# Questions

- **What is the difference between automation and autonomy**

  Automation: physically situated tools performing highly repetitive pre-planned actions for well modeled tasks under the close world assumption

  Everything relevant is known and modeled, only expected situations

  Autonomy: physically situated agents that not only performs actions but can also adapt to the open world, where the environment and tasks are not know a priori, by generating plans and learning with constraint of their bounded rationality

  Models can be available but are only partially and unpredictable corrects

- **Which of the following statements are true for a mobile robot?**
  - Holonomic robots have 2 degrees of freedom

    False: A robot is holonomic iff DDOF=DOF (= deltaM) and the DOF for a robot that works on a workspace of dimensionality 3 has three degrees of freedom
    → An holonomic robot has 3 DoF
  - Swedish wheels have 3 degrees of freedom

    True: Swedish wheels have 3 DoF, they have rotation around the wheel axis, around the contact point and around the rollers
  - Robot odometry is the path followed by the robot

    False: robot odometry refers to the use of data from motion sensors to estimate the robot's position and orientation over time. It is not represent the actual path followed by the robot

- **How many degrees of freedom does a "Synchro Drive" type robot have? Why?**

Synchro driver robot has 2 degree of freedom.
It has two motors and three (steered) wheels that are locked together by a two belts
One motor provide the power for spinning the wheels and the other the power for steering the wheels

- 🔴 **Illustrate the kinematic configuration of a 3 wheels robot that you know**

  1) Omnidirectional : the three spherical wheel are disposed as the synchro driver (but is a different type of robot), it has a degree of maneuverability equals to 3, where the degree of mobility is 3 and steerability is 0. It has 3 motors

  2) Tricycle: we have three wheels, only can steers, the other two wheels are connected. This configuration has only one motor. Degree of maneuverability equals to 2, steerability 1 e mobility 1

  3) Differential: it has three wheels, one spherical and two standard. It has two independent motors for each std wheel. The degree of mobility is 2 and steerability 0

- **What is holonomic and when a robot is a holonomic one?**

  Holonomic means that can move instantaneously in any directions, corresponds to the ability of control all its degrees of freedom independently and instantaneously, performing complex maneuvers without having to change their orientation.

  A holonomic robot is a robot with zero non-holonomic constraints. An holonomic constraint can be expressed as an explicit function of position variables only.
  It is treated as a mass point capable of instantaneously change velocity and direction

  A robot is holonomic if and only if the differential degree of freedom DDOF is equals to the degree of freedom DOF

- 🔴 **Illustrate the paradigms for programming robot software architectures**

  Pippone sulle architetture

- **Illustrate at least 4 sensors useful for indoor robot localization. Explain the basic working principles**

  1) IMU: sensor that provides the acceleration, velocity and position of a mobile robot. It is composed by three orthogonal accelerometers and three orthogonal gyroscope, mounted on each axis in order to obtain the instantaneous value

  2) LIDAR: sensor that emits laser beams and measure the time it takes for the beams to hit an object and reflect back to the sensor in order to obtain the distance value

  3) ULTRASONIC SENSOR: principle similar to lidar, it emits height frequency sound waves and measure the time for each echos to return after bouncing into a object in order to obtain the distance value

  4) INFRARED: emits infrared energy and measures whether any significant amount of IR light is returned. It is a very popular and cheap sensor but it is sensitive to lighting conditions and reflection

- 🔴 **What are exteroceptive sensors in robotics? List at least 5 exteroceptive sensors**

  They are sensor which sense stimuli that are external to the robot, acquire information from the robot's environment

  1) Compass

  2) GPS

  3) LIDAR

  4) STRUCTURED LIGHT

  5) ULTRASONIC

  6) "TIME OF FLIGHT CAMERAS"

- 🔴 **How do tactile sensors work?**

  A tactile sensor is a device designed to sense and measure physical contact, pressure, or force exerted on its surface. Typically it consists of two conductive layers separated by an insulating material. When pressure is applied, the distance between the conductive layers changes, altering the capacitance between them proportionally to the applied force

- 🔴 **What is LIDAR and how does it work?**

  Light detector and ranging, it is a sensor that emits laser beams and measure the time it takes for the beams to hit an object and reflect back to the sensor in order to obtain the distance value.
  LiDAR creates a detailed map of the surroundings (a point cloud), which can be used to identify the robot's location relative to known landmarks or within a pre-mapped environment

- **Define the following terms:**
  - **Accuracy:** degree of conformity between the sensed value and the true value
  - **Precision:** reproducibility of sensor results
  - **Repeatability:** capability of reproducing the same output values over the same constant input
  - **Resolution:** minimum difference between two values that can be detected by a sensor
  - **Sensitivity:** ratio between the output change and the input change
  - **Stability:** capability of keeping the same measuring characteristic over time

- 🔴 **What are the principles of SLAM?**

  SLAM stands for Simultaneous Localization and Mapping. It consists in solving both localization and mapping problem. Localization estimates the robot

position in the environment given the map while mapping is the process of building the map of the environment given the robot position. SLAM problem takes in input robot control and sensors observations and gives in output the position of the robot and the map

The SLAM problem is the problem of mapping the environments while simultaneously estimates the robot position with respect to that map
The Slam problem came in many flavors: volumetric slam, features based slam, topological slam and metric slam
To solve exist three main paradigm:
1)extended kalman filter
2)graph approaches
3)particle filter

- 🔴 **Which is the difference between a metric and topologic map?**

  A metric map refers to a representation of the environment in which distances and spatial relationships are measured explicitly. Metric maps are based on sensors data and represent the physical layout of the environment with details about obstacles and other features.

  A topological map focuses on representing connections and relationships between different locations in the environment without explicitly preserving metric distances but representing the environment in a graph structure with nodes and edges. Topological maps are useful for navigation and path planning

- 🔴 **Explain the concept of C-Space for mobile robots**

  vedi risposta Andrea

- 🔴🔴 **Difference between topological and metric grid-based map**

  vedi risposta prima

- 🔴 **What is ROS and what is not ROS?**

  Robot operating system is a flexible open source framework for writing software for robot applications, acts also as a meta operating system for the robot.
  It has a modular design
  It is not a programming language, for the developing in fact is used c++ or python (other language can be supported), is not a IDE and not only a library since it contains command line tools, building systems, internal server

  The main components are nodes, messages, service and action

- **What is the "MoveIt!" package mainly used for?**

  It is a motion planning library for ROS that provides a comprehensive set of tools for robot arm control and other manipulators, focusing on planning, manipulating, and executing motions

  We can use to compute the motion planning, collision checking, calculate the forward and inverse kinematics, grasping and manipulating objects allowing pick and place task

  MoveIt is state of the art software for mobile manipulation

- **Describe ROS message service**

  The main element in ROS are: nodes, messages, services, actions

  The nodes are programs (process) where the computation is done
  Nodes can communicate sending and receiving data throw:

  - Messages → they contains data to sent to nodes, each message has a unique name, called topic. A node that want to receive a message have to subscribe to a specific topic, to send have to publishing a specific topic
  - Services → exchange data between nodes, the communication is based on a request-response systems

- Actions → used for long time operation, allow to create “local” servers and clients

- **What is meant by “probabilistic localization”? Illustrate some probabilistic localization techniques**

  Probabilistic localization utilizes a robot’s belief, function that captures the uncertainty associated with the robot’s knowledge about its own location, to compute possible position(s).

  - One technique is called Markov Localization and it consists of calculating a belief for each of the possible poses and assigning the position to the pose with maximum belief.
    More used for global localization because it should converge to the correct pose fairly quickly.
    It can start from any unknown position, it has a discrete representation space
  - Another technique is called Extended Kalman filter and it is used for local localization. It predicts what the robot should be sensing after some actions and then it will adjust the estimated position based on real perception.
    It starts from an initial known position and it has a continuous world representation

- **What is the direct kinematics for a mobile robot?**

  Direct kinematics, also known as forward kinematics, for a mobile robot refers to the mathematical process of determining the position and orientation of the robot in its environment given the parameters of its motion. This typically involves using the robot's wheel velocities, wheel angles, and other relevant parameters to compute its pose (position and orientation) in the global coordinate system.
  The specific equations and approach depend on the type of mobile robot and its configuration

- **Describe the difference between shared control, autonomy and intelligence**
  - Shared control is when a person and a robot both contribute to the performance of a task in a collaborative way, often by providing control inputs for a robot, usually the robot acts as helper for the human
    → involves a collaboration between human operator and a robot
  - Autonomy: physically situated agents that not only performs actions but can also adapt to the open world, where the environment and tasks are not know a priori, by generating plans and learning with constraint of their bounded rationality
  - Intelligence: is defined as the ability necessary to achieve the goal(s) and as the capability of a system to learn, adapt, reason, and make decisions that are not explicitly programmed

- 🔴👀 **Describe active sensor and list 4**

  vedi Andrea
- 🔴👀**Hybrid architecture**

  pippone architecute
- 🔴👀**Locomotion system**
- 👀 Definition of pose, position, path, trajectory, c-space
- 👀 Definition of proprioceptive, exteroceptive, exproprioceptive

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LEGENDA

🔴 già chieste quest'anno

👀 nuove domande