NYU

Introduction to Robot Intelligence [Spring 2023]

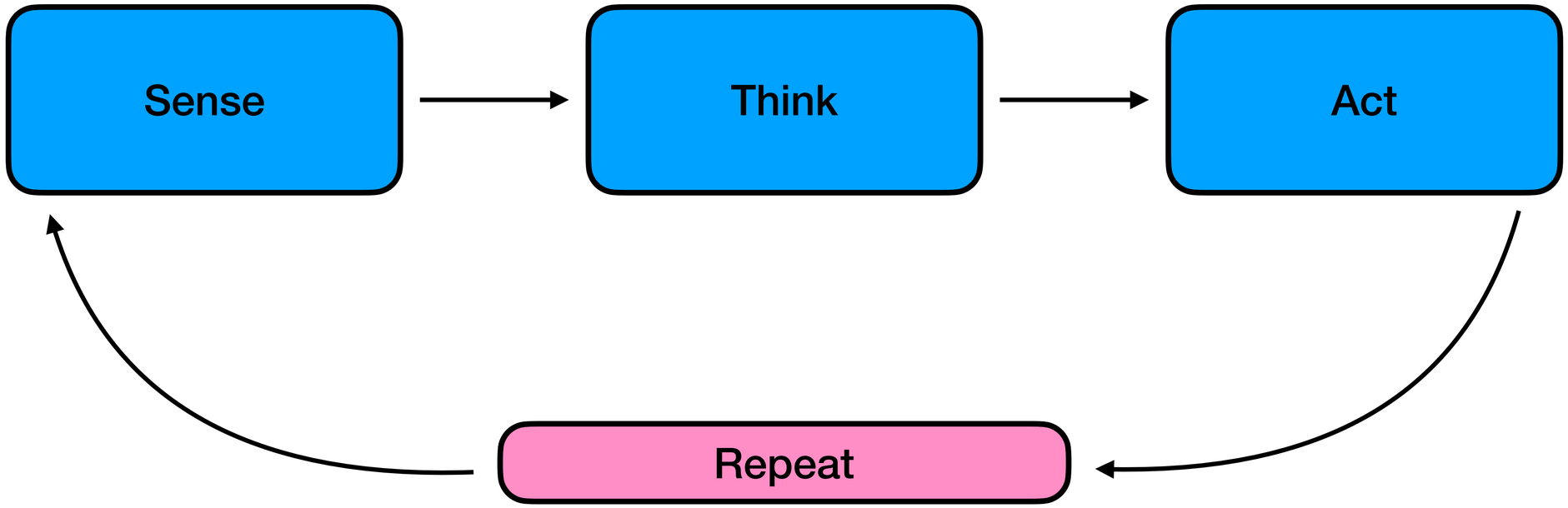
Robot Anatomy

February 14, 2023

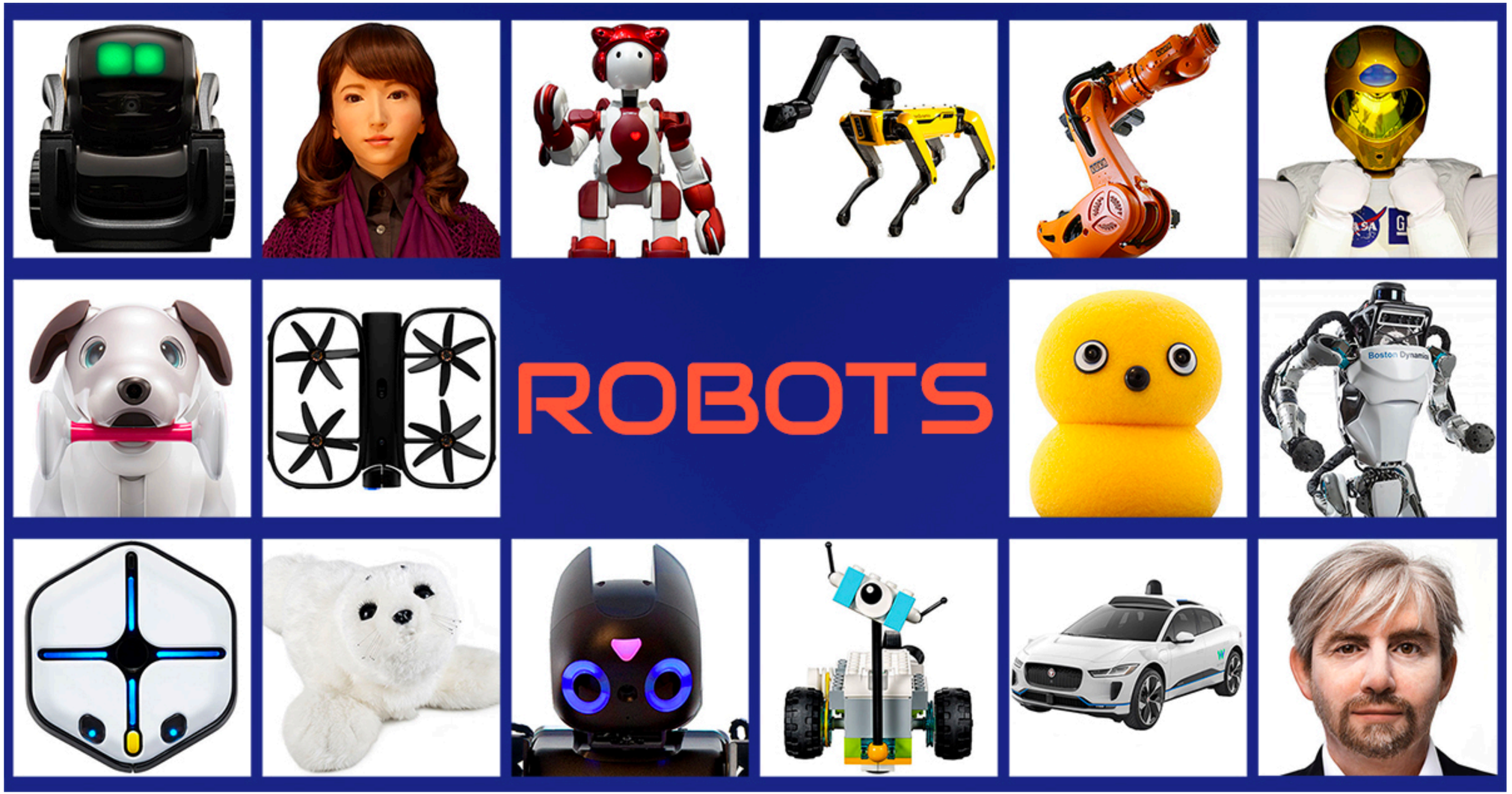
Lerrel Pinto

Recap: What is a robot?

Recap: What is a robot?



Recap: Types of robots



Source: robots.ieee.org

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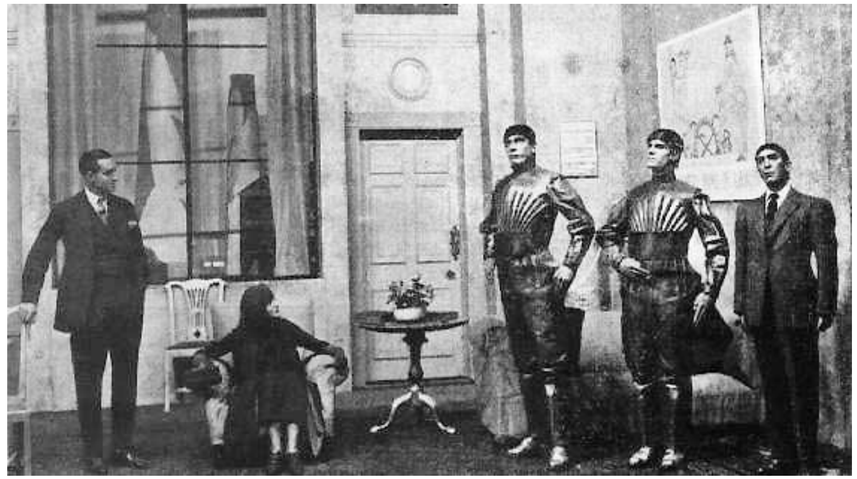
- 1920s: from Czech, from *robota* ‘forced labor’. The term was coined in K. Čapek's play *R.U.R.* ‘Rossum's Universal Robots’ (1920).



https://www.sciencefriday.com/segments/the-origin-of-the-word-robot/

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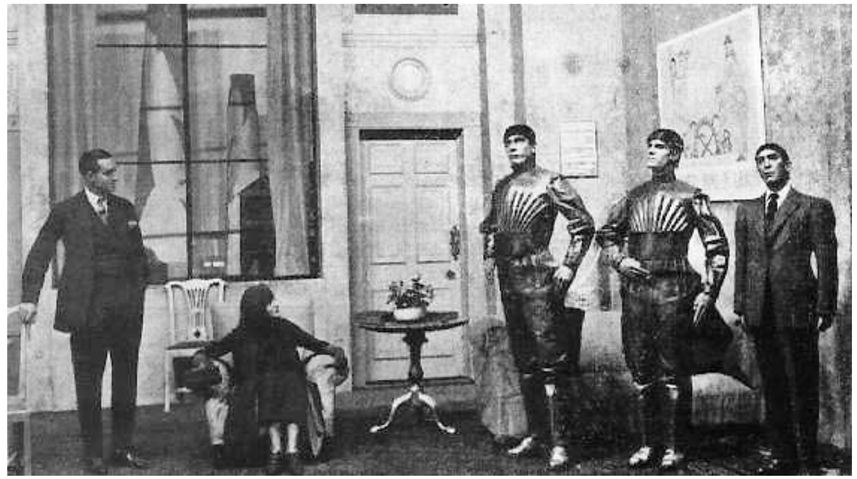

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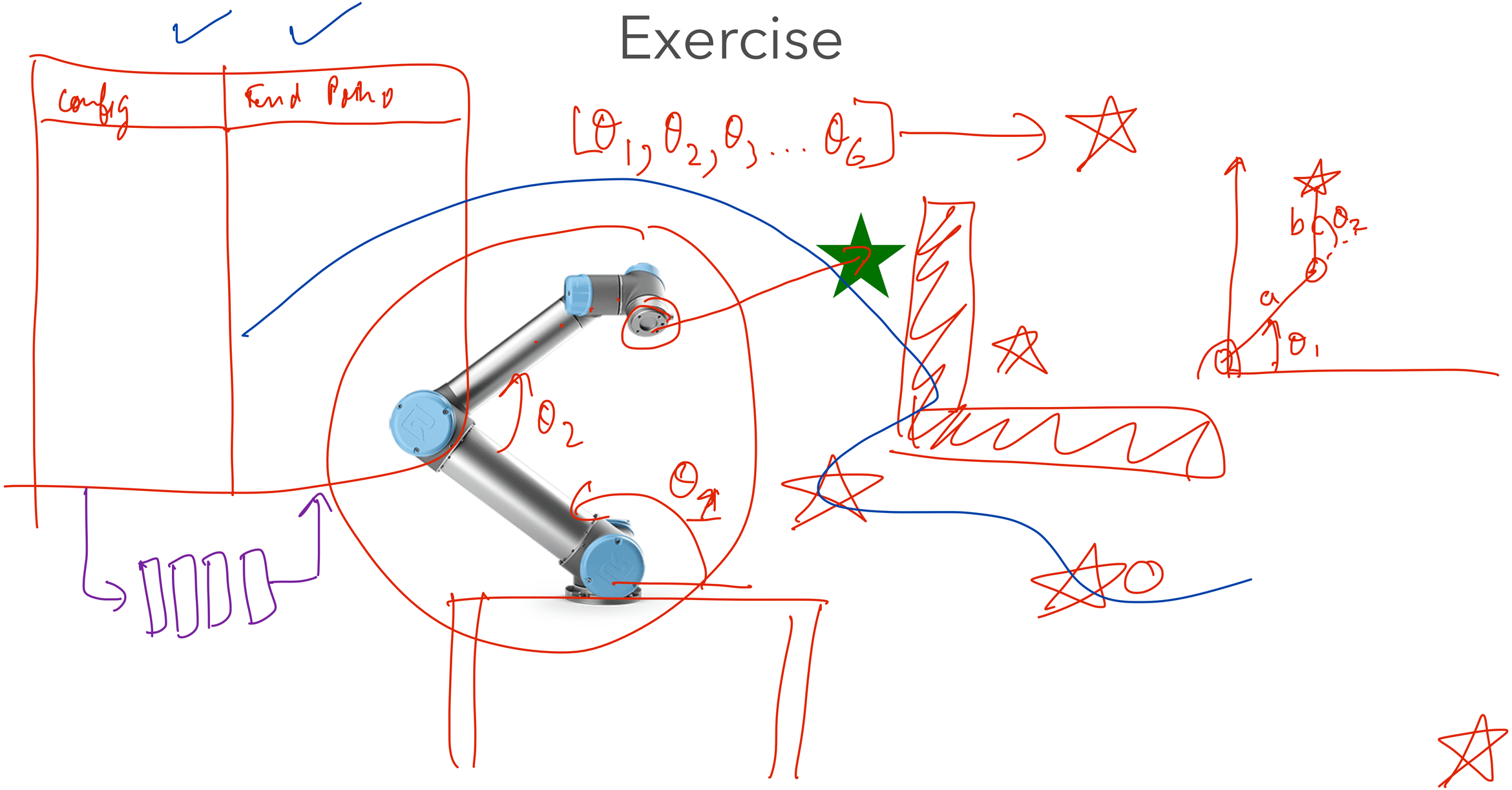
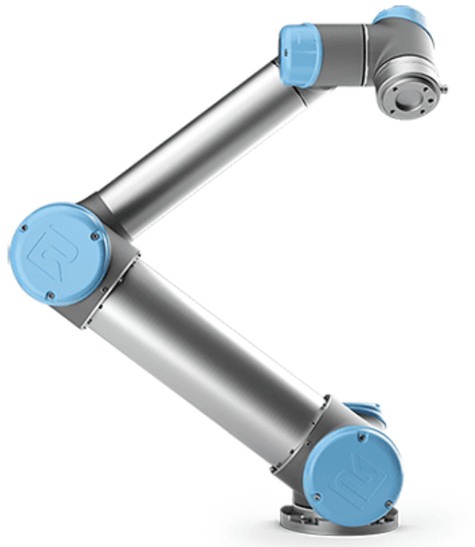
Exercise


Config
Send Path
$[\theta_1, \theta_2, \theta_3 \ldots \theta_6]$
θ_2
θ_3
b
θ_2
a
θ_1

Today's class

How do we mathematically represent a robot?



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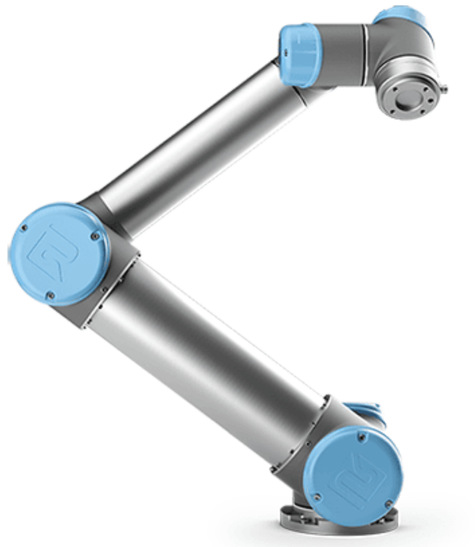
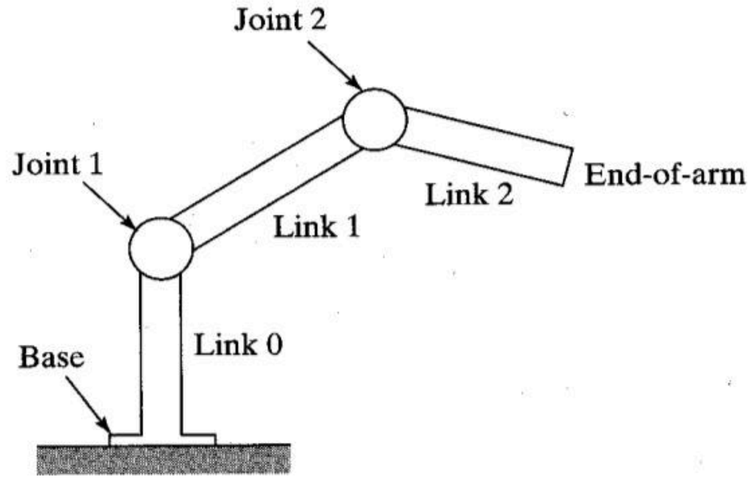
Mathematical object

Today's class

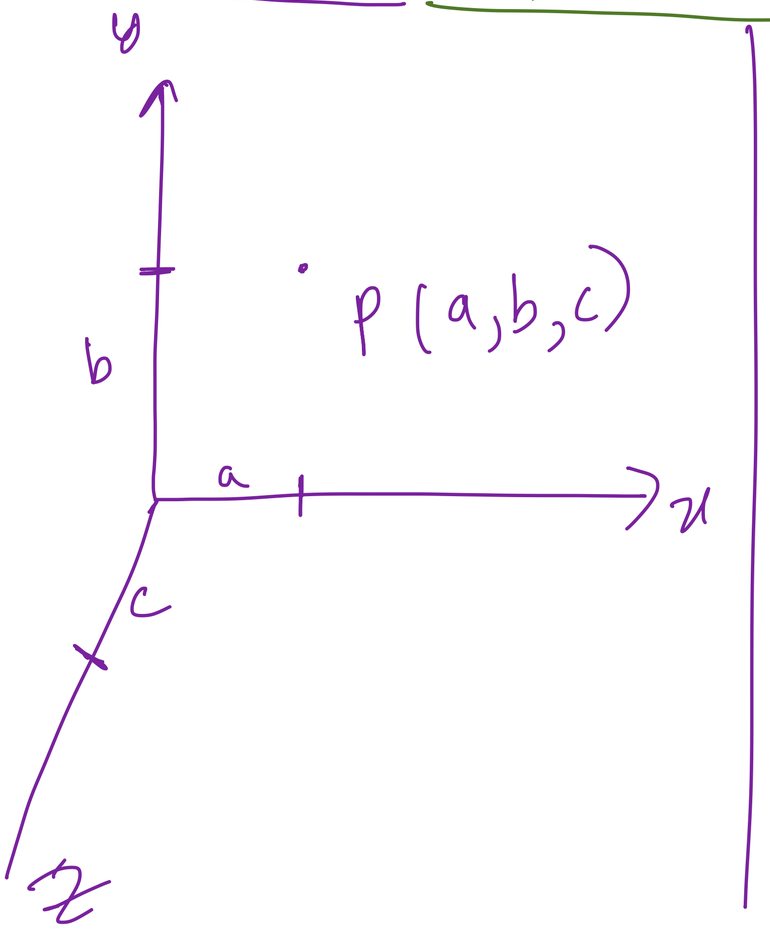
Making assumptions.

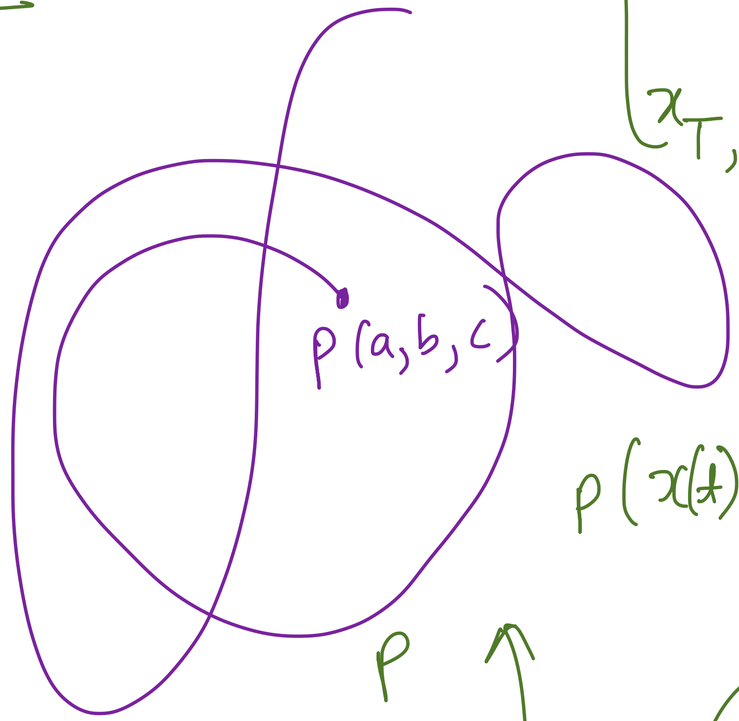




Properties of a point

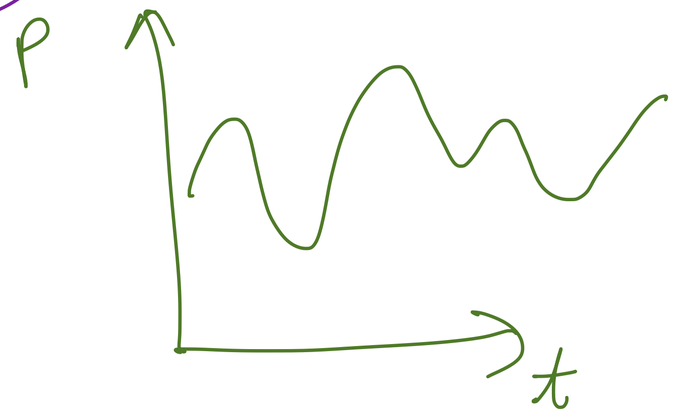
Particles, trajectories, and vectors.

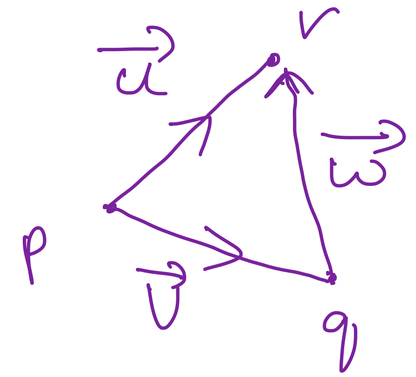




$$\begin{bmatrix} x_1, y_1, z_1, t_1 \\ \vdots \\ x_T, y_T, z_T, t_T \end{bmatrix}$$

$p(x(t), y(t), z(t))$





$\vec{v} = q - p$

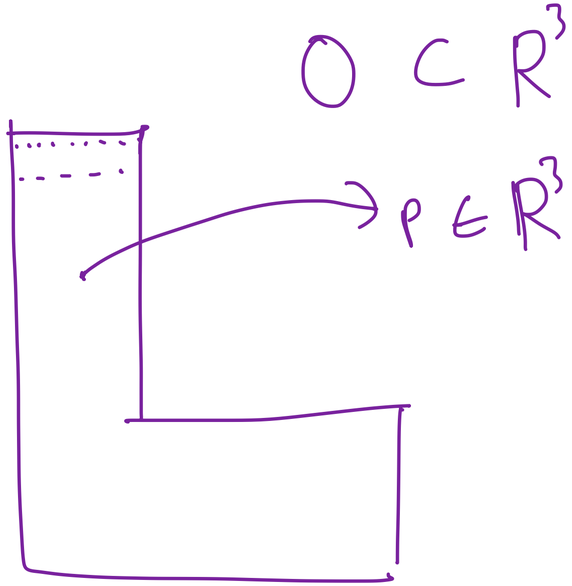
$\vec{w} = r - q$

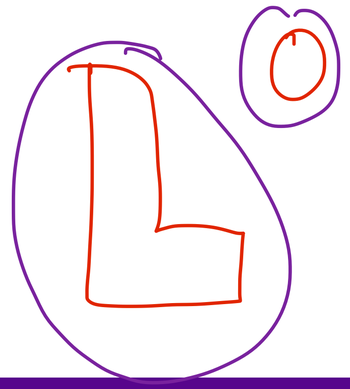
$\vec{v} + \vec{w} = \vec{u}$

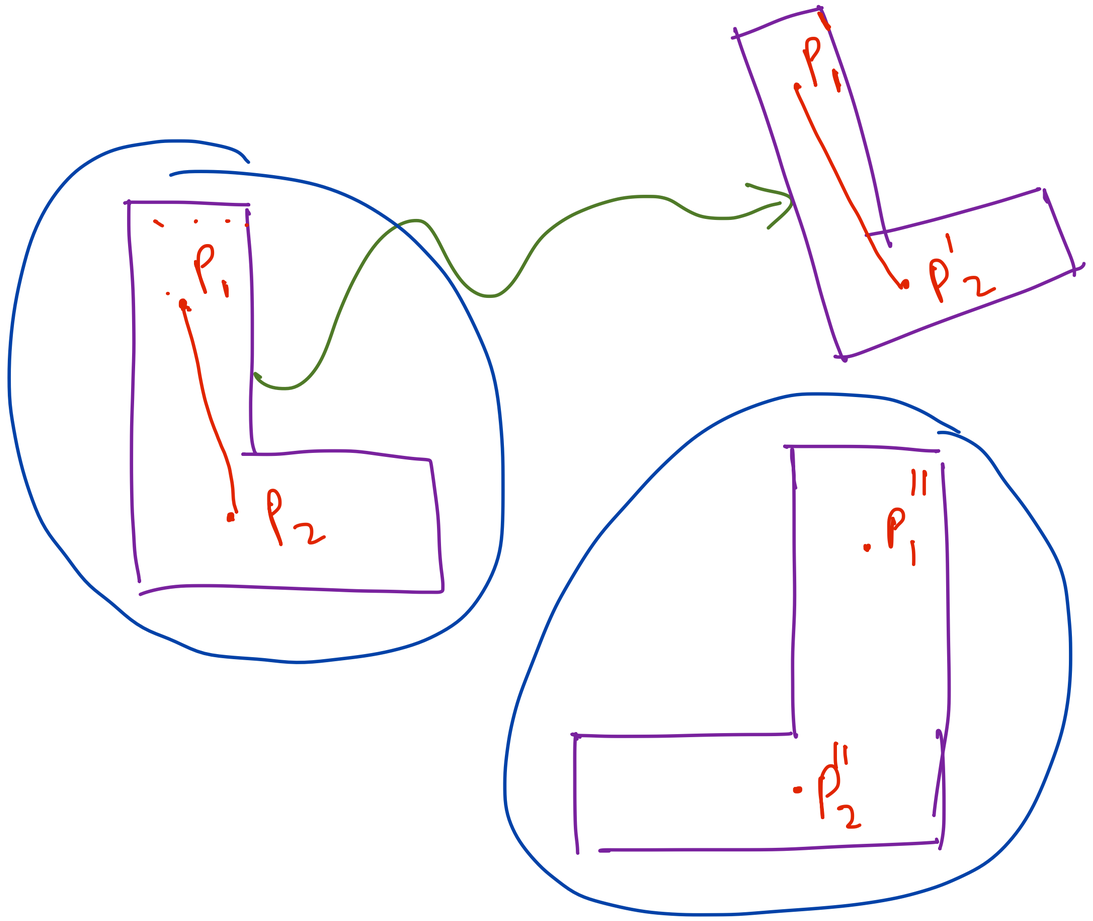
$r - p = \vec{u}$

Properties of an 'object'

Collections of points, rigid motion.



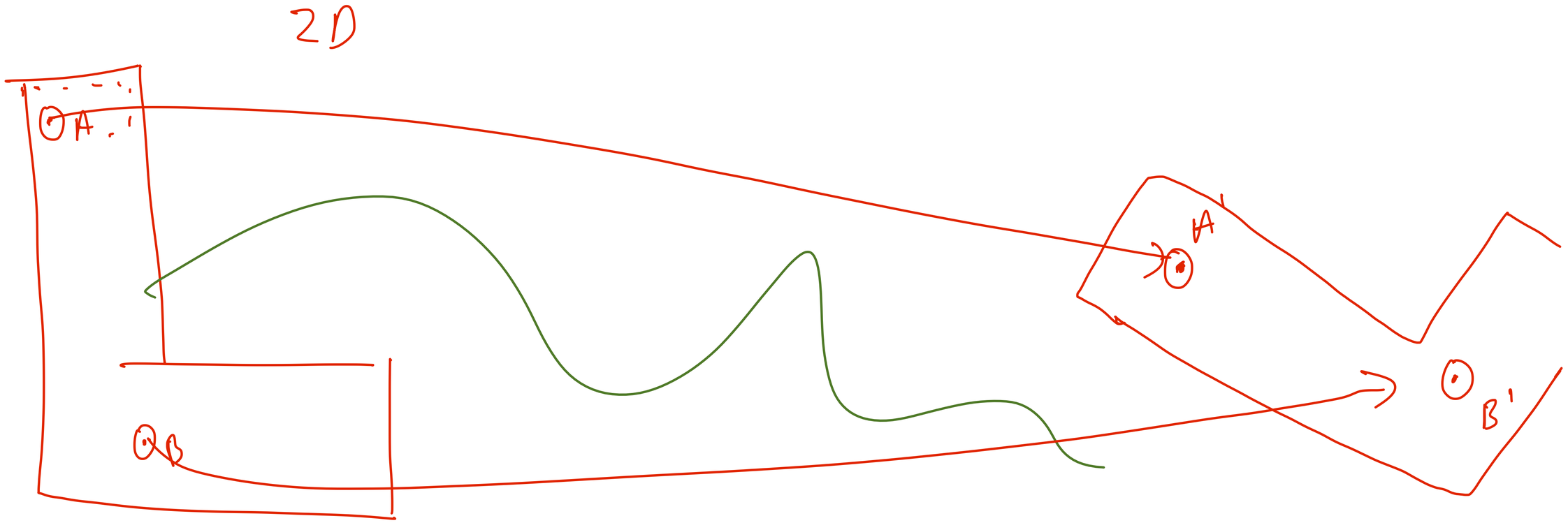




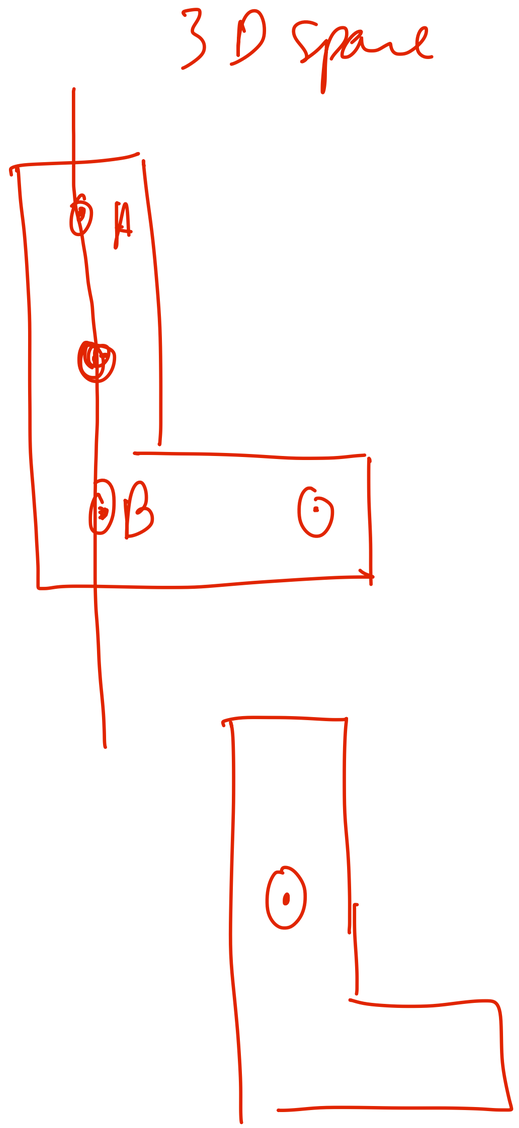
Properties of an ‘object’

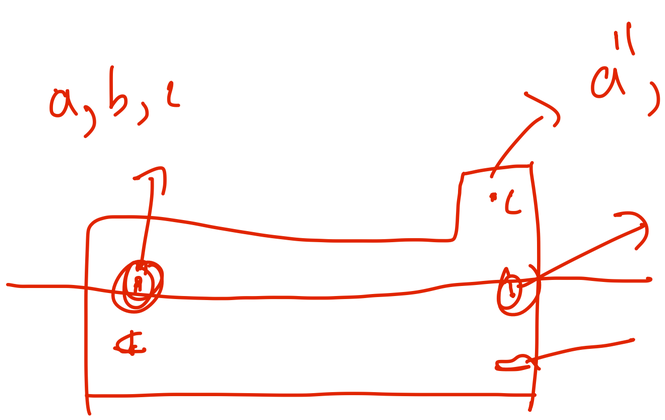
Rigid body definition:
A rigid body is a collection of particles such that the distance between any two particles remains fixed, regardless of any motions of the body or forces exerted on the body.

Ex1: Where is the object?



Ex2: How many queries to localize?





9 number

7 numbers

Rigid body transformations

A mapping $g : \mathbb{R}^3 \to \mathbb{R}^3$ is a *rigid body transformation* if it satisfies the following properties:

1. Length is preserved: $\|g(p) - g(q)\| = \|p - q\|$ for all points $p, q \in \mathbb{R}^3$.

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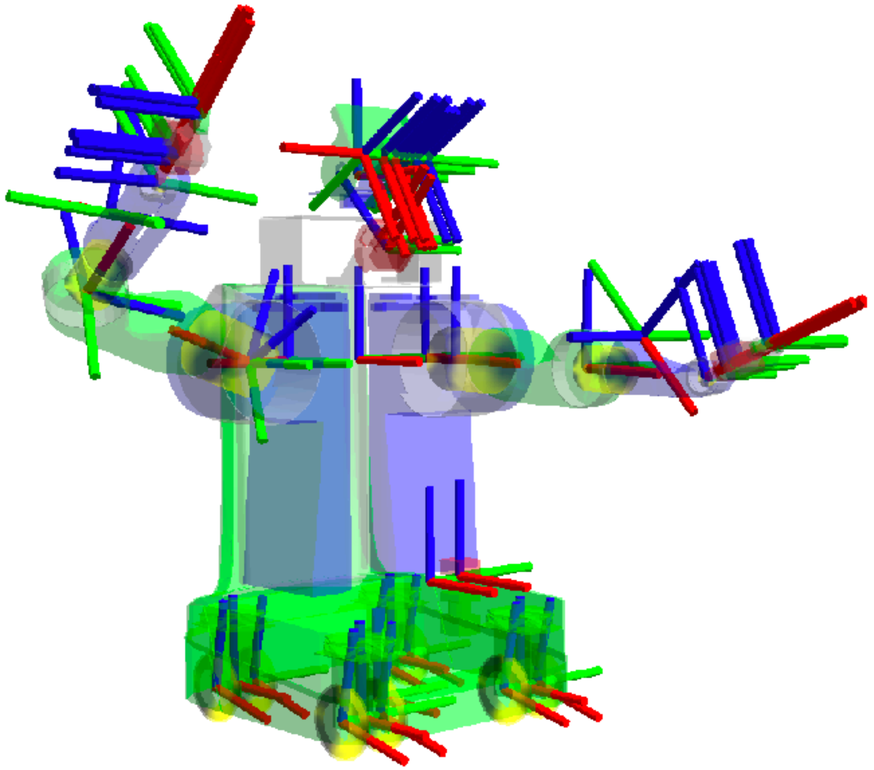
2. The cross product is preserved: $g_*(v \times w) = g_*(v) \times g_*(w)$ for all vectors $v, w \in \mathbb{R}^3$.

Robot as a collection of rigid bodies



Questions?