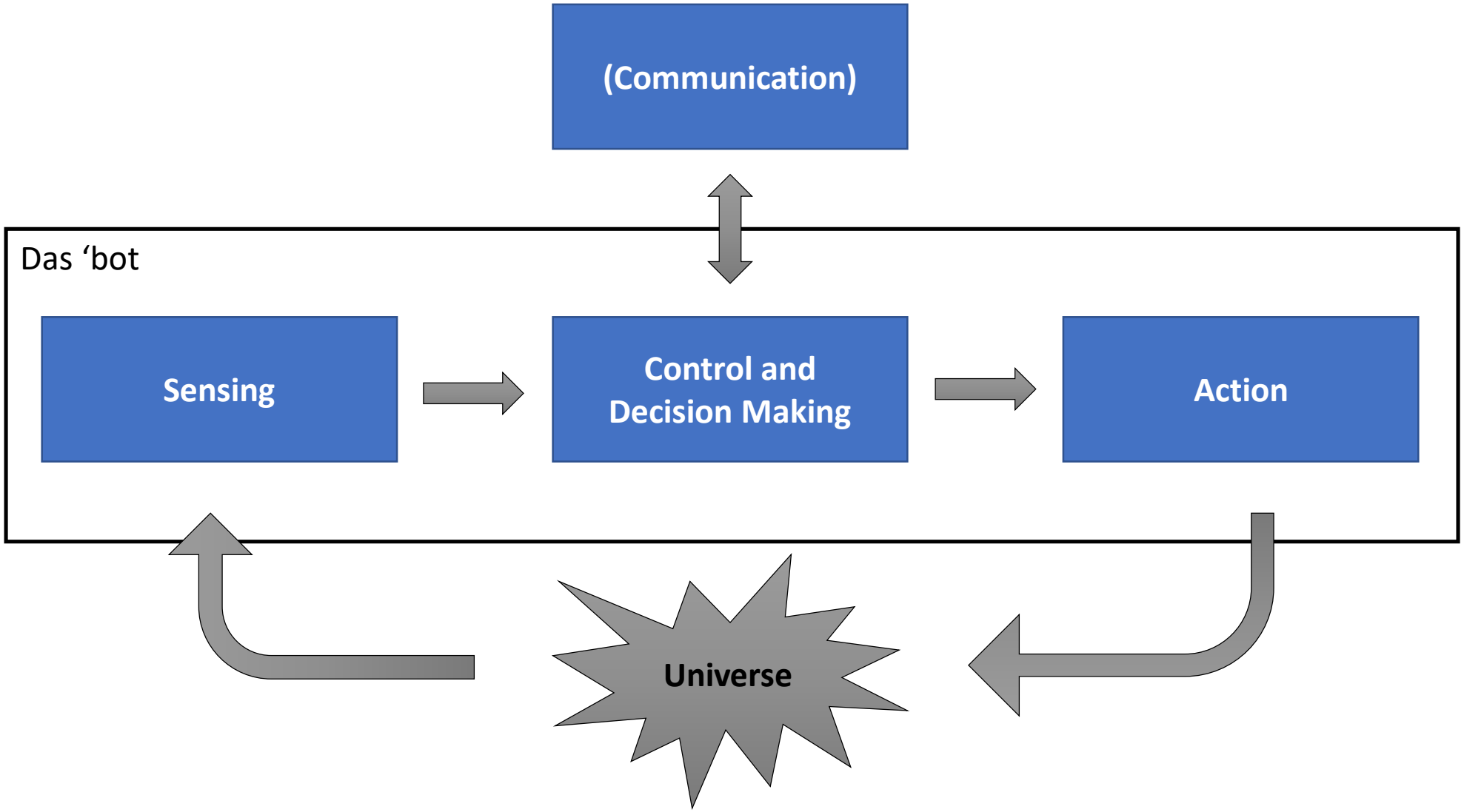
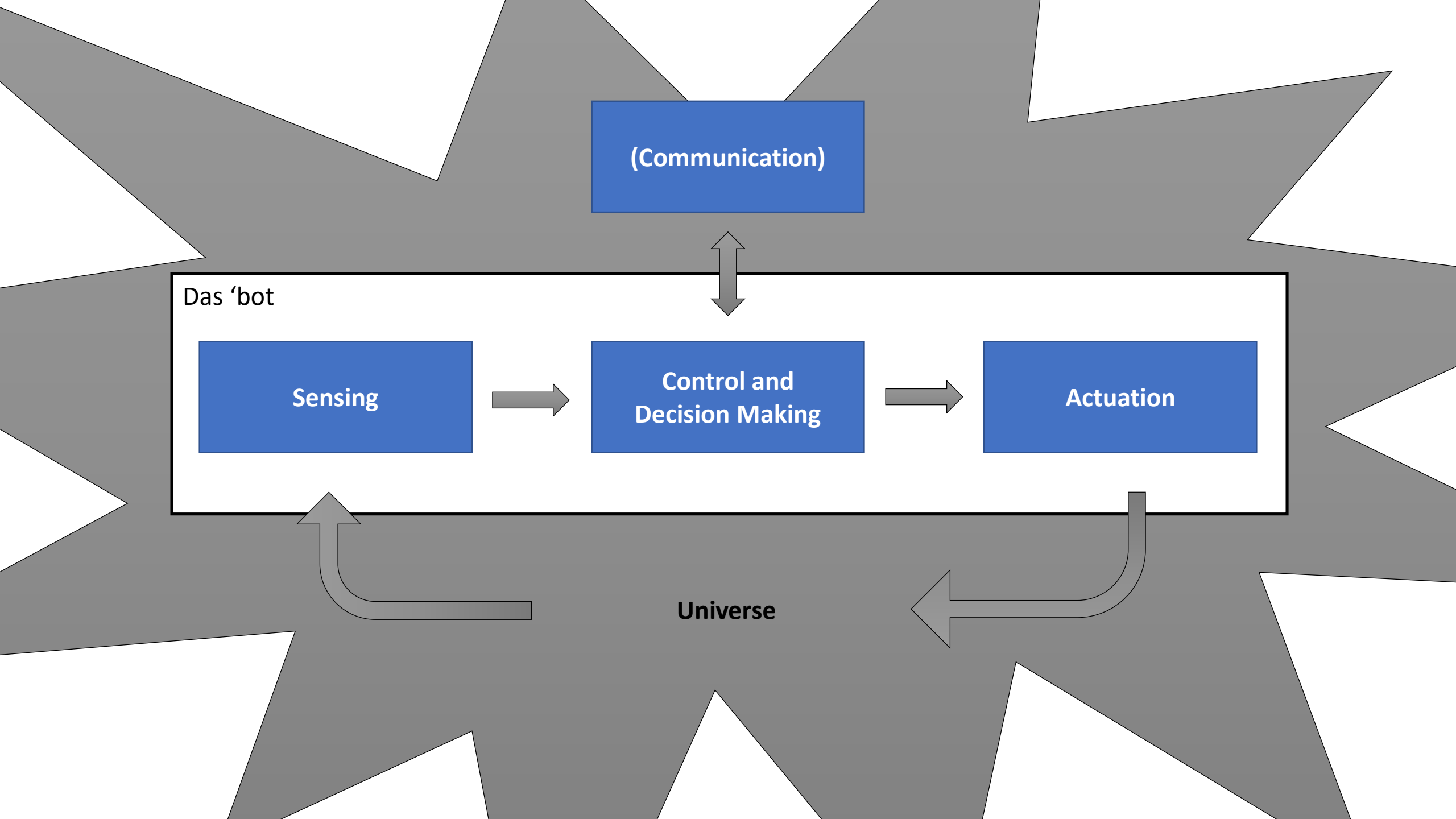
Robots


(Communication)
Das ‘bot
Sensing
Control and
Decision Making
Action
Universe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Sensing

- Receiving information about the robot's physical surroundings
- *Perception* is essentially a synonym – you may use it interchageably with "sensing."
  - I usually reserve it for information that has been processed as an *interpretation* of the signals
- Sensors must be appropriate for the robot's tasks

States

- The *state* of the robot is a description of its “current conditions.”
  - Where is it? What the charge on the battery?
  - What *mode* is it in?
- The state is represented by one or more variables: position, speed, current task, etc.
  - discrete/continuous
  - internal/external
- States may or may not be *observable*
- The *state space* is the set of all possible states (which can be quite large when you think about it)

A dirty, little secret

- You (and your robot) can never really know anything for certain.
- The best you can do is make *estimates* of the current state.
  - Sensors have inaccuracies
  - Our physical models are always approximations
- Even worse, your sensors will rarely tell you the same thing
  - Dealing with that eventuality is called *sensor fusion* – taking conflicting information from different sensors and making a reasoned estimate of the truth

Action

- Actuators and effectors

Action

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Action

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- Locomotion:
  - Driving
  - Flying
  - Swimming
  - Crawling
  - Walking

- Manipulation:
  - Grasping/gripping
  - Picking
  - Inserting
  - Placing

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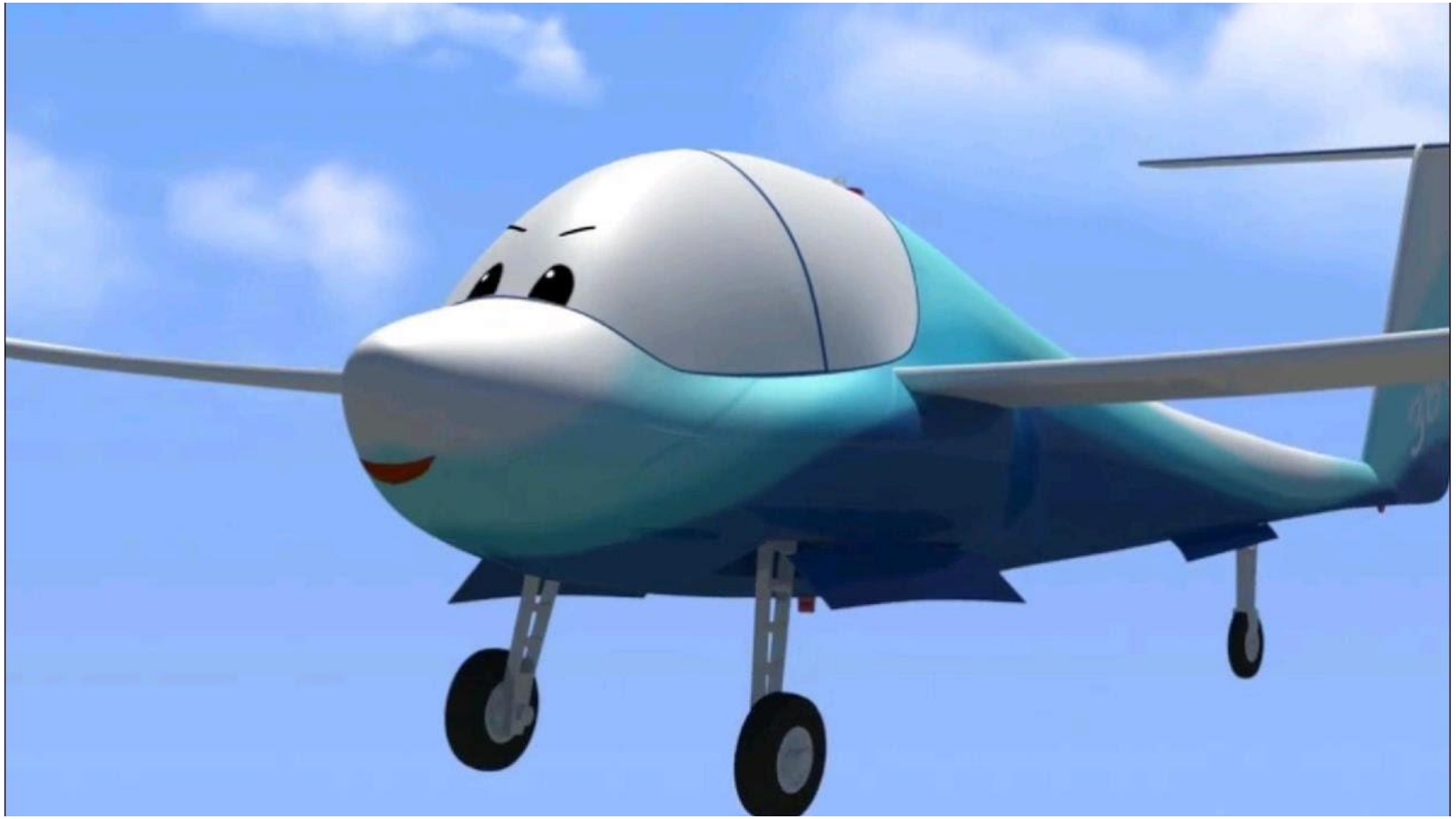
Degrees of Freedom

- Each coordinate of motion represents a degree of freedom:
  - Aerial vehicle
  - Ground vehicle
  - Robotic arm

How many DoF?



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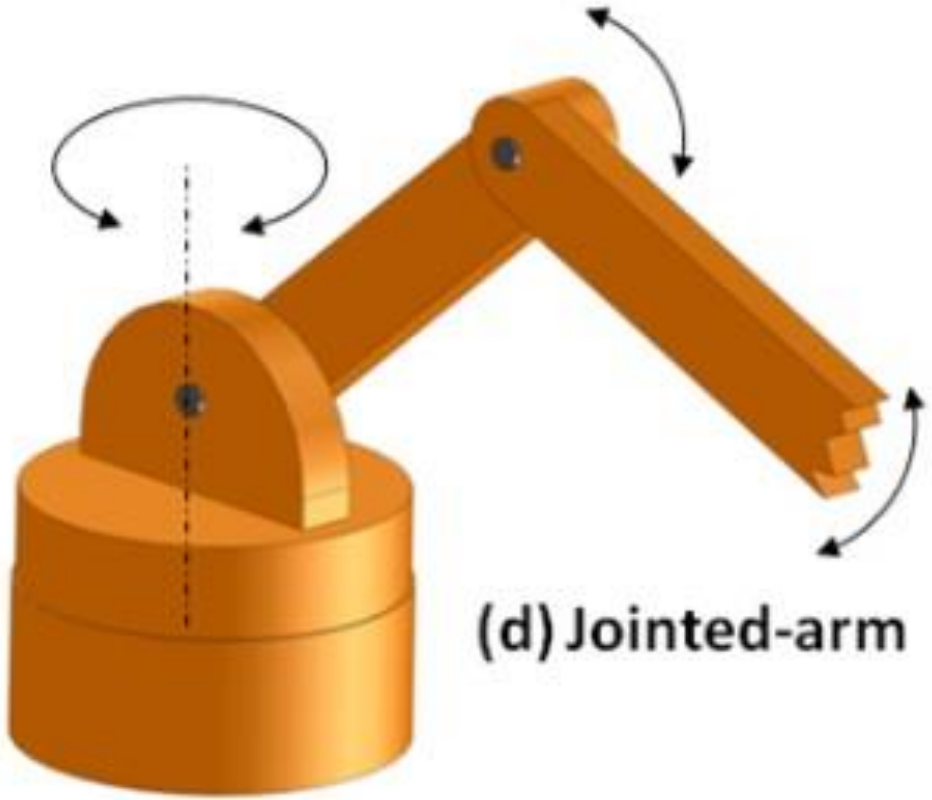


How many DoF?

Pose

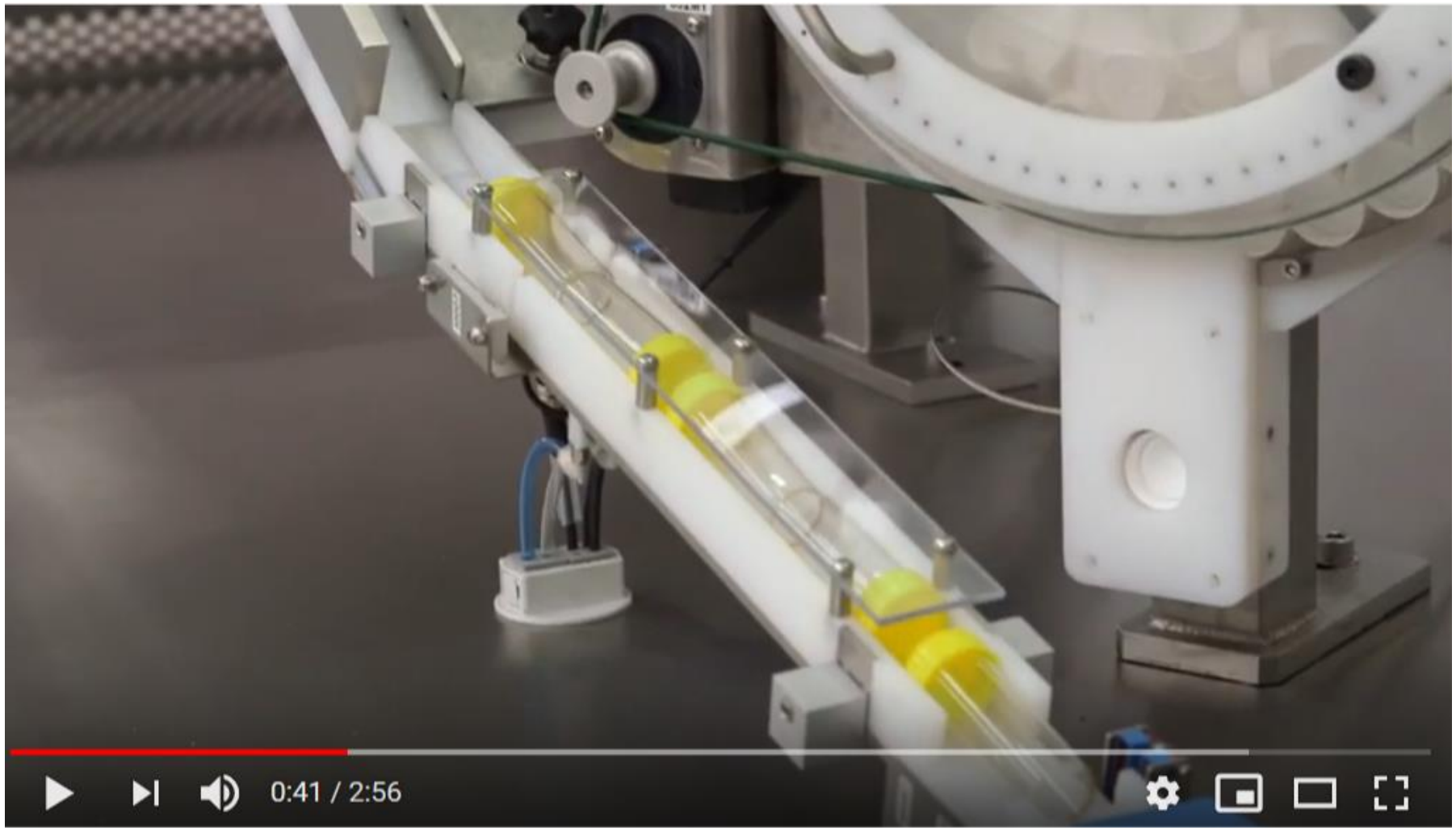
- The *pose* is the description of a vehicle's geometrical state:
  - position
  - orientation
- For a robotic arm, we can define the geometrical state in terms of *joint space*, the position of each of the joints

Autonomy

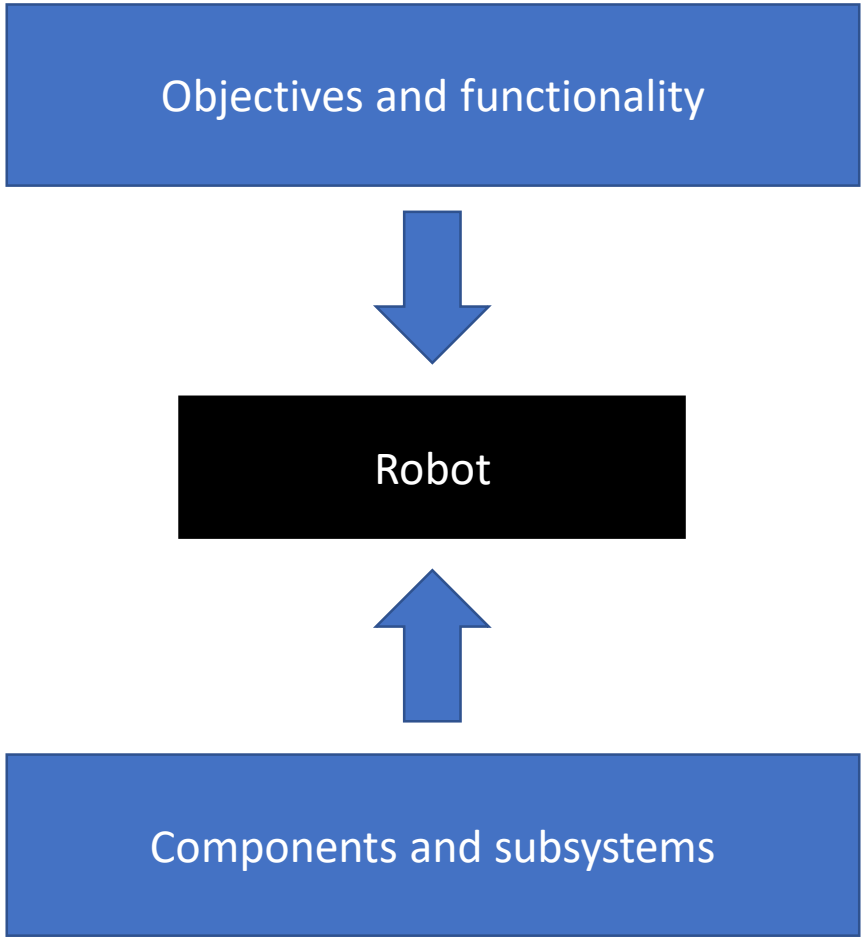
- Interpret the sensors, make representations of the world (and the robot's state)
- Use that information to make decisions
- Control actuators to take action
  - Could be as simple as on/off (e.g., a night light)
  - More complex control might be so-called "PID" control for speed
  - Still more complex: path planning from A to B; etc.

Deconstructing Marty

Working together



Top-down vs. Bottom-up design



Top-down Design: Define the system by its functionality

- Functions are what the system has to do
  - “detect object”
  - “locate object” (e.g. “measure distance”)
  - “propel (self)”

Defining Functionality

- Actions of the system
- Strive to be solution independent – anything that implies a solution narrows the solution space
- For illustrative purposes, we often define them as verb:noun pairs
  - (but “be <something>” is typically *not* a good functional definition)

Soil monitoring robot

A capstone team did some work at a local vineyard to help the manager make better decisions about vineyard management. Specifically, the manager wanted a better way to monitor soil moisture and temperature, among other data. There are a few fixed probes throughout the vineyard, but the manager wants better resolution and probes are expensive. They asked us to investigate the possibility of building a robot that could move around the vineyard and collect data.

Define the functionality of such a robot.

Soil monitoring robot

Deconstructing Marty

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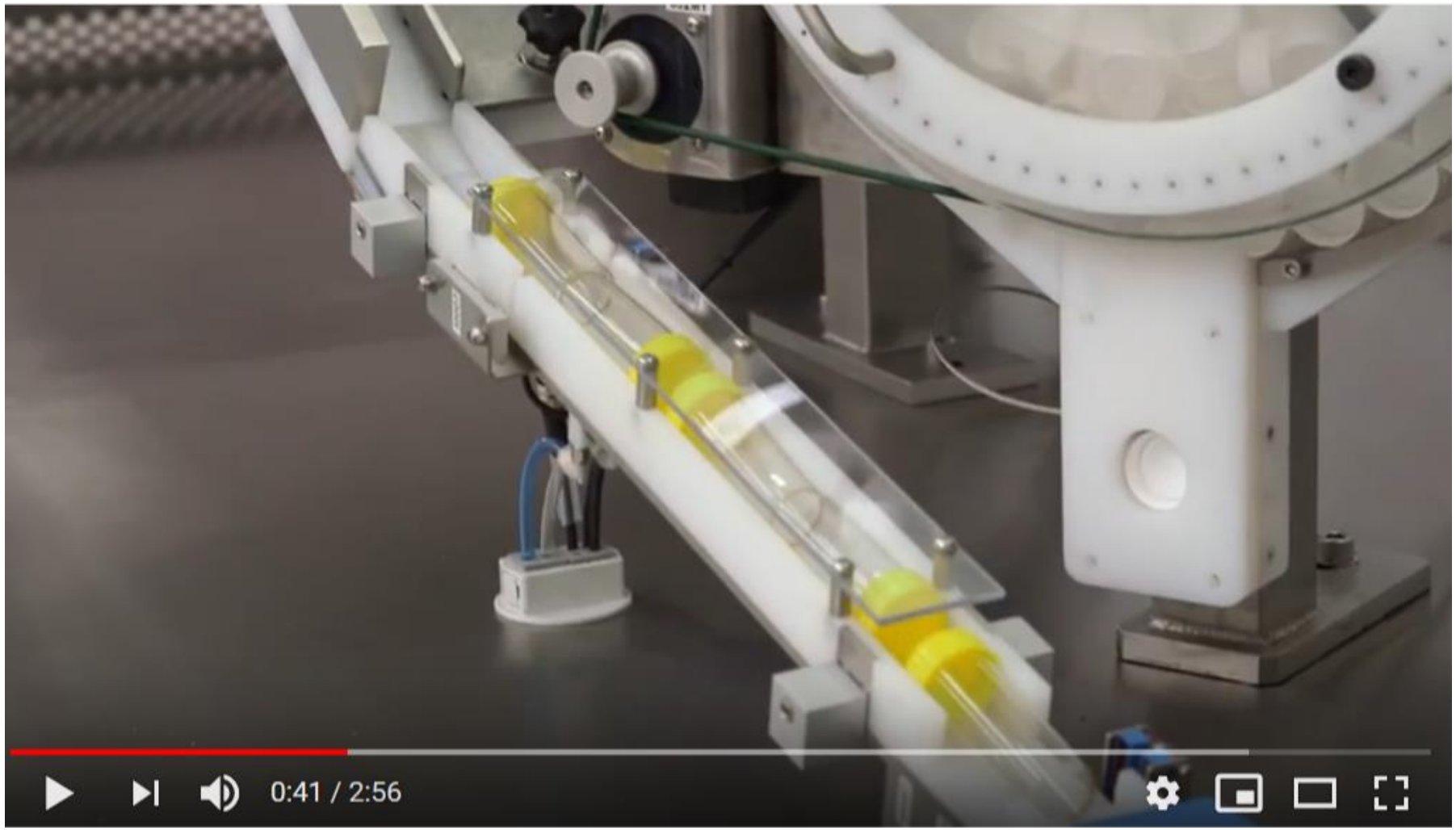

DigSafe Robot

You work for a large electrical company, which commits a lot of resources to marking out electrical lines so that when contractors are digging, they don't dig up your wires. You are aiming to make the process more efficient, and one of your brilliant ideas is to make a robot that can survey an area for buried cables and mark them, much as is done by a person now. You have GIS information on where lines *should* be, but they aren't always accurate.

Define the functionality of such a robot.

How you define functionality affects your solution space

- Consider the difference between:

Less restrictive	**More restrictive**
Move around workzone	**Drive around workzone**
Store data	**Transmit data**
Measure soil temperature	**Insert probe**