TOUR DE OAAR

END - TERM REPORT

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GOALS OF THE PROJECT

Telescope handling

Basic Telescope handling
Exploring the night sky

Softwares Of OAAR

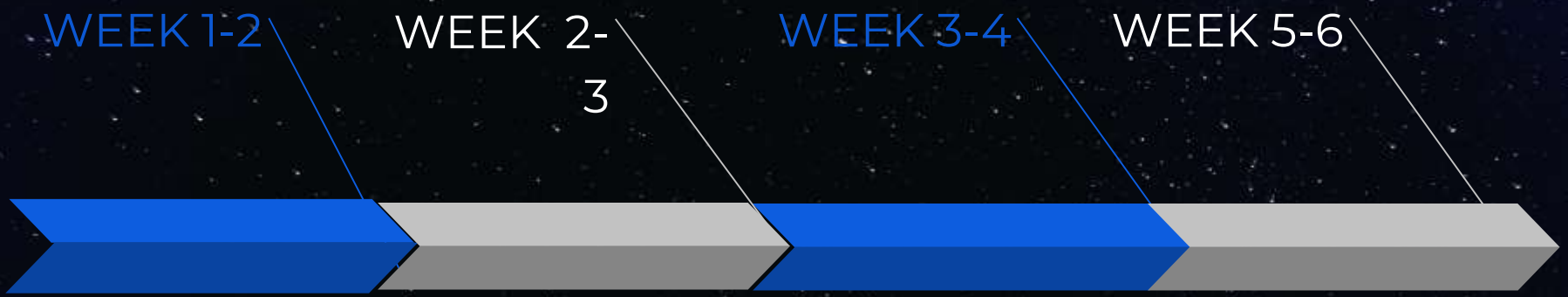
Arduino
MATLAB
Python Libraries (Numpy, Astropy)
DDW
FocusMax, ASCOM

Astrophotography

Mastering Astrophotography

Simulation

Universe Sandbox
Stellarium



- Coordinate system
- Telescope

- Observatory Tour
- Python
- Arduino
- Astrophotography
- Telescope Handling
- Intro to MATLAB

- MATLAB
- AUTOFOCUSER PHD2
- ASCOM
- RAINDROP SENSOR

- CELESTRON CPWI
- FOCUSMAX
- EOS UTILITY
- UNIVERSE SANDBOX

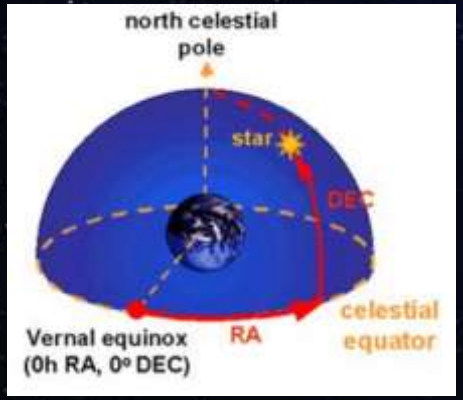
Week - 1

- Coordinate System
- Types of Telescope
- Parts of Telescope
- Types of Mounts

Intro to Coordinate Systems

- Equatorial Coordinate system
- Azimuthal Coordinate system
- Ecliptic Coordinate system
- Galactic Coordinate system
- Supergalactic Coordinate system

💡But why do we need so many coordinate systems if we already have cartesian and polar coordinate systems ?



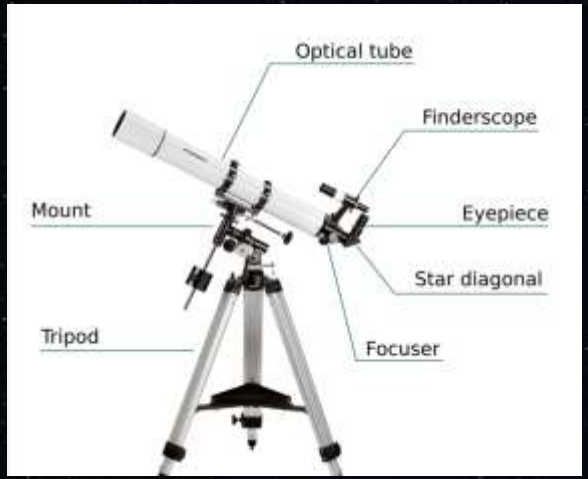
Coordinates in Equatorial coordinate system

Coordinates in Azimuthal coordinates

Telescopes

By using Telescopes, we can understand the different coordinate systems.

Types of Telescopes



Reflective Telescope
Uses Mirrors to converge light

💡 But when to use Reflecting one and when Refracting one?

Refracting Telescope
Uses lenses to converge light

Types of Mounts we have used

Azimuthal mount Telescope

Can we say which one is equatorial and which is Alt-Azimuth just by looking to the Telescope?

Equatorial Mount Telescope

Astrophotography :-

- Find the best location with minimum light pollution and clear night sky.
- Use a tripod and set exposure time to 10 seconds.
- Try to manually focus on the object.
- Try different composition and angles to take pictures.

ISO **SHUTTER SPEED**

FOCUS **BASIC EDITING**

ARYA **SOHEL** **NILAY**

VISHAKHA

AYAN

SIRI

Week - 2

- Observatory Tour
- Introduction to Python
- Introduction to basic
- Arduino

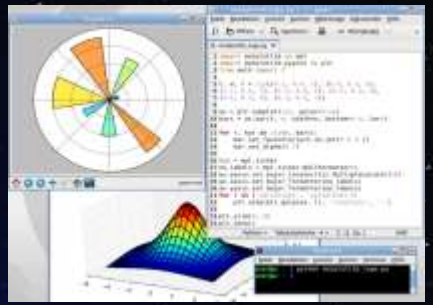
OBSERVATORY TOUR

GETTING CLOSER TO SPACE

Q. If we have telescopes in the club room why do we need an Observatory?

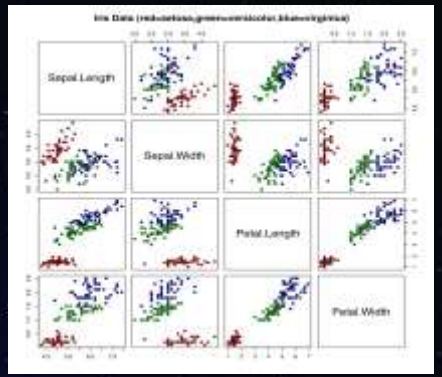
Why use Python?

- **Data Analysis and Visualisation** - Python's Matplotlib and Pandas libraries make it possible to visualise data in a clear and efficient way. Matplotlib provides a large selection of plots, enabling users to produce insightful visualisations quickly.
- **Interfacing with Astronomical software** - As a result of certain processing, whenever a certain modification was made in the ASCOM simulator, a matching change was made in the code. This code was then forwarded to the Arduino code, and the final changes were seen in the hardware's positions.



Continued…

- **Machine Learning and Simulations** - Due to its numerous libraries, like Scikit-learn and TensorFlow, which offer potent tools for model construction and deployment, Python is a popular choice for machine learning and simulations.
- **Huge collection of Libraries** - Effective numerical computations are made possible by Python's NumPy library, data management and analysis capabilities are provided by pandas, and astronomical data analysis and visualisation are made possible by Astropy.



Takeaways !!

- Basics including Functions
- **Numpy Library** : NumPy is a powerful Python library for scientific computing that provides support for large, multi-dimensional arrays and a wide range of mathematical functions.
- We learned about weather monitoring APIs.
- Additionally, we completed a task that gave us insight into the Numpy, recursion, and **JSON APIs**.

Arduino

Arduino is a free and open-source electronics platform that includes both hardware and software. The Arduino board, a development board with a microcontroller at its core, is what makes Arduino tick.

If we have so much fast and efficient computers why we need this small computer??

What is a Microcontroller??

- To operate electrical equipment, a microcontroller (a tiny computer on a single integrated circuit) is employed.
- It is equipped with a CPU, memory, and input/output devices.

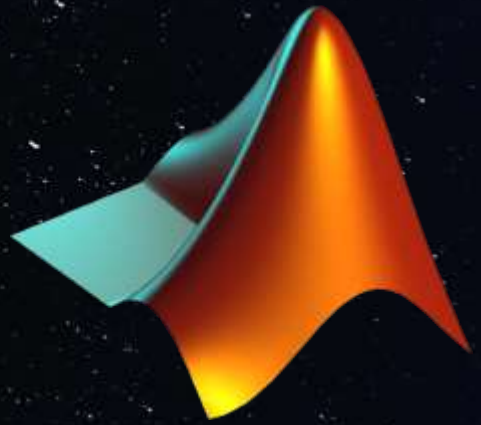
Week 3-4

- Introduction to MATLAB
- MATLAB in weather monitoring.
- Autofocuser App and PHD2 Guiding
- ASCOM (to control devices efficiently)
- Raindrop Sensor and Weather Monitoring

MATLAB

- MATLAB, short for matrix laboratory, is a programming language and numerical computing environment used for data analysis visualization, and algorithm development. It is widely used in engineering,science, and finance.

- In MATLAB, statements are executed one at a time in the order they are written. The semicolon at the end of a statement suppresses the output. Basic operations include arithmetic, logical, and relational operators. Variables are assigned with the equal sign.



Why use MATLAB ?

DATA ANALYSIS

MATLAB provides powerful tools for manipulating and visualizing data, allowing for more accurate and detailed analysis. With MATLAB, astronomers can extract valuable insights from vast amounts of data.

IMAGE PROCESSING

MATLAB's image processing toolbox enables astronomers to enhance and analyze astronomical images, revealing details that would otherwise be difficult or impossible to see. With MATLAB, astronomers can create stunning images of the cosmos.

SIMULATION

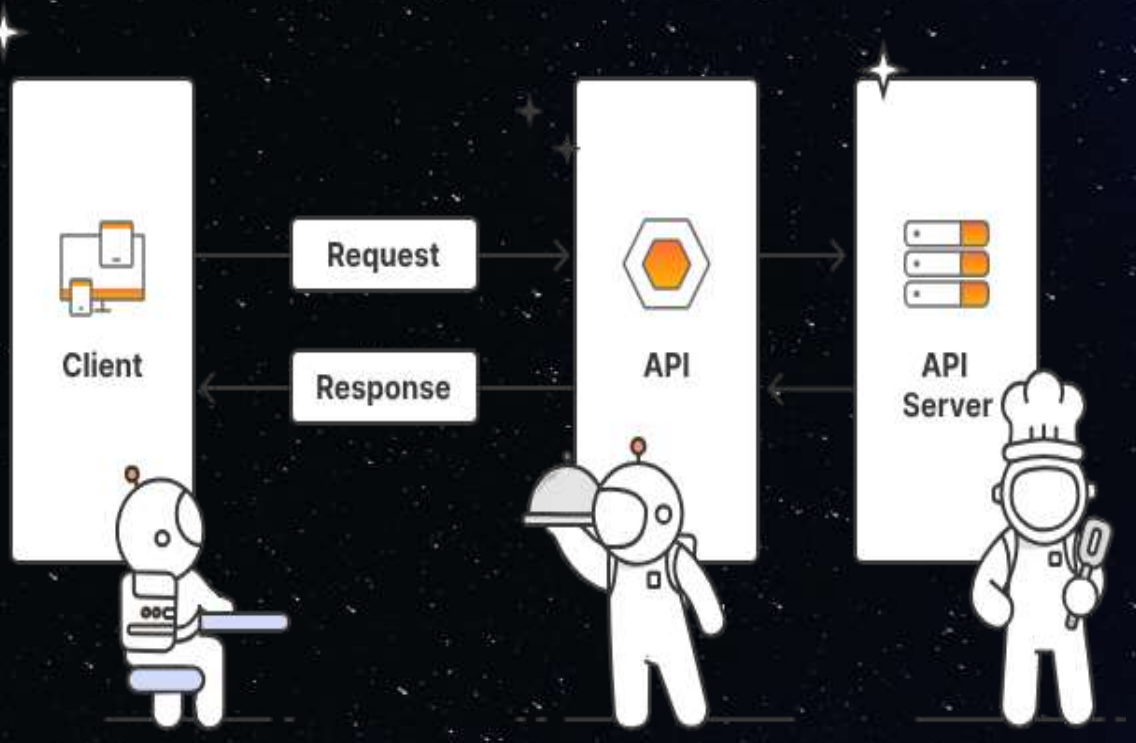
MATLAB allows us to create realistic simulations of astronomical phenomena, such as motion of planets and stars. These simulations can help astronomers better understand the behavior of celestial objects

MACHINE LEARNING

MATLAB's machine learning toolbox can be used to analyze large datasets and identify patterns and trends. This can help astronomer make new discoveries and improve our understanding of the universe.

API (Application Programming Interface)

The API is a server that receives the request, retrieves the appropriate data, and returns a response to the client. Our focus was mainly to retrieve data using Python from weather API and display the parameters useful to monitor weather.



How we used it?

```
import requests as req
import json

response = req.get(
    "http://dataservice.accuweather.com/forecasts/v1/daily/1day/894180?apikey=ZJ4J1oiEAipQe0YG6TxF8XGPbSrVndAU")

data = json.loads(response.text)

headline = data["Headline"]
print(headline['Text'])

daily_forcecasts = data["DailyForecasts"]
print("Temperature will range from", daily_forcecasts[0]['Temperature']['Minimum']['Value'], "to", daily_forcecasts[0]['Temperature']
      ['Maximum']['Value'], daily_forcecasts[0]['Temperature']['Minimum']['Unit'])
print("During day", daily_forcecasts[0]['Day']['IconPhrase'], "will be", daily_forcecasts[0]['Day']
      ['PrecipitationIntensity'])
print("During night", daily_forcecasts[0]['Night']['IconPhrase'], "will be", daily_forcecasts[0]['Night']
      ['PrecipitationIntensity'])
```

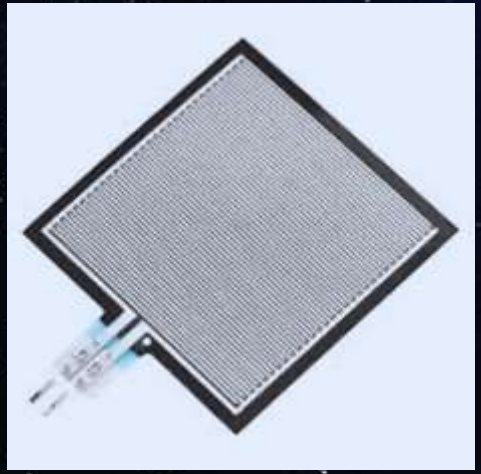
Raindrop sensor

- Electronic devices that detect the presence or rain by monitoring the weather.
- Whenever it rains the sensor gets wet activating multiple parallelly attached resistors that completes the circuit.

- To assemble all these we need a program to output a signal when a raindrop is detected.
- We can use a multimeter to test the output signal and make sure the device is working properly.

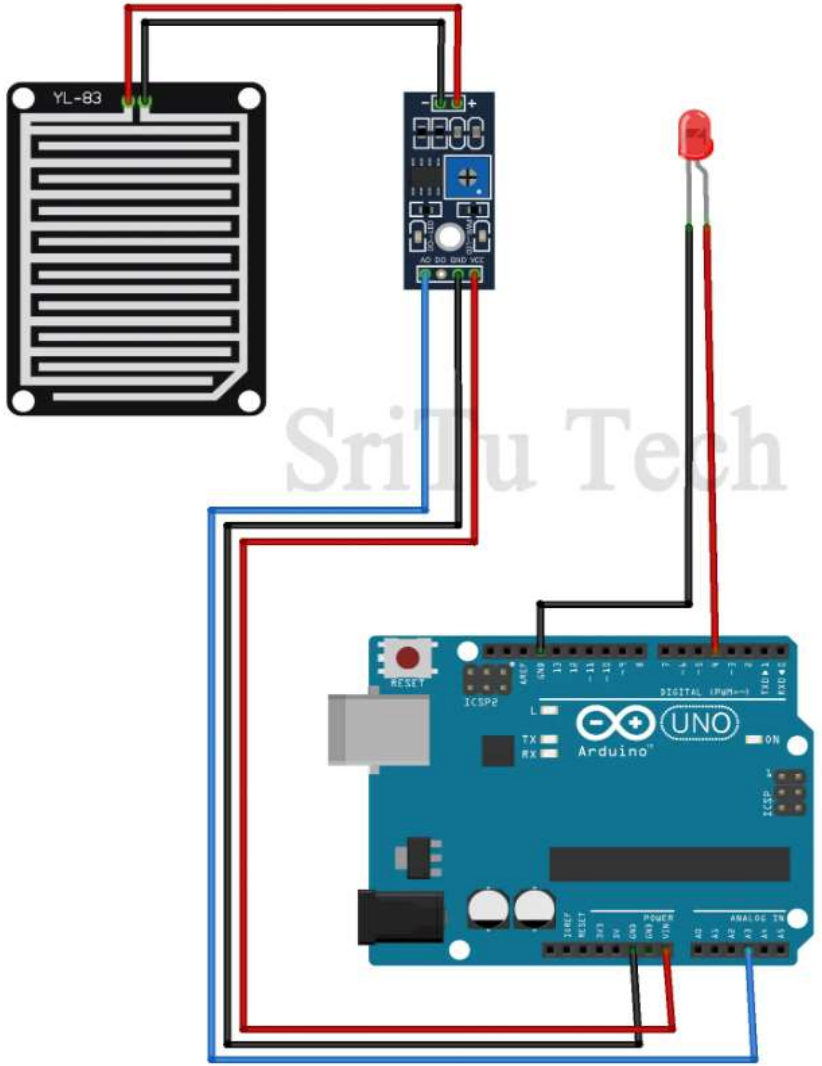
Parts and components

- Rain Sensor
- Breadboard
- Arduino UNO Board
- LED/Buzzer
- Jumper Wires



SENSOR

MODULE




```arduino
void setup() {
  Serial.begin(9600);//enable serial monitor
  pinMode(4, OUTPUT);//define LED pin
}
void loop() {
  int value = analogRead(A3);//read value
  Serial.print("Value : ");
  Serial.println(value);
  if (value < 300) {//check condition
    digitalWrite(4, HIGH);
    Serial.print("Heavy rain  LED on ");
  } else {
    digitalWrite(4, LOW);
  }
}
```

*The value of 300 is an arbitrary threshold chosen in the code to differentiate between heavy rain and other rainfall conditions. It is to be determined experimentally or based on the specifications of the particular rain sensor being used. Different rain sensors may provide different analog values for different levels of rainfall intensity, and the threshold value of 300 would be specific to the characteristics of the rain sensor.

Observing the Skies: Utilizing Astronomical Observatories for Advanced Weather Monitoring

Using specialised instruments such as radiometers and spectrometers, observatories can measure atmospheric parameters such as temperature, pressure and humidity as these atmospheric conditions play a crucial role in weather patterns.

Radiometers are used to measure the radiation emitted by the atmosphere which can provide information about temperature and humidity.

Spectrometers are used to measure the absorption and emission of light by the atmosphere, which can provide information about chemical composition and pressure.

Guiding software PHD2 for observatories

- PHD2 stands for push here dummy, this software is also used to track celestial objects.
- PHD2 guiding software is a powerful tool that helps us to obtain high quality images.
- With the help of PHD2 we can also have images of faint objects much better than they are supposed to.

Good practices to use PHD2

- *Make sure the mount is properly polar aligned.*
- *Use a guide camera that provides high signal to noise ratio.*
- *Finally use a guide scope that has a focal length that matches your imaging scope.*

ASCOM Standards for Astronomy
(Astronomy Common Object Model)

- A software use to connect astronomical softwares and devices.
- It facilitates seamless integration of Telescopes, camera, observatory control systems.
- The ASCOM Architecture is based on Client-server Model where Client are softwares and server are hardwares.
- ASCOM-compliant devices undergo rigorous testing to ensure they meet specific guidelines and API specifications.
- ASCOM offers range of extensions includes remote control, focus automation, dome control and plotting models.

Week 5-6

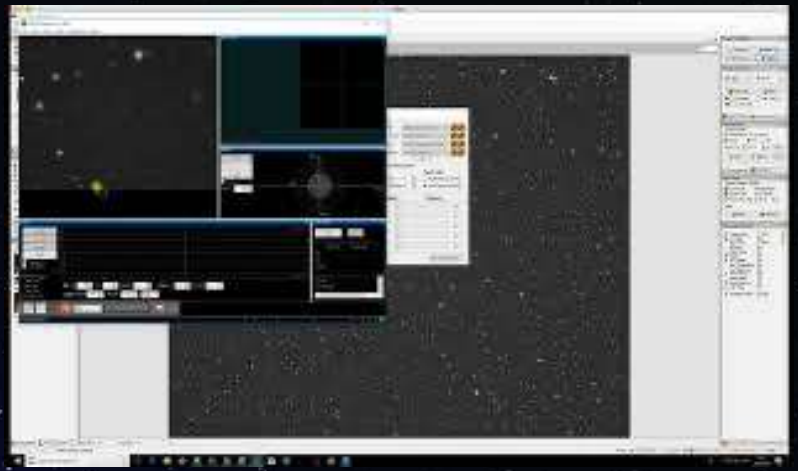
- Guide to Celestron CPWI
- FOCUSMAX software
- EOS utility for astrophotography
- Universe Sandbox

Celestron CPWI

- A software designed specially to work for celestron telescopes.
- Real-time planetarium interface for easy navigation.
- Time lapse imaging to capture stunning images of celestial objects.
- Navigate the vast universe using CPWI search for objects or categories like star,planet, galaxies and track objects in real time.
- Stack multiple images to reduce noise and enhanced details.

FOCUSMAX software

- FocusMax is routinely used worldwide with unattended, all-night robotic-telescope operations including, asteroid and supernova searches,
- It is time efficient, by automating the focusing process we do not have to wait for many hours to get sharpest images
- It works on fine-tuning algorithms and adjust the focus.
- With the help of this software Researchers are able to discover many new planets which can’t be done without this.



PHD2 GUIDING SOFTWARE

EOS UTILITY SOFTWARE

ASCOM

FOCUSMAX

CELESTRON CPWI

EOS Utility Software

- EOS Utility is a software from Canon that allows users to remotely control their cameras from a computer.
- Techniques like long exposure and stacking to capture clear and detailed images of celestial objects can be easily achieved with EOS utility.
- It allow user to change shutter speed, ISO , aperture remotely and also supports live view and timelapse shooting.

Universe Sandbox

- It is a physics based space simulator that allows us to explore our universe and beyond.
- With this software, you can create, destroy, and manipulate celestial bodies to your heart's content. Use it to learn about the universe and see how it evolves over time.
- In Universe Sandbox, you can simulate how gravity affects celestial bodies and their orbits.
- Use Universe Sandbox to simulate collisions between celestial bodies. See what happens when a comet hits a planet or two stars collide

Sun Sun collision

Star Clusters using Python

Takeaways:

- **Cluster Identification**: The K-means algorithm effectively grouped stars into 8 clusters based on their characteristics. Each cluster represents a group of stars that are relatively similar in terms of their position, mass, and velocity. These clusters can provide insights into the structure and distribution of stars within the star cluster.
- **Optimal Number of Clusters**: The KElbowVisualizer was used to find the optimal number of clusters (K) for the given dataset. The "elbow point" on the visualization plot indicates that 8 clusters are appropriate for representing the underlying structure of the data.
- **Outlier Detection**: Before performing K-means clustering, the data was sorted, and outliers were identified and processed. Outliers are data points that significantly deviate from the majority of the data. By handling outliers appropriately, the clustering algorithm can produce more accurate and meaningful clusters.
- **Data Preprocessing**: The dataset of stars with positions, mass, and velocities likely required some preprocessing steps, such as handling missing values, scaling or normalizing the features, and ensuring data quality. Proper data preprocessing ensures that the K-means algorithm performs effectively and efficiently.

Thank You !!

“Cosmos is within us”