Beamer-Plus

Interactive Presentations

Chandra Gummaluru

`chandra-gummaluru.github.io`

Videos

You can include videos anywhere on a slide:

once	**loop**	**manual**
plays the video once	plays the video on loop	plays the video on click

3D Models

You can include 3D models, such as the one shown below:

Example a Robot

We can take inspiration from the way animals learn in nature.

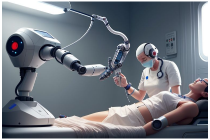
We want to design a robot (machine) that does the same.

Applications of Robotics

Robots can be designed for many different purposes:

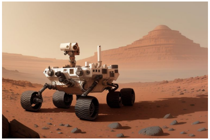
transportation
autonomous vehicles

healthcare
surgical devices



agriculture
farming equipment

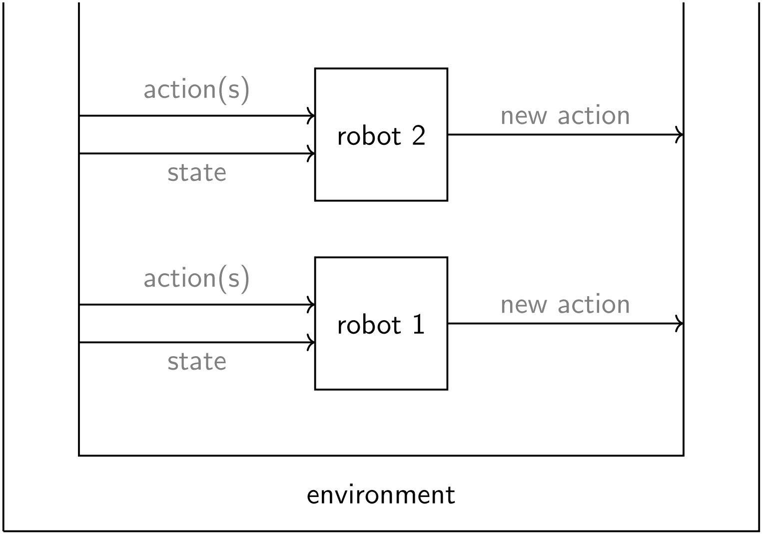
science
space rovers



However, the learning process is roughly the same.

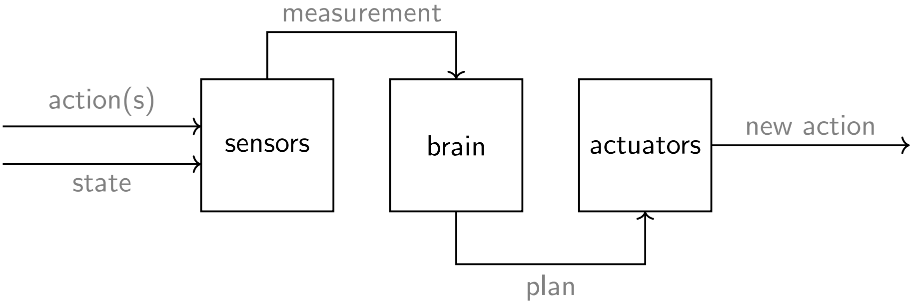
Components of a Robotic System

Overview (Robots, the Environment)



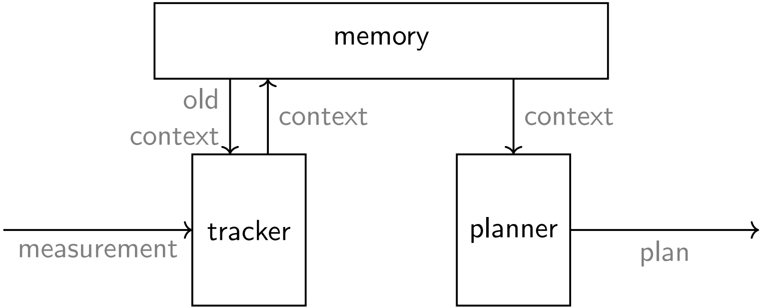
Components of a Robotic System

Robot (Sensors, Actuators, the Brain)



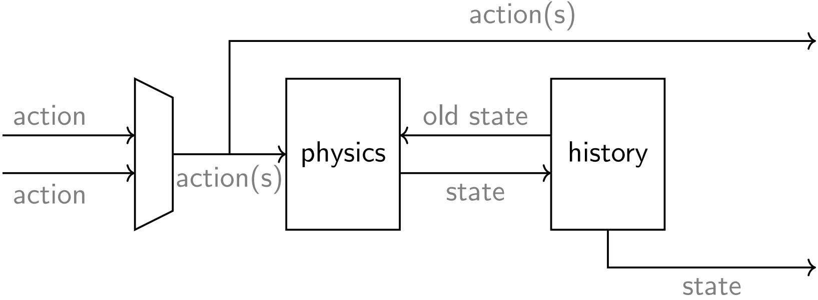
Components of a Robotic System

Brain (Tracker, Planner, Memory)



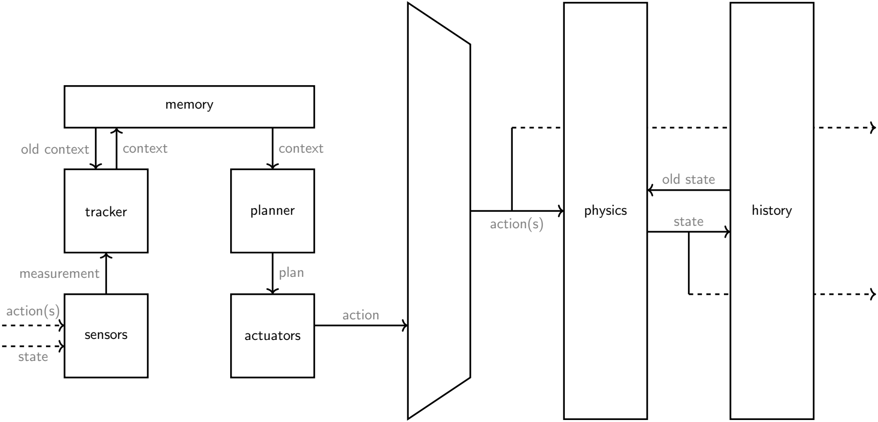
Components of a Robotic System

Environment (Physics, State)



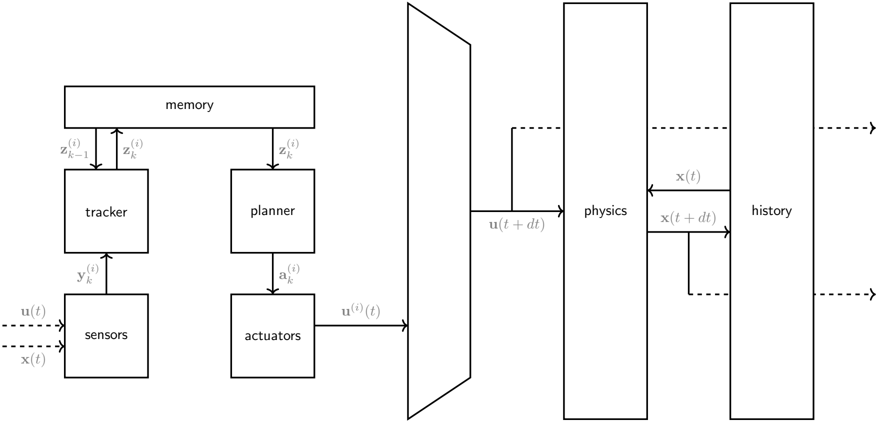
Components of a Robotic System

Detailed Overview



Components of a Robotic System

Detailed Overview (Mathematical Notation)



Equations of a Robotic System

Sensing

measure

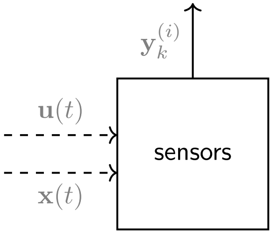
take a measurement of the state

$$\mathbf{y}^{(i)}(t) = \mathrm{sns}^{(i)}\left(\mathbf{x}(t), \mathbf{u}(t), t\right)$$

segment

convert into a discrete-time signal
with a sampling period of $T^{(i)}$

$$\mathbf{y}_k = \mathrm{dt}\left(\mathbf{y}^{(i)}(t), t, T^{(i)}\right)$$



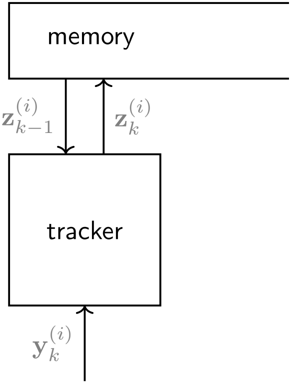
Equations of a Robotic System

Tracking

track

update the context:

$$\mathbf{z}_k^{(i)} = \mathrm{trk}^{(i)}\left(\mathbf{z}_{k-1}^{(i)}, \mathbf{y}_k^{(i)}, k\right)$$



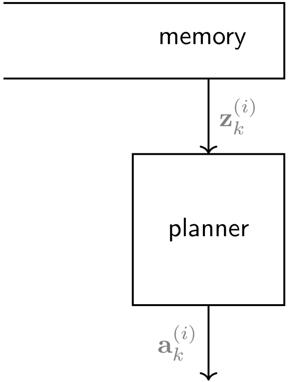
Equations of a Robotic System

Planning

plan

select an action

$$\mathbf{a}_k^{(i)} = \mathrm{pln}^{(i)}\left(\mathbf{z}_k^{(i)}, k\right)$$



Equations of a Robotic System

Acting

smooth

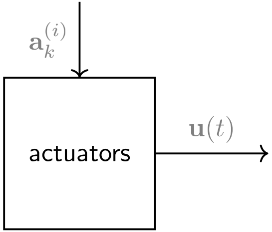
convert into a continuous-time signal
with a sampling period of $T^{(i)}$

$$\mathbf{a}^{(i)}(t) = \mathrm{ct}\left(\mathbf{a}_k^{(i)}, t, T^{(i)}\right)$$

execute

make the move

$$\mathbf{u}^{(i)}(t) = \mathrm{act}^{(i)}\left(\mathbf{a}^{(i)}(t), t\right)$$



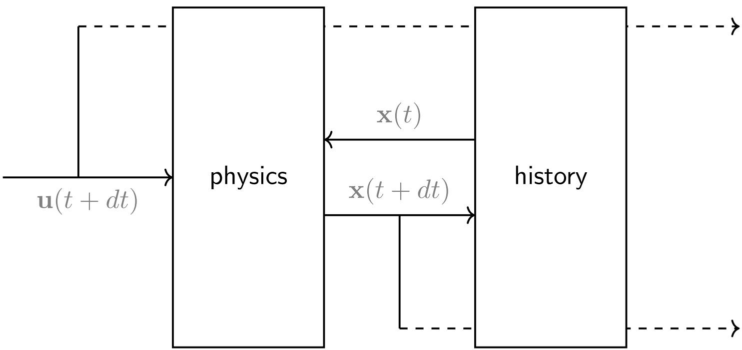
Equations of a Robotic System

Simulating

simulate

simulate the environment's response

$$\dot{\mathbf{x}}(t) = \mathrm{phy}\left(\mathbf{x}(t), \mathbf{u}(t), t\right)$$



This Course

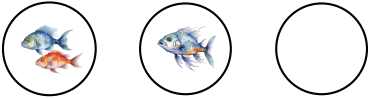
This course focuses on **planning**.

Setup

Planning Problems

We assume that:

- there are several decision makers called **agents** (e.g.  , )
- the environment is always in one of a set of **states**, $\mathcal{S}$



2 fish 1 fish 0 fish

- for each state, $s \in \mathcal{S}$, each agent, i, has a set of **actions**, $\mathcal{A}^{(i)}(s)$

fish wait fight

Setup

Planning Problems

At time-step k, each agent will:

sense	plan	move
measure the state	select an action	make the move
S_k	$A_k^{(i)} \in \mathcal{A}_k(S_t)$	$\left(S_k, A_k^{(i)}\right)$

The environment then transitions to a random state, S_{t+1}, based on a stationary distribution,

$$p(s'|s, \mathbf{a}) = \text{pr}\left[S_{k+1} = s' | S_k = s, \mathbf{A}_k = \mathbf{a}\right]$$

and each agent attains a reward, $\mathrm{rwd}^{(i)}(s, \mathbf{a}, s')$.

Setup

Planning Problems

A **path** is any sequence of transitions of the form

$$p = \langle (s_0, \mathbf{a}_1, s_1), (s_1, \mathbf{a}_2, s_2), \ldots \rangle$$

Each agent wants to manipulate p to maximize its own total reward.