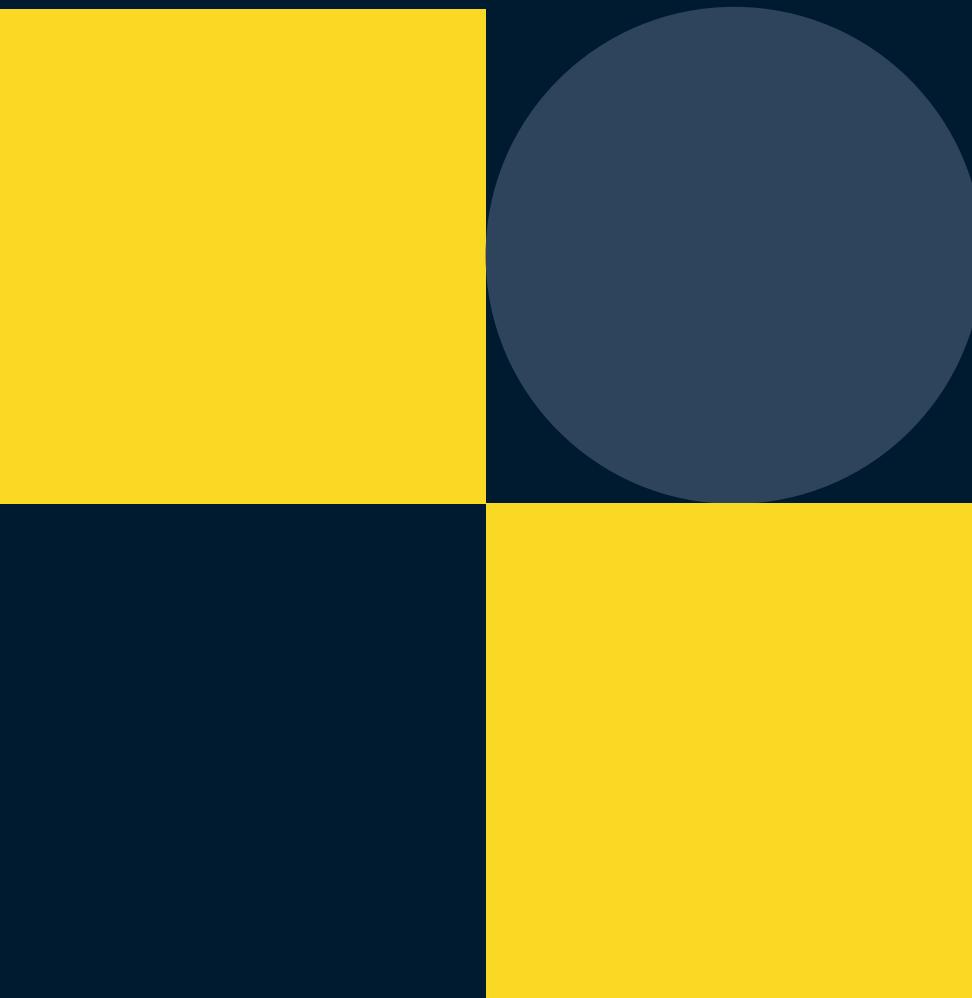
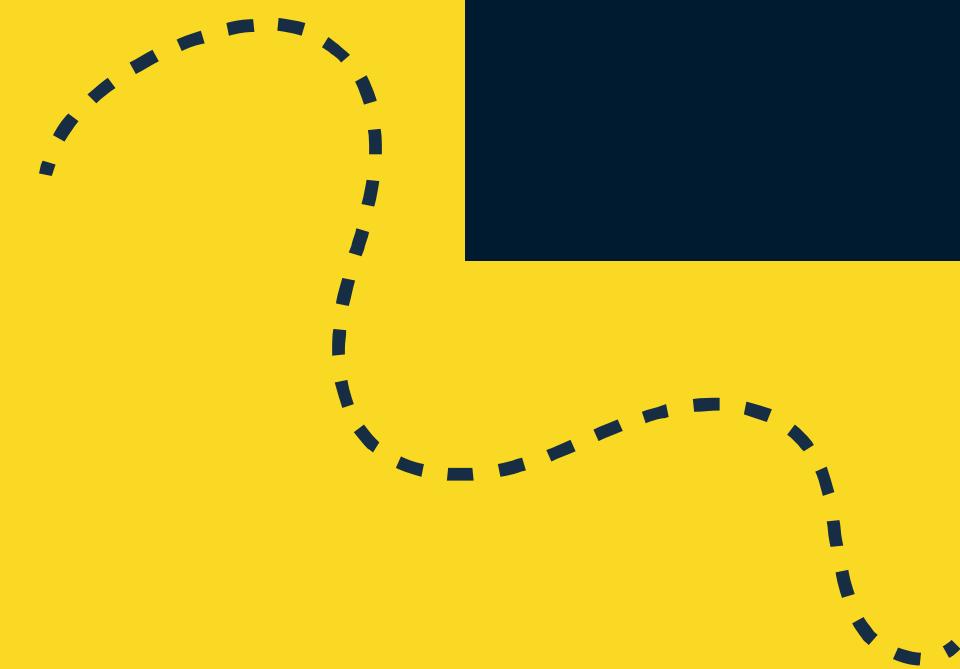


# Introduction to Mechatronics

ITSP Bootcamp 2025

Ayush Prasad



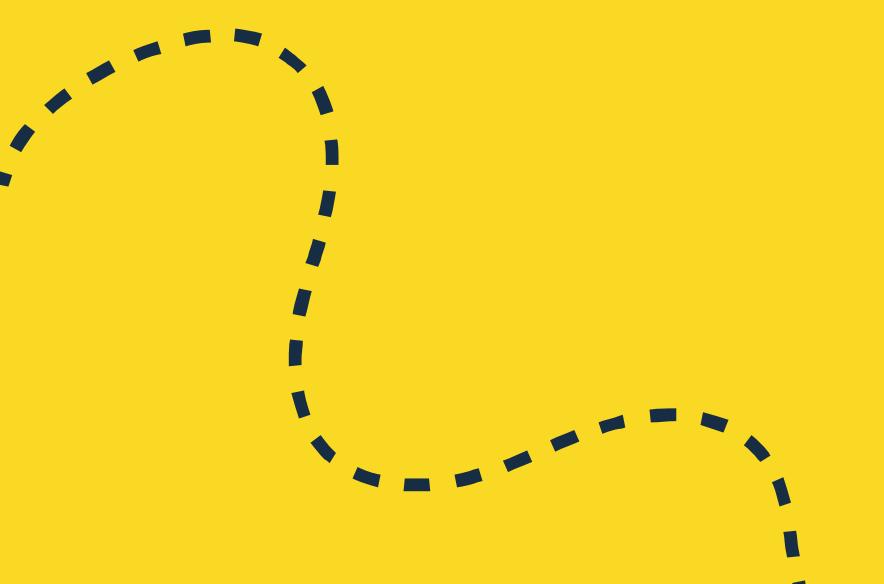


# What is Mechatronics?

Integration of **mechanical**, **electronic**,  
**computer**, and **control engineering**.

**Applications:** Robotics, automotive systems,  
consumer electronics, industrial  
automation- pretty much almost all ITSPs.

**Key Disciplines:** Mechanics, Electronics,  
Control Systems, Programming.





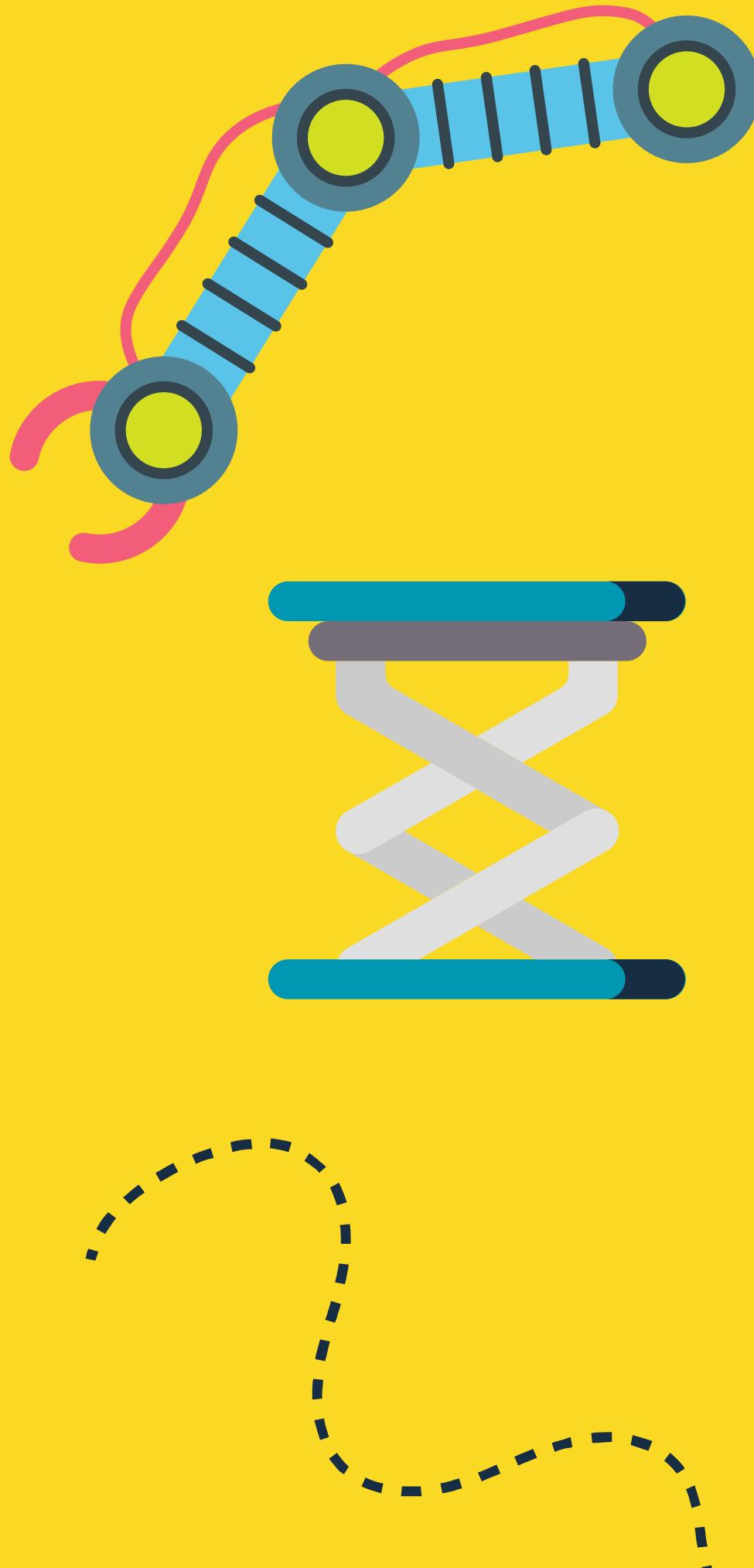
# Actuators

**Actuators** are essential components that convert energy into motion for systems.

They come in various types, including **electric**, **pneumatic**, and **hydraulic** actuators.

Understanding their roles helps in designing effective mechatronic systems for various applications.

**Examples in real-life:** Linear actuators, rotary actuators





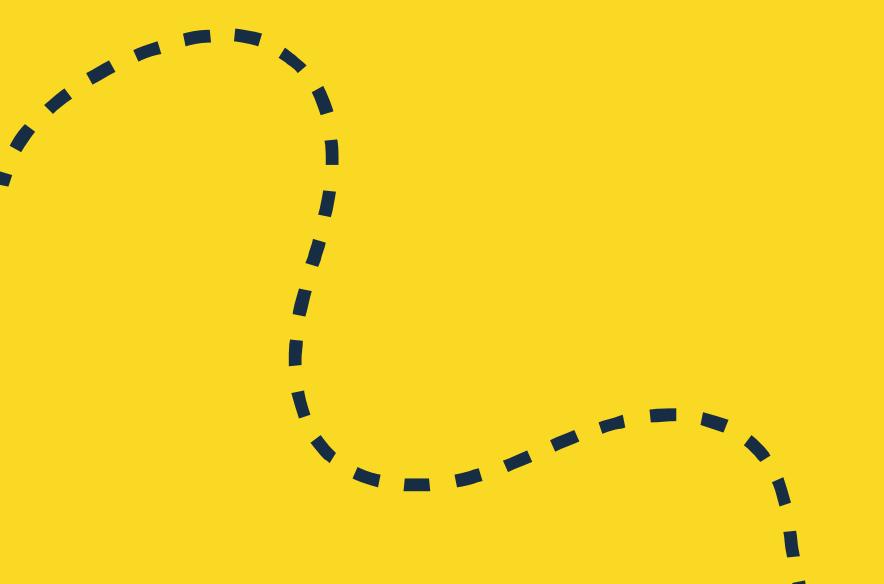
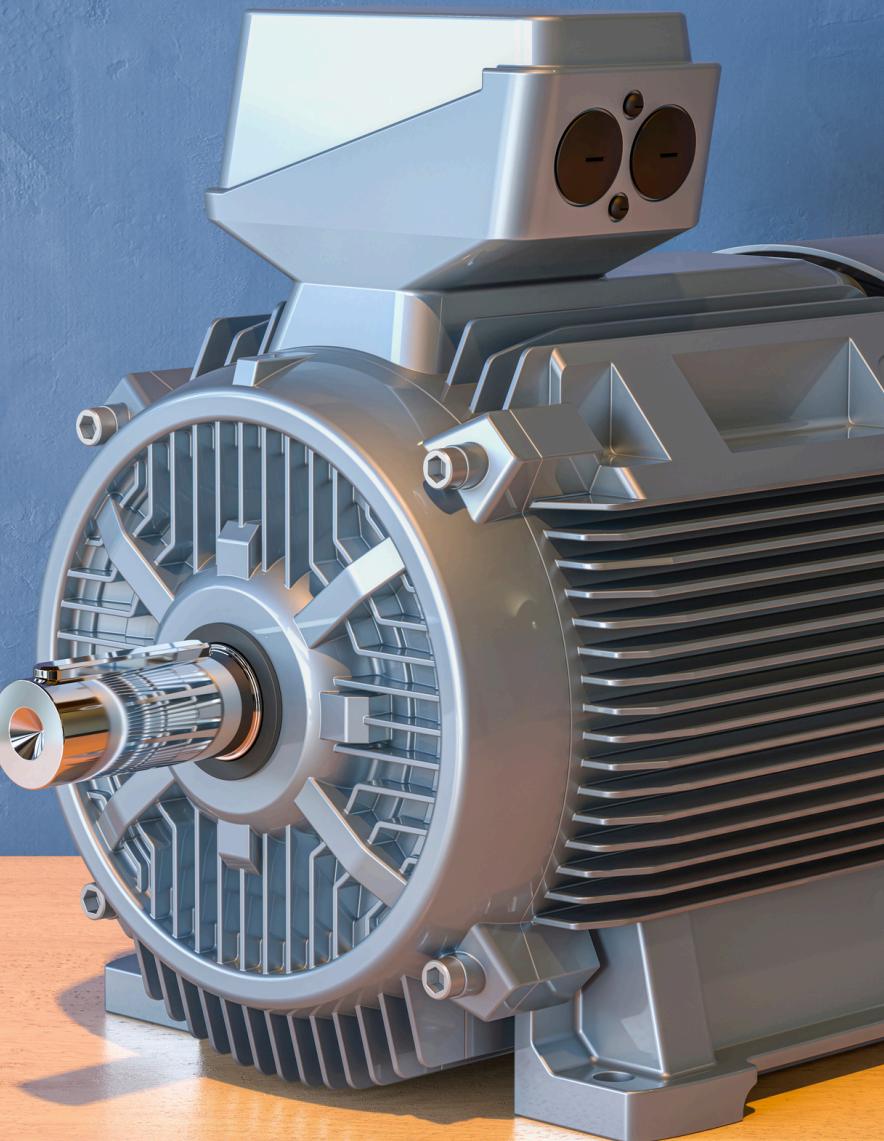
# Motors

**DC motors** are commonly used for simple applications due to their ease of control. **BLDC** and **induction motors** are used for high speeds.

**Stepper motors** provide precise positioning, making them ideal for 3D printers and CNC machines.

**Servo motors** are used in robotics for controlled motion, offering high efficiency and accuracy.

**Use-cases: Speed vs precision vs torque**





# Motor Control

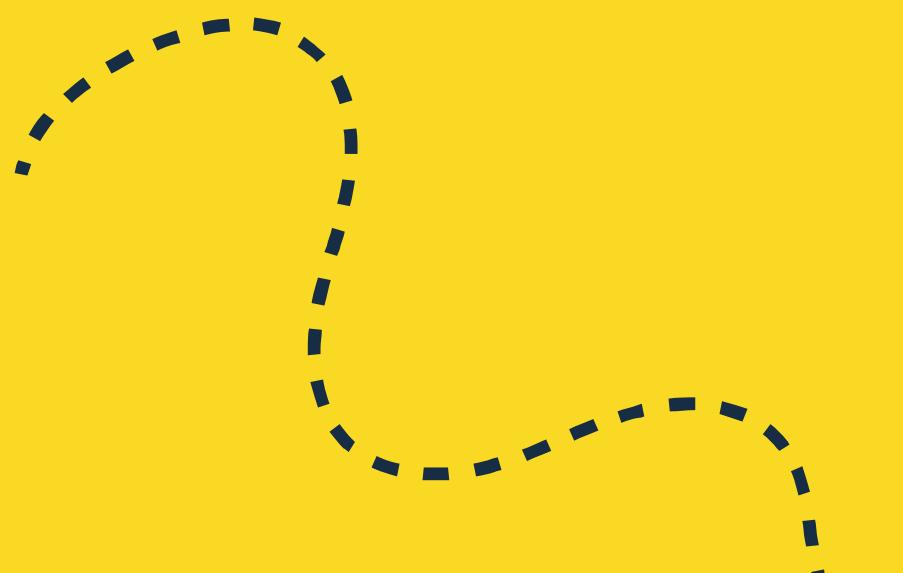
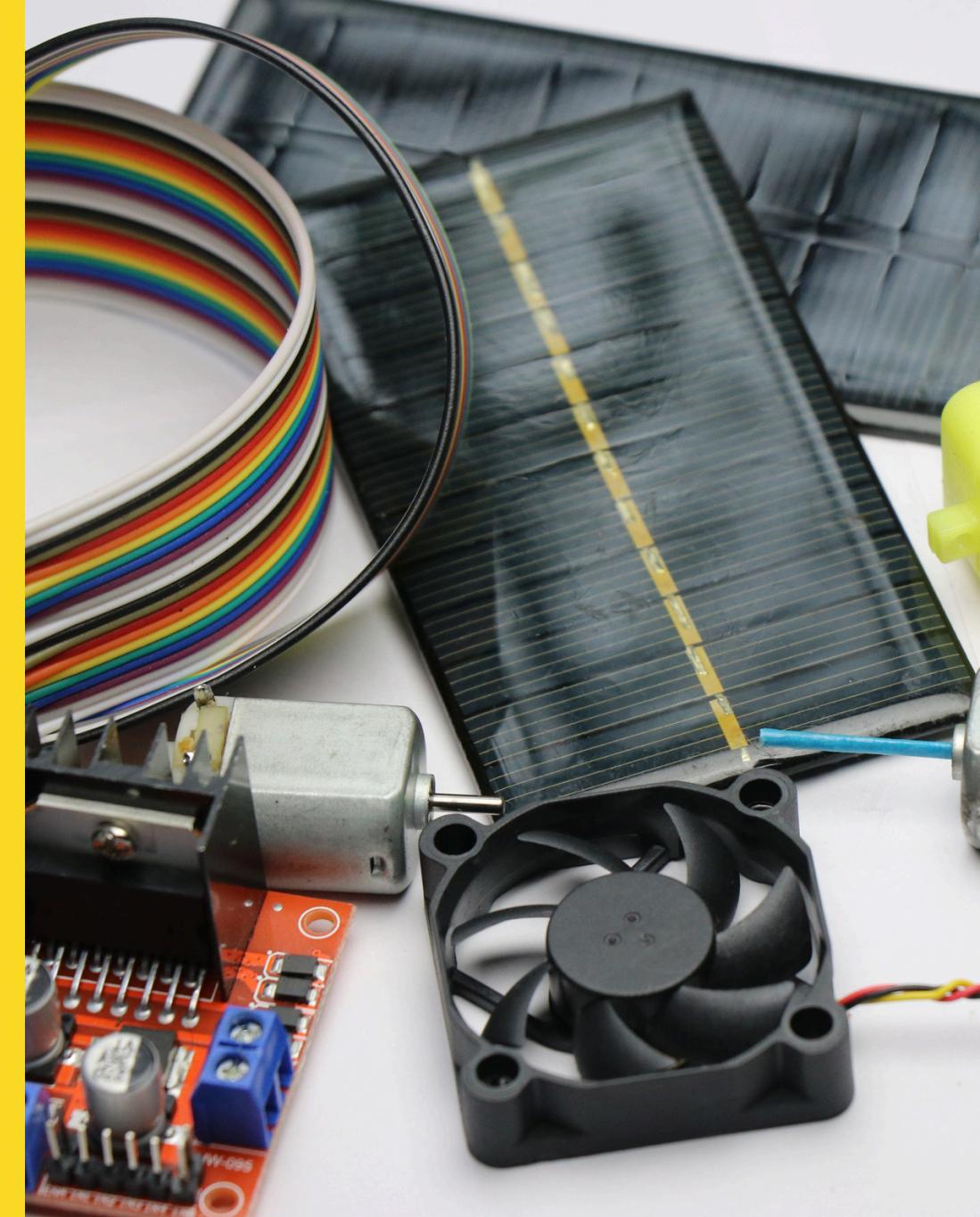
**Controlling direction and speed:** H-Bridge, PWM

**Motor drivers:** L298N, DRV8833, A4988, ESC (for BLDC)

**Feedback control:** encoders, PID basics



**Safety and protection:** current limiting,  
thermal shutdown





# Batteries and Power

**Battery types:** Li-ion, Li-Po, other kinds

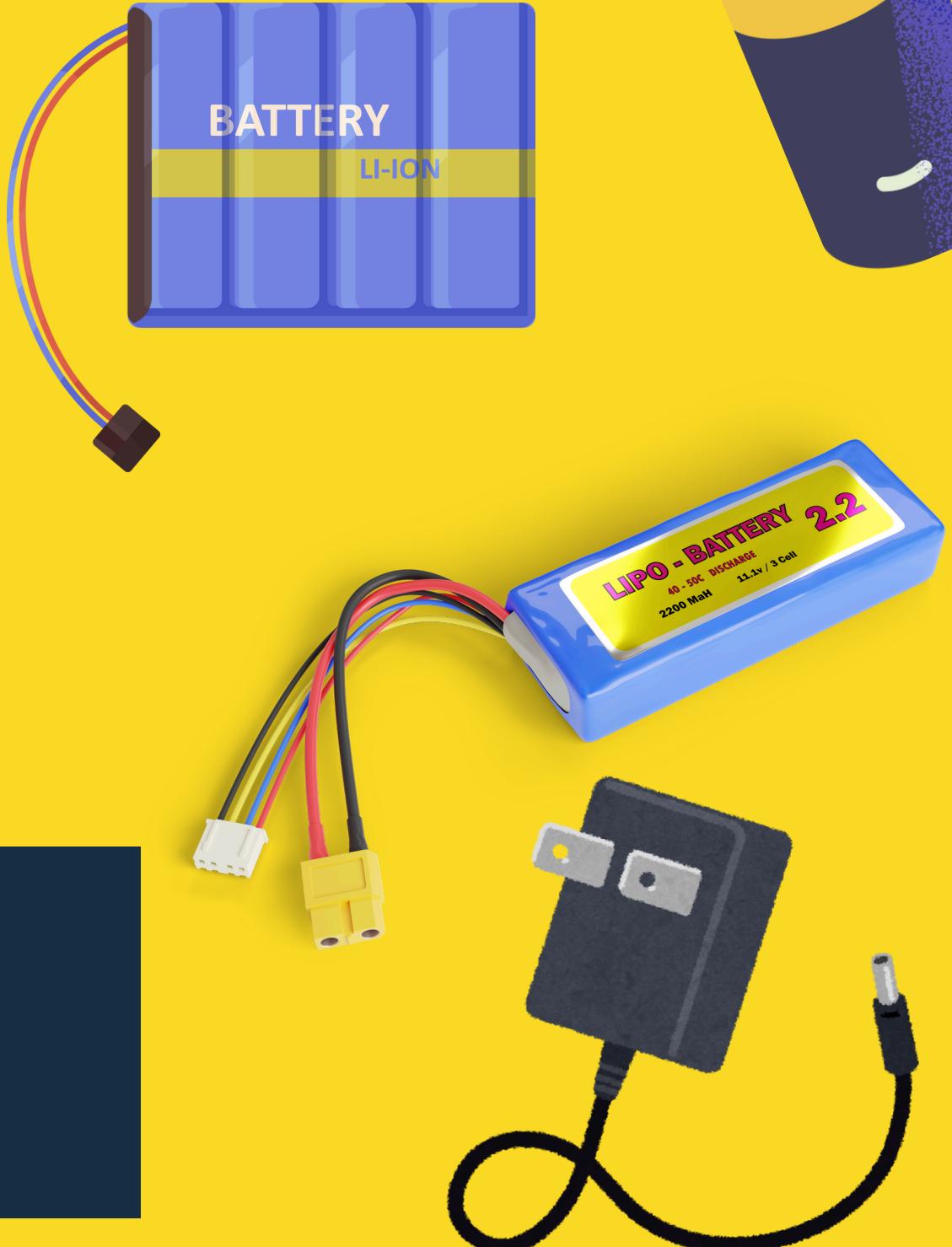
Voltage, capacity (mAh), C-rating

Usage of **AC-DC adapters** for static projects

**Voltage Converters, Charging, AC sources**



**Voltage Ratings & Overcurrents,  
Reverse Breakdowns**





# Microcontrollers

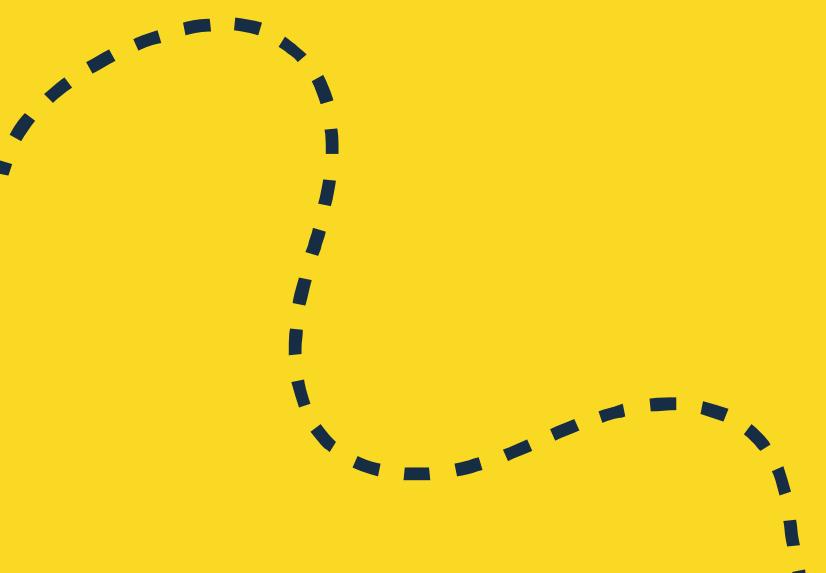
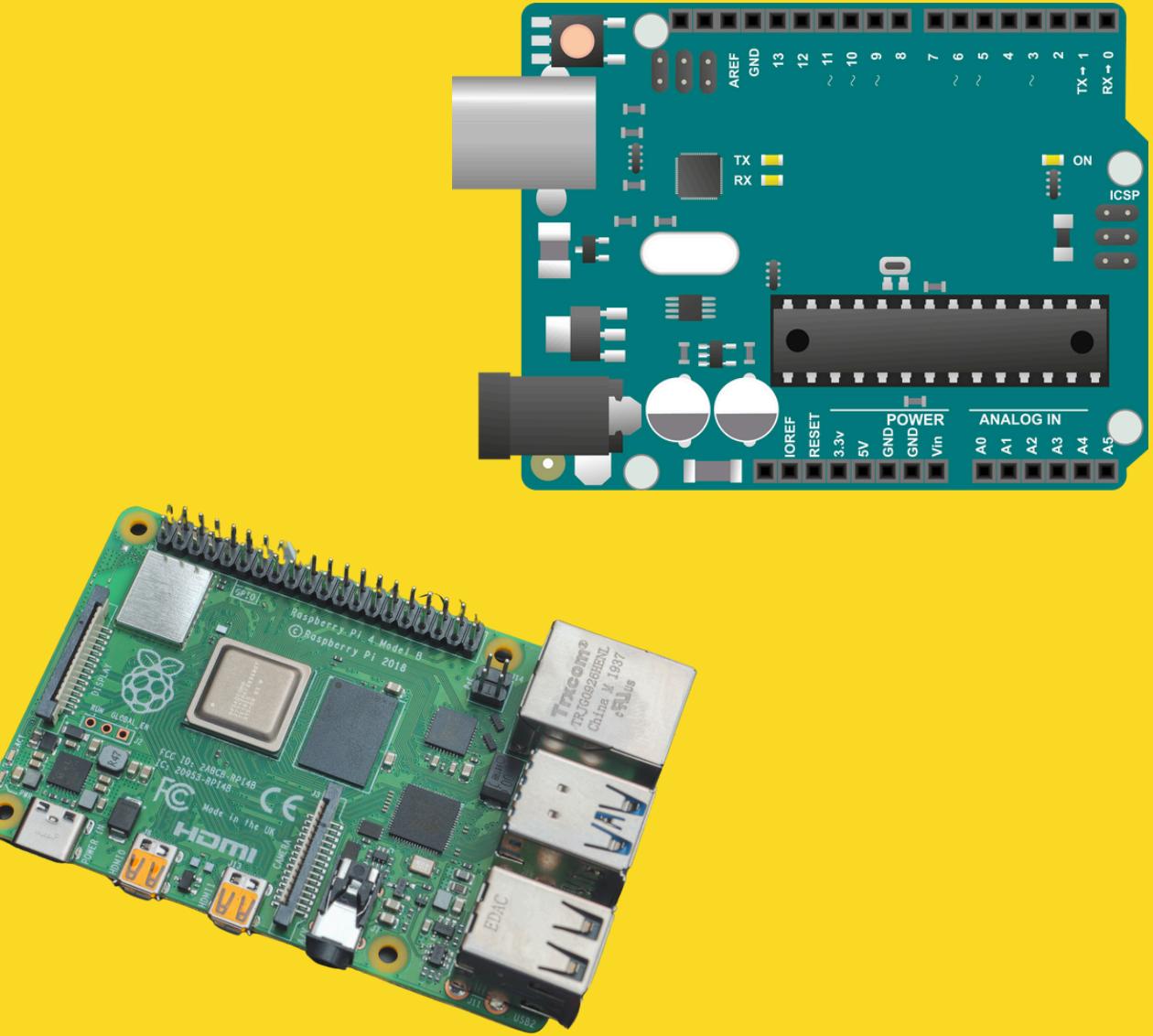
# Arduino, Raspberry Pi, RP2040, ESP32, LilyPad

# **Form vs. Function:** use case scenarios

# Advantages of Raspberry Pi

# WiFi in microcontrollers: Do I need it?

# Controlling Peripherals & Actuators



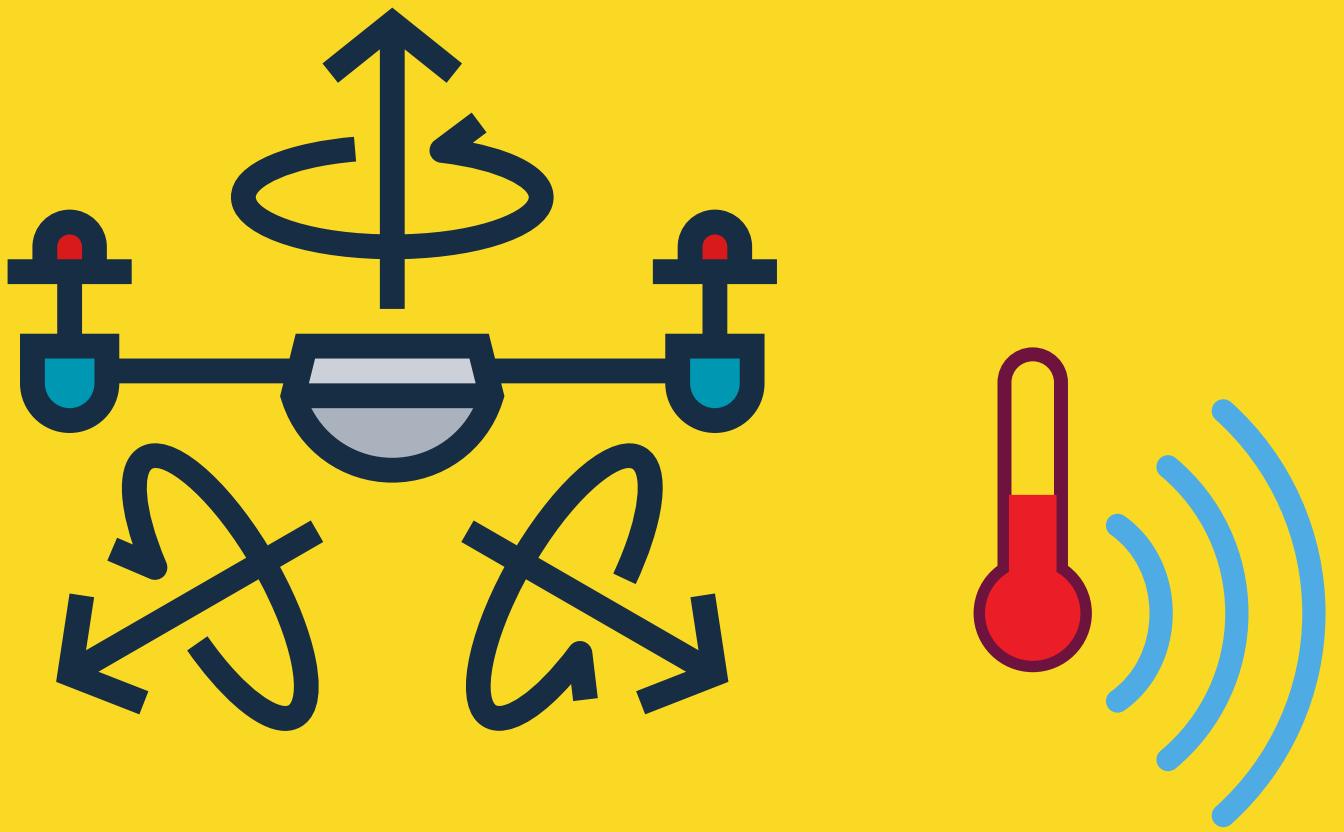


# Sensors in mechanics

Converting **mechanical/chemical** signals to **electrical**

**IR, ultrasonic, gyroscope, accelerometer,  
encoders**

Role in **feedback and automation**





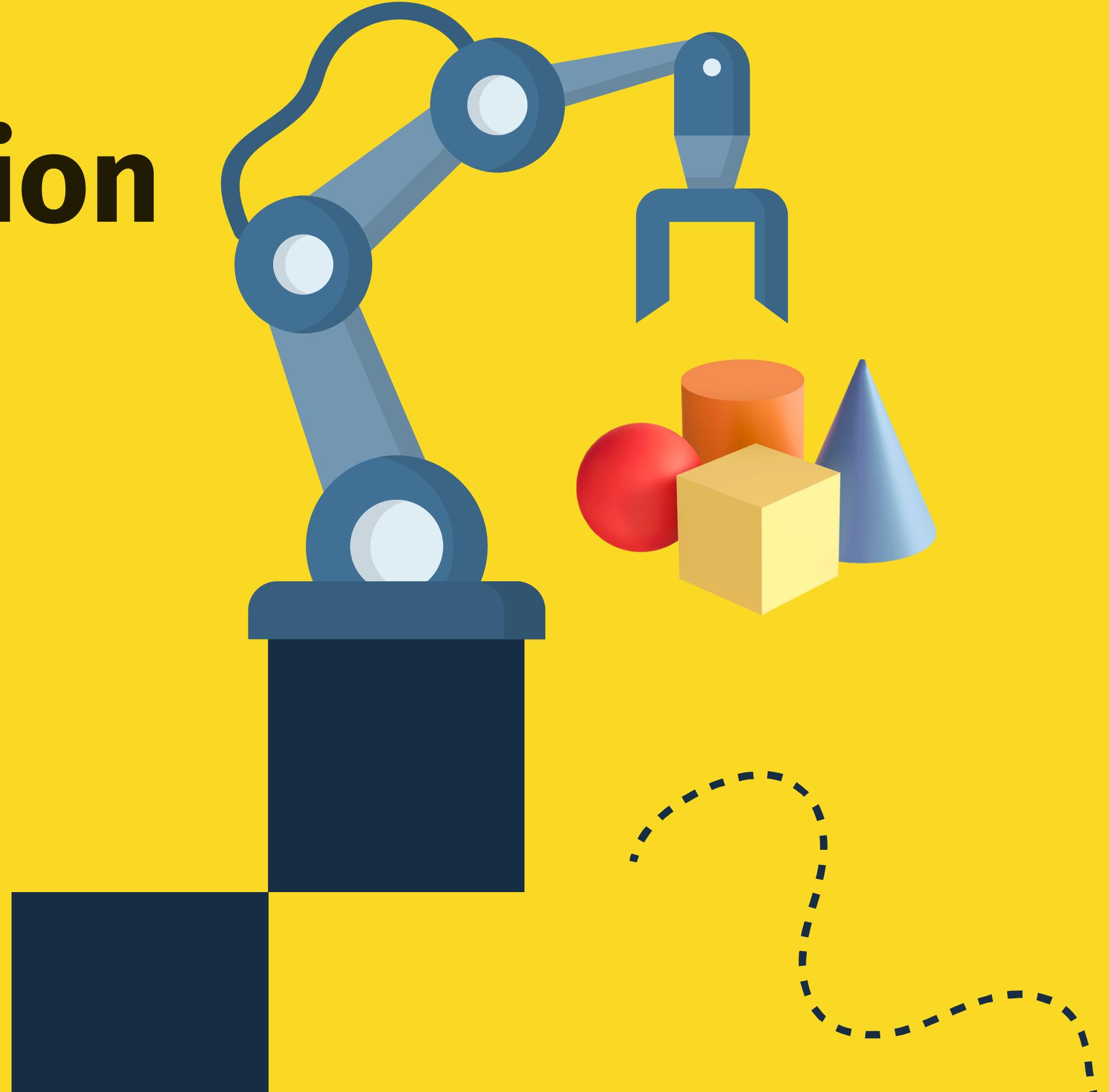
# Robot Manipulation

Robots use **mechanical arms** to grasp and move objects with precision.

Advanced sensors help robots identify and interact with various **types of objects**.

**End effectors, degrees of freedom**

**Kinematics:** Inverse, Forward





# Navigation

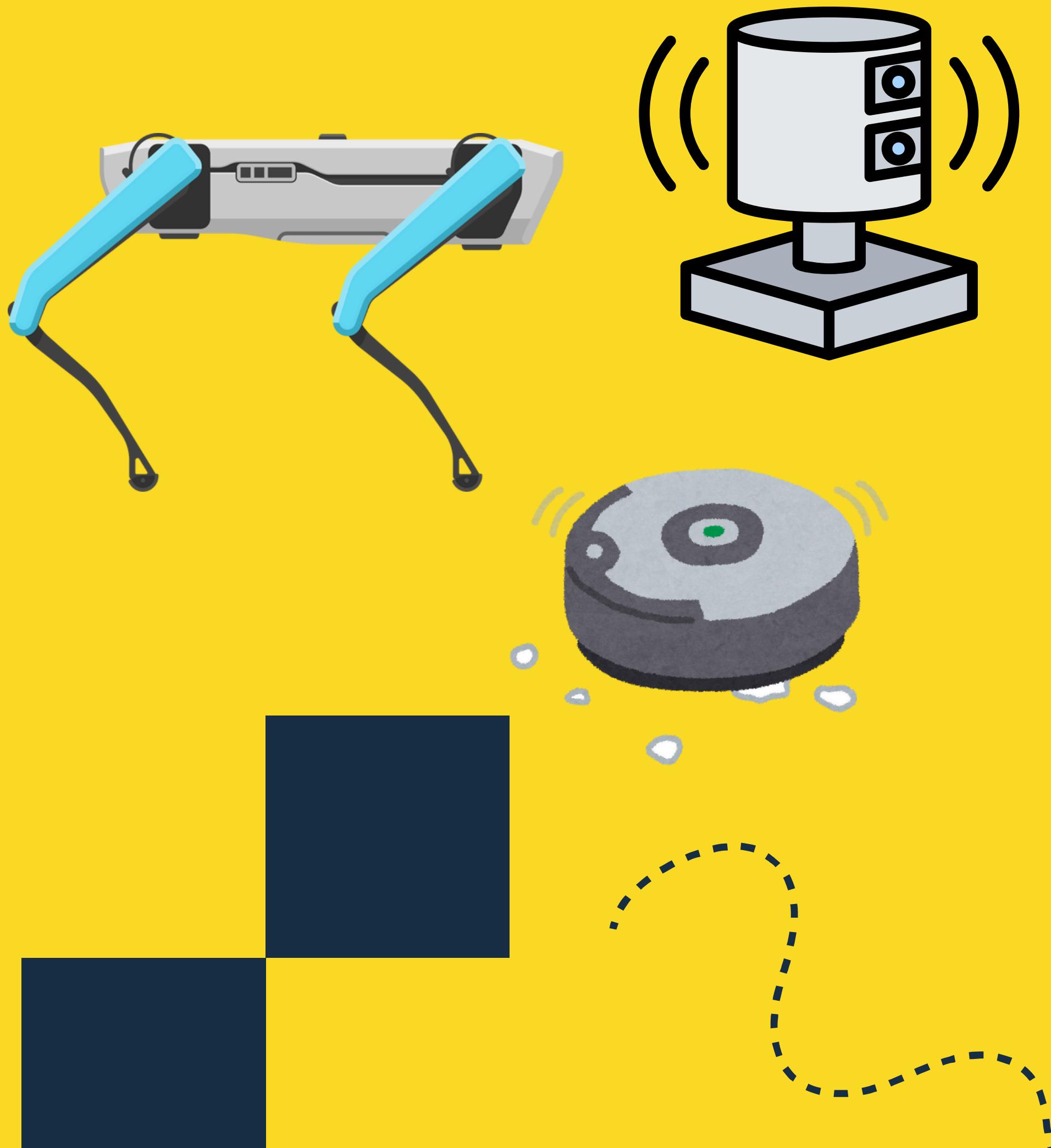
**Wheels, legs, tracks**

Robot navigation combines both **pathfinding** and localization for efficient movement.

Techniques such as SLAM help robots **map** their environment in real-time.

Robots use sensors to accurately detect their position and **navigate** obstacles effectively.

Can start with **obstacle avoidance**





# Swarm Robotics

Sometimes having a group of small robots working collaboratively is more efficient rather than depending on one big robot.

- Decentralized Control: No central leader; each robot makes decisions based on local information.
- Scalability: System performance remains stable as more robots are added.
- Robustness: The swarm continues functioning even if some robots fail.
- Simple Agents, Complex Behavior: Individual robots follow simple rules, but together they exhibit intelligent, emergent behavior.



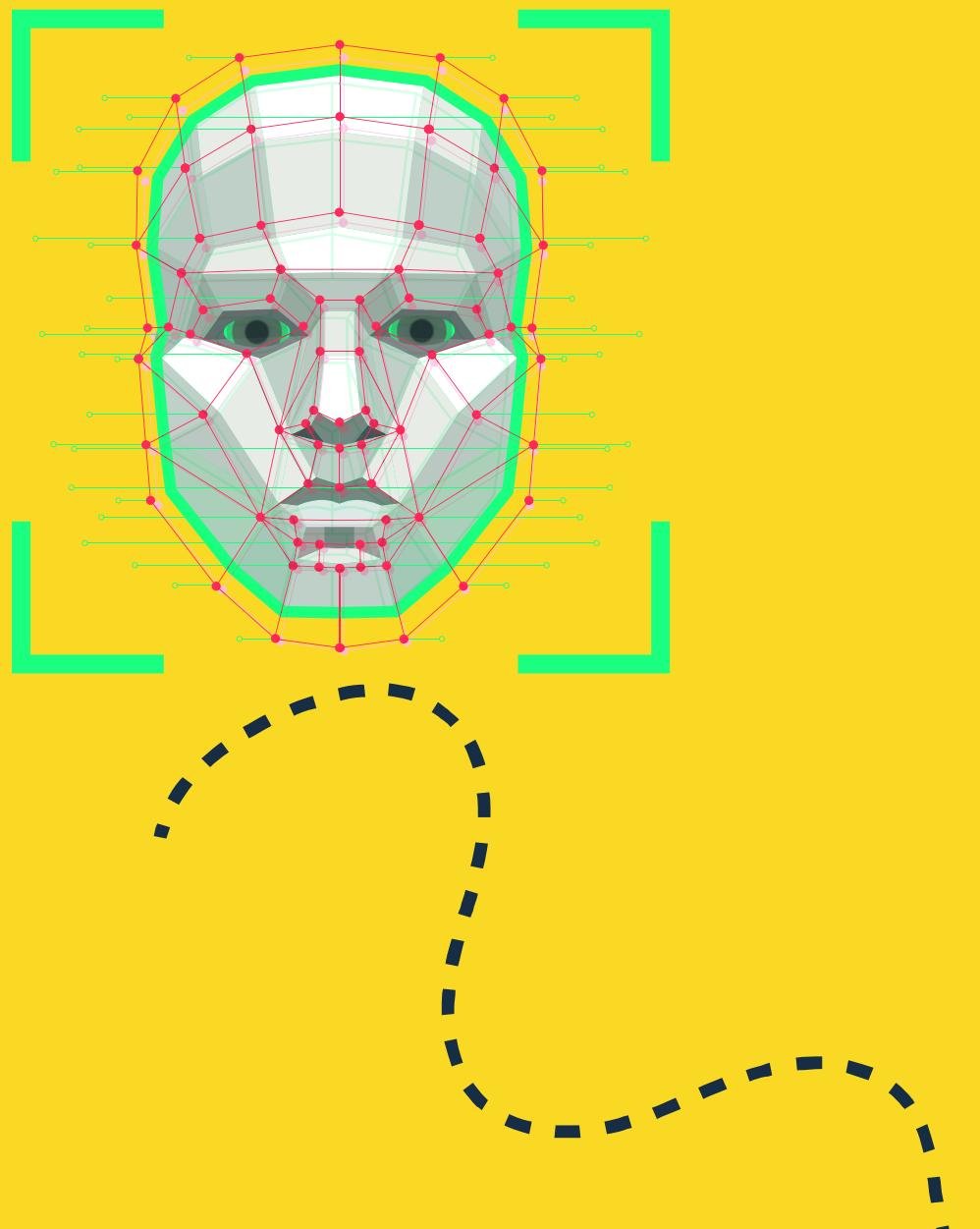
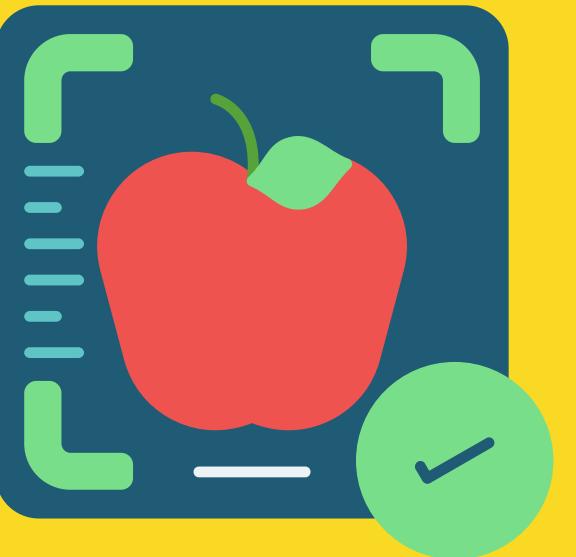


# Computer Vision

Computer vision allows robots to **interpret visual data** and understand their surroundings.

- Applications: Object detection, line following, face recognition
- Tools: OpenCV, simple camera modules

**YOLO, TensorFlow**





# Resources

## Web Platforms:

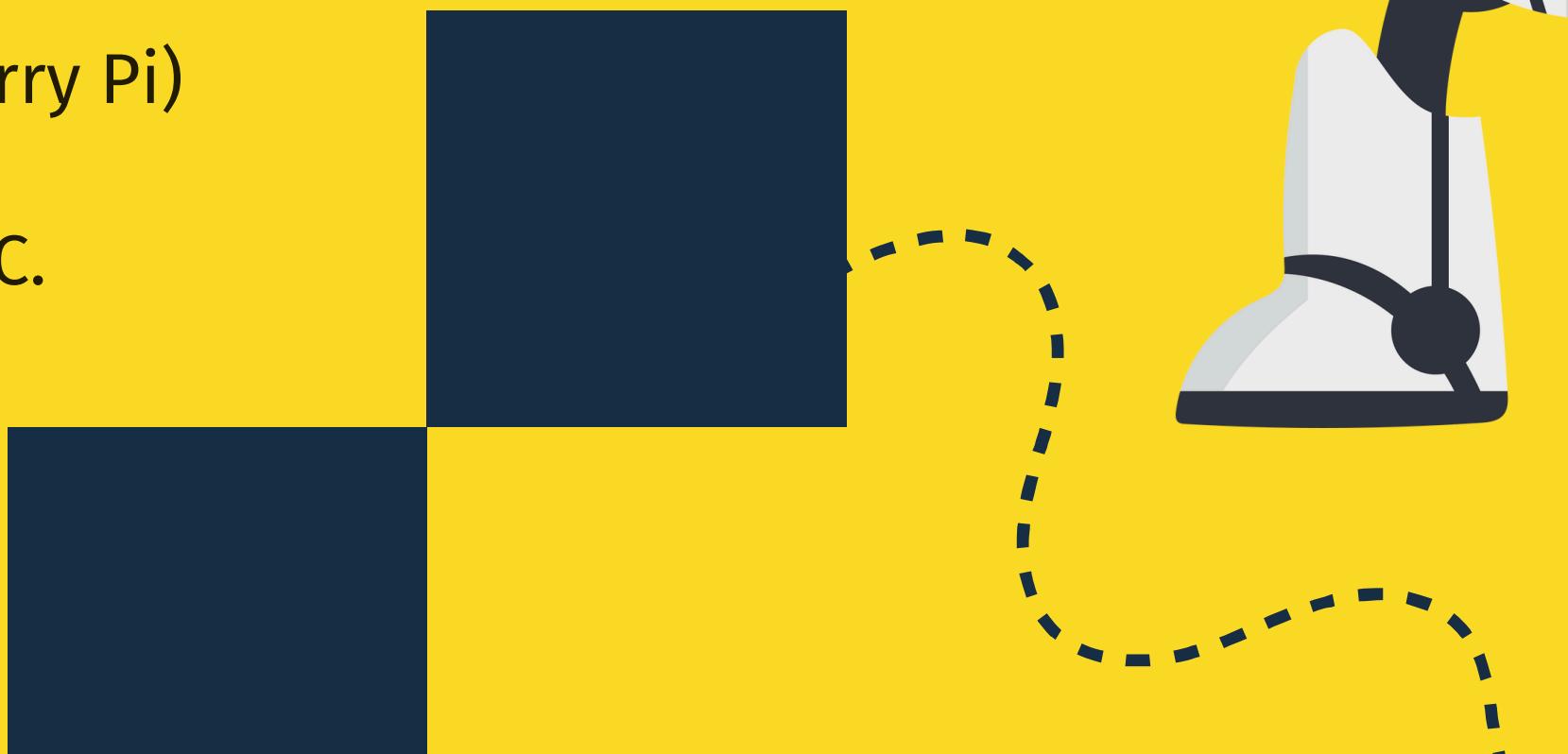
- Arduino Project Hub
- Raspberry Pi Projects
- Hackster.io

## Courses & Tutorials:

- Mechatronics by Coursera (offered by University of California, Irvine)
- Introduction to Robotics by MIT OpenCourseWare
- FreeCodeCamp tutorials on YouTube (Arduino, Raspberry Pi)

## Books:

- Mechatronics: Principles and Applications by Godfrey C. Onwubolu
- Robot Dynamics & Control by M. Vidyasagar





# QUESTIONS?

# THANK YOU!

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