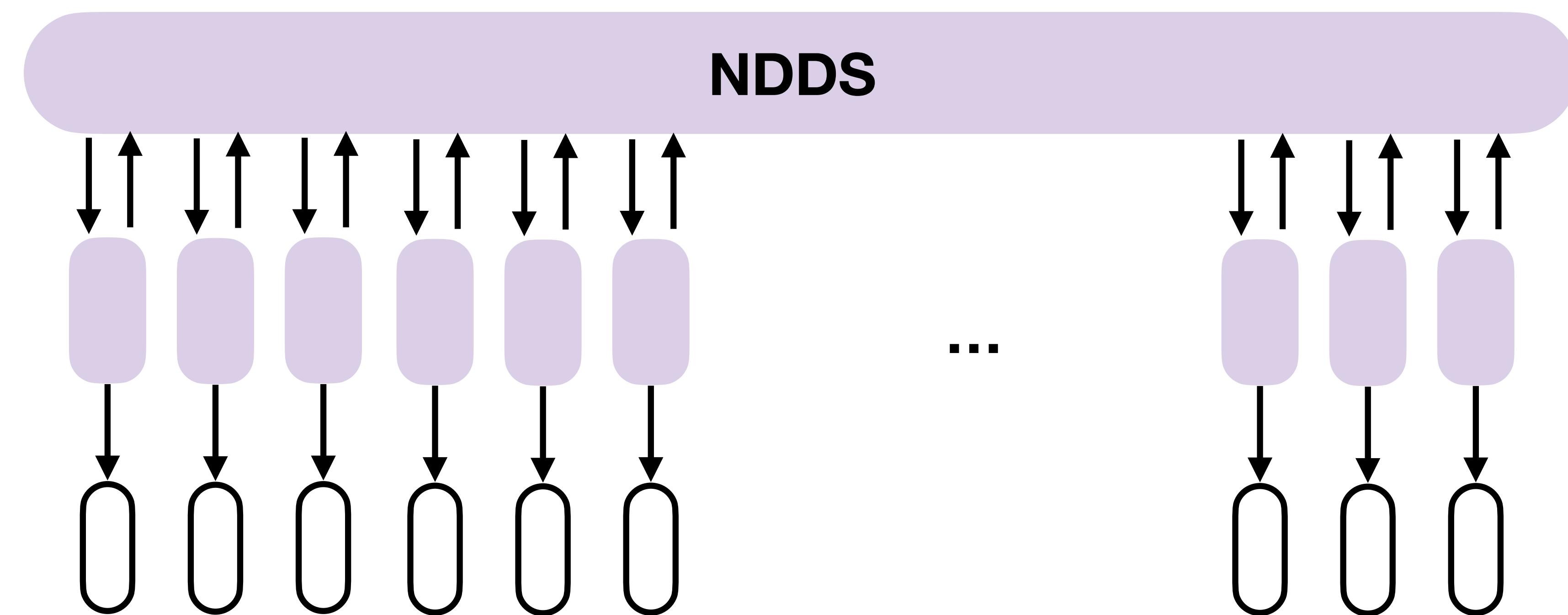


Lecture 02A - Control Architectures





NYU

ROB-UY 2004

Robotic Manipulation & Locomotion

Agenda

- 1. Robot Control**
- 2. Control Architecture Implementation**



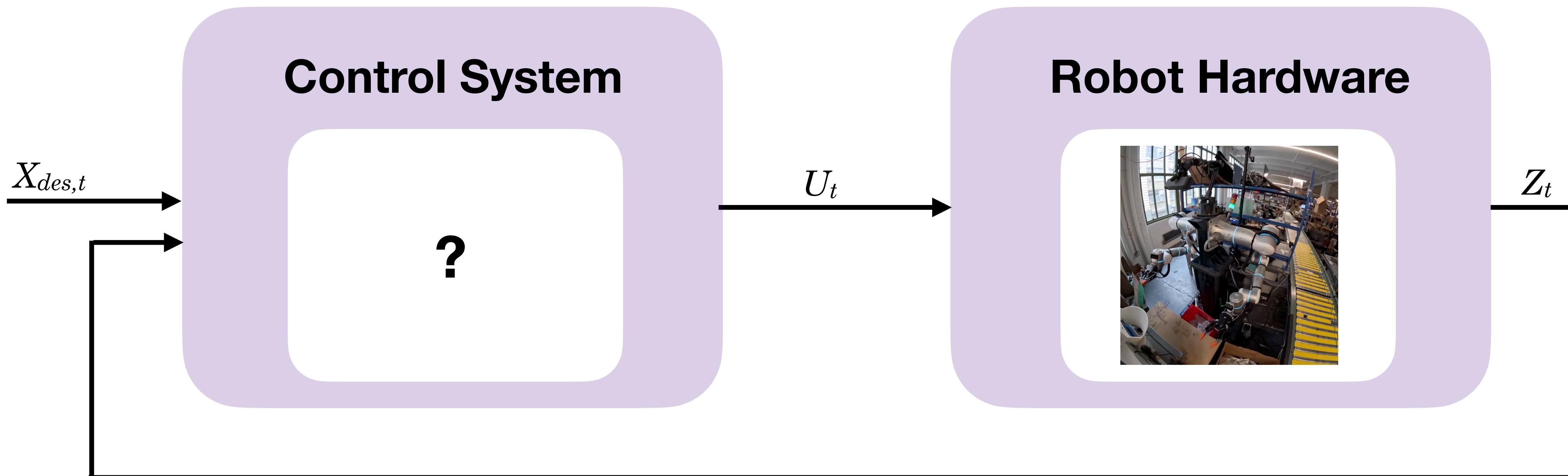
NYU

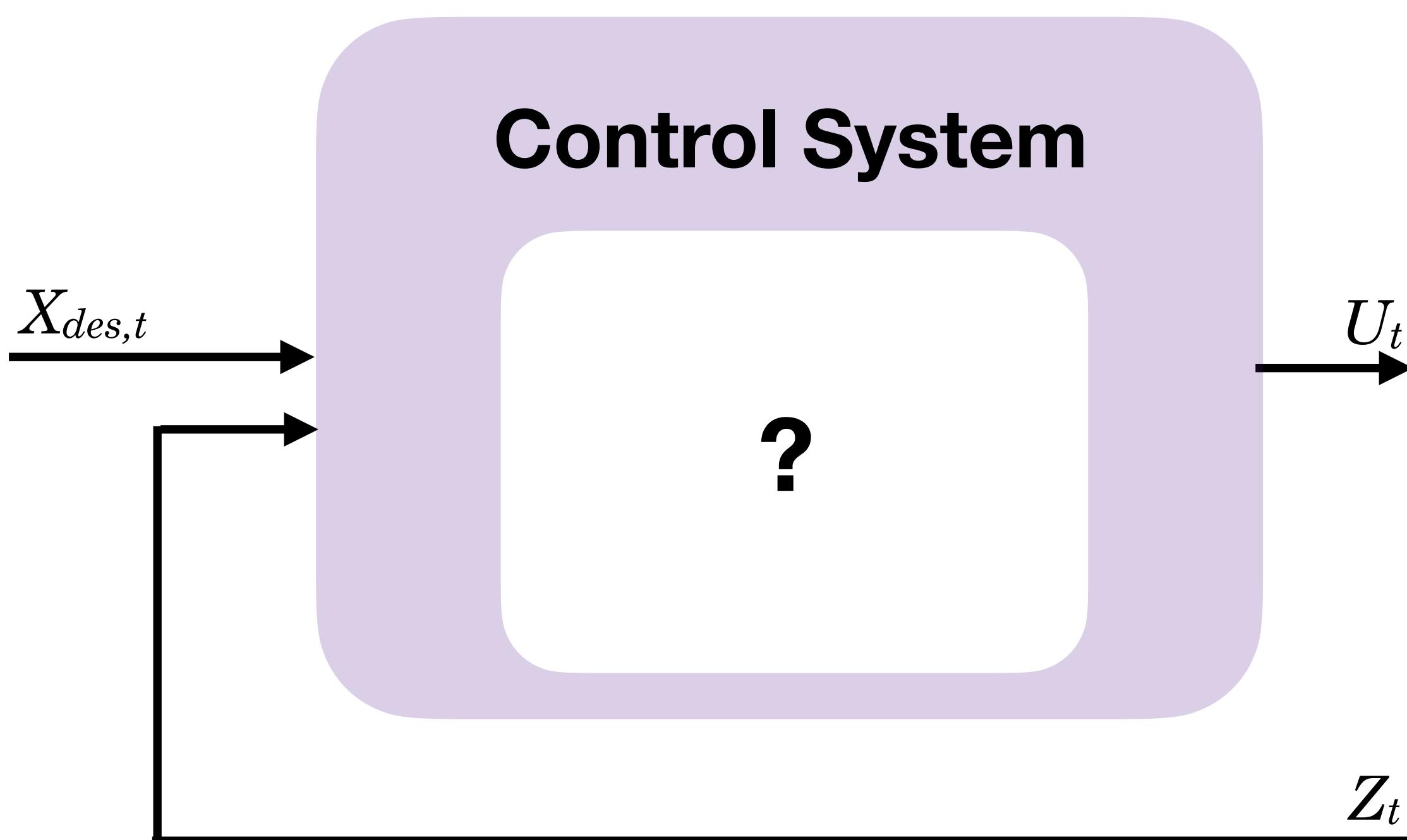
ROB-UY 2004

Robotic Manipulation & Locomotion

Robot Control Architectures

CLOSED LOOP CONTROL

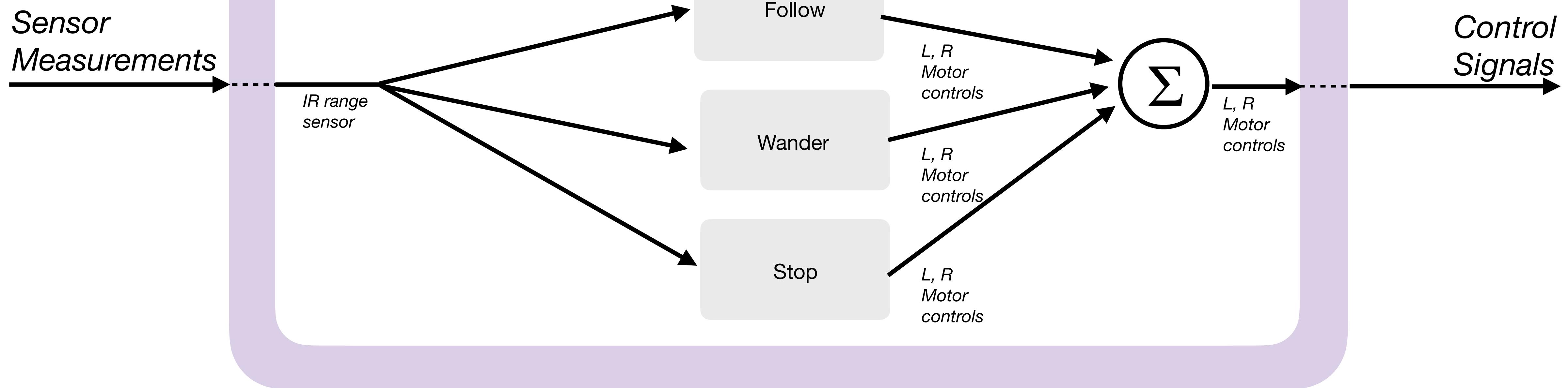


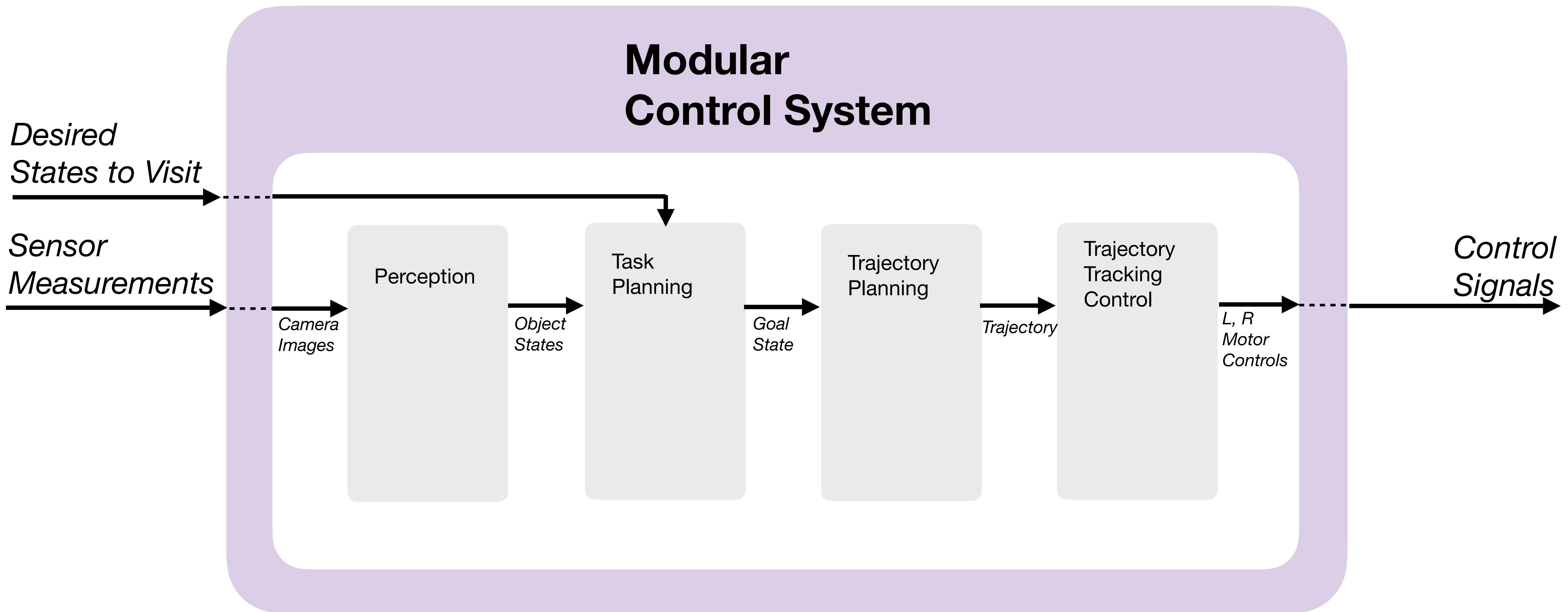


Control System Architectures

1. Behavior Based
2. Sense-Plan-Act (aka Modular)
3. Hybrid Architectures
4. End-to-End (ML)

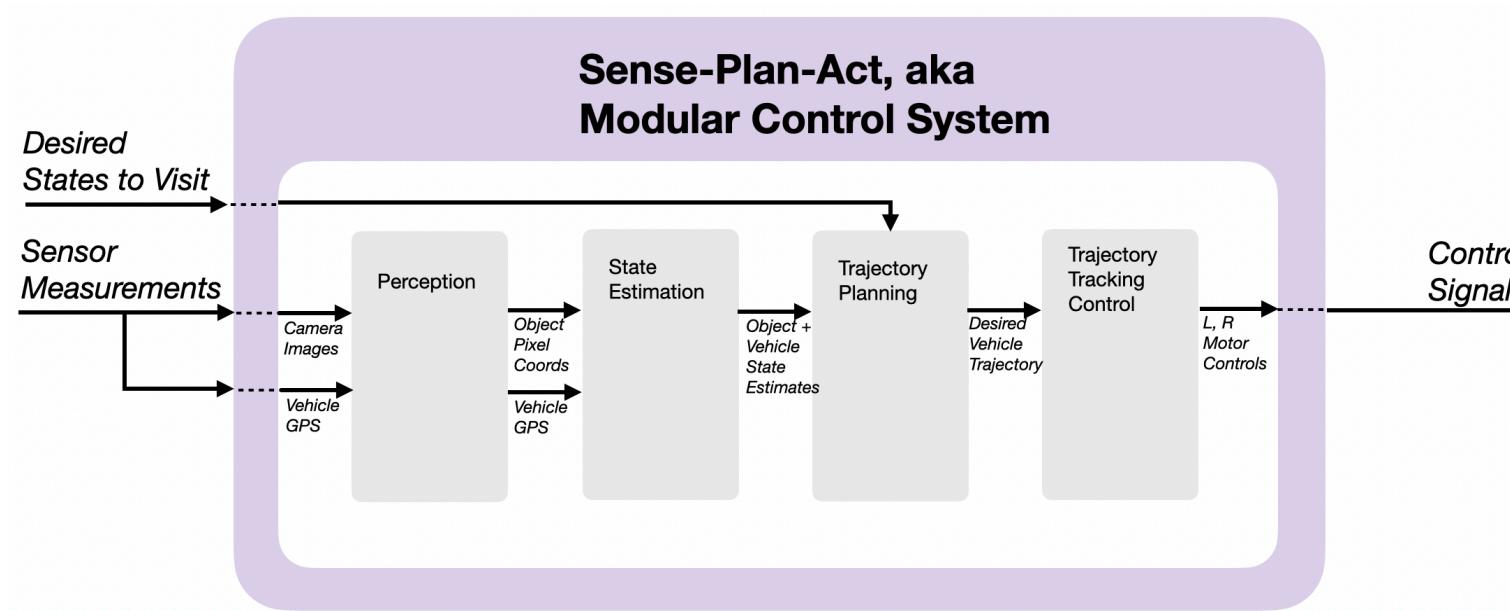
Behavior Based Control System





Modular Control Systems

- Are characterized by their “division of labor”



Hybrid Control Systems

- Also characterized by their “division of labor”
- But, have many control loops that run:
 - Asynchronously
 - At different rates

Hybrid Control System

Sensor Measurements

Camera Images
Vehicle GPS

Perception

Object Pixel Coords
Vehicle GPS

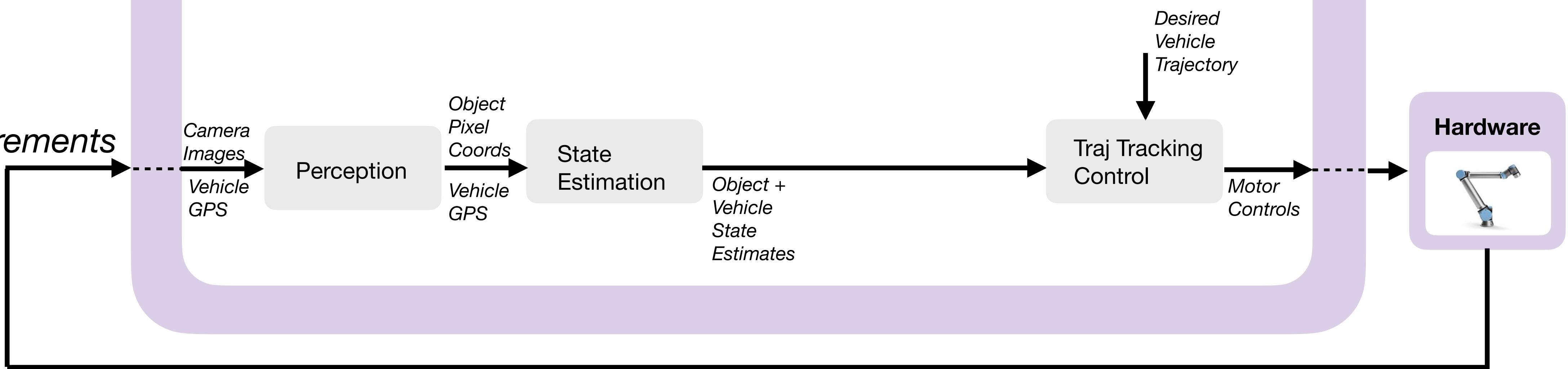
State Estimation

Object + Vehicle State Estimates

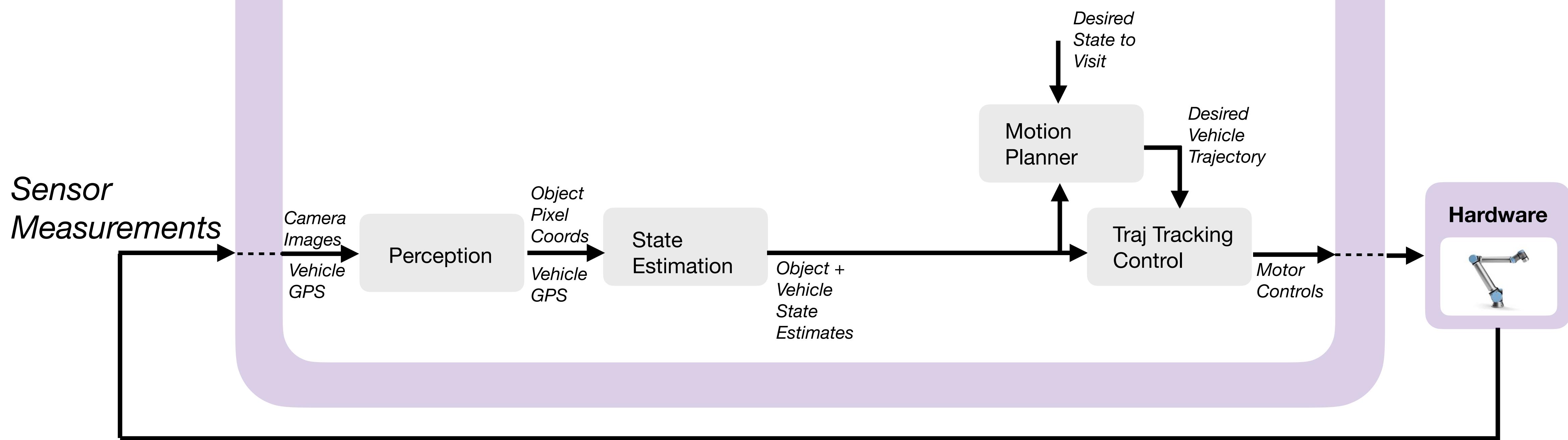
Desired Vehicle Trajectory
Traj Tracking Control

Motor Controls

Hardware



Hybrid Control System



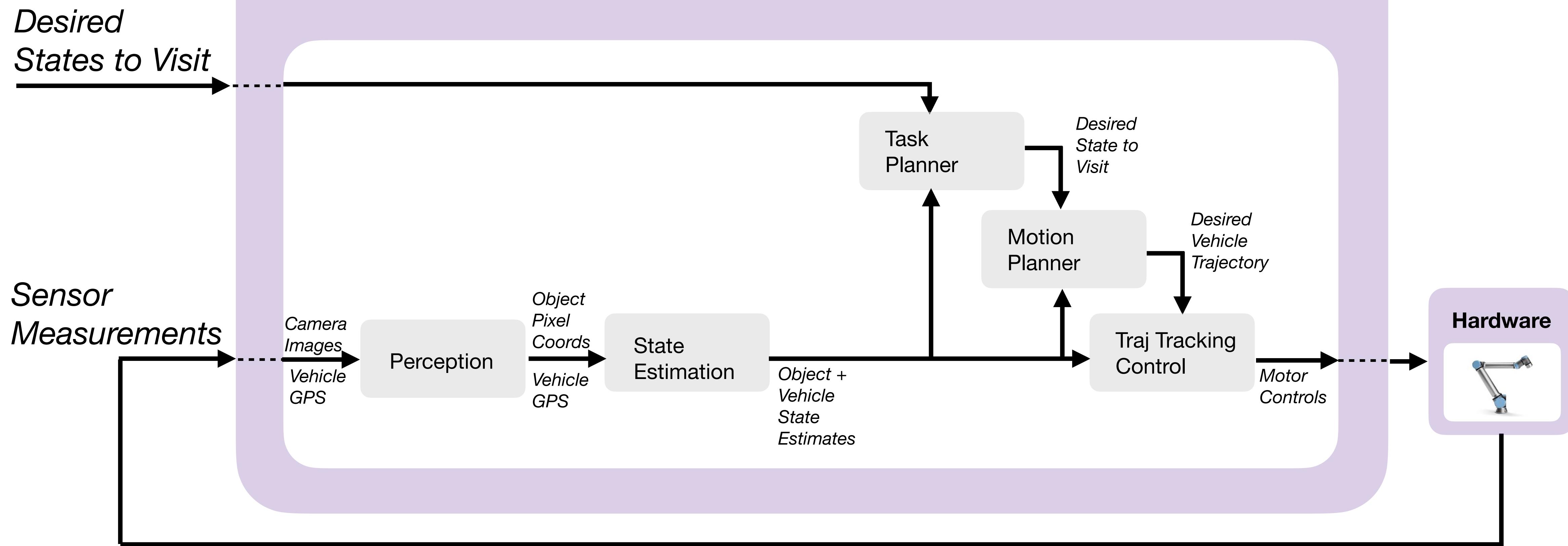


NYU

ROB-UY 2004

Robotic Manipulation & Locomotion

Hybrid Control System

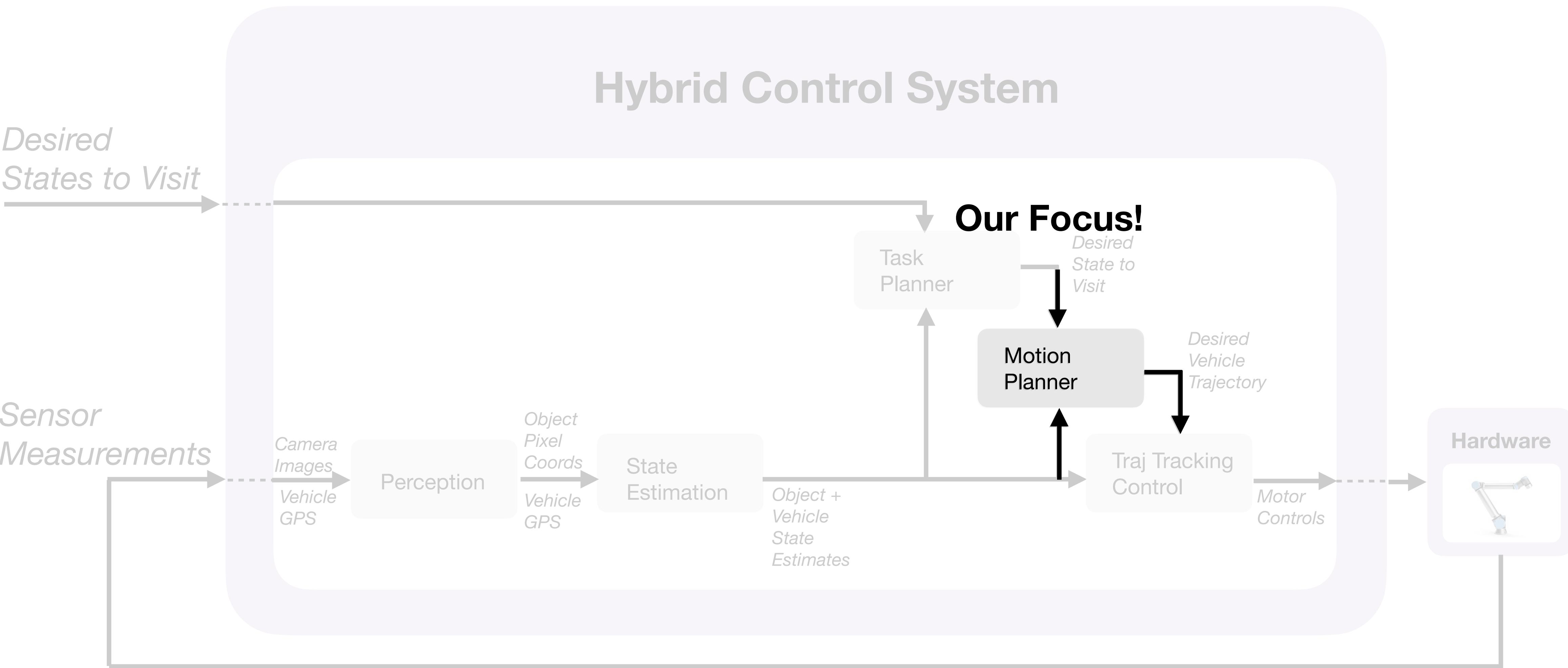


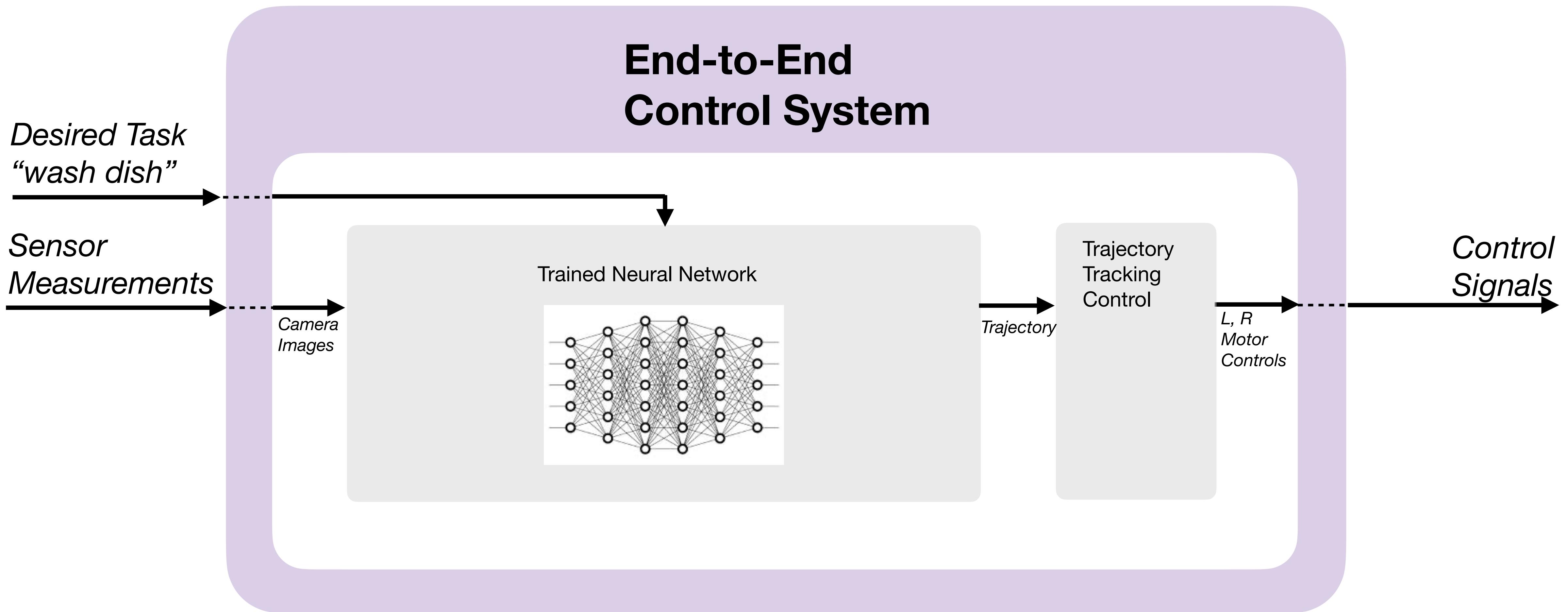


NYU

ROB-UY 2004

Robotic Manipulation & Locomotion







NYU

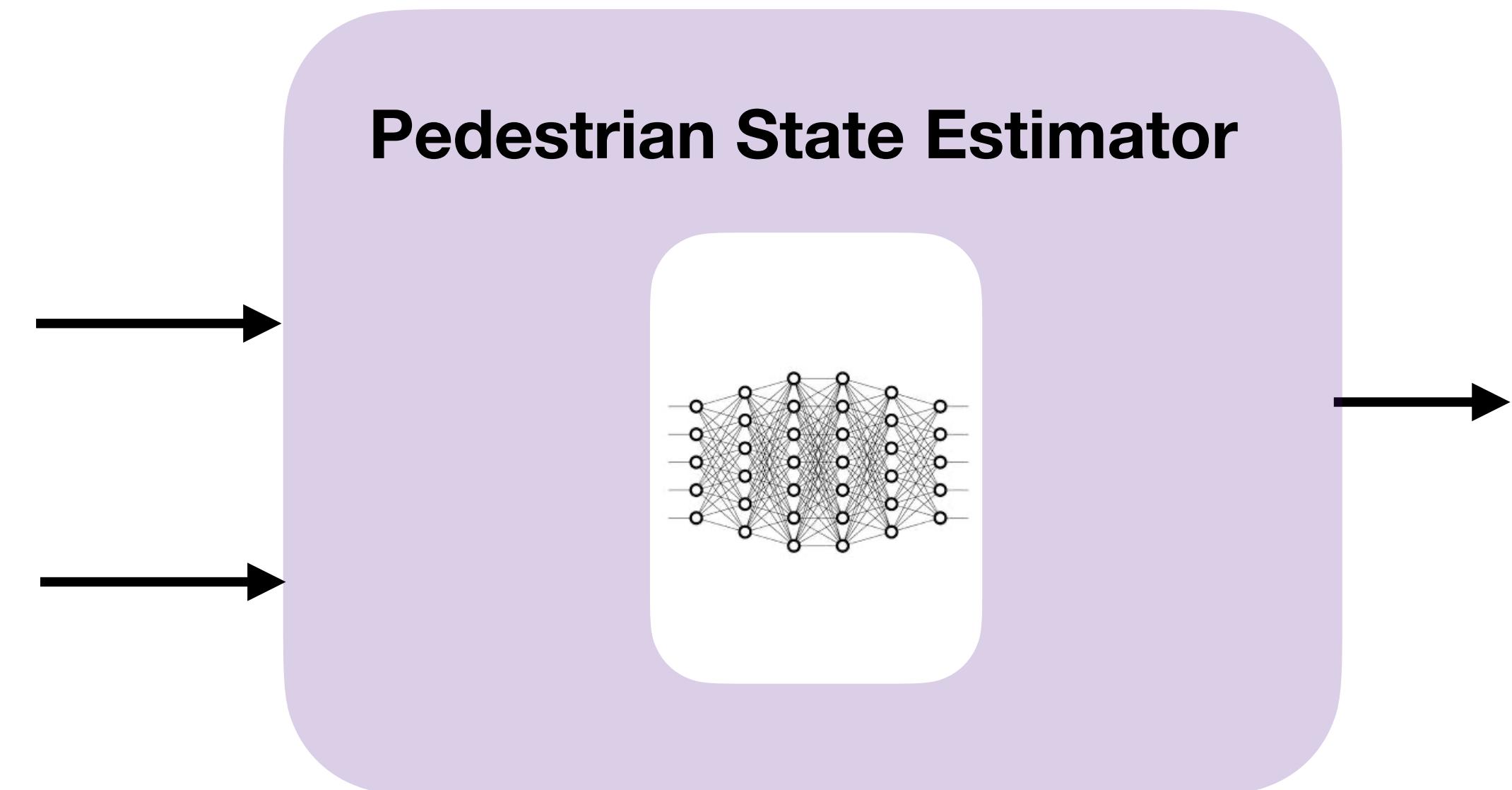
ROB-UY 2004

Robotic Manipulation & Locomotion

Robot Control Implementation

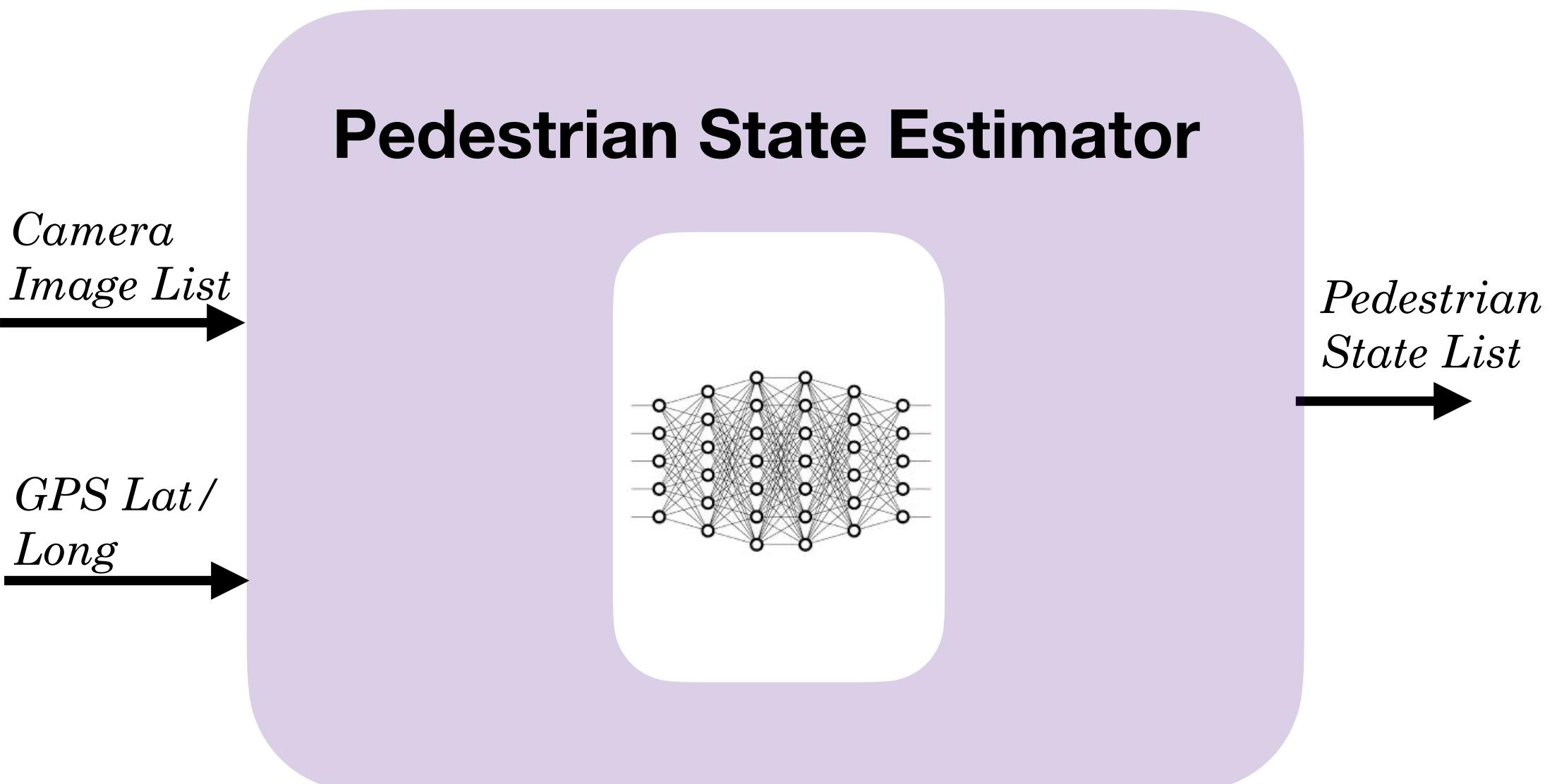
Publish Subscribe Implementations (e.g. ROS)

- **Nodes** - Are processes that have input and output signals



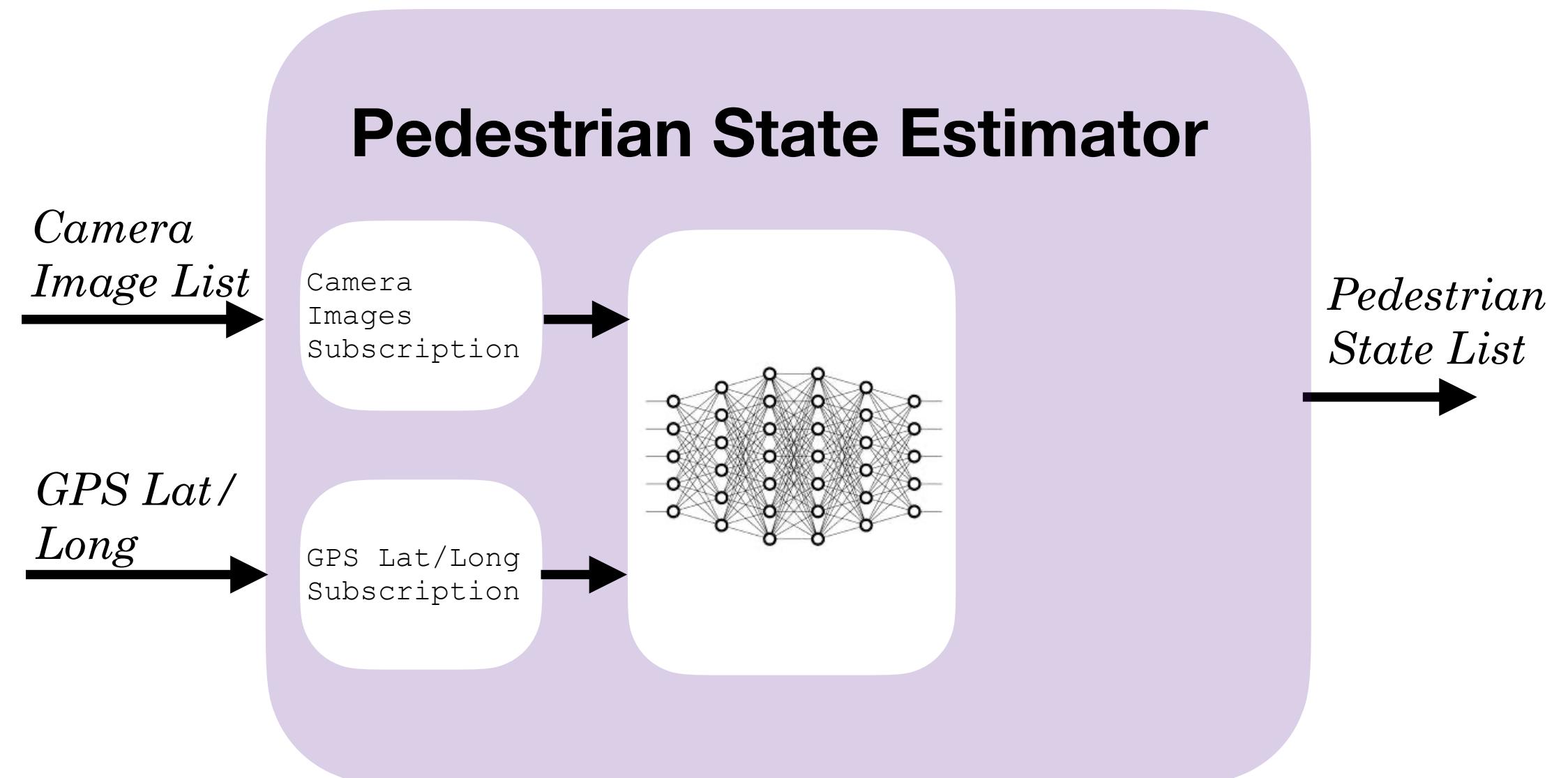
Publish Subscribe Implementations (e.g. ROS)

- **Nodes** - Are processes that have input and output signals
- **Topics** - Are signals



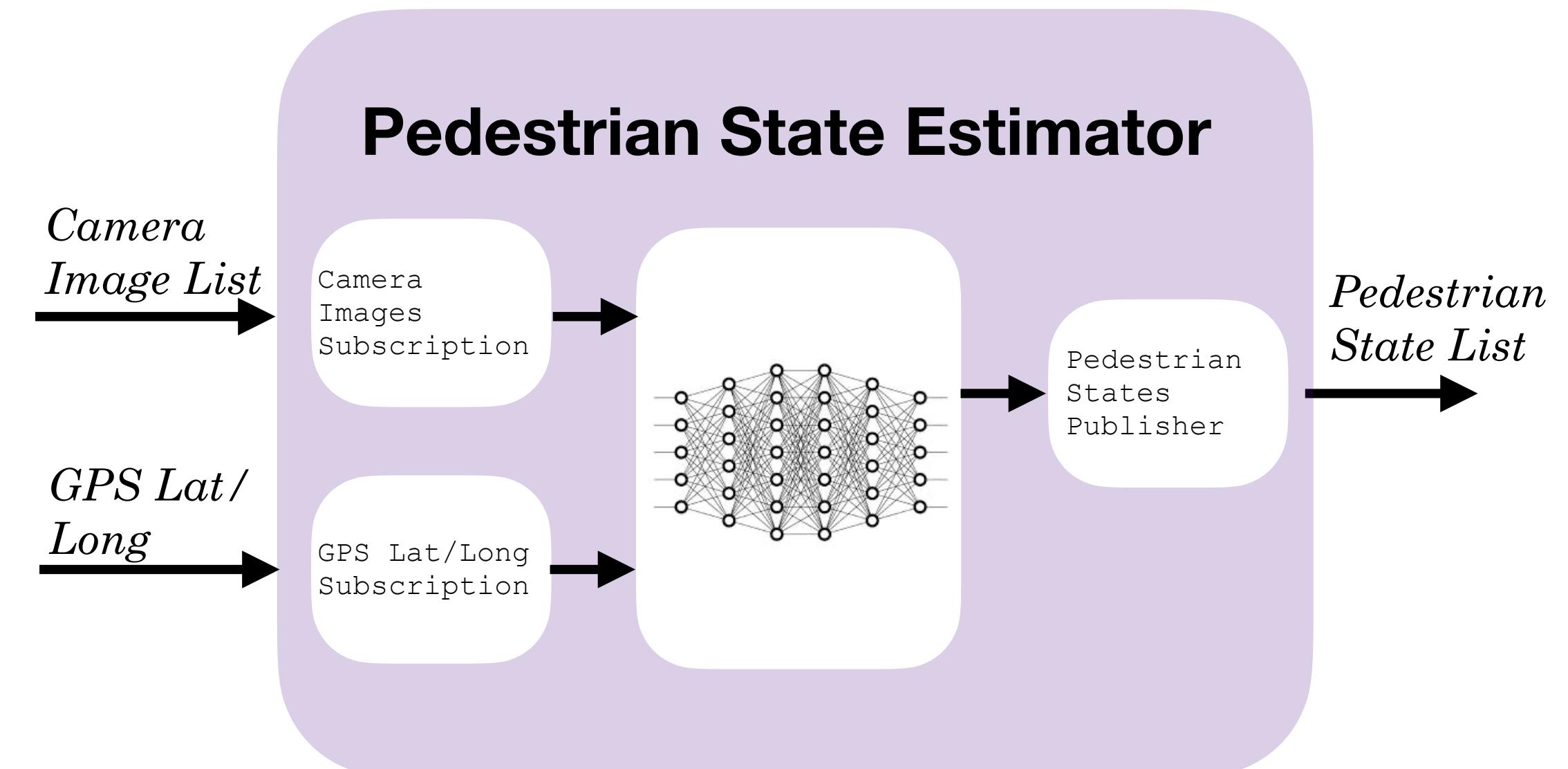
Publish Subscribe Implementations (e.g. ROS)

- **Nodes** - Are processes that have input and output signals
- **Topics** - Are signals
- **Subscriptions** - A node's input signals



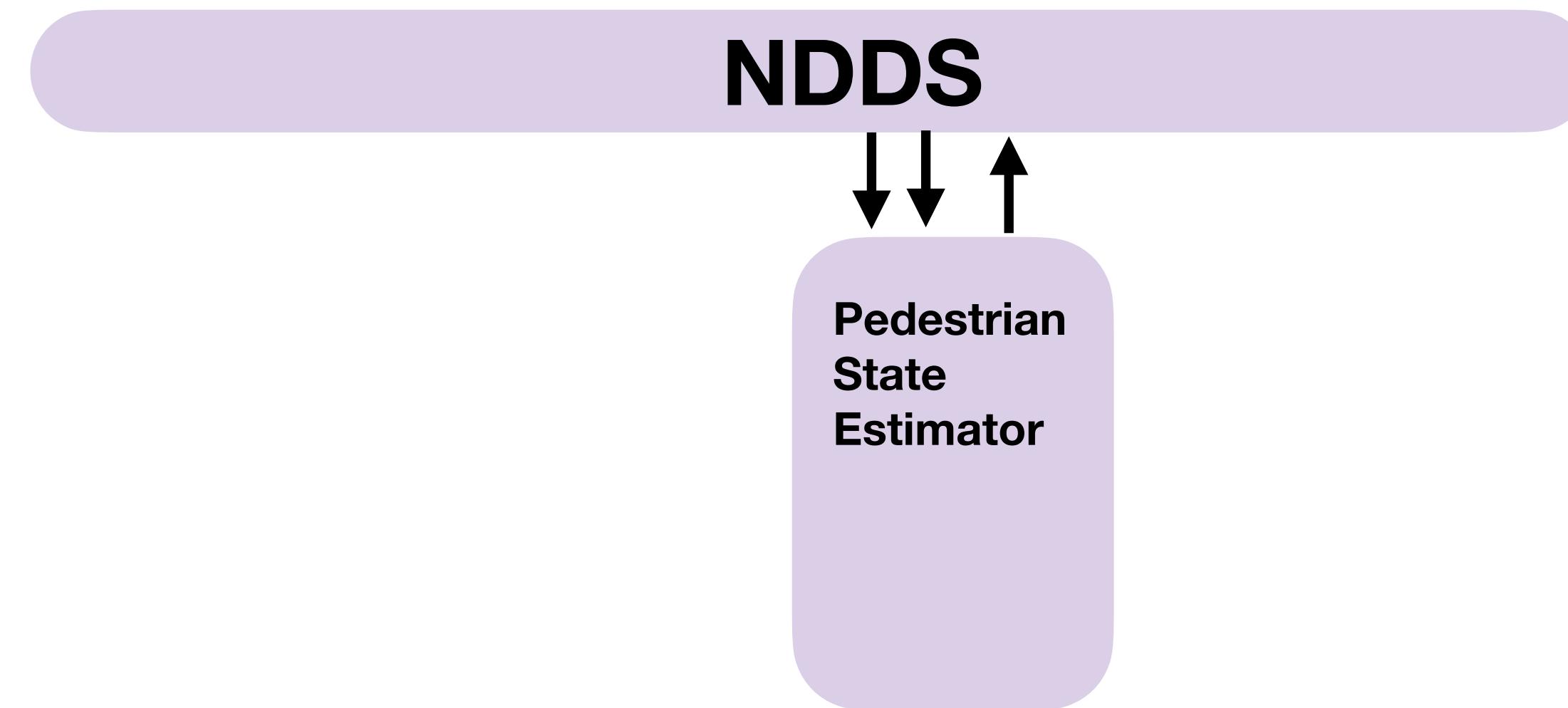
Publish Subscribe Implementations (e.g. ROS)

- **Nodes** - Are processes that have input and output signals
- **Topics** - Are signals
- **Subscriptions** - A node's input signals
- **Publishers** - A node's output signals



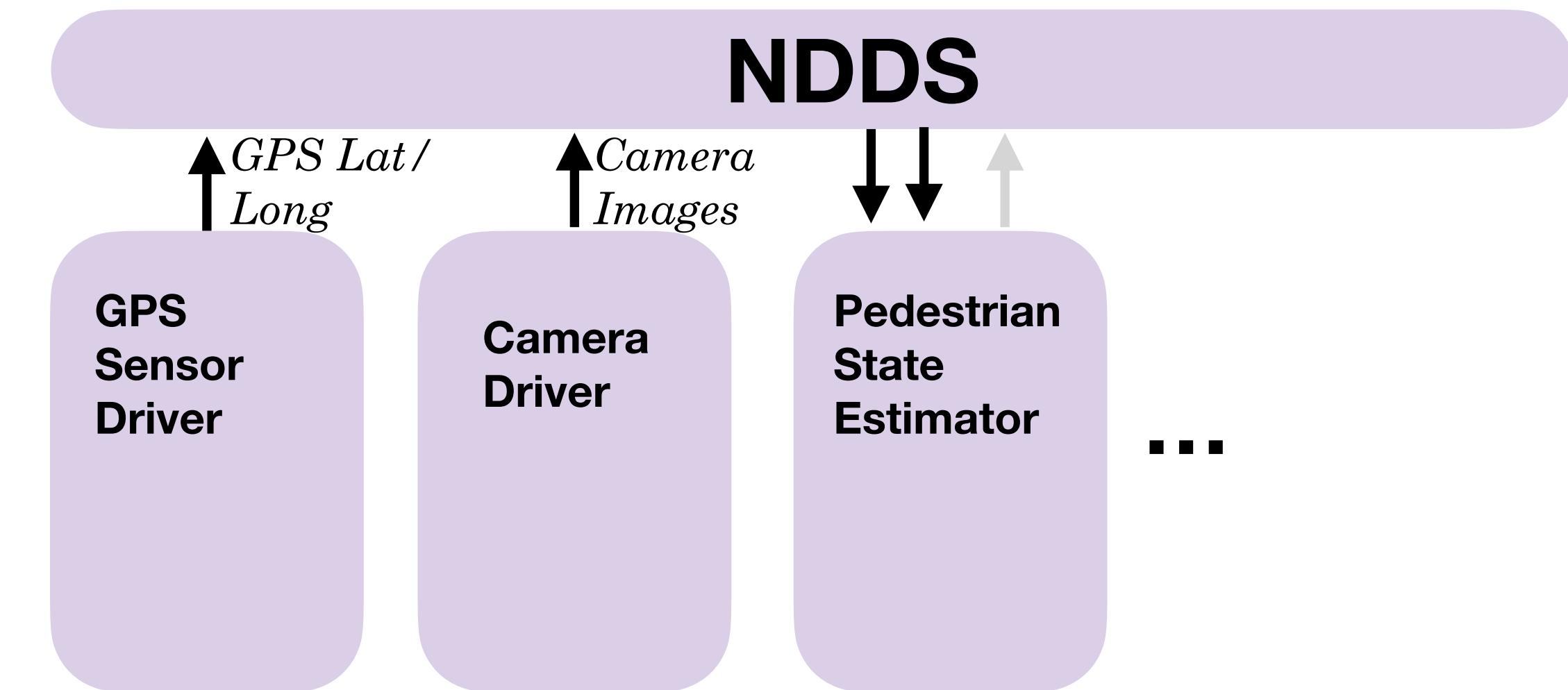
Publish Subscribe Implementations (e.g. ROS)

- **Nodes** - Are processes that have input and output signals
- **Topics** - Are signals
- **Subscriptions** - A node's input signals
- **Publishers** - A node's output signals
- **NDDS** - Network Data Delivery Service manages the asynchronous message exchange.



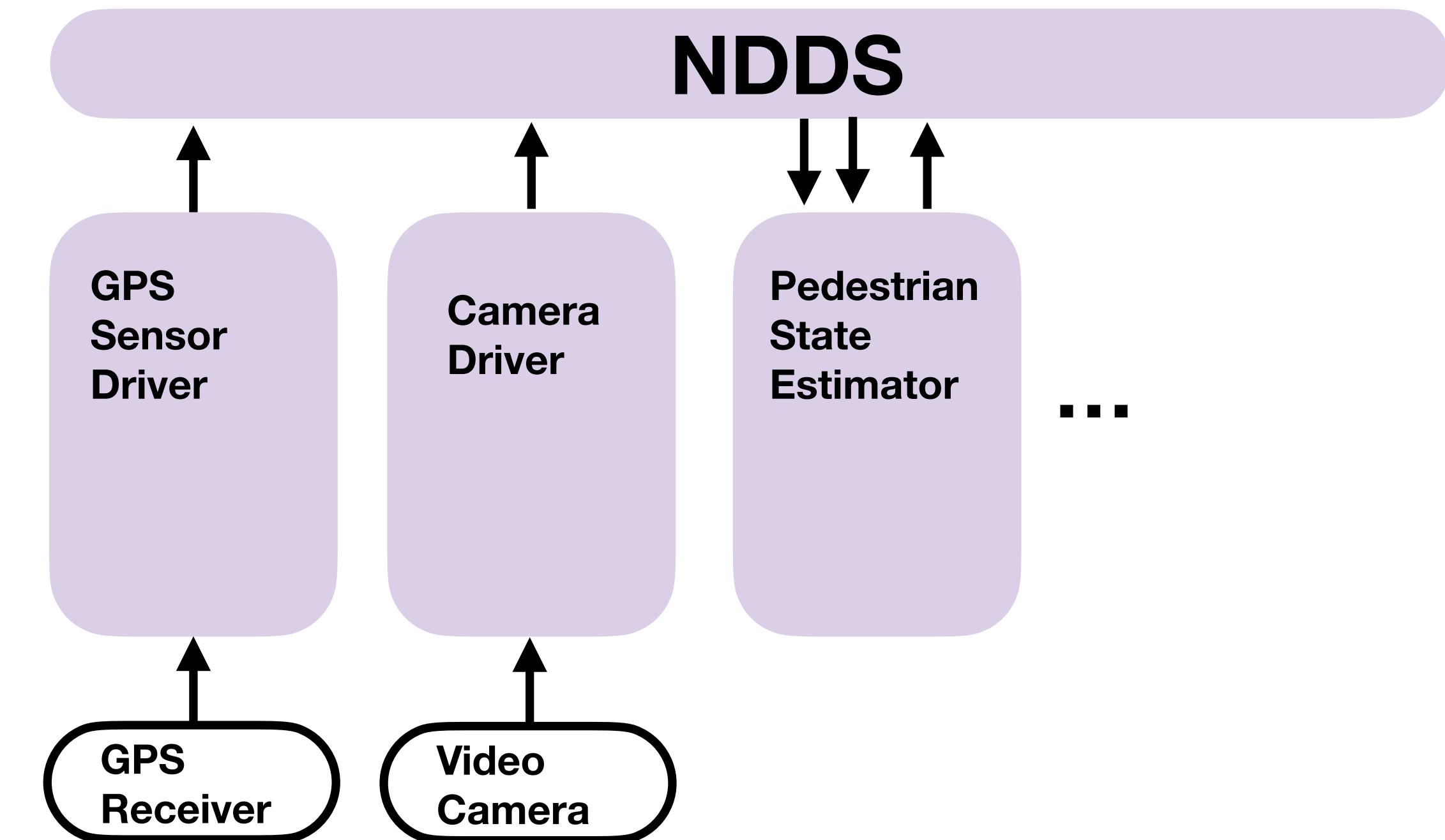
Publish Subscribe Implementations

- **NOTE 1**
 - A **single node** can have many input signals, therefore **many subscriptions**



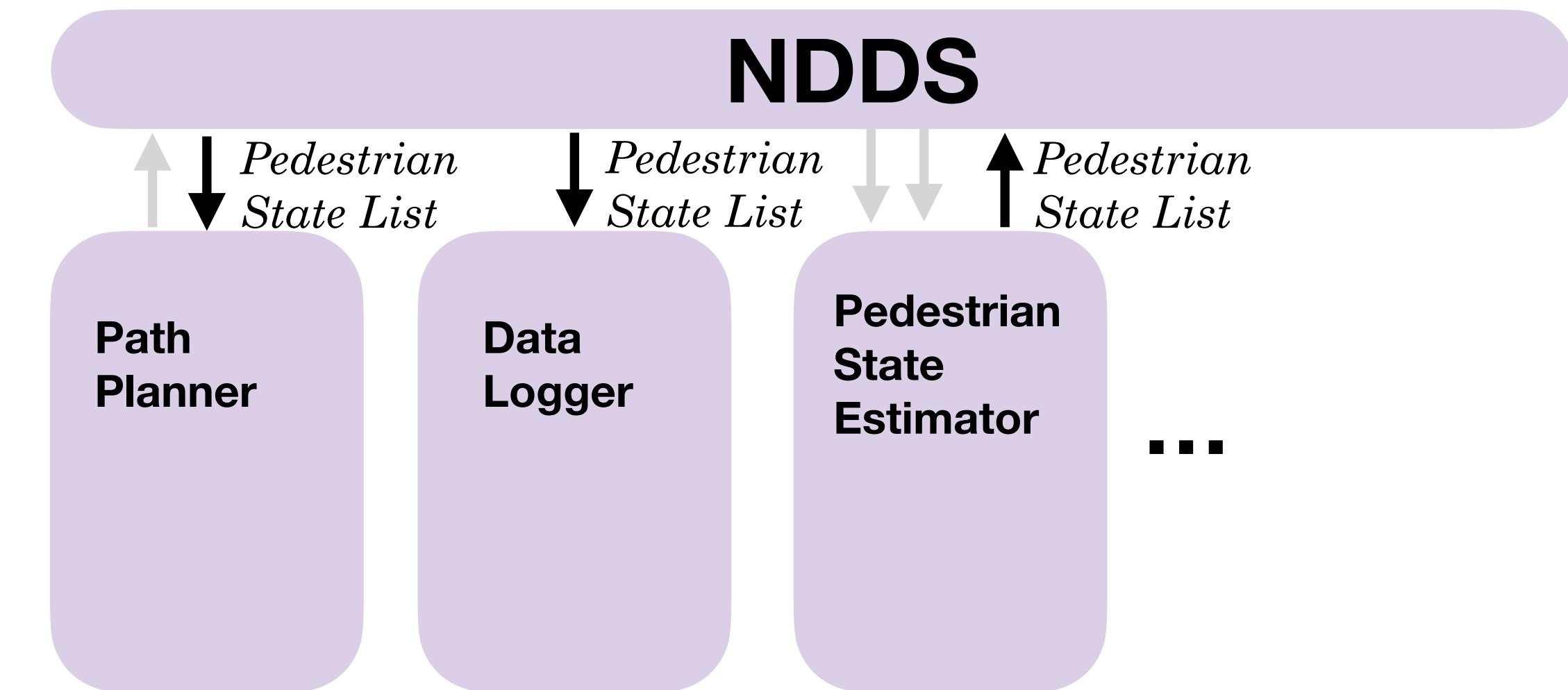
Publish Subscribe Implementations

- **NOTE 2**
 - Sensor inputs often have drivers embedded in nodes, then publish the signals



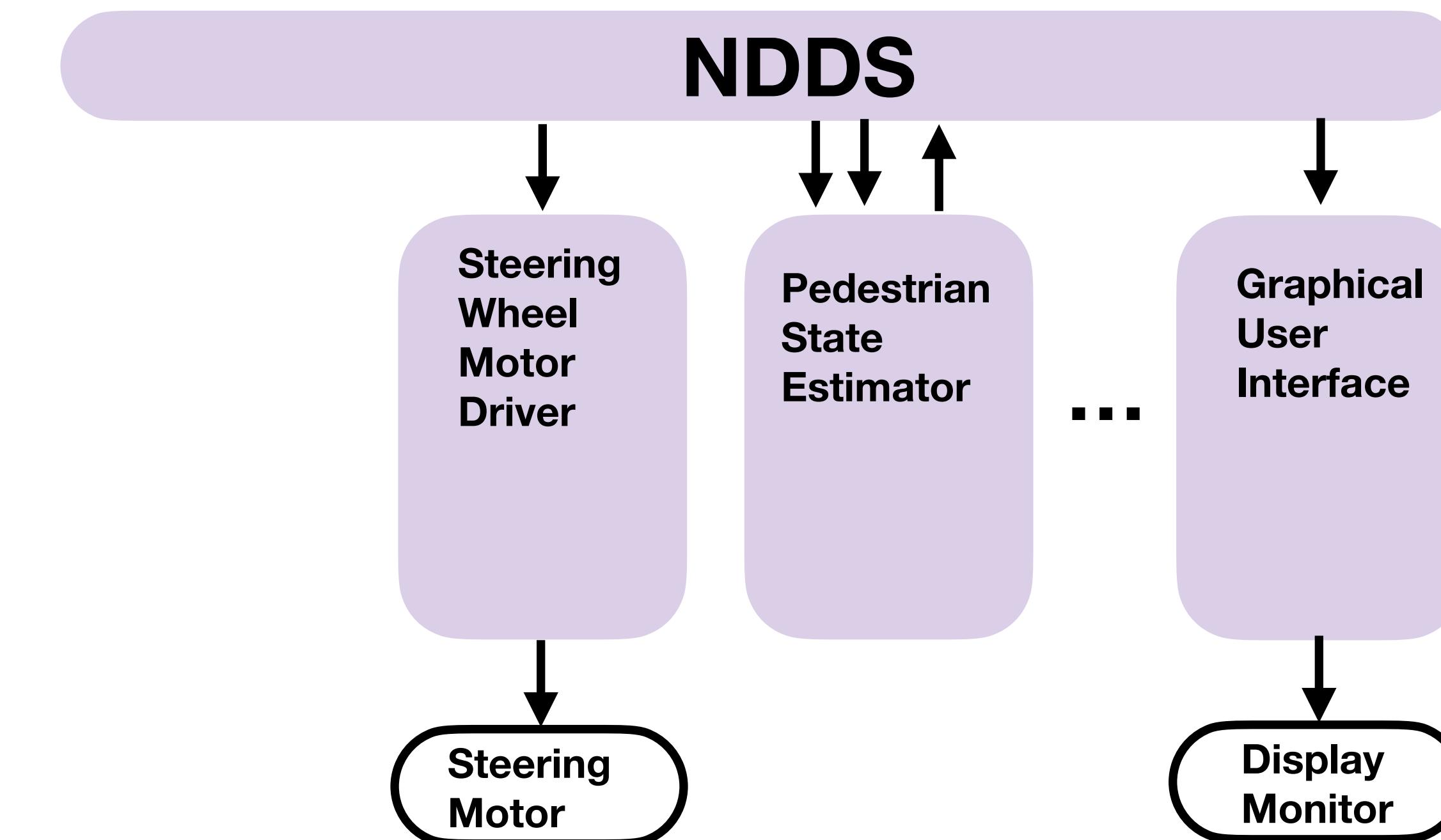
Publish Subscribe Implementations

- **NOTE 3**
 - A node's output signal, or **published topic**, can have **many subscribers** in different nodes



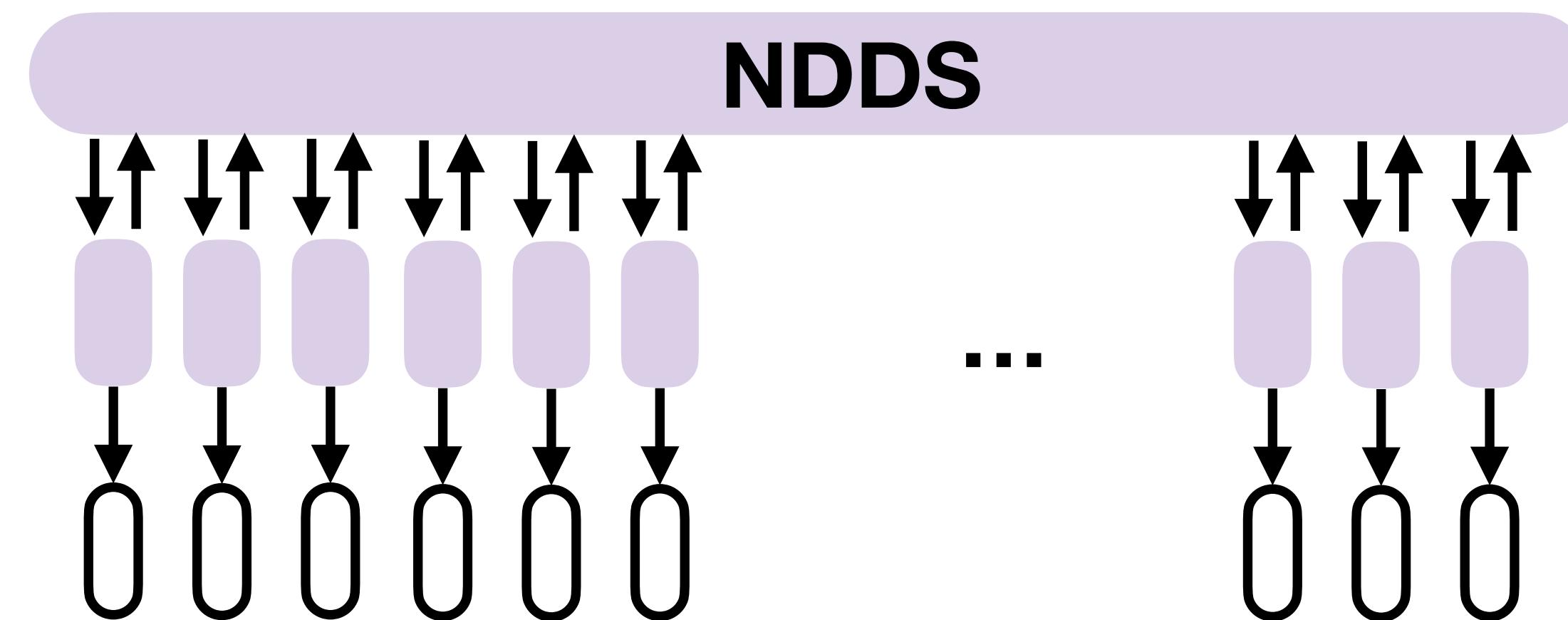
Publish Subscribe Implementations

- **NOTE 4**
 - Actuators often have drivers embedded in nodes, and subscribe to the input signals



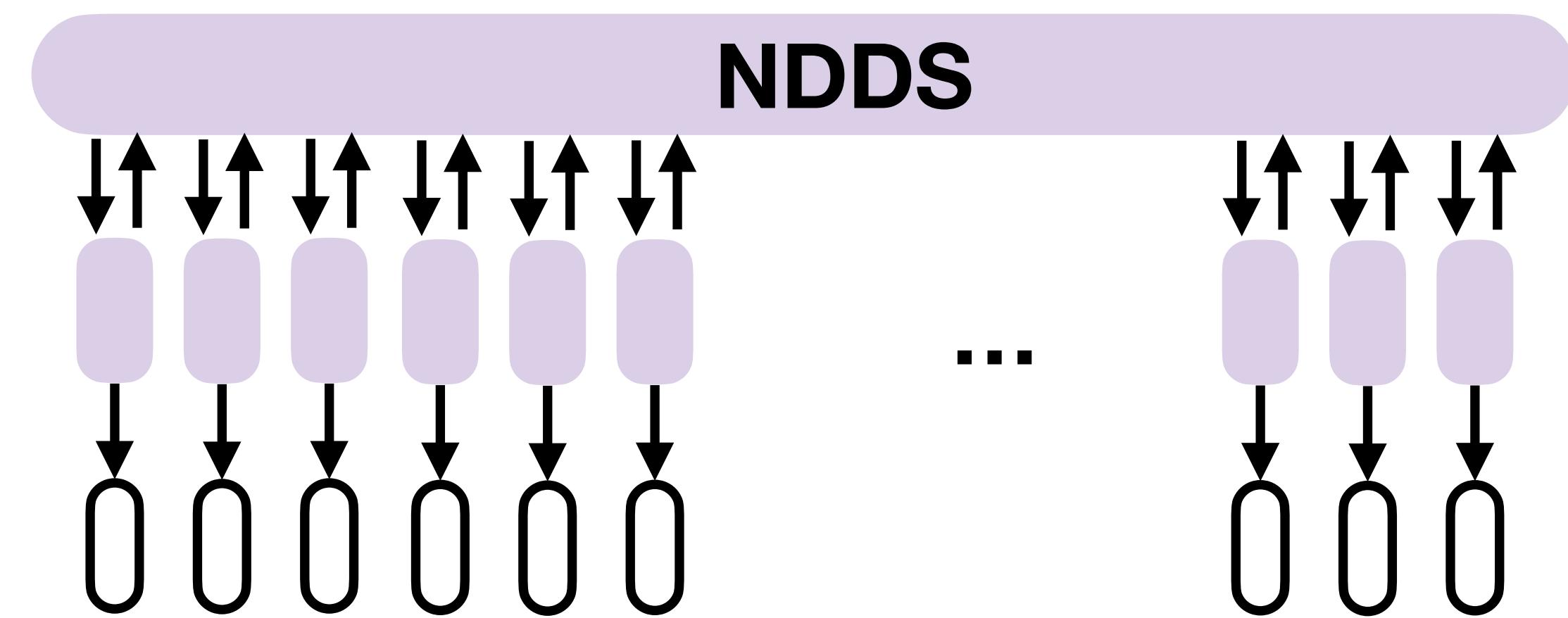
Publish Subscribe Implementations

- **NOTE 5**
 - Can have 100s of nodes with many publishers and subscribers



ROS 2 - Robot Operating System

- **Launch file** - A mechanism for starting many nodes
- **Many computers** - can be used for the, each with their own set of nodes
- **Service** - Allows “on-call” nodes to operate and respond with signals.
- **Languages** - C++, Python
- **Operating Systems** - Linux, Windows???, Mac???
- **Much Tooling and online resources!!**





NYU

ROB-UY 2004

Robotic Manipulation & Locomotion

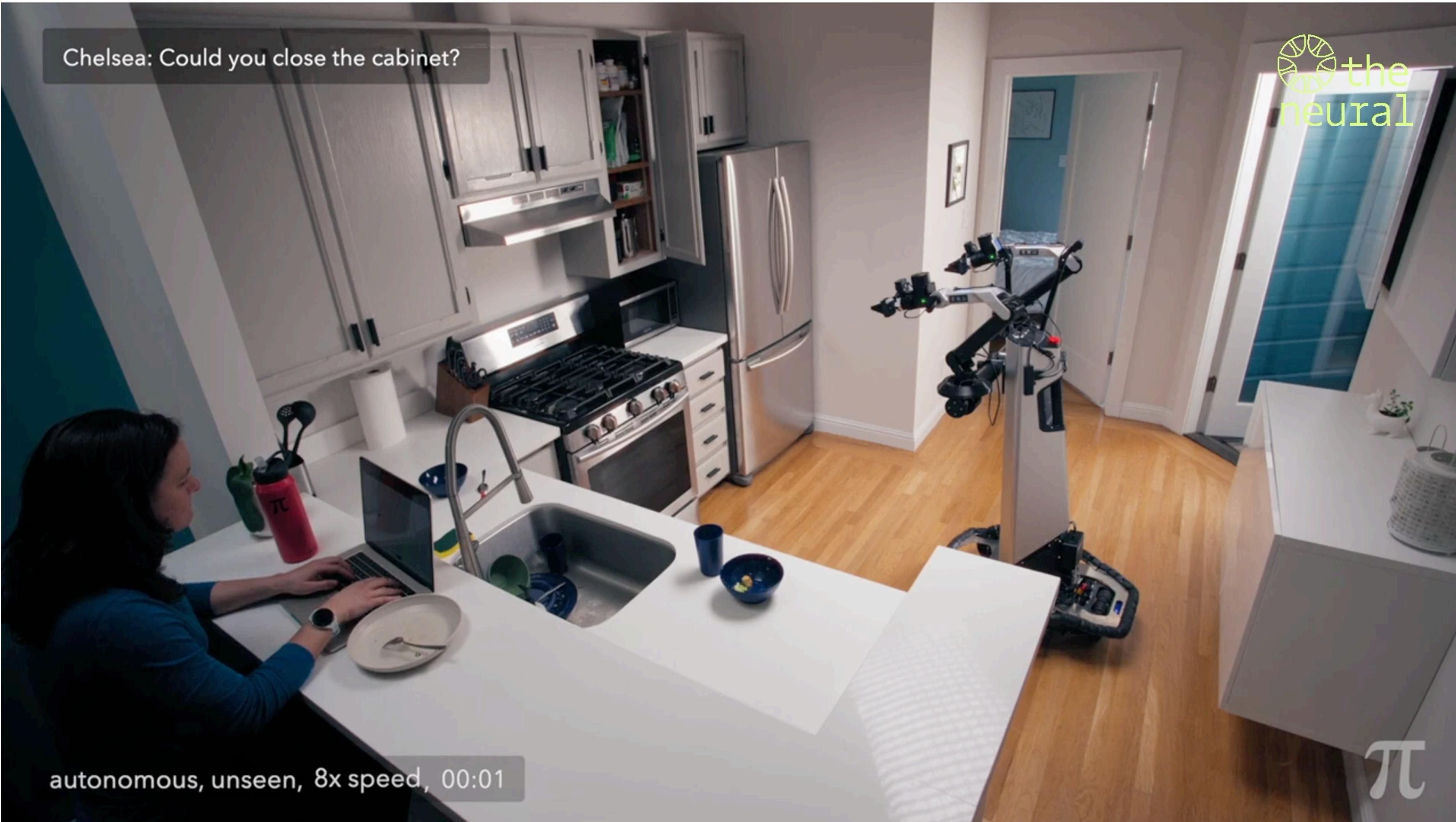
What's exciting in Robotics Today?



NYU

ROB-UY 2004

Robotic Manipulation & Locomotion





NYU

ROB-UY 2004

Robotic Manipulation & Locomotion

Unitree G1

World's First Side-Flipping Humanoid Robot

