



Lesson 6:

Environmental Monitoring

Data Analysis

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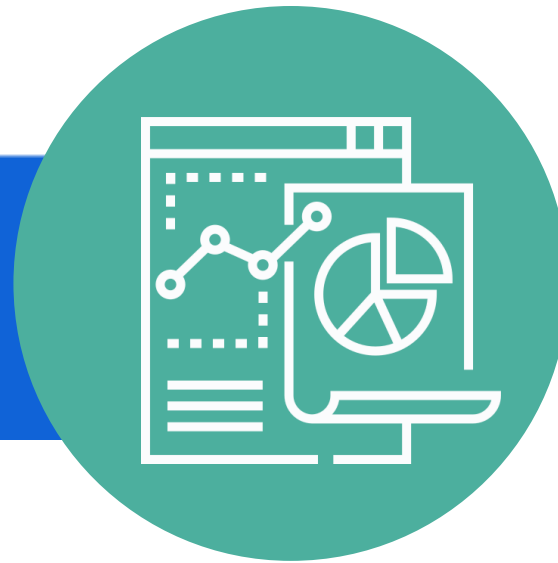


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Lesson Objectives

Understand basic concepts of
data analysis



Understand how data analysis relates
to Environmental Monitoring



Analyse the data collected during the Use Case 2 Mission!



Data Analysis



What is Data analysis?

Defintion: Data Analysis is the process of inspecting, transforming and modeling gathered data to extract useful information.

Main Purpose: The purpose of data analysis is to utilize the information in order to reach helpful conclusions and make informed decisions.

Benefits of Data Analysis for Environmental Monitoring

1 Detection

- Environmental monitoring wants to detect pollution levels, climate patterns, changes in biodiversity and other negative environmental impacts of human activity.
- While the data collection process is imperative, detecting the parameters of such issues is only possible through data analysis and result interpretation to understand, where, how, why and when those negative effects appear.

2 Informed Decision Making

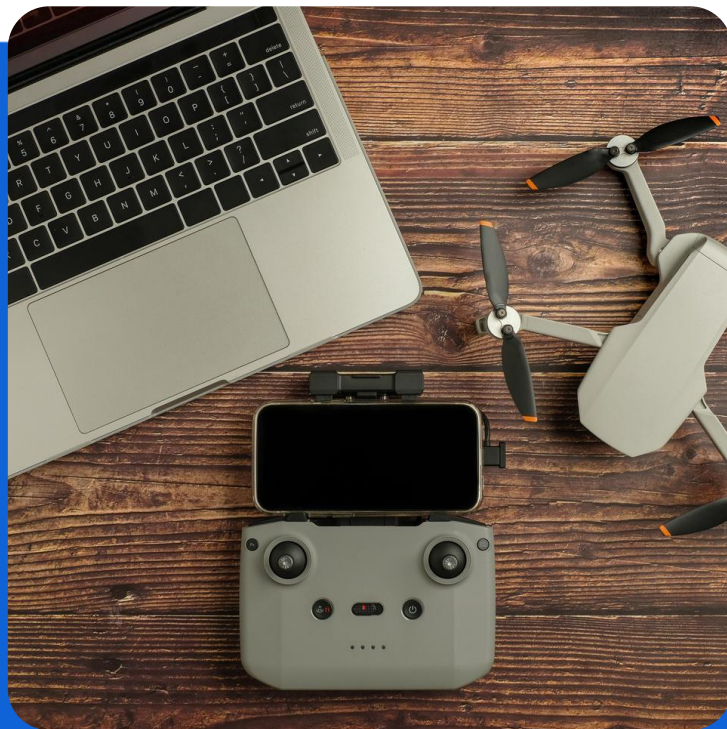
- Scientists, policy makers, government officials, are constantly making decisions that have effects on the environment.
- Through data analysis, there is ample information to direct those decisions towards a beneficial and effective course.

3 Accountability

- Entities that cause negative environmental effects must be held accountable.
- Through the data analysis process that detects issues and their parameters, accountability can be

Transferring Data: Methods

- Wireless Transmission: Using Wi-fi or bluetooth is convenient for real-time data transfer. Connecting the drone with a device such as a computer wirelessly will allow the data to slowly transfer from one to the other.
- SD Cards: SD cards are removable and make it easy to transfer large amounts of data between devices. They are also quite versatile. Using an SD card involves removing it from the drone and connecting it with a device such as a computer to transfer the data.



Transferring Data: Challenges

Potential Data Loss

During data transfer, wireless or not, it is potential for data to be lost. This can occur for a variety of reasons, like:

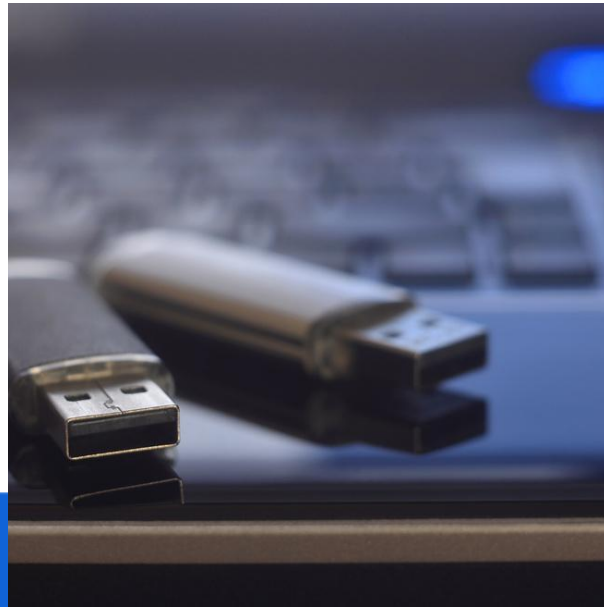
- Lost wireless connection, where the entirety of the data was unable to be transferred due to lost wifi or bluetooth signal.
- Data corruption, where during transfer parts of the data become corrupted.

Privacy and Security

During and after transferring data, it is important to keep the information private and secure. To this end, it is advised that:

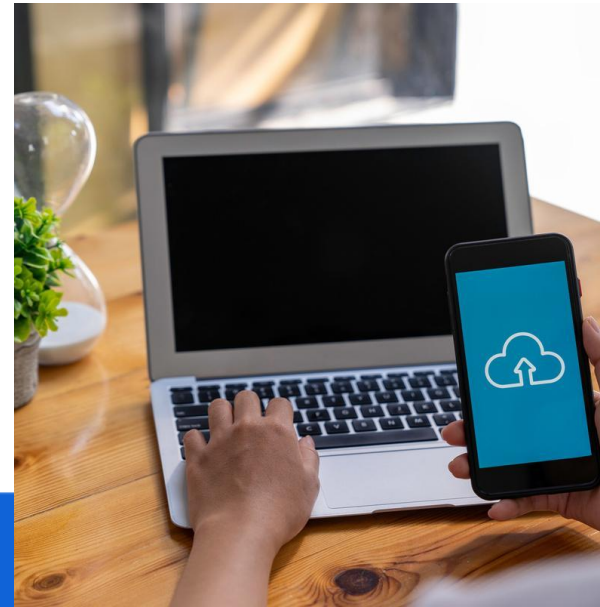
- Trusted networks are used during wireless transfer.
- Sensitive data is encrypted to remain safe in case of interference.

Storage and Organisation



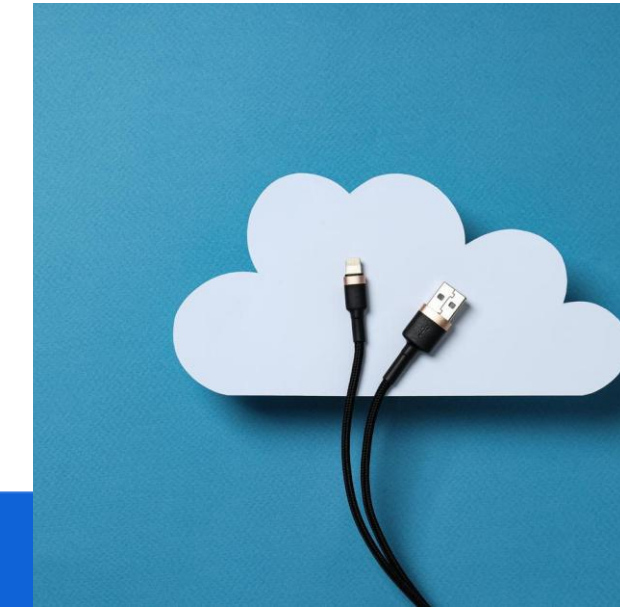
Local Storage

- Physical devices that allow full control over data and its security.
- Data is stored on site and accessible without an



Cloud Storage

- Remote servers that store data and make it accessible through the internet.
- Storage capacity can easily expand
- Convenient for sharing and



Tools and

Alternatives

- Local: Hard Drives, USB Drives, SD Cards
- Cloud: Google Drive, One Drive, Dropbox

Analysing Data: Preparation



Error Removal

Identify and correct any errors in data.

Ensure all data is expressed in the same formats and units



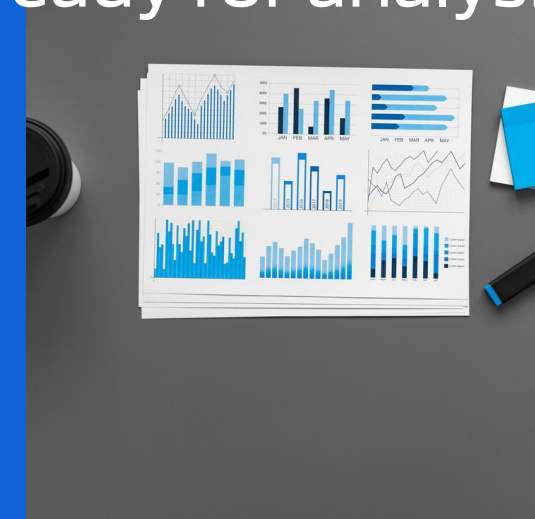
Inconsistencies



Filling Gaps

Identify and address missing data points.

Ensure data is properly formatted and ready for analysis



Formatting



Categorizing

Organise data into categories for better interpretation.

Analysing Data: Tools

Many types of data analysis tools exist. The most common ones are:

- Microsoft Excel: a widely used tool that can cover from basic to advanced data analysis
- Google Sheets: An accessible online spreadsheet tool
- GIS (Geographic Information Systems): Specialised software for spacial data analysis.

Many different tools exist that utilize GIS, like QGIS.



Analysing Data: Useful Operations

Operation	Excel Process/Function
Removing Duplicates	go to Data>Remove Duplicates
Sorting	go to Data>Sort
Calculating Mean	=AVERAGE(select range of cells)
Calculating Median	=MEDIAN(select range of cells)
Calculating Standard Deviation	=STDEV.S(select range of cells)

There are some very useful basic data operations used during data analysis.

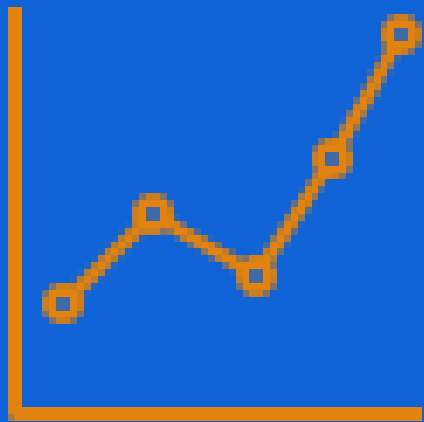
- Calculating the Mean, which is the average value of the data set.
- Finding the Median, the middle value after sorting the data.
- Calculating Standard Deviation, that measures the variation in the data.
- Sorting and Removing Duplicates

Analysing Data: Spotting Patterns

Using the data gathered during environmental monitoring, several useful trends and patterns can be identified.

- Seasonal Trends: Detecting changes in temperature, humidity and other measured values over time.
- Anomalies: Detecting unusual values.
- Correlations: Exploring and identifying relationships between different parameters. For example, correlating higher pollution levels with factory activity.

Analysing Data: Visualisation



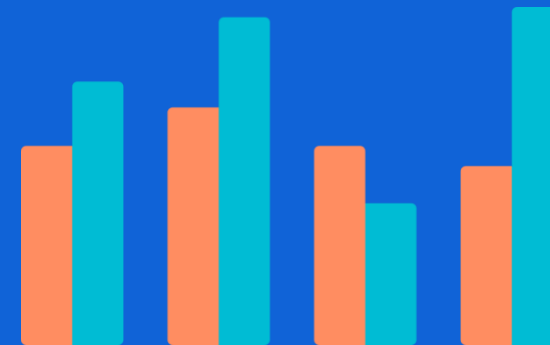
Line Plots

Show trends over time. Clear visualisation of data fluctuations

Comparing variables and showing relationships between data points.



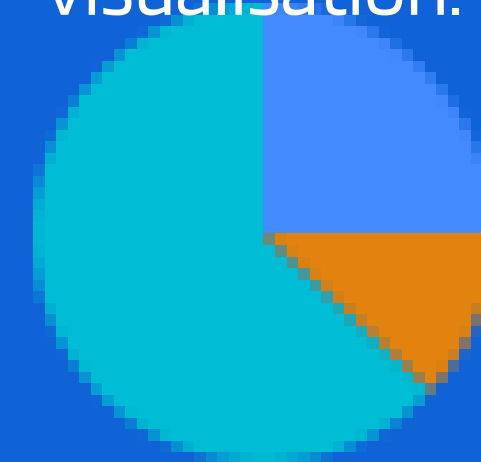
Spider Graphs



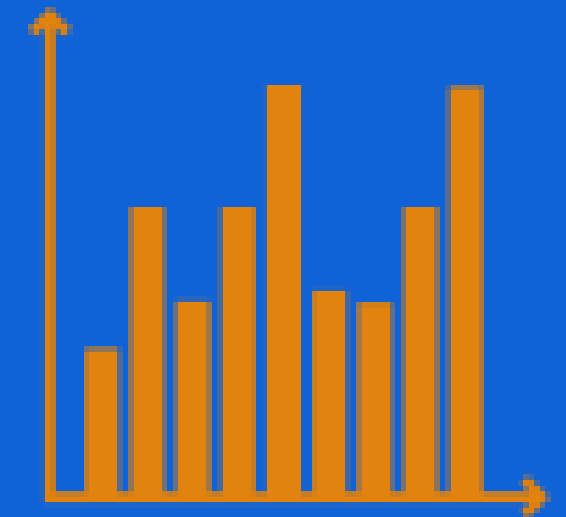
Bar Charts

Comparing quantities in different categories

Proportions and percentages within a whole. Clear distribution visualisation.



Pie Charts



Histograms

Organise data into categories for better interpretation.

Use Case 2 Mission: Exporting Data

(1)

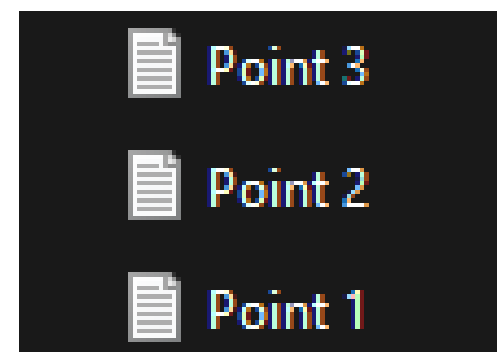
Point 1		Point 2		Point 3	
1	107	1	220	1	154
2	37.84	2	38.22	2	38.02
3	80	3	130		
4	71	4	71		
5	74	5	73		
6	-32.00	6	-32.00	6	-34.00
+ length 11 =		+ length 11 =		+ length 11 =	

Exporting Data

Picking up from where we left off with our program, now it is time to use the collected data!

In Mind+, right-clicking on the created lists brings up the option to Export, seen in (1). This will download a text file with the data of the list.

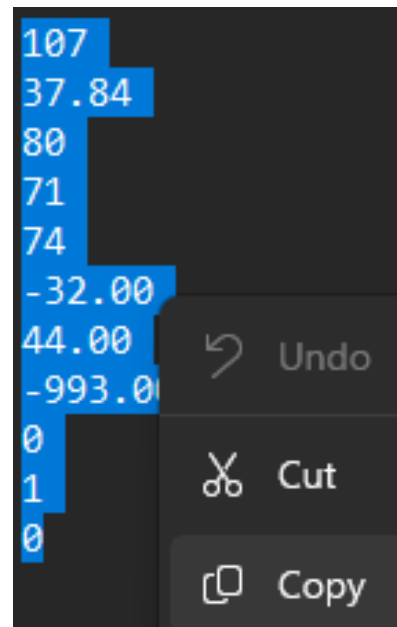
(2)



Repeat the process for each list and obtain 3 text files, seen in (2).

Use Case 2 Mission: Transferring Data

(3)



107
37.84
80
71
74
-32.00
44.00
-993.00
0
1
0

Undo
Cut
Copy

(4)

	Point 1	Point 2	Point 3
TOF Height			
Barometer Height			
Relative Height			
Motherboard Minimum Temp			
Motherboard Maximum Temp			
X Acceleration			
Y Acceleration			
Z Acceleration			
X Speed			
Y Speed			
Z Speed			

(5)

	Point 1	Point 2	Point 3
TOF Height	107	220	154
Barometer Height	37.84	38.22	38.02
Relative Height	80	130	120
Motherboard Minimum Temp	71	71	69
Motherboard Maximum Temp	74	73	72
X Acceleration	-32	-32	-34
Y Acceleration	44	9	4
Z Acceleration	-993	-1000	-945
X Speed	0	0	0
Y Speed	1	0	0
Z Speed	0	0	1

Creating an Excel File

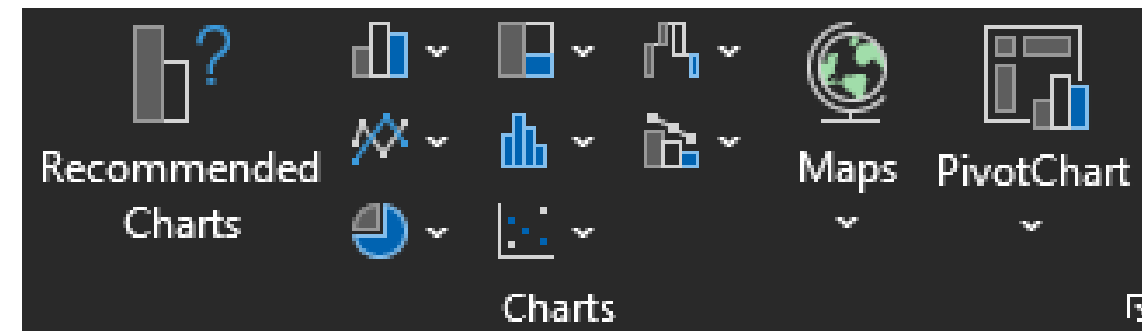
Each text file contains the values of the corresponding list. Opening the file allows us to copy the data, as seen in (3).

We will paste the data in the D4STEM UC2 Excel Template file, seen in (4). Any other excel file or data analysis software can be used as well.

Use Case 2 Mission: Data Visualisation

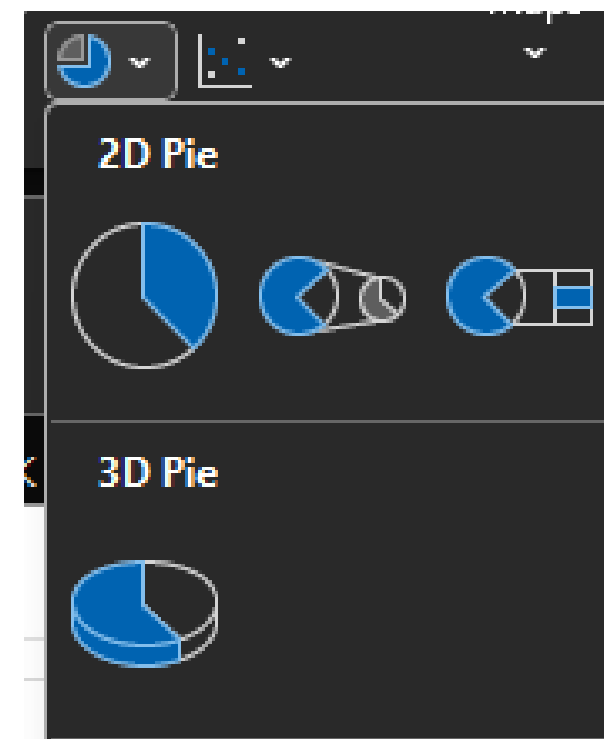
(6)

	Point 1	Point 2	Point 3
TOF Height	107	220	154
Barometer Height	37.84	38.22	38.02
Relative Height	80	130	120
Motherboard Minimum Temp	71	71	69
Motherboard Maximum Temp	74	73	72
X Acceleration	-32	-32	-34
Y Acceleration	44	9	4
Z Acceleration	-993	-1000	-945
X Speed	0	0	0
Y Speed	1	0	0
Z Speed	0	0	1



(7)

(8)



Creating a Graph

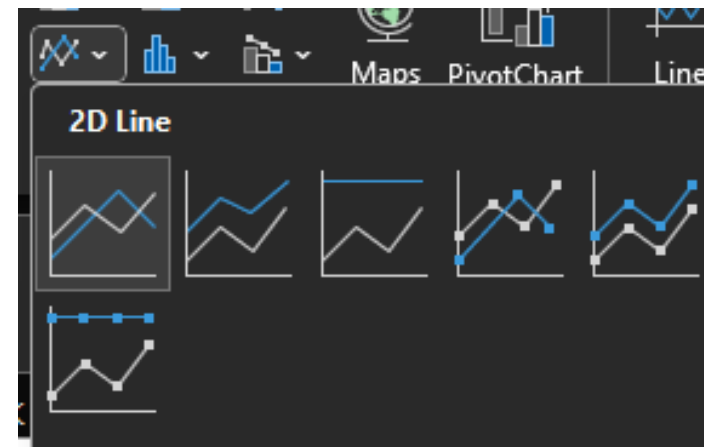
Step 1 of creating a graph in Excel is selecting the data we want to visualise. Clicking and dragging allows us to select our table, seen in (6).

Insert

In the **Insert** tab of the excel toolbar, we can choose from a selection of different graphs, seen in (7).

Use Case 2 Mission: Data Visualisation (2)

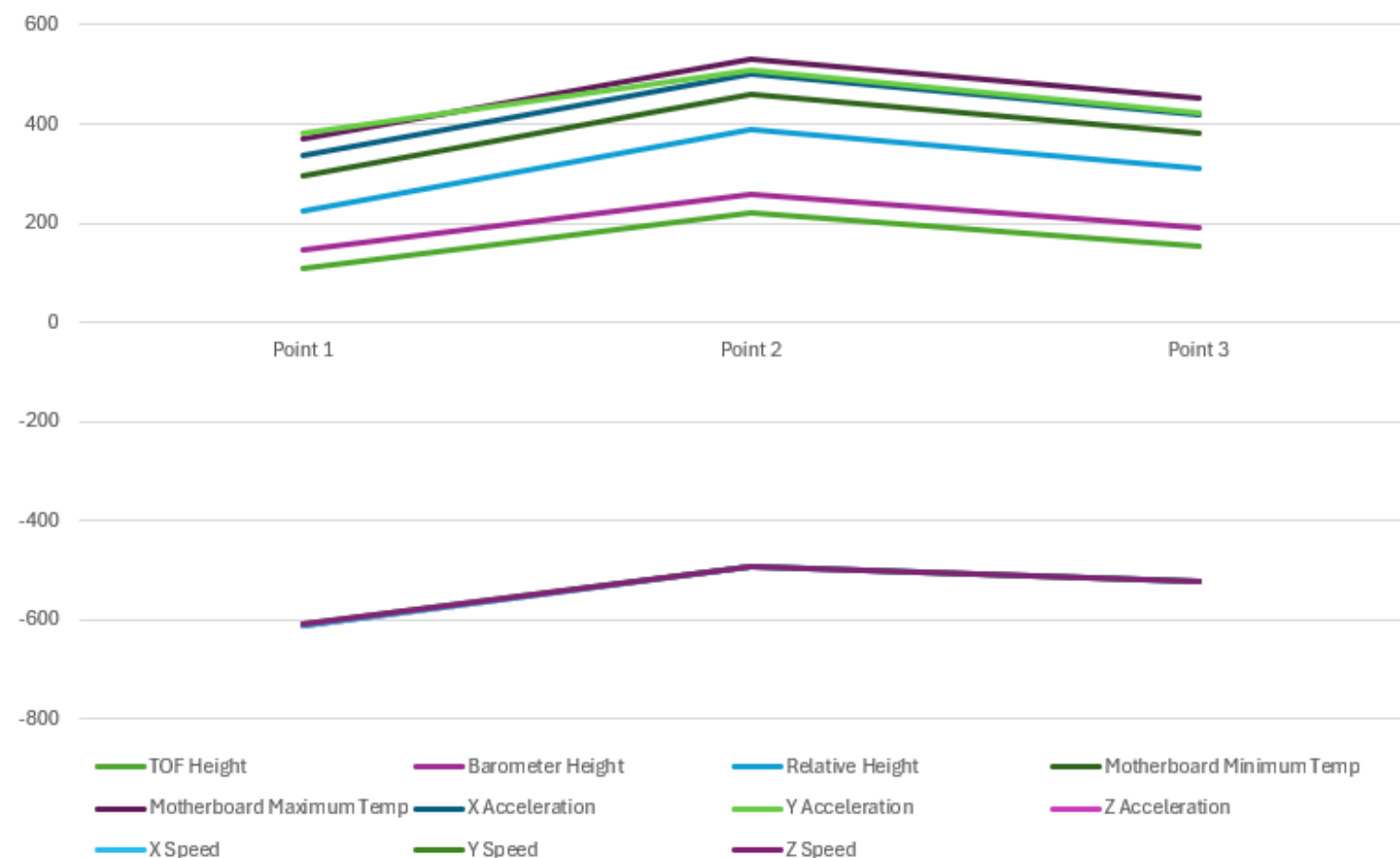
(9)



Creating a Line Graph

We measured the same values over different points during drone flight.

(10)

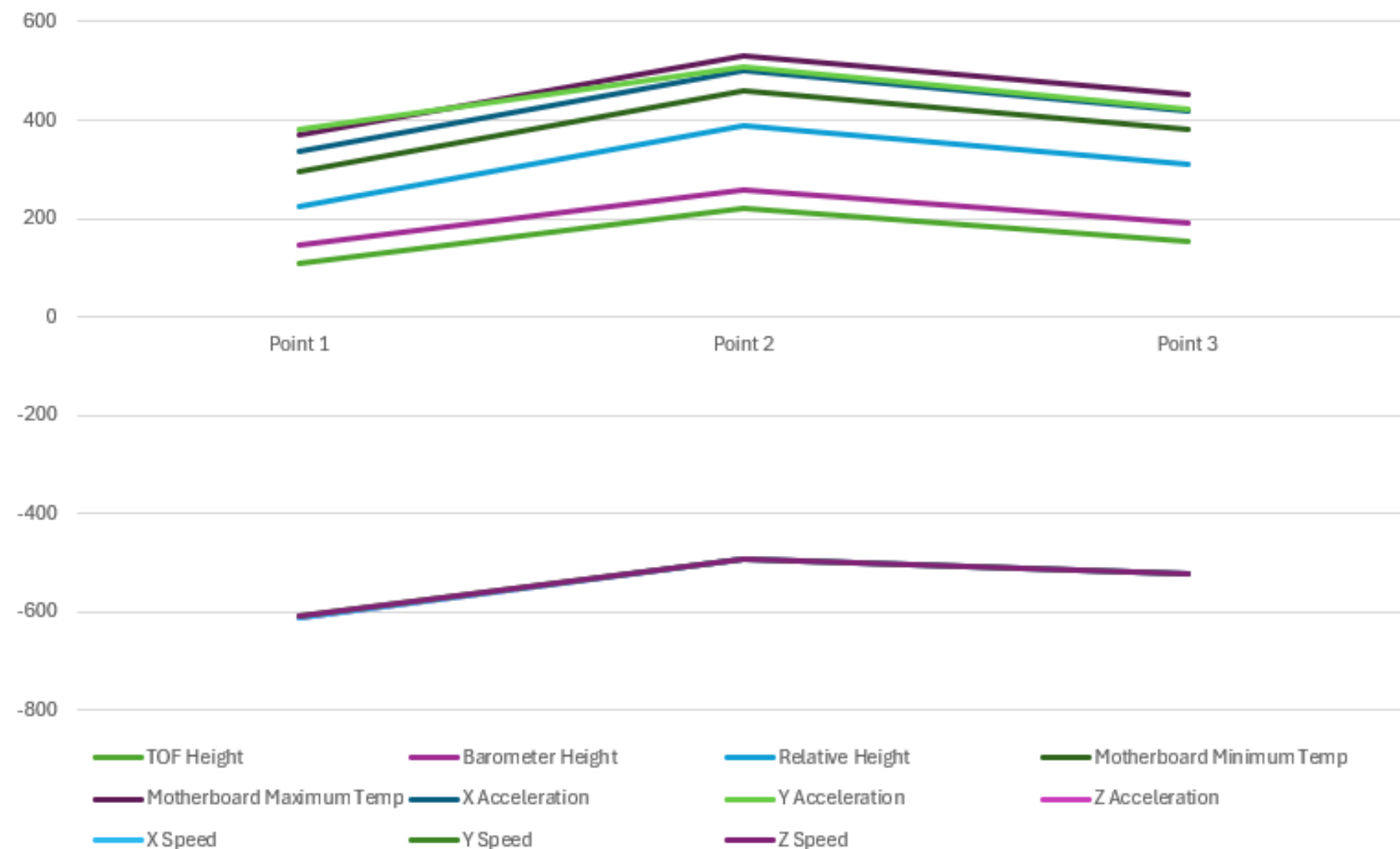


To compare how these values changed over time, a good option is a 2D line graph, seen in (9).

To get the visualisation we want, clicking on the graph, then , then [Select Data...](#) and choosing  [Switch Row/Column](#) is needed.

Use Case 2 Mission: Data Analysis

(11)



Understanding the Line Graph

In our line graph, each coloured line represents one of the different values measured in our program, through the drone's internal sensors.

By following each line, we can see how each value changed from Point 1, to Point 2, and Point 3.

The legend helps us understand which line corresponds to each value.

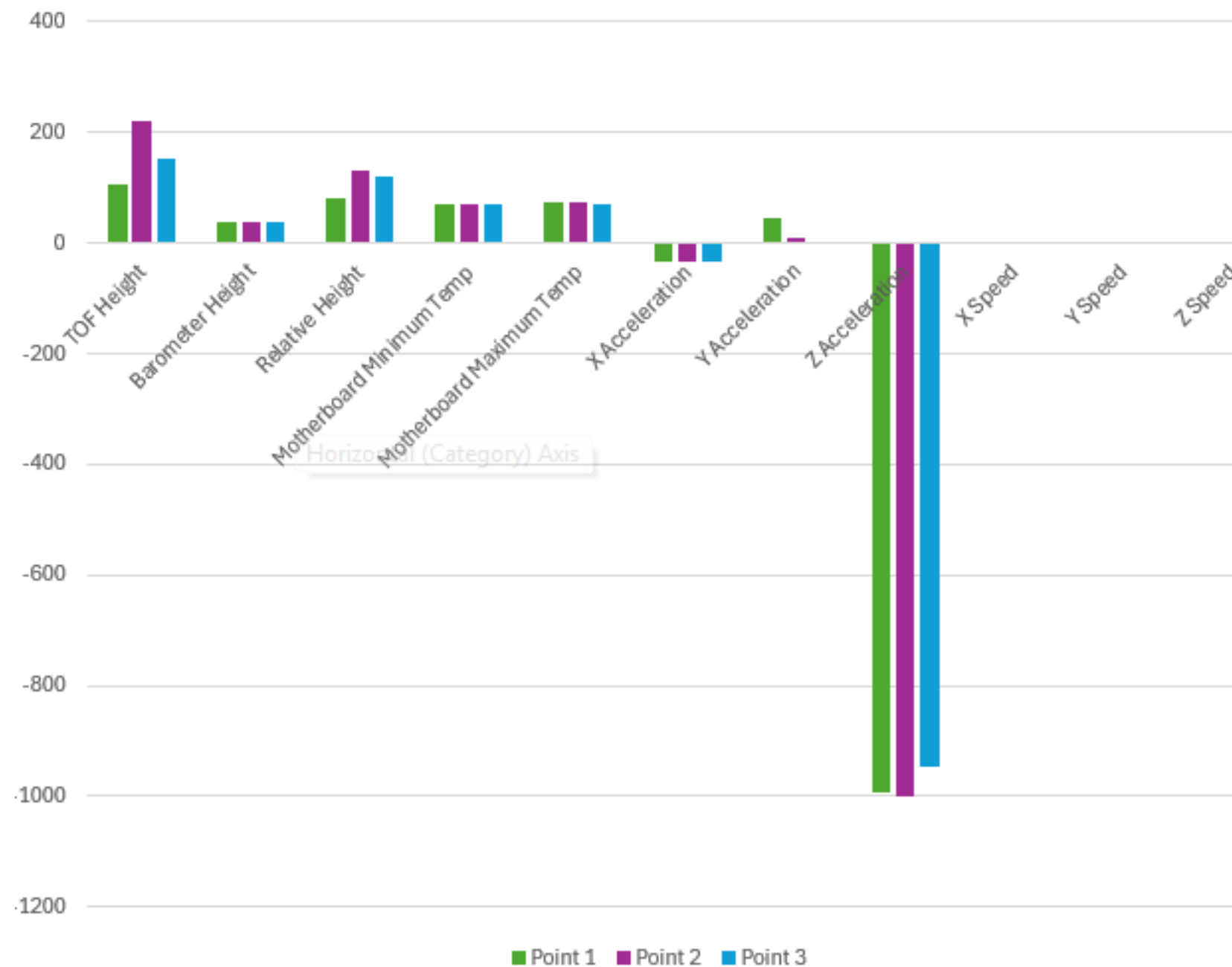
(e.g. X Acceleration is dark blue)

Through the graph, we can draw many conclusions:

- At Point 2, all variables had their highest value.
- All variables follow the pattern of Point 2 >

Use Case 2 Mission: Data Analysis (2)

(11)



Understanding the Bar Graph

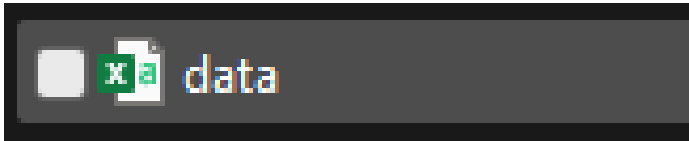
Lets create a Bar Chart the same way.

This time, the same variables are grouped together, and we can easily compare their value at each point.

What conclusions can you draw from this graph and how is it different from the previous one?

Experiment with different types of graphs, repeat the flight and compare graphs from different flights, and continue to develop your data analysis

Use Case 2 Mission: Bonus



New entry		
#####	Temp 23	Hum 47.5
New entry		
#####	Temp 24	Hum 53.9
#####	Temp 24	Hum 53.9
#####	Temp 24	Hum 53.9
#####	Temp 24	Hum 53.8
#####	Temp 24	Hum 53.9
New entry		
#####	Temp 24	Hum 54.7
#####	Temp 24	Hum 54.9
#####	Temp 24	Hum 54.8
#####	Temp 24	Hum 54.6
#####	Temp 25	Hum 54.4
New entry		
#####	Temp 25	Hum 54.3
#####	Temp 25	Hum 54.2
#####	Temp 25	Hum 54.0

Transferring data

The data measured in our bonus section through an external sensor is stored in an SDcard.

Removing this SD card from the Breakout Board and loading it into a computer lets us collect the .csv file with all the sensor measurements.

In the SD card, there will always be a data.csv file. If the file remains there, then the contents are separated by the line “New entry” for every new session. We can also transfer the data.csv file to the computer, and the program will create a new one for the next session!

The data in those .csv files can be visualised and analysed

Questions

- How does data analysis relate to problem solving?
- Why is it useful to move from numbers to visualisation through graphs?
- Can you think of an example in environmental monitoring using data collection and analysis?

What are your questions?



Additional Resources

Further Reading

[Environmental Data Science: An Introduction](#)

[Role of Data Science in Climate Change Monitoring](#)

Videos

[Ways to represent data | Data and statistics | 6th grade | Khan Academy](#)



Thank you for your
attention !



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