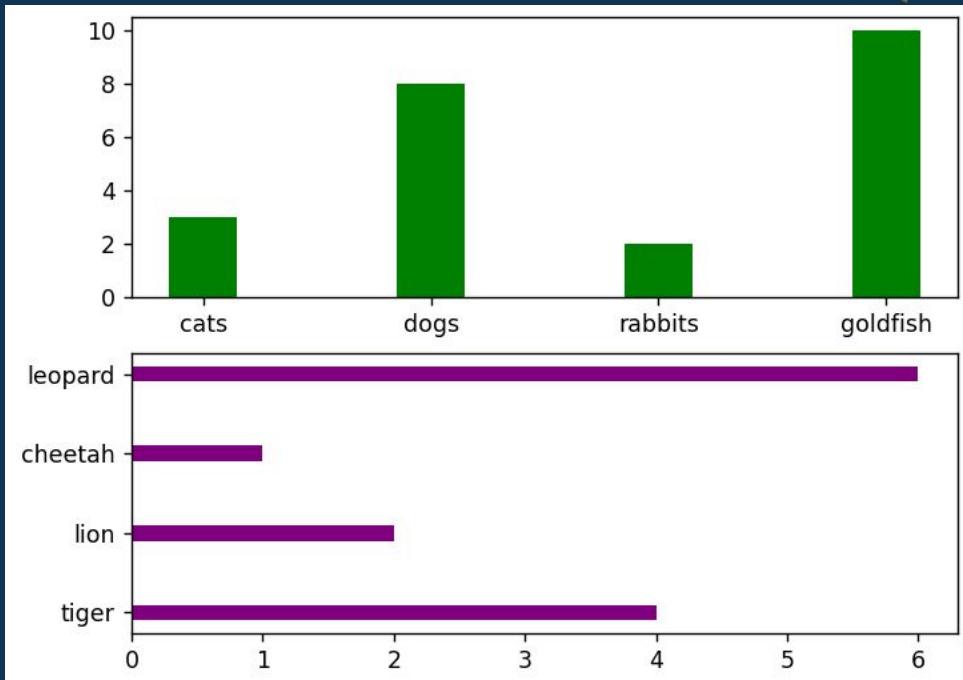
#Legend for the two curves
plt.legend()
plt.show() #plt.savefig('sine.png')
```

Matplotlib: Barplot

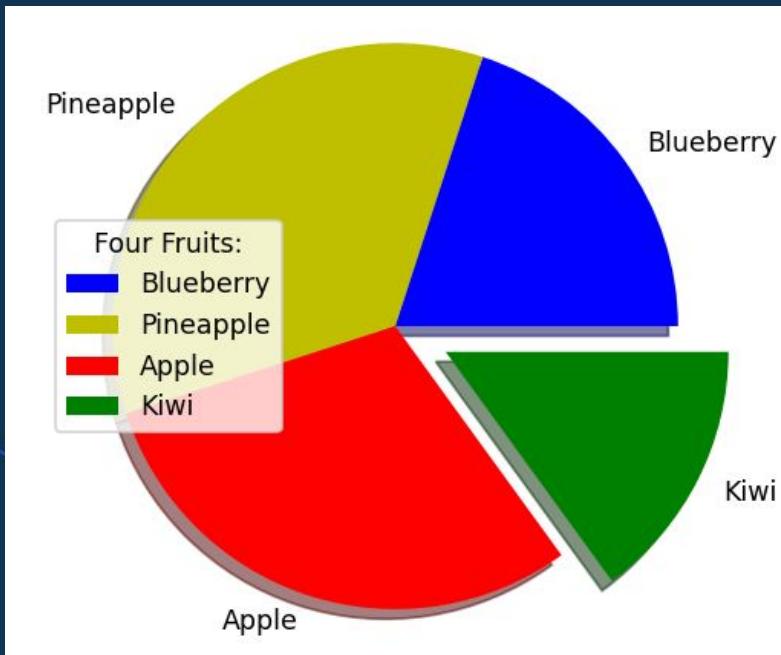
```
import matplotlib.pyplot as plt
import numpy as np

#x,y for 1st and 2nd barplots
x1 = np.array(["cats", "dogs", "rabbits", "goldfish"])
y1 = np.array([3, 8, 2, 10])
x2 = np.array(["tiger", "lion", "cheetah", "leopard"])
y2 = np.array([4, 2, 1, 6])

#SubPlot, parameters(rows, columns, index of current plot)
plt.subplot(2,1,1)
plt.bar(x1, y1, color = 'g', width=0.3)
plt.subplot(2,1,2)
plt.bart(x2, y2, color = '#800080', height=0.2)
plt.show()
```



Matplotlib: Pie chart



```
import matplotlib.pyplot as plt
import numpy as np

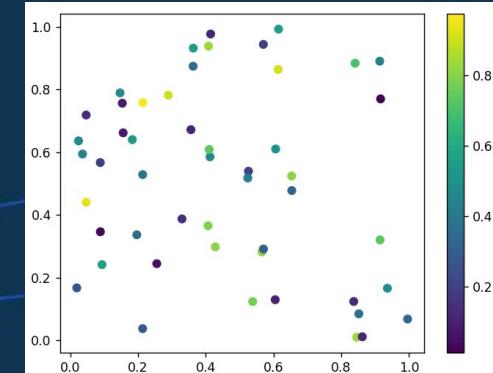
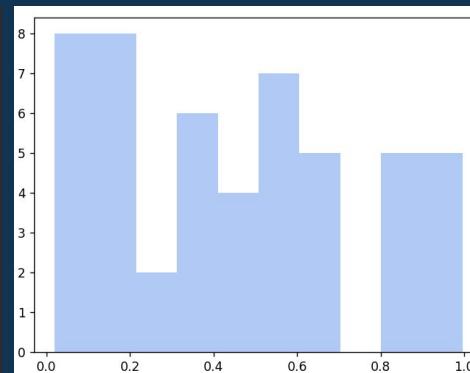
y = np.array([20, 35, 30, 15])
mylabels = ['Blueberry', 'Pineapple', 'Apple', 'Kiwi']
mycolors = ['b', 'y', 'r', 'g']
myexplode = [0, 0, 0, 0.2]

plt.pie(y, labels = mylabels, colors = mycolors,
        explode = myexplode, shadow = True)
plt.legend(loc='center left', title = "Four Fruits:")
plt.show()
```

Histograms & Scatterplots

A graph showing frequency distributions, the number of observations within each given interval.

```
N = 50  
x = np.random.rand(N)  
y = np.random.rand(N)  
colors = np.random.rand(N)  
  
plt.hist(x, color='cornflowerblue', alpha=0.5)  
plt.show()  
  
plt.scatter(x, y, c=colors)  
plt.colorbar()  
plt.show()
```



Let's take a break

CoGrammar



Advanced Visualisations

CoGrammar



Why advanced visualisation?

- ❖ Complex data demands **more sophisticated and flexible visual analysis** methods
- ❖ Answering **specific questions** sometimes requires **going beyond standard plots**.

Seaborn

CoGrammar



Seaborn

- ❖ **Matplotlib** is a low-level plotting library, create highly customizable visualizations.
- ❖ **Seaborn**, built on top of Matplotlib, is a high-level interface for creating statistical graphics, with a range of built-in statistical functions for complex statistical analyses with the visualizations.
- ❖ Designed to work with **Pandas** dataframes

Seaborn

Installation

```
pip install seaborn
```

```
# Import seaborn, matplotlib
import seaborn as sns
import matplotlib.pyplot as plt

#Check available datasets
print(sns.get_dataset_names())

# Load an example dataset
peng_df = sns.load_dataset("penguins")
#Check the dataset
peng_df.info()
```

Importing

```
import seaborn as sns
```

- ❖ `load_dataset()` is like `pd.read_csv()`

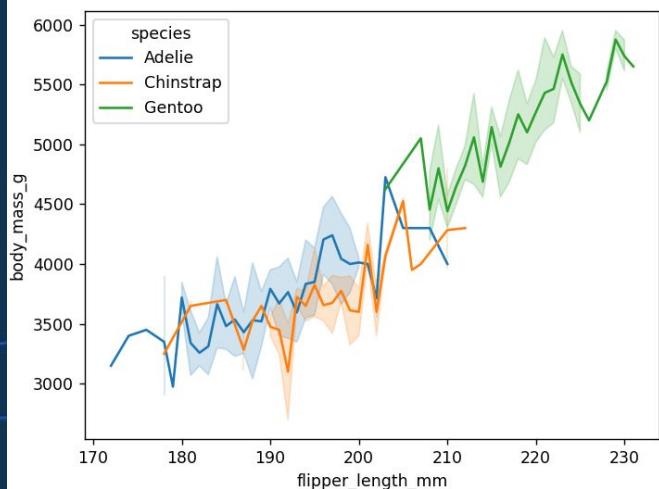
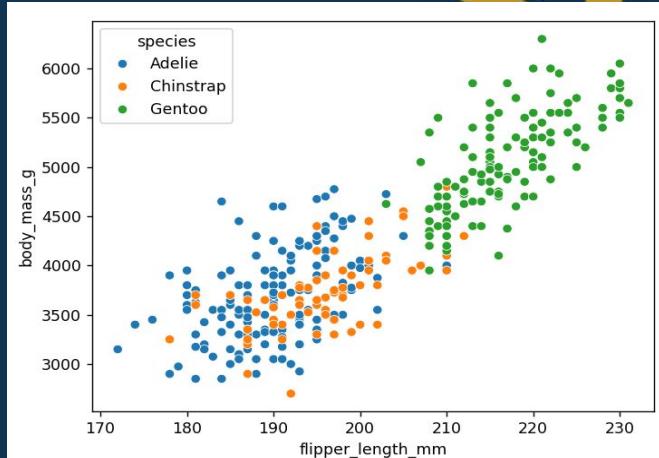
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 344 entries, 0 to 343
Data columns (total 7 columns):
 #   Column           Non-Null Count  Dtype  
 ---  -- 
 0   species          344 non-null    object 
 1   island            344 non-null    object 
 2   bill_length_mm    342 non-null    float64
 3   bill_depth_mm    342 non-null    float64
 4   flipper_length_mm 342 non-null    float64
 5   body_mass_g       342 non-null    float64
 6   sex               333 non-null    object 
```

Seaborn plots

Scatter and Line plots

```
#Scatterplot
sns.scatterplot(x="flipper_length_mm", y="body_mass_g",
                 data=peng_df, hue="species")
plt.show()

#Lineplot
sns.lineplot(x="flipper_length_mm", y="body_mass_g",
              data=peng_df, hue="species")
plt.show()
```



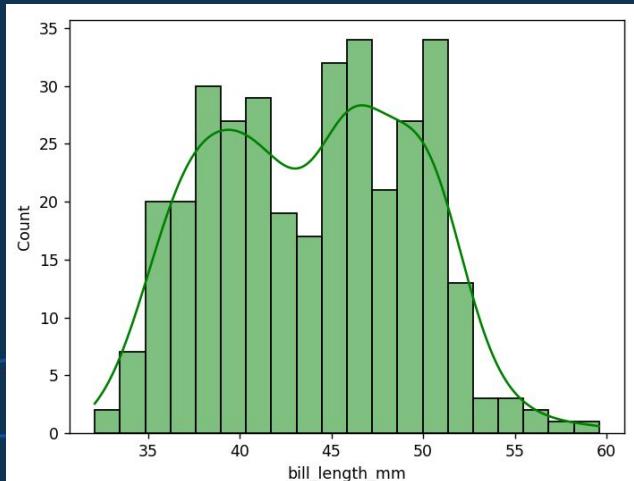
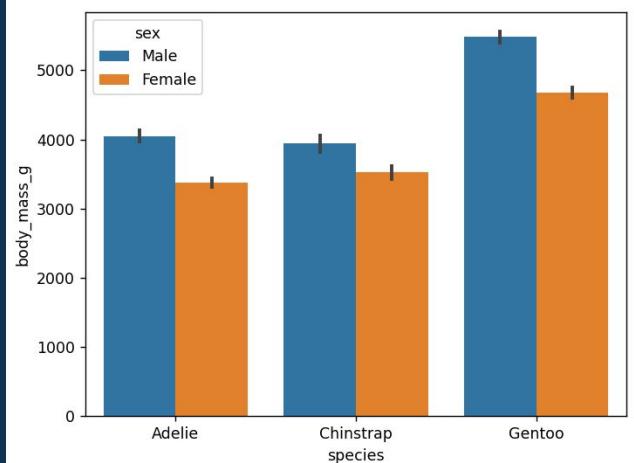
- ❖ If not in Jupyter or IPython notebook, explicitly call `matplotlib.pyplot` for displaying the plot

Seaborn plots

Bar plots and histogram

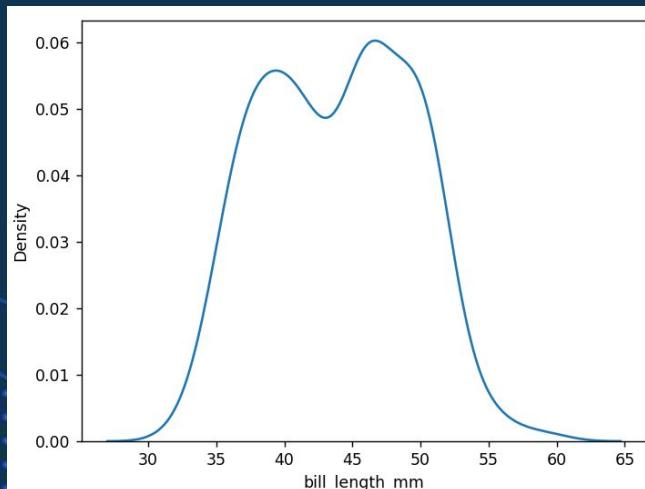
```
#BarPlot  
sns.barplot(x="species", y="body_mass_g",  
             hue="sex", data=peng_df)  
plt.show()
```

```
#Histogram  
sns.histplot(x="bill_length_mm", data=peng_df,  
             bins=20, kde=True, color="green")  
plt.show()
```



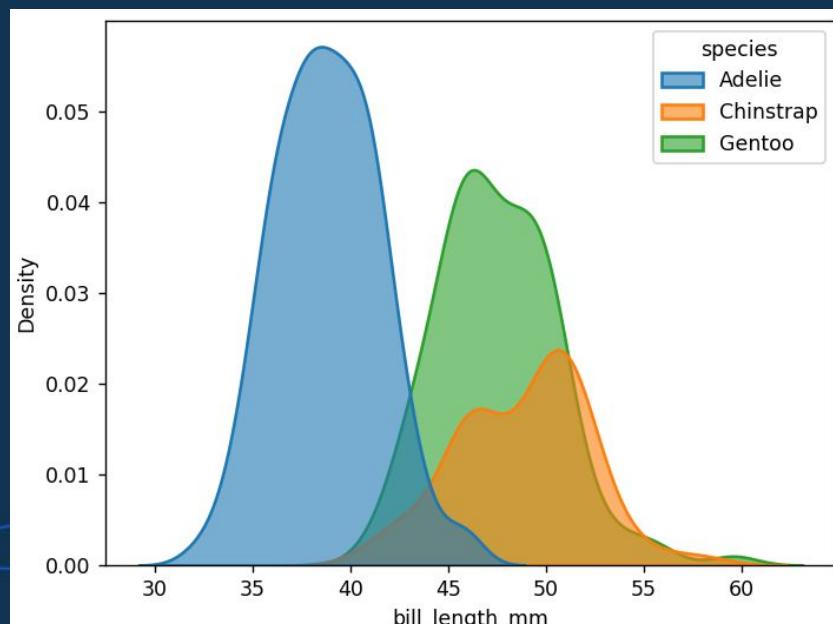
Seaborn plots

```
#Kernel density plot  
sns.kdeplot(data=peng_df, x="bill_length_mm")  
plt.show()  
sns.kdeplot(data=peng_df, x="bill_length_mm",  
             hue="species", fill=True, alpha=0.6,  
             linewidth=1.5)  
plt.show()
```



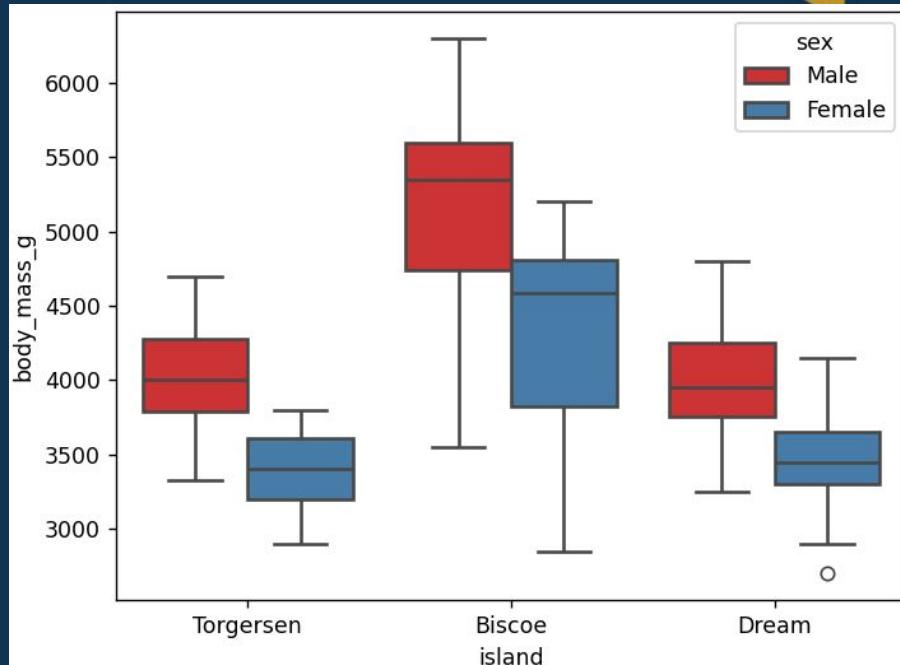
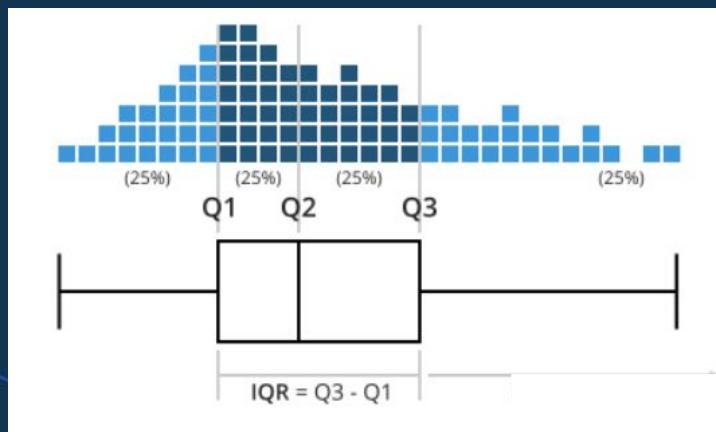
Kernel density plots:

Smooth curves representing density of data points, great for comparing distributions of several groups.



Seaborn plots

Boxplot

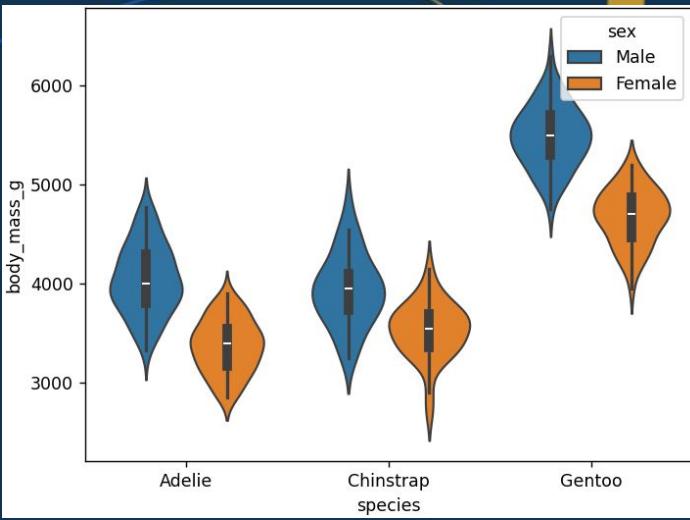


```
#BoxPlot
sns.boxplot(x="island", y="body_mass_g", hue="sex",
             data=peng_df, palette="Set1", Linewidth=1.5)
plt.show()
```

Seaborn plots

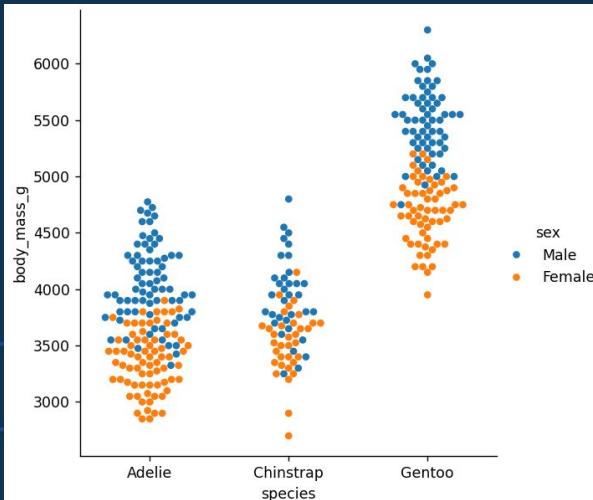
Violinplot: Combine aspects of KDEs and boxplots, ideal for showing density alongside summary statistics.

```
#Violinplot  
sns.violinplot(x="species", y="body_mass_g",  
hue="sex", data=peng_df)  
plt.show()
```



Categorical plot

```
#Categorical plot  
sns.catplot(data=peng_df, kind="swarm",  
x="species", y="body_mass_g", hue="sex")  
plt.show()
```



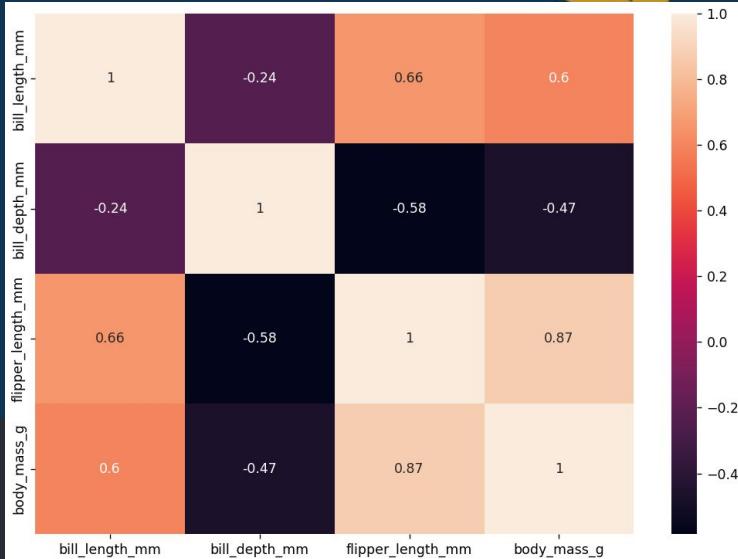
Seaborn plots

Heatmap

Color-coded matrices excellent for **revealing structure, highlighting correlations, and identifying clusters.**

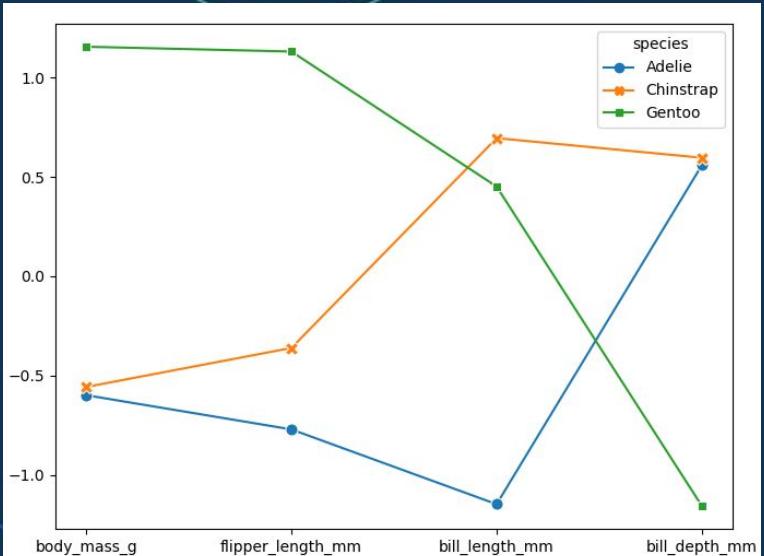
```
#Heatmap
# Create correlation between variables (floats only)
print(peng_df.dtypes)
peng_float = peng_df.select_dtypes(include=[np.float64])
corr = peng_float.corr()

#Plot
plt.figure(figsize=(10,7))
sns.heatmap(corr, annot=True)
plt.show()
```



Customization in heatmaps is key for optimal interpretation.

Parallel coordinates



- ❖ Show many dimensions on the same plot
- ❖ Each feature has a vertical axis, data points become lines crossing them.
- ❖ Ideal when you have many interrelated variables and need to spot outliers or group characteristics.

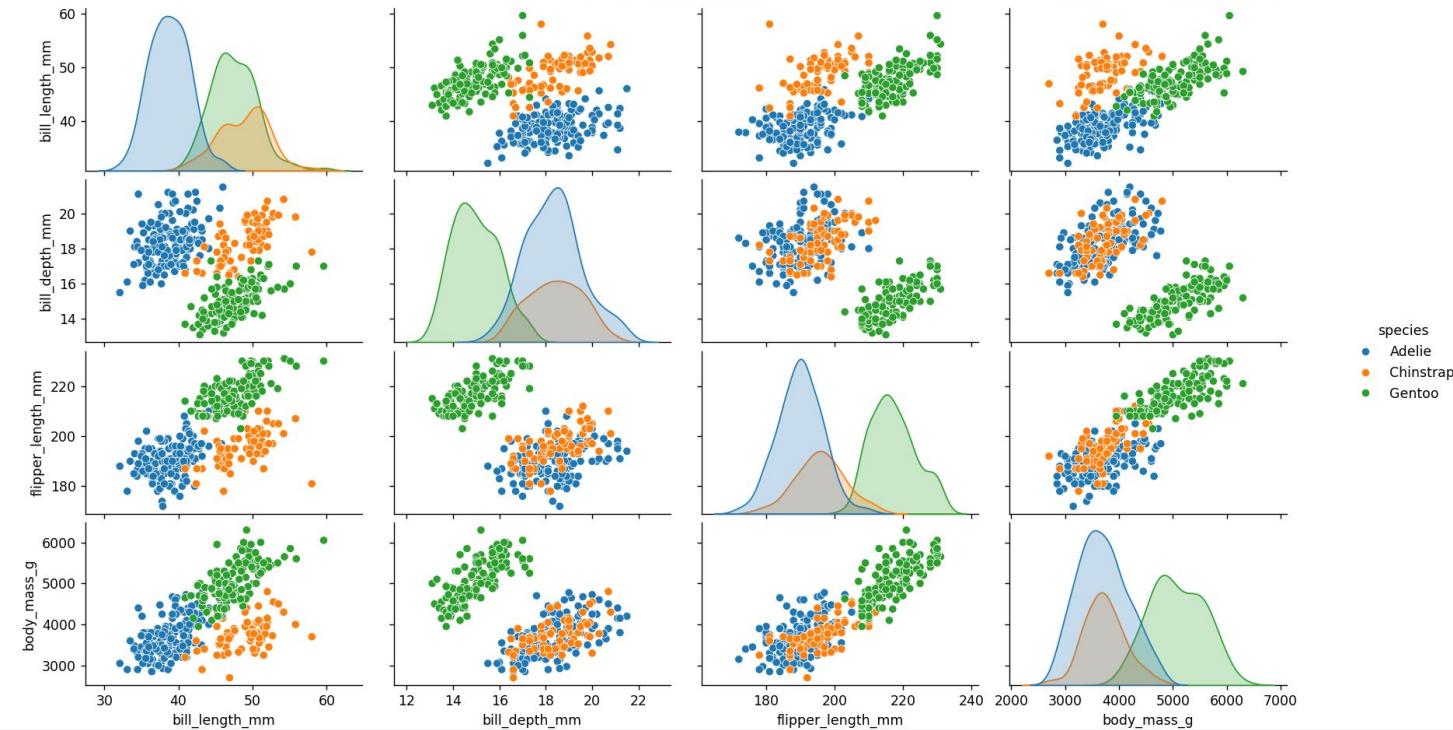
```
#Parallel coordinates
# Calculate the average values for each continent
average_data = peng_df.groupby('species')[['body_mass_g', 'flipper_length_mm',
                                             'bill_length_mm','bill_depth_mm']].mean()

# Normalize the data for better visualization
normalized_data = (average_data - average_data.mean()) / average_data.std()

# Create parallel plot
plt.figure(figsize=(8, 6))
parallel_plot = sns.lineplot(data=normalized_data.transpose(),
                             dashes=False,
                             markers=True,
                             markersize=8)
plt.show()
```

Seaborn plots

Pairplot



#Pairplot

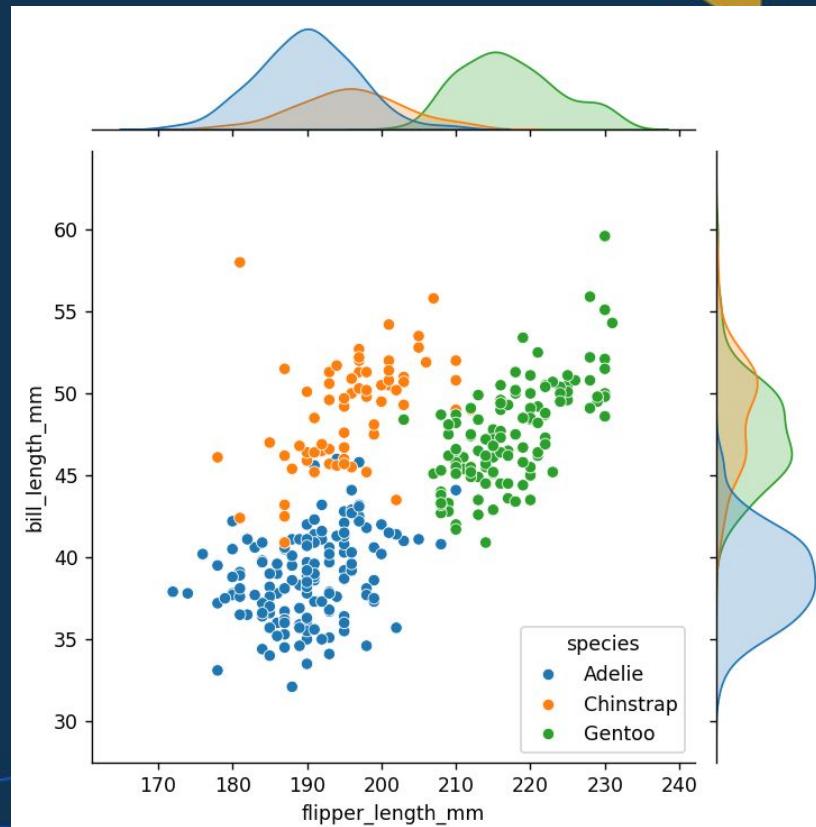
```
sns.pairplot(peng_df, hue="species")  
plt.show()
```

Compact way to depict pairwise relationships between several variables simultaneously.

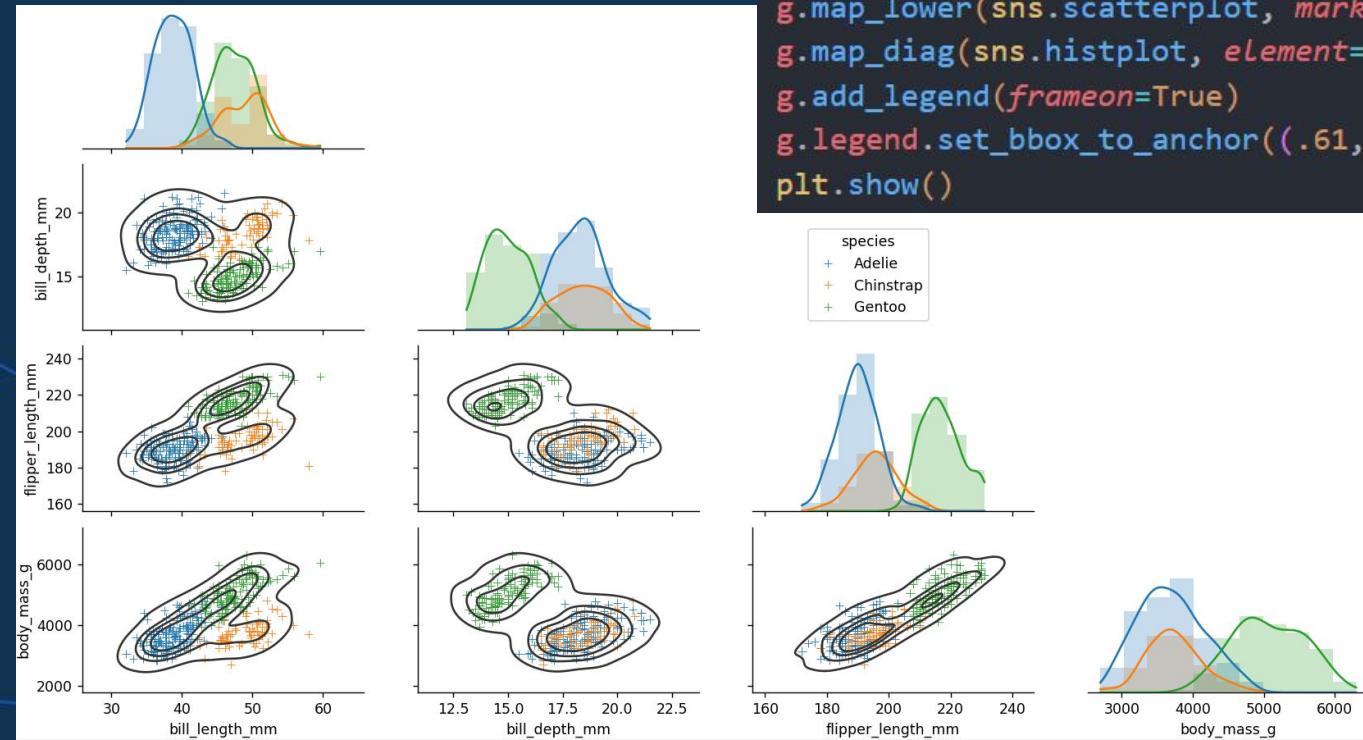
Seaborn plots

Jointplot

```
#Jointplot  
sns.jointplot(data=peng_df, x="flipper_length_mm",  
                y="bill_length_mm", hue="species")  
plt.show()
```

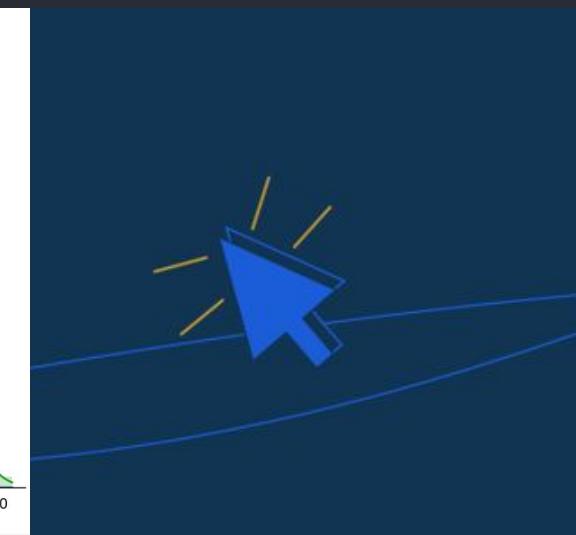


Combination plots

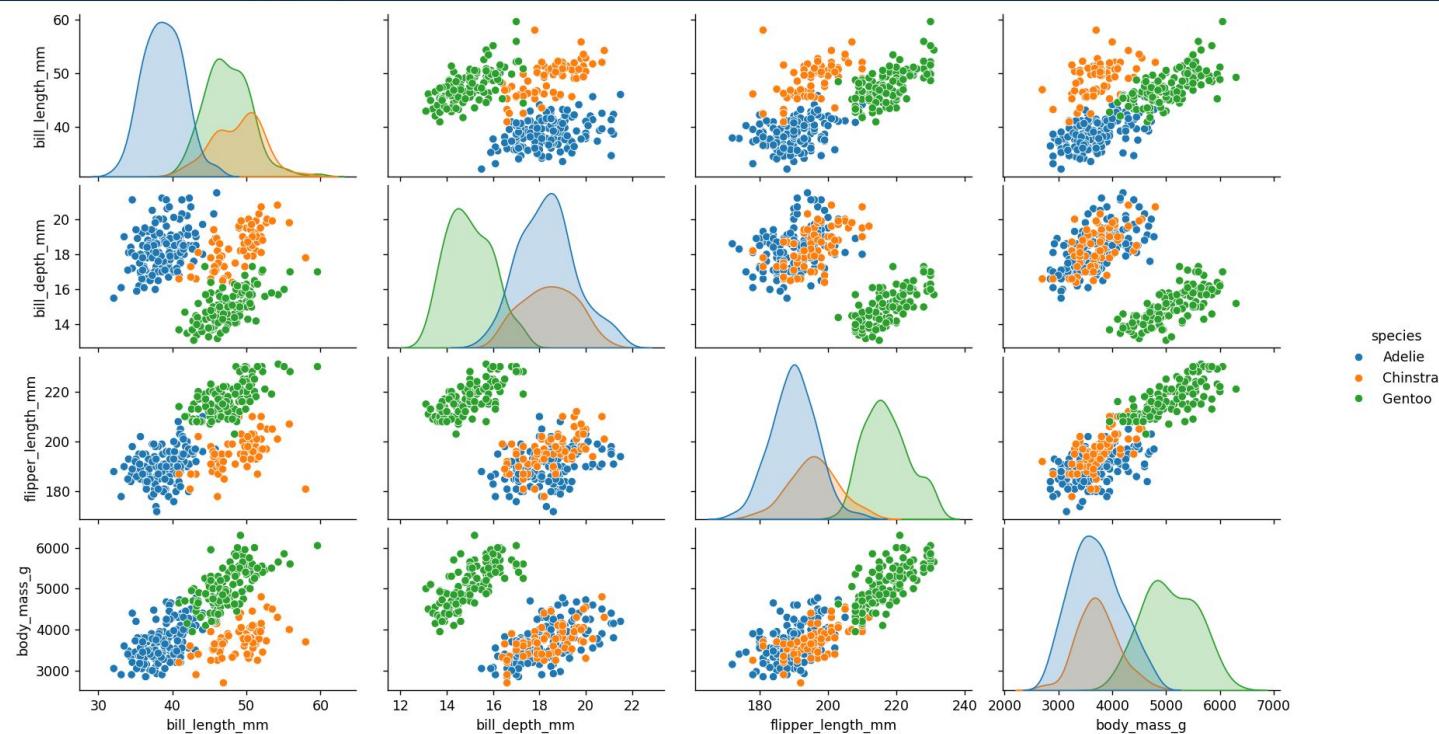


#Combination plots

```
g = sns.PairGrid(peng_df, hue="species", corner=True)
g.map_lower(sns.kdeplot, hue=None, Levels=5, color=".2")
g.map_lower(sns.scatterplot, marker="+")
g.map_diag(sns.histplot, element="step", Linewidth=0, kde=True)
g.add_legend(frameon=True)
g.legend.set_bbox_to_anchor((.61, .6))
plt.show()
```



Visualisation analysis



Gentoo, on average

- ❖ Higher body mass, flipper length
- ❖ Lower bill depth

Adelie has lower bill length on an average



Summary

- ❖ **Visual perception**
 - **Pre-attentive attributes** (color, position, size, shape) are quickly processed by our brains. **Use them deliberately for emphasis.**
 - **Our brains group visual elements automatically;** leverage this fact by using **spatial arrangement, similarity, and clear layout** to reinforce the **key takeaways** of your visualization.
- ❖ **Less is More**
 - **Clear labels, thoughtful color choice, and minimal clutter** improve the impact of your visual message. Unnecessary embellishment creates a distraction.

Summary

- ❖ **Chart Choice vs. Your Question**
 - Comparing **individual values**? **Bar charts**, or **dot plots**.
 - Analyzing **trends over time**? **Line charts**.
 - Interested in **proportions of a whole**? **Pie charts**, **treemaps**
 - Focus on **relationships between variables**? **Scatter plots** (and their extensions) and **heatmaps**.

Resources

- ❖ Matplotlib:
https://matplotlib.org/stable/gallery/color/named_colors.html
https://matplotlib.org/stable/api/pyplot_summary.html
- ❖ Seaborn examples:
<https://seaborn.pydata.org/examples/index.html>
- ❖ If SSL error while getting Seaborn built-in data, download the data csv file from here - <https://github.com/mwaskom/seaborn-data>
- ❖ Resources to be installed for tutorial: **Python, NumPy, Pandas, Jupyter Notebook, Matplotlib, Seaborn**

Which method is best for handling missing data in small datasets?

- A. Deleting rows with missing values
- B. Imputing values with the dataset mean or median
- C. Ignoring the missing data
- D. Duplicating rows to fill gaps

What is the best way to detect outliers?

- A. Sorting data manually
- B. Using boxplots or statistical measures
- C. Ignoring extreme values
- D. Counting rows with missing values

Questions and Answers

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Thank you for attending

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