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ROS Developer

Learning Path

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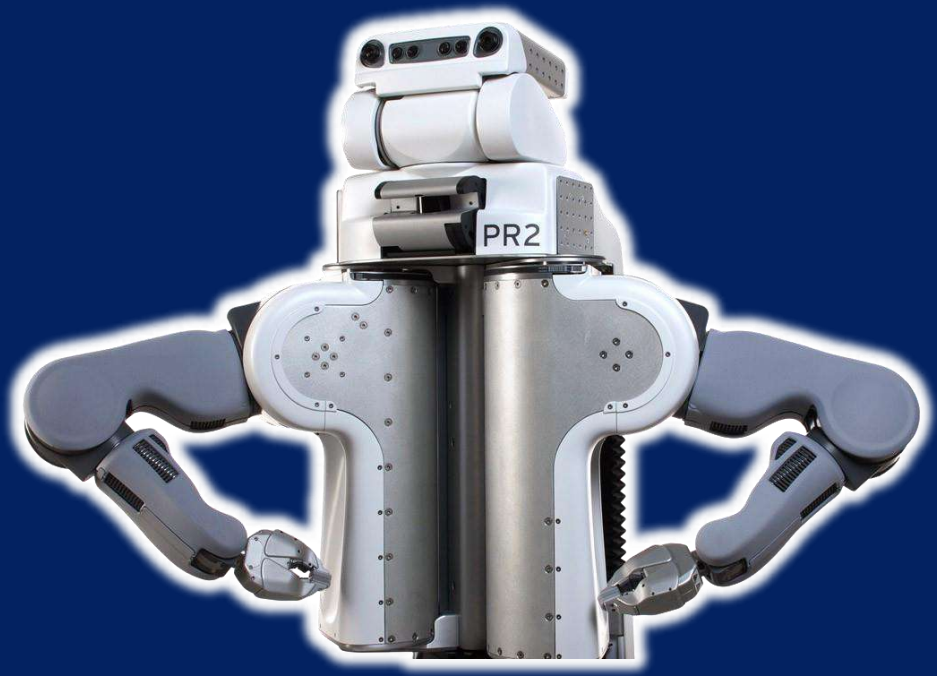
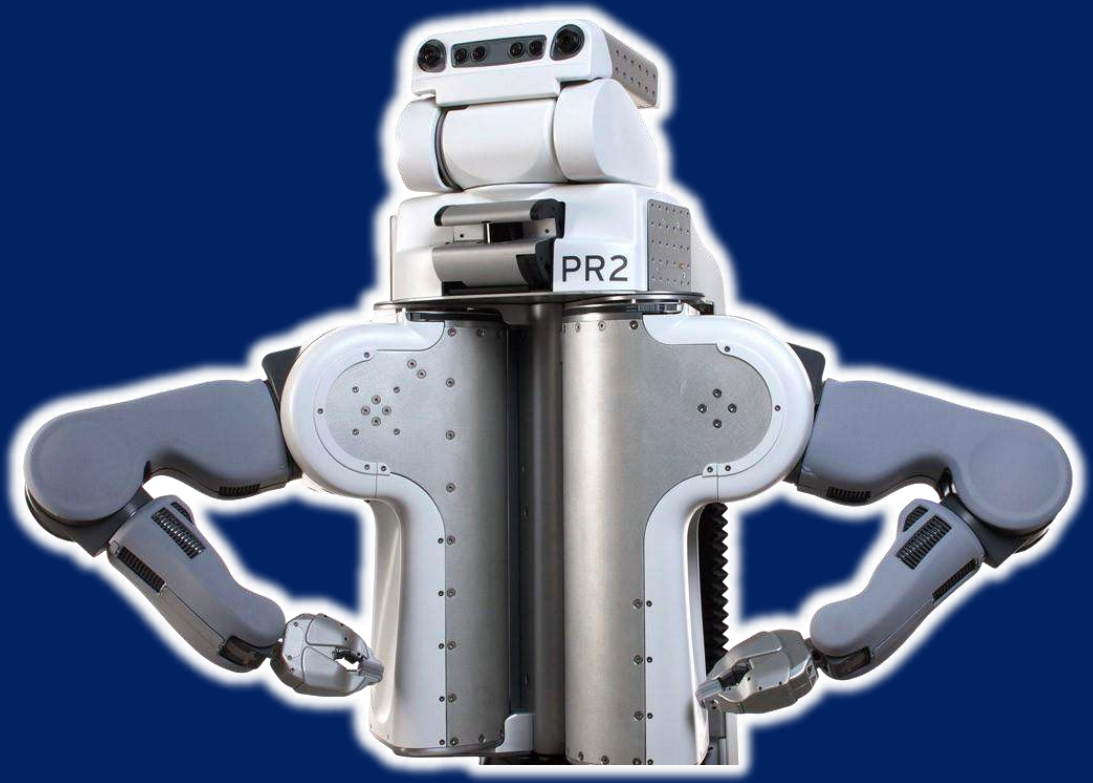
Introduction to Robotics

& Robot Programming



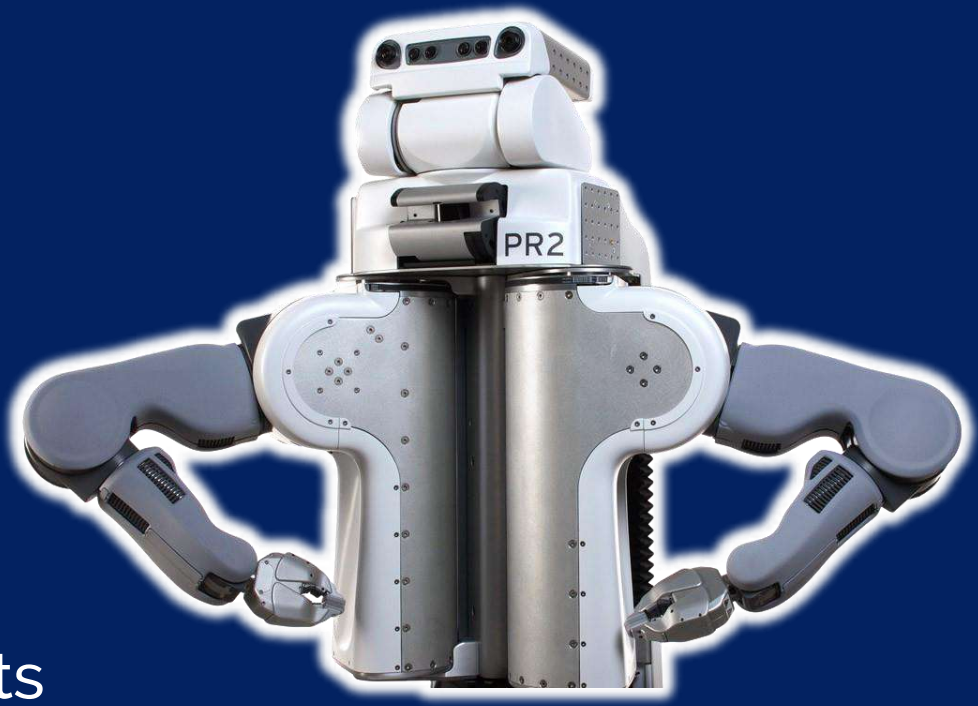
Agenda

- What is a Robot?
- Robotics in a nutshell
- Different types of robots
- Applications of robotics
- Kinematics & Dynamics of robot



Agenda

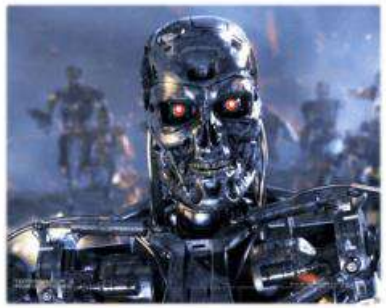
- How to build your own robot?
- Selecting sensors, actuators, and computation unit for your robot
- How to program a robot?
- Software frameworks for programming robots



What is a Robot?

What is a Robot?

Sci-Fi Movies and Fictional characters



Terminator

R2-D2

Optimus Prime

Iron man

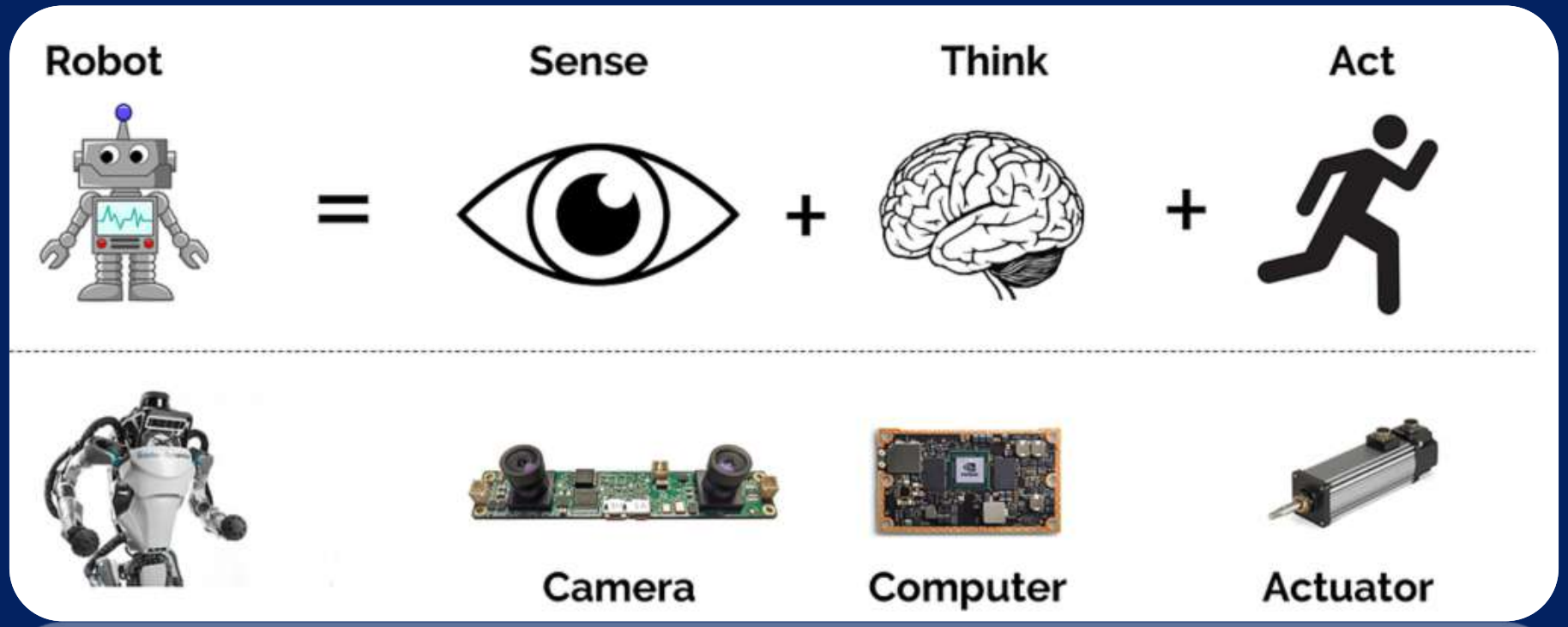
What is a Robot?

Definition: My version (After referring multiple definitions on web)

"A robot is an intelligent machine which has the capability to sense the environment around it, make decisions based on computations, and then perform some actions based on the decisions".

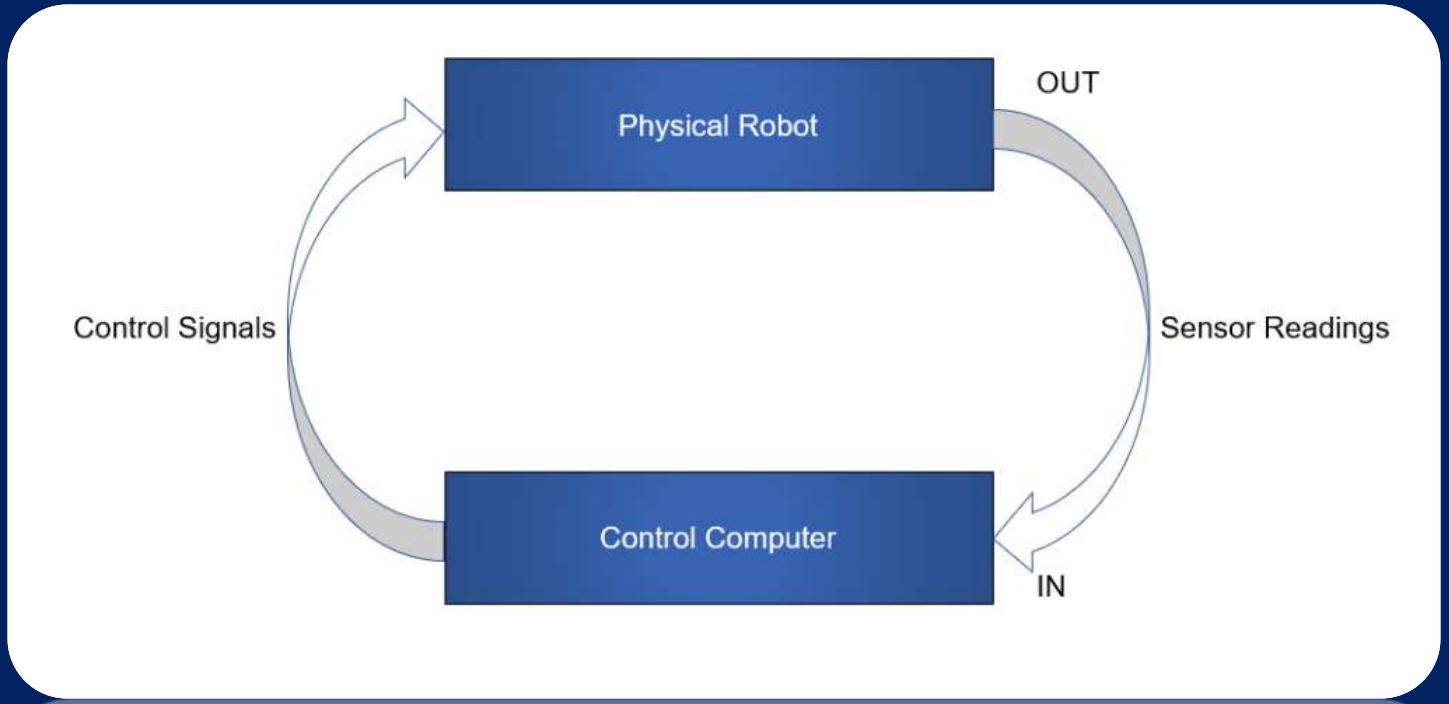
What is a Robot?

Basics blocks in a robot



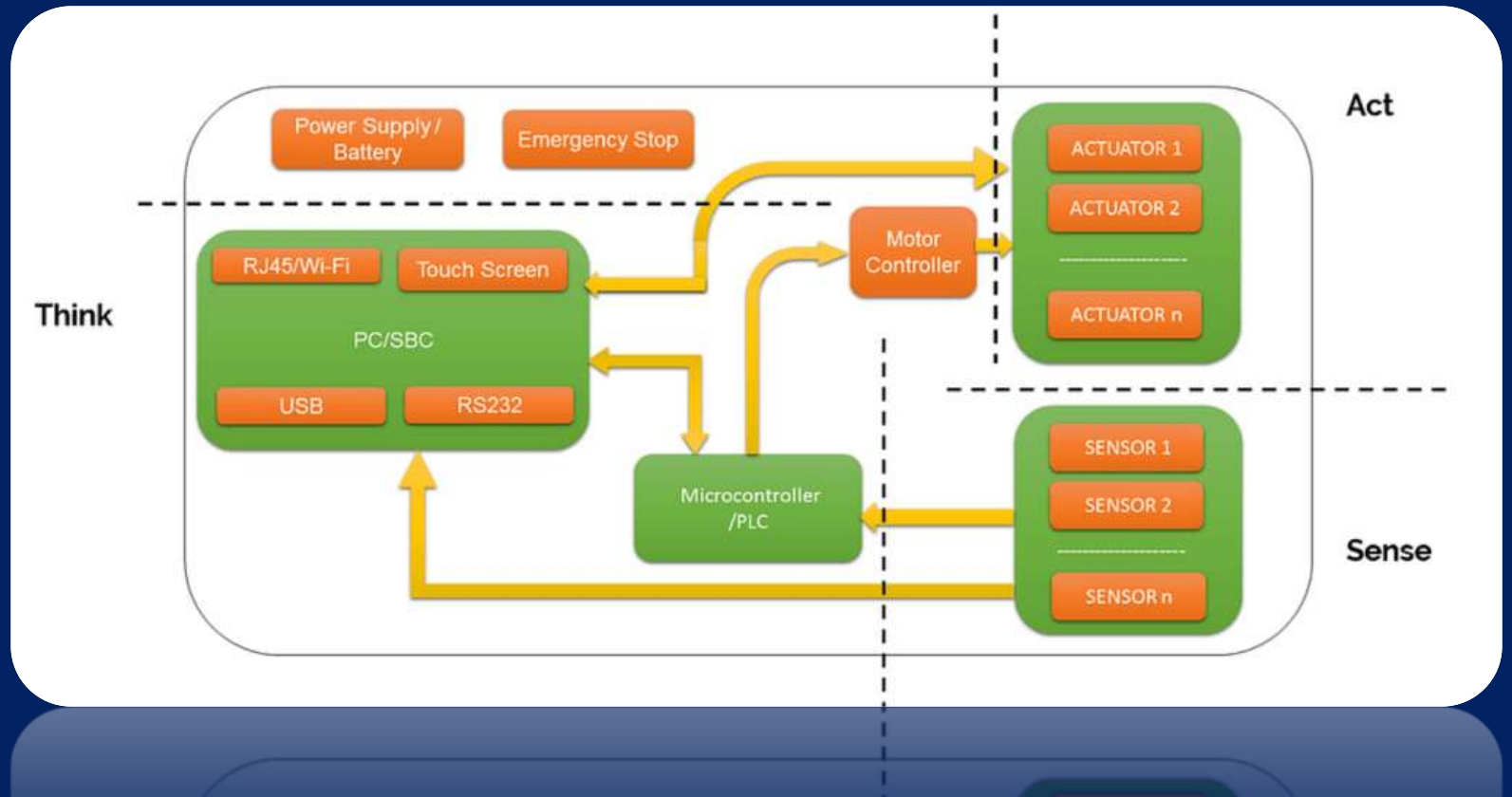
What is a Robot?

Robot feedback loop



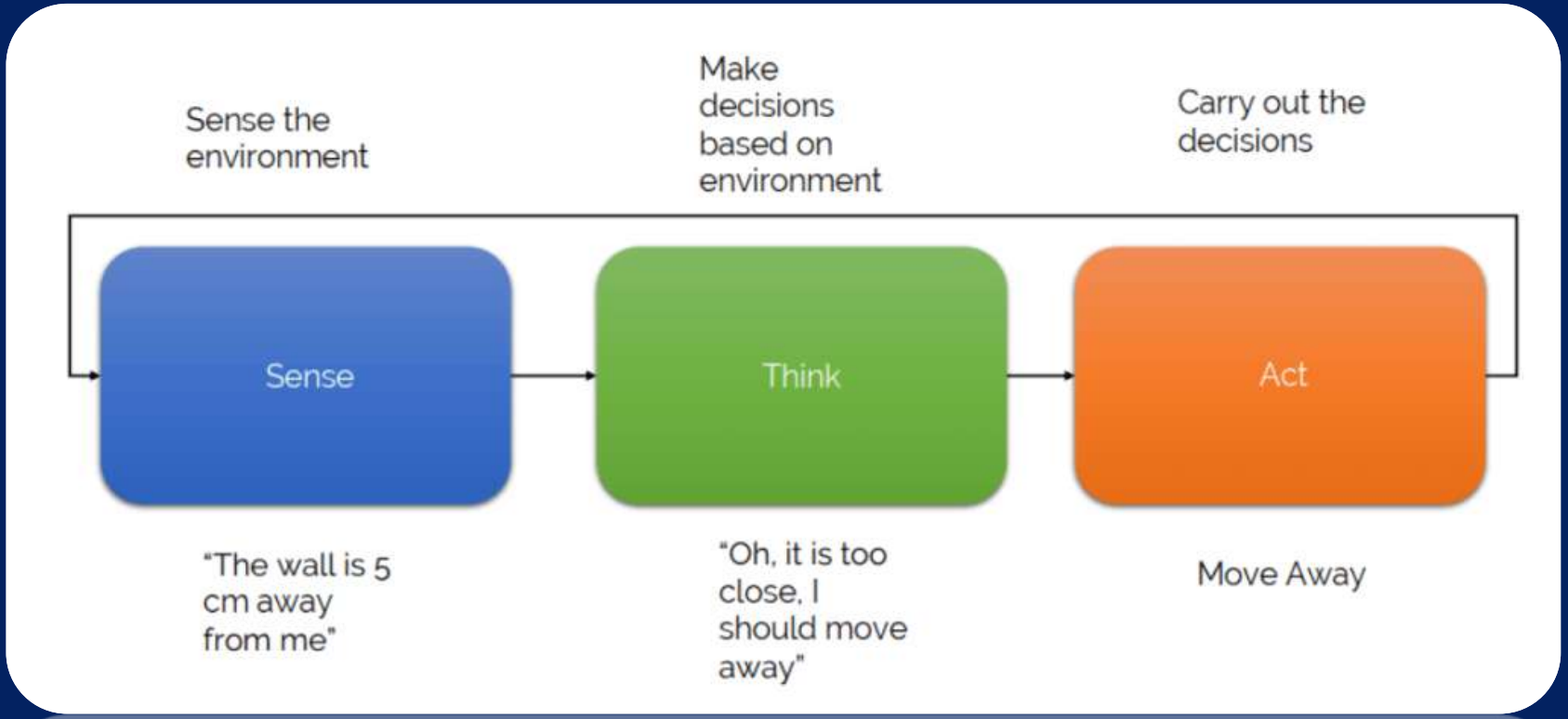
What is a Robot?

Robot detailed block diagram



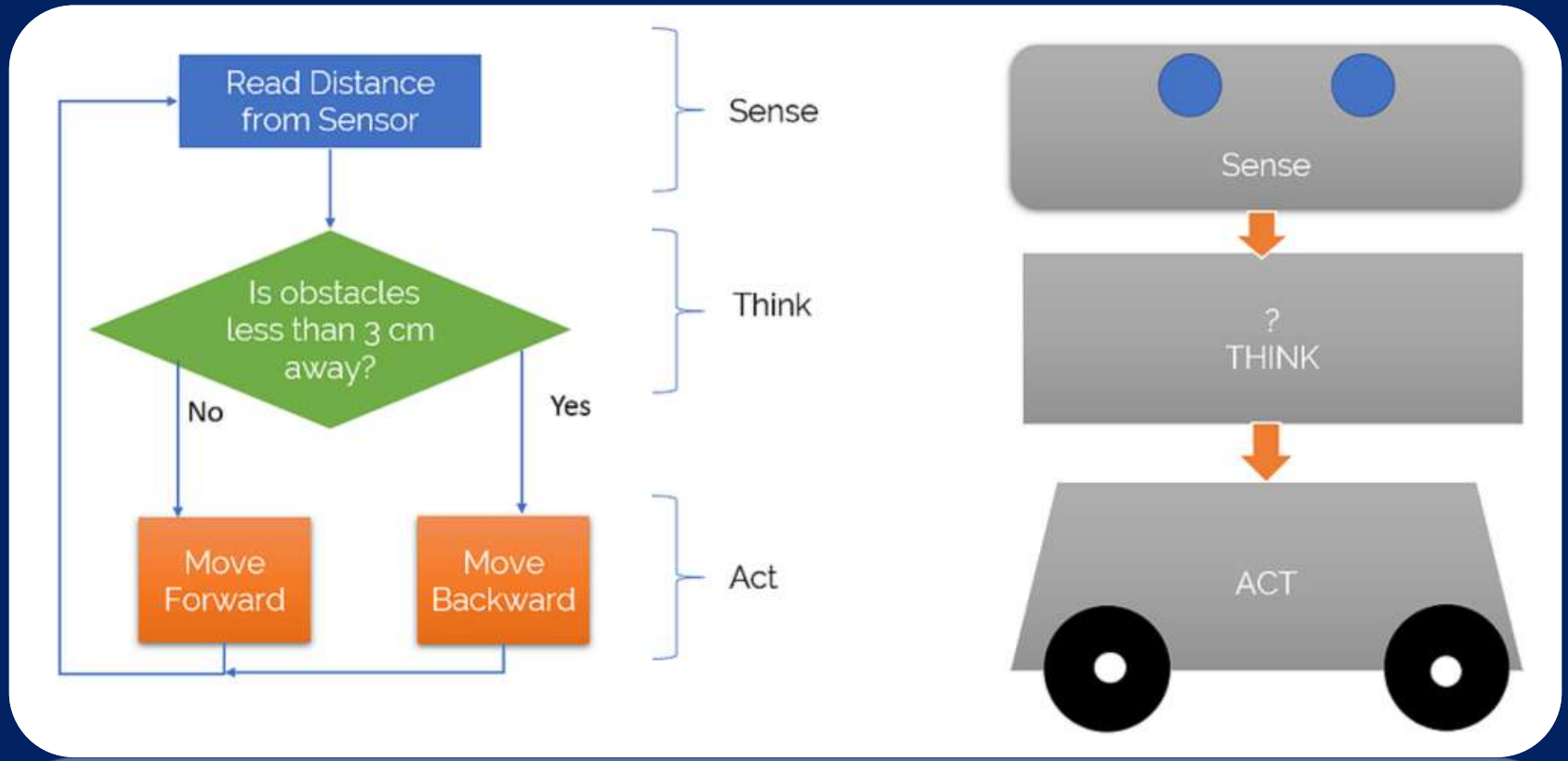
What is a Robot?

Block diagram of Obstacle avoidance robot



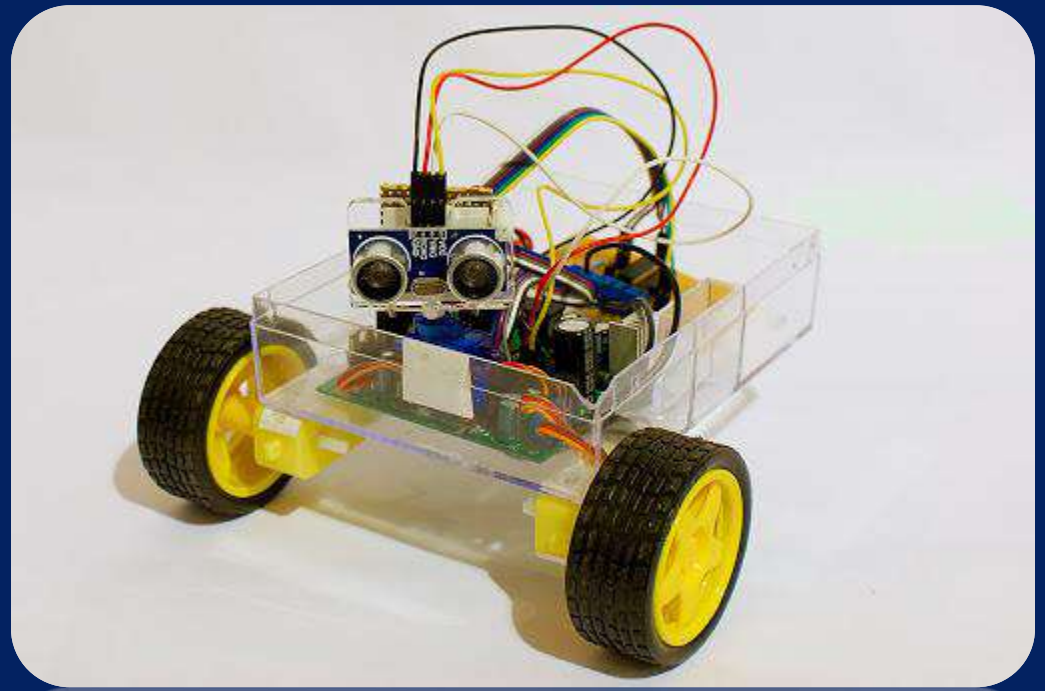
What is a Robot?

Block diagram of Obstacle avoidance robot



What is a Robot?

Obstacle avoidance robot



Robotics in a nutshell

Robotics in a nutshell

My understanding of robotics

"Robotics is an interdisciplinary branch of engineering which deals with the conception, design, simulation, and manufacturing of a robotic system. "

Robotics in a nutshell

History of Robotics:
https://en.wikipedia.org/wiki/History_of_robots

- 'Robot' from (Czech word **robota**) meaning forced labor
- Mentioned in Karel Capek play R.U.R 1920
- 'Robotics' from Isaac Asimov (short story Runabout)

Robotics in a nutshell

Laws of Robotics: Isaac Asimov (Science-fiction writer)

Law One

A robot may not injure a human being or, through inaction, allow a human being to come to harm.

Law Two

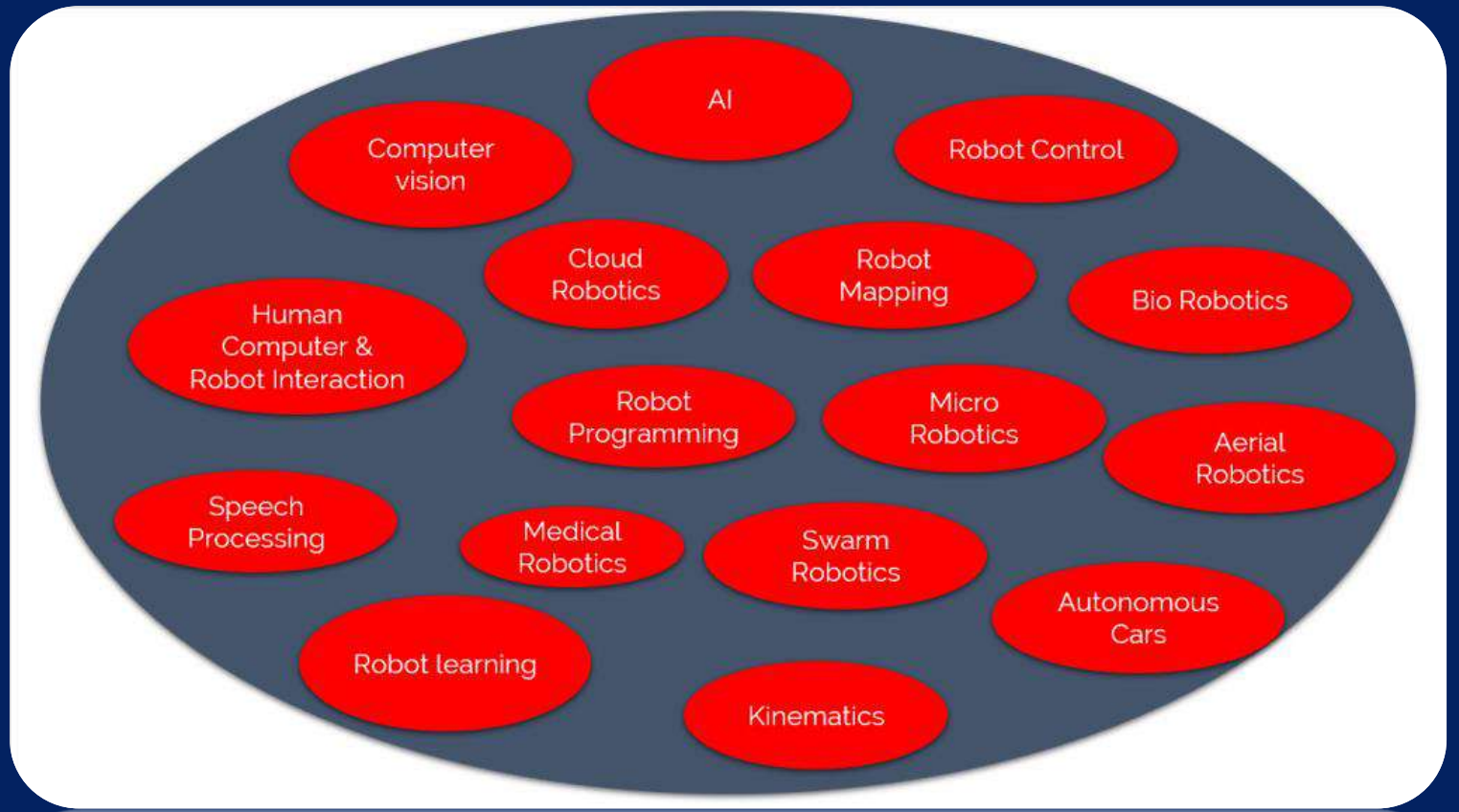
A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.

Law Three

A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Robotics in a nutshell

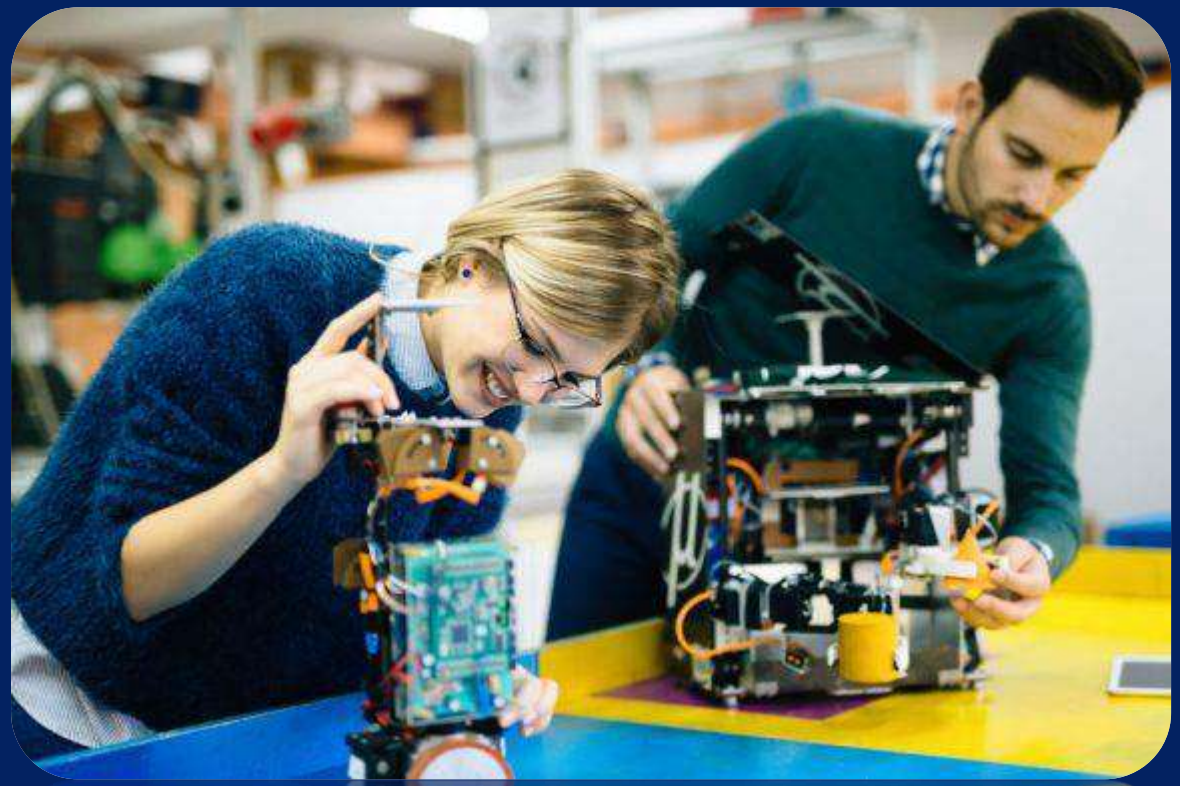
Major areas of Robotics



Robotics in a nutshell

Who is a Robotics Engineer

“A robotics engineer is like a full-stack engineer. He should have a good understanding of mechanical engineering, electronics engineering, and computer engineering. “



Different types of Robots & Applications

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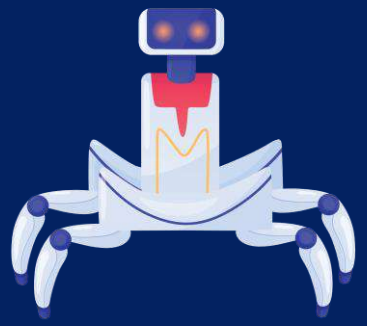
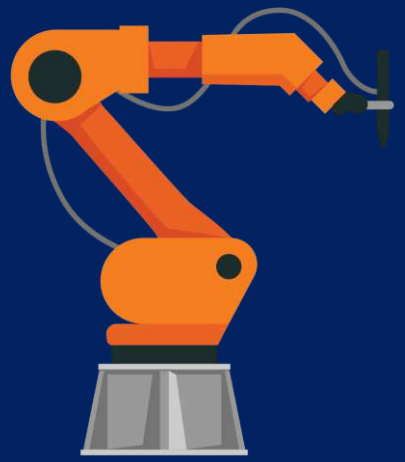
Different types of Robots & Applications

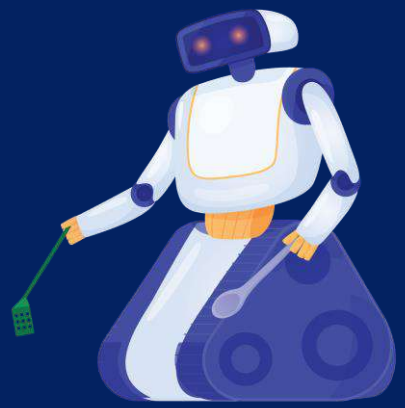
Reference:
https://robocademy.com/2020/03/30/what-are-the-different-types-of-robots-available/



Different types of Robots & Applications

1. Robotics arm/manipulators
2. Mobile robots





Kinematics & Dynamics of robot

Kinematics & Dynamics of robot

1. Robot Kinematics: Study of the geometry of motion of robot
    1. Forward kinematics (for a robot arm): takes as input joint angles and calculates the Cartesian position and orientation of the end effector. The end-effector/gripper is a device or tool that connects at the end of a robotic arm.
    2. Forward kinematics(for mobile robot) takes wheel velocities and calculate the position and orientation of the robot.

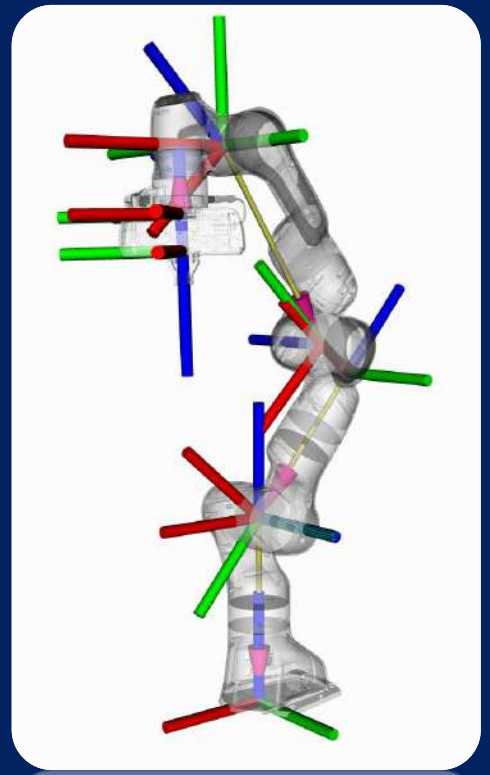
Kinematics & Dynamics of robot

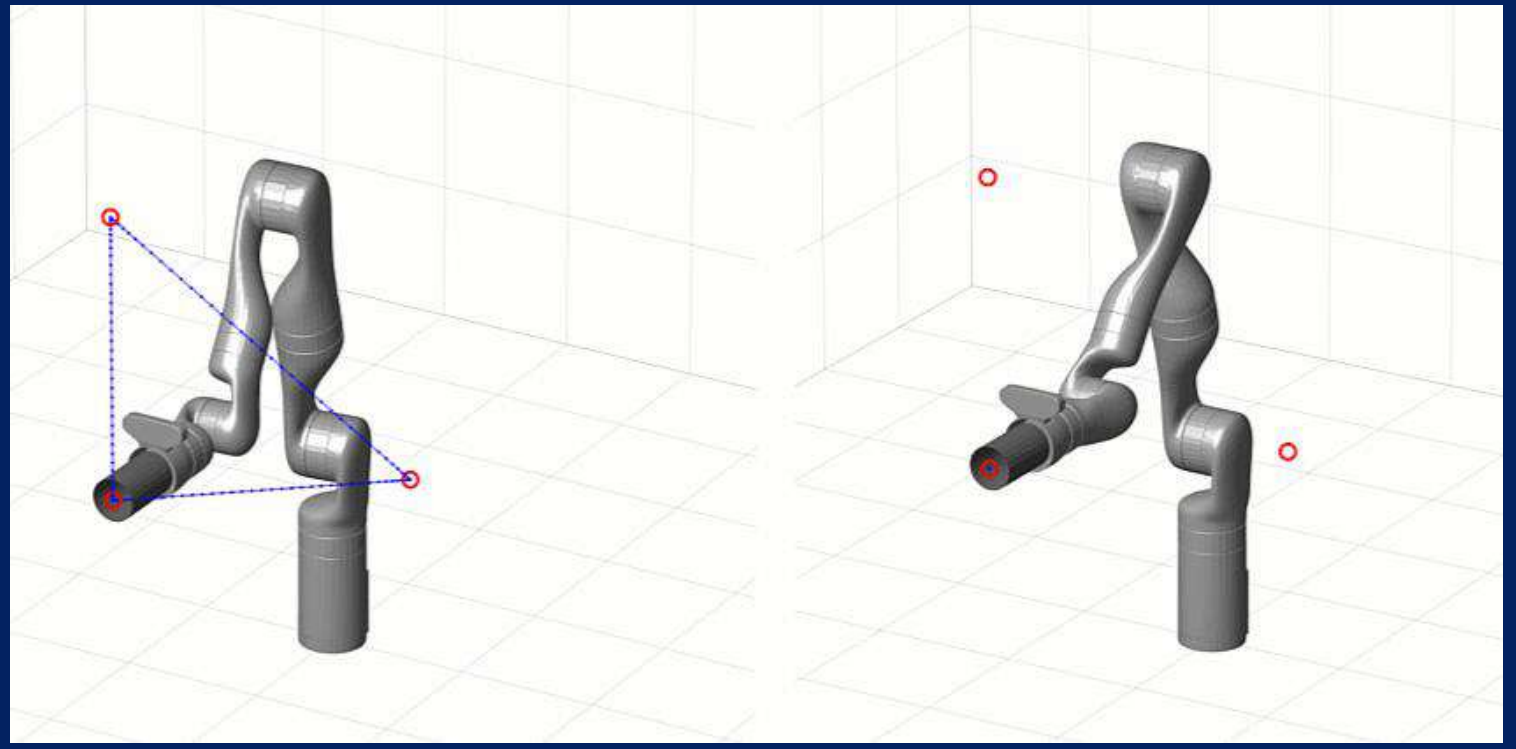
1. Robot Kinematics: Study of the geometry of motion of robot
    1. Inverse kinematics (for a robot arm): takes as input the Cartesian end-effector position and orientation and calculates joint angles.
    2. Inverse kinematics(for mobile robot) takes the input as goal position of the robot and calculates the wheel velocities in order to reach the goal.

Reference:
https://robocademy.com/2020/04/21/robot-kinematics-in-a-nutshell/

Kinematics & Dynamics of robot

Manipulator Kinematics





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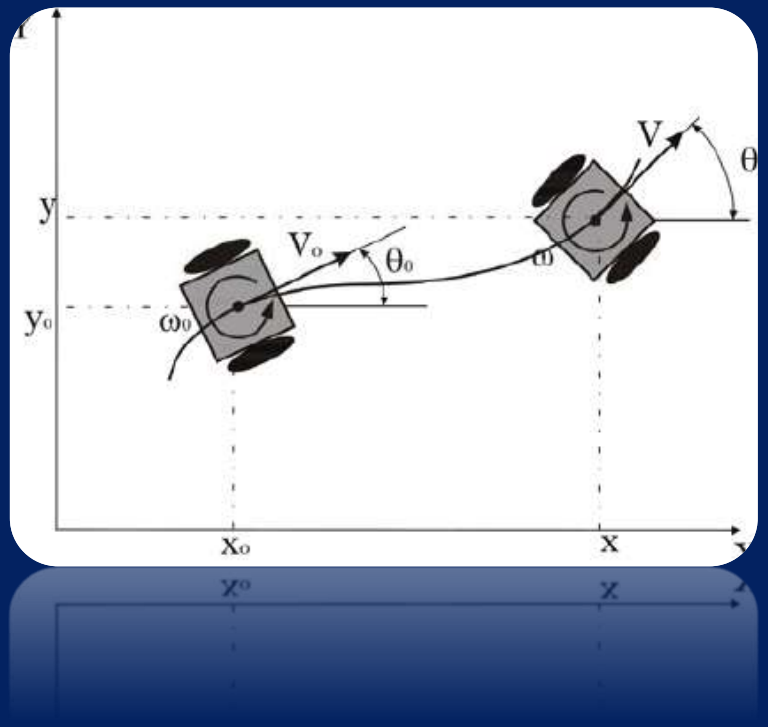
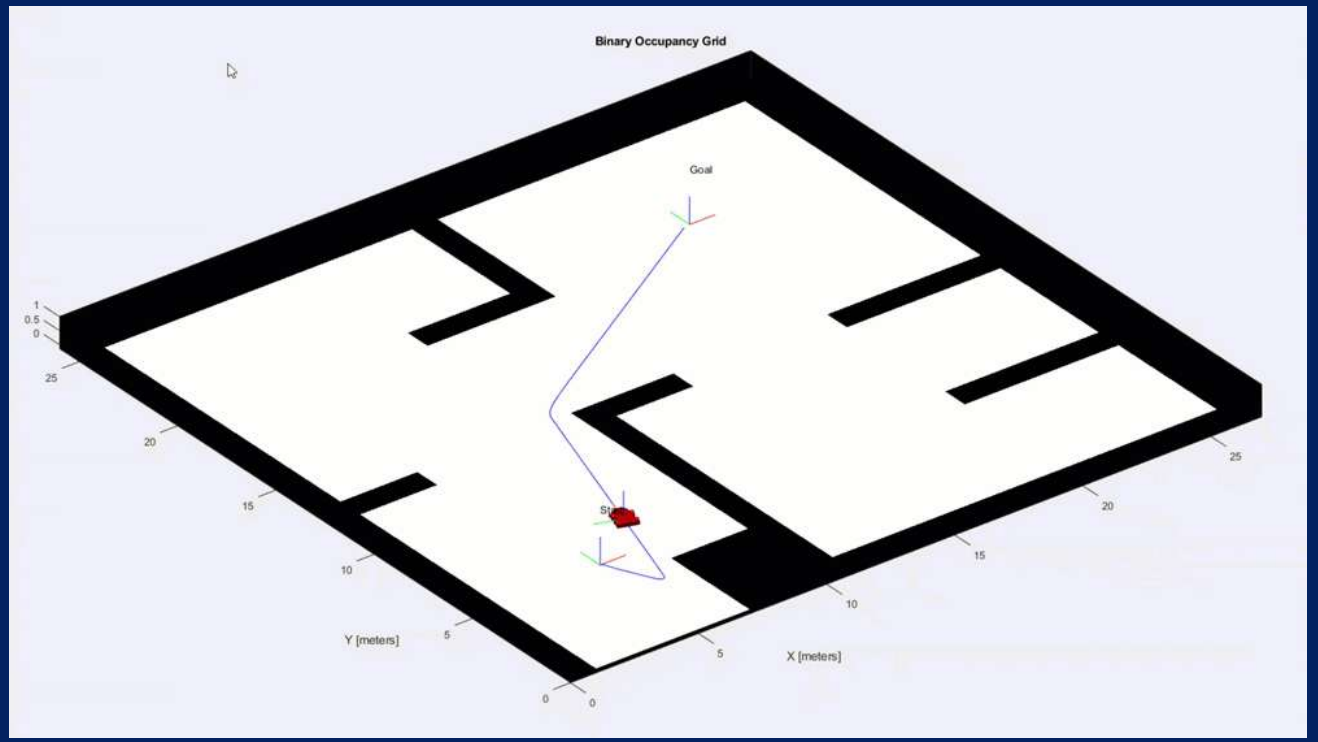
Kinematics & Dynamics of robot

Mobile Robot Kinematics





Kinematics & Dynamics of robot

1. Robot Dynamics: Study of force and acceleration relationship acting on robot mechanism. [Rigid body dynamics]
    1. Forward dynamics: given the forces, work out the accelerations
    2. Inverse dynamics: Given acceleration, work out the forces

Reference:
http://www.scholarpedia.org/article/Robot_dynamics

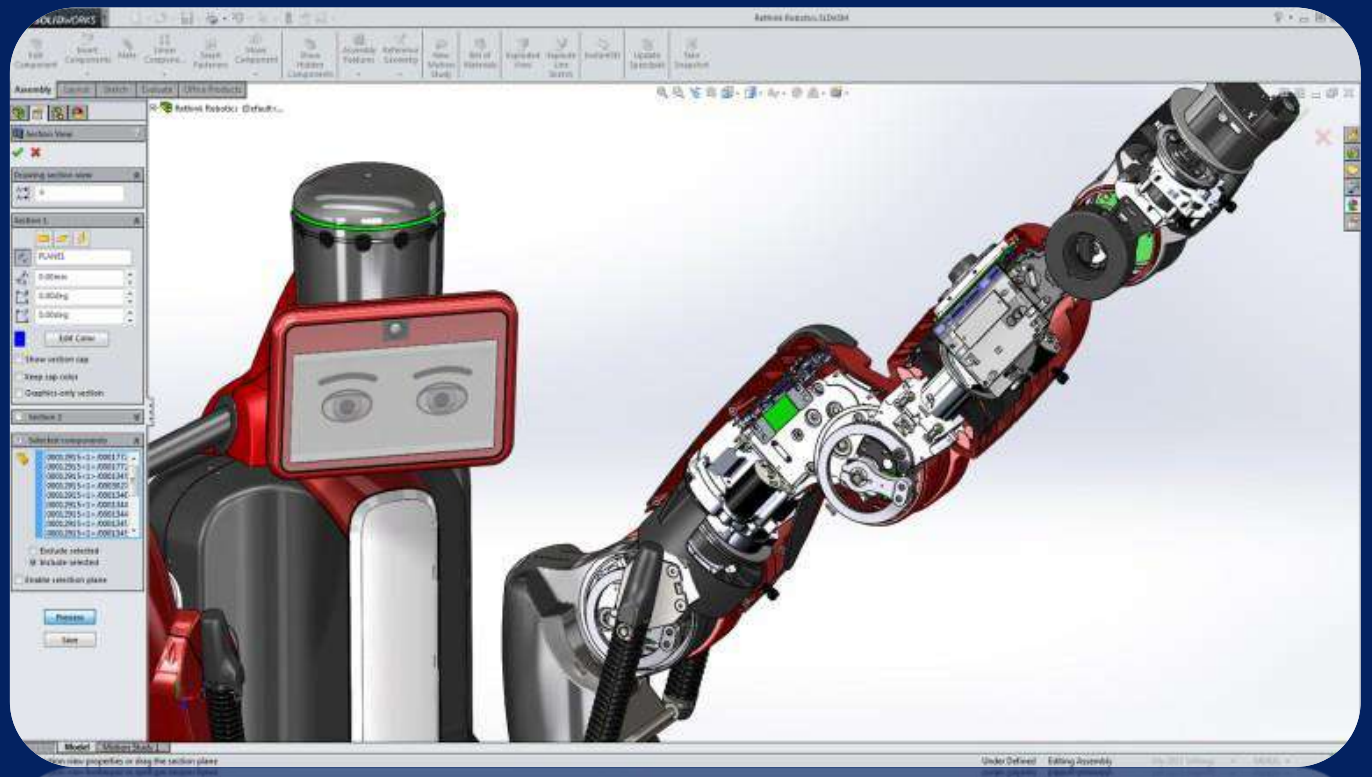
How to build your own robot?

How to build your own robot?

1. Robot designing

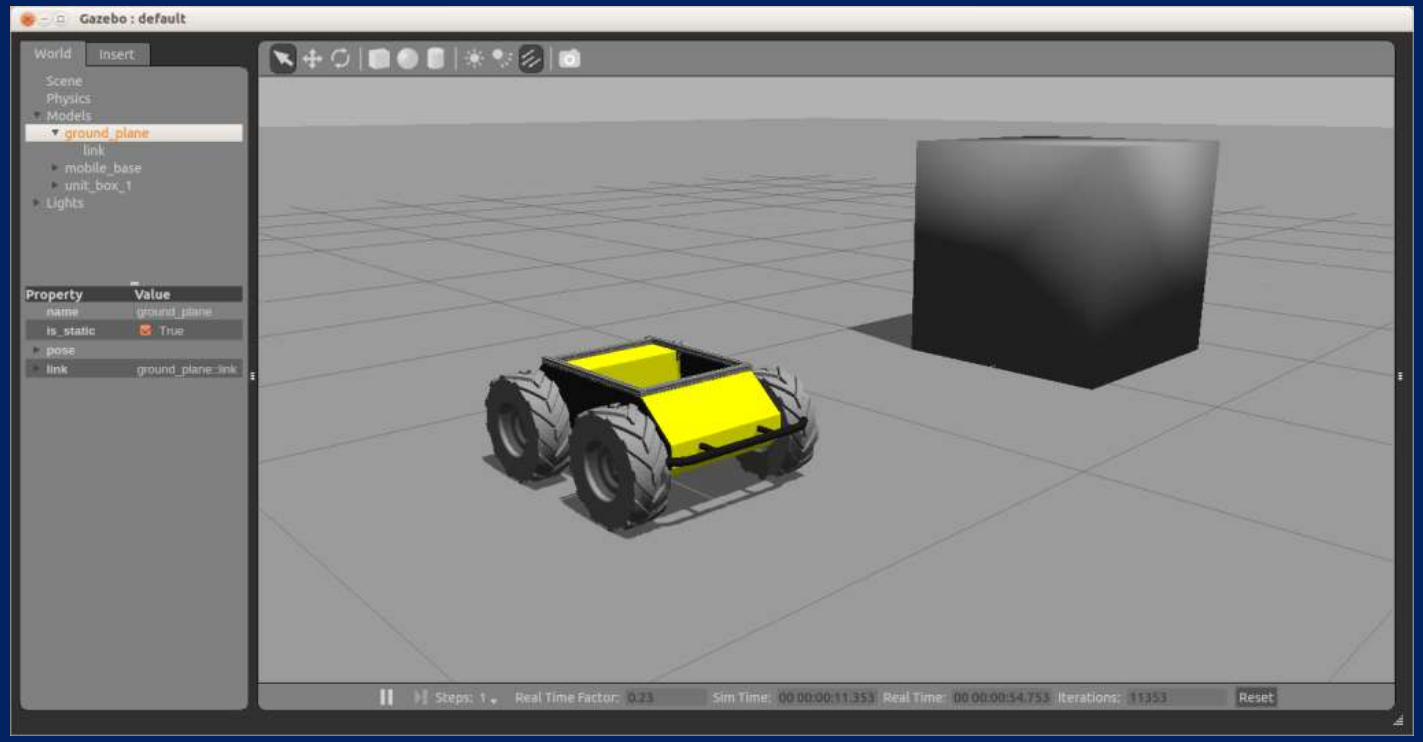
How to build your own robot?

2. 3D Modeling



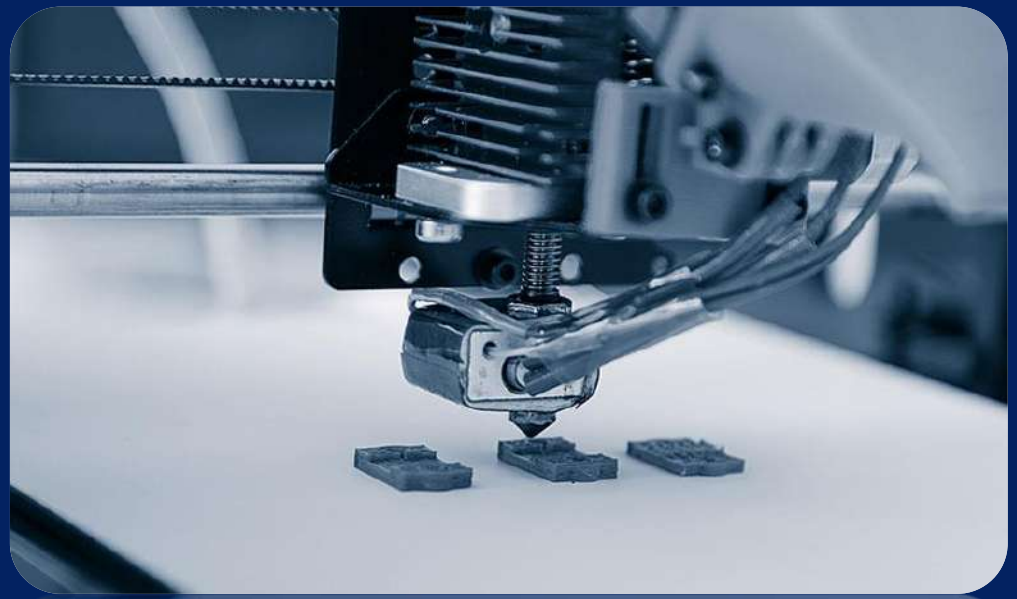
How to build your own robot?

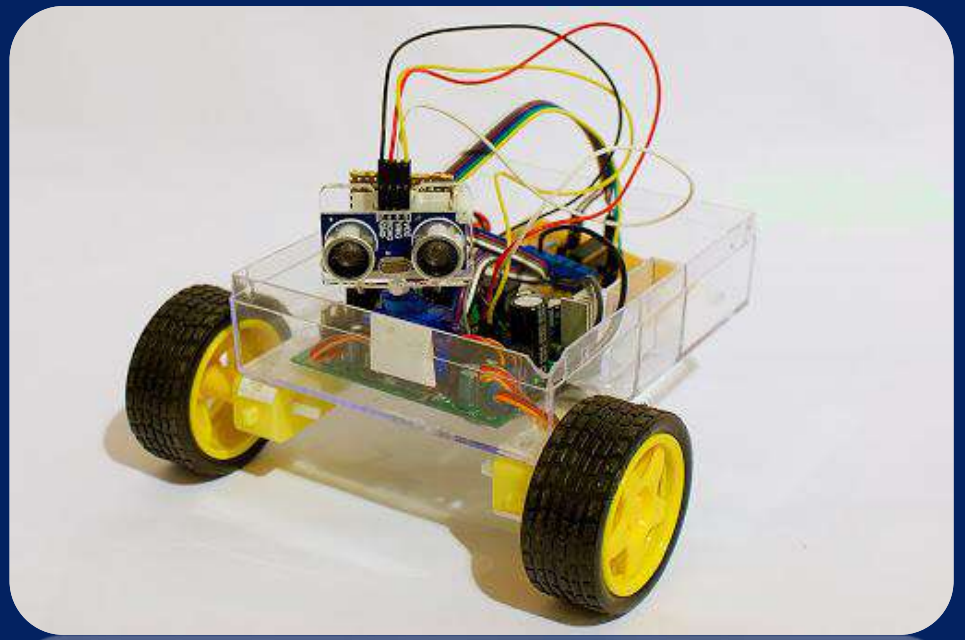
3. Simulation



How to build your own robot?

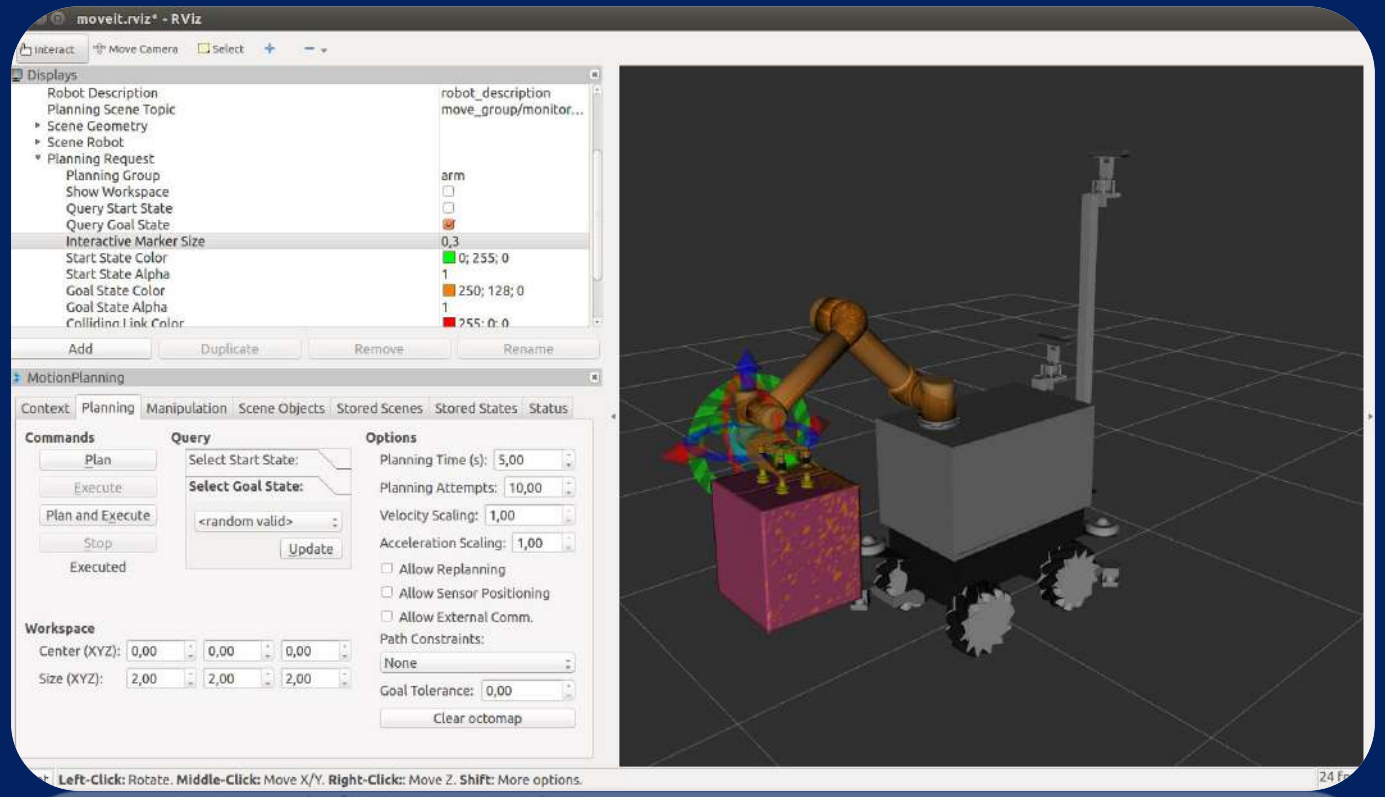
4. Prototyping





How to build your own robot?

5. Robot software



Selecting sensors, actuators, and computation unit for your robot

Selecting sensors, actuators, and computation unit for your robot

How to select sensor for your robot
https://robocademy.com/2020/04/10/how-to-choose-a-sensor-for-your-robot/

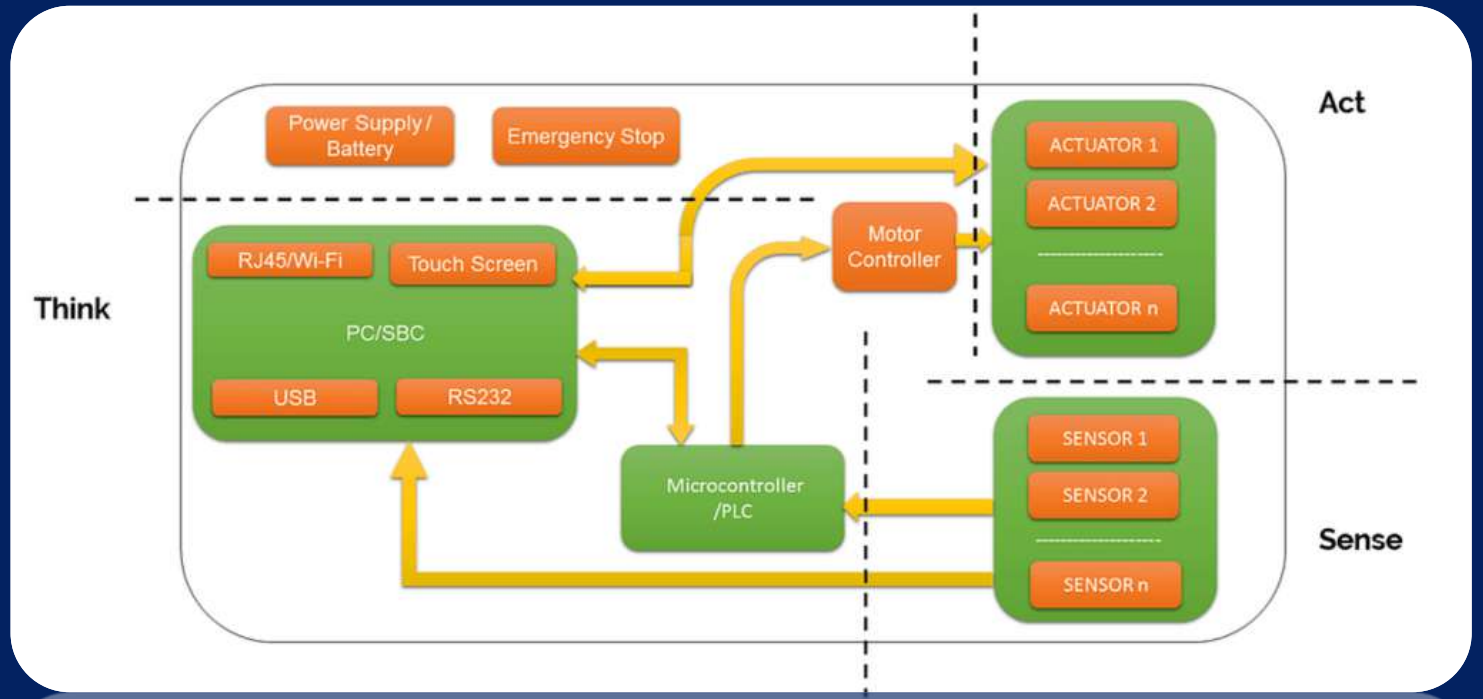
How to select actuator for your robot
https://robocademy.com/2020/04/13/how-to-choose-an-actuator-for-your-robot/

How to choose brain for your robot
https://robocademy.com/2020/04/18/how-to-choose-a-brain-for-your-robot/

How to program a robot?

How to program a robot?

Robot programming is programming the *PC/SBC/microcontroller/PLC* inside a robot for performing a specific application using actuators and feedback from various sensors.



Software frameworks for programming robots

Software frameworks for programming robots

Programming languages: C/C++, Python, Java, C#, SCADA, RAPID programming

Software frameworks: ROS, OpenCV, PCL, Gazebo, Open Rave, Webots, V-REP

Time for Discussions

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Thank You!