AI- Project

Collaborative HRI in industrial setting

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Outline

Goal Statement

Formulate a robot model that can adjust its behavior to interact and collaborate effectively with a human whose own behavior and performance are subject to unpredictable changes like mood swings, changes of emotional states, boredom etc.

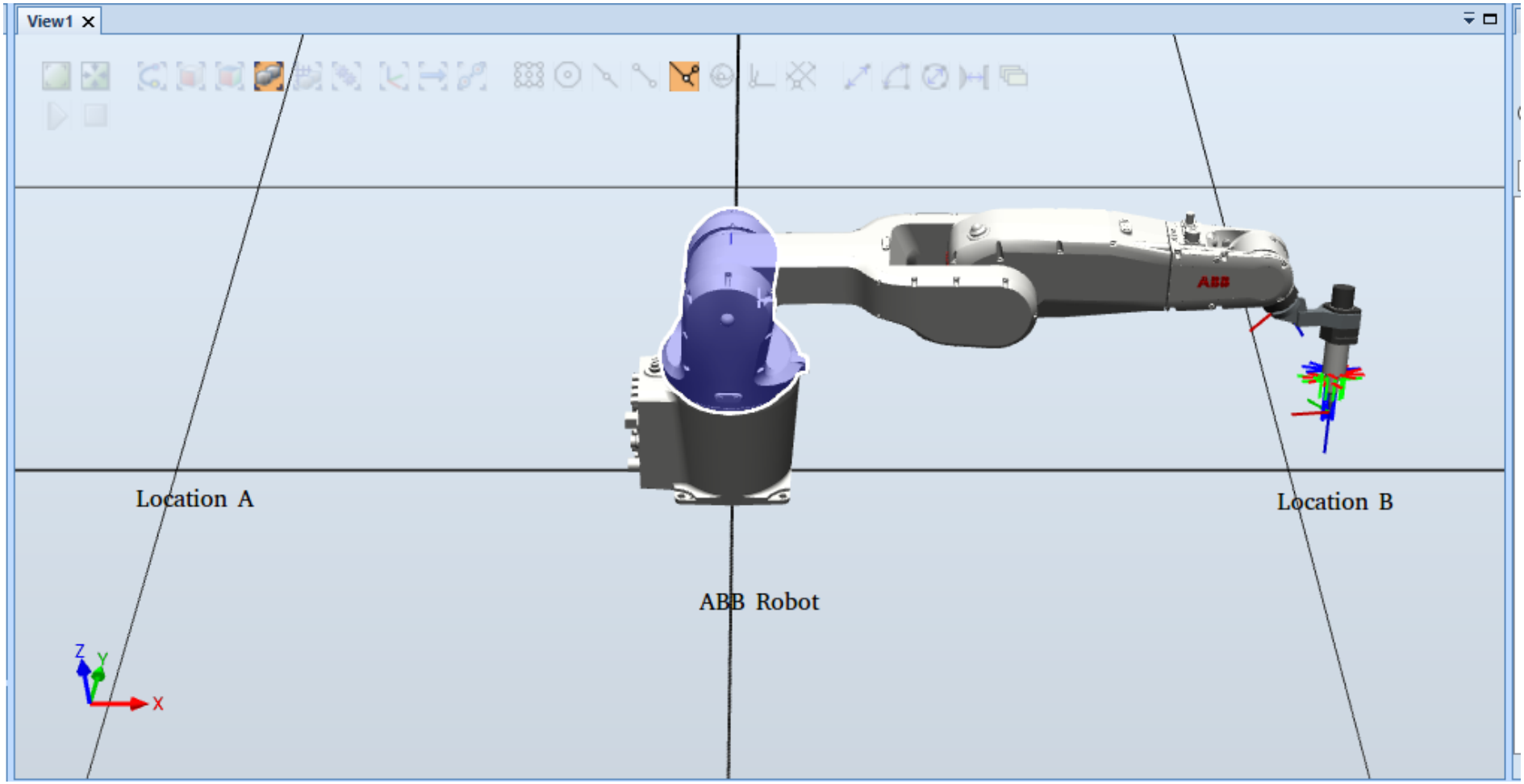
Goal Statement

Scenario

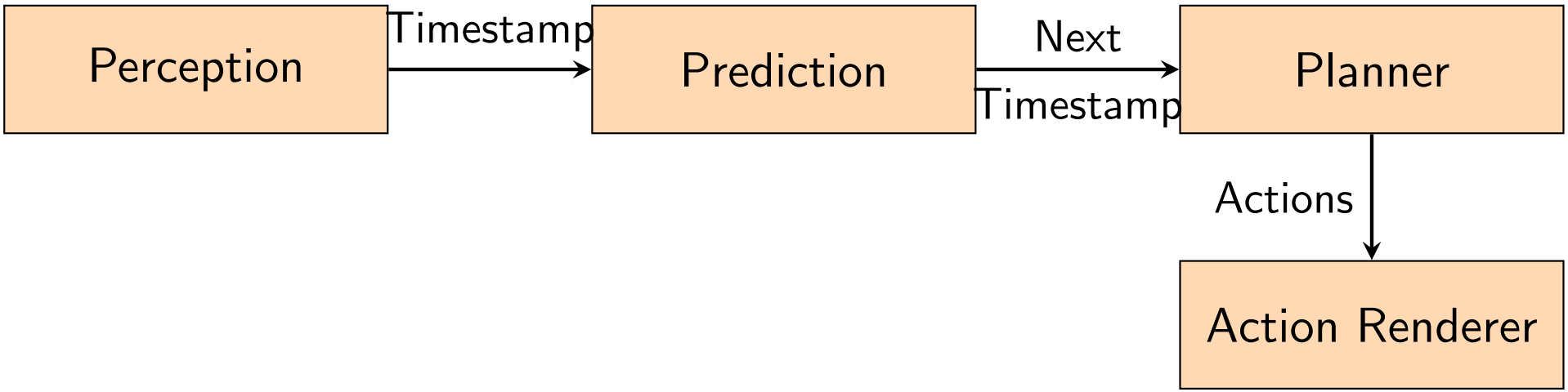
- **Robot** has to pick up a raw material from Location A and drops it in Location B.
- **Employee** will be waiting for the raw material in Location B and when he gets the raw material, the employee performs his analysis on the object and after he is done with the task, he will ask for the next raw material.
- We try to adapt the robot to employee behaviour, specifically, we predict when the employee finishes his analysis and asks for the next raw material. Using this predicted value, we plan a energy efficient trajectory for the industrial robot.

Goal Statement

Scenario



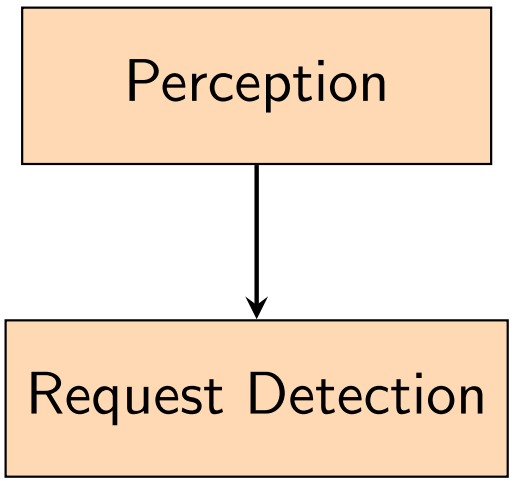
Architecture



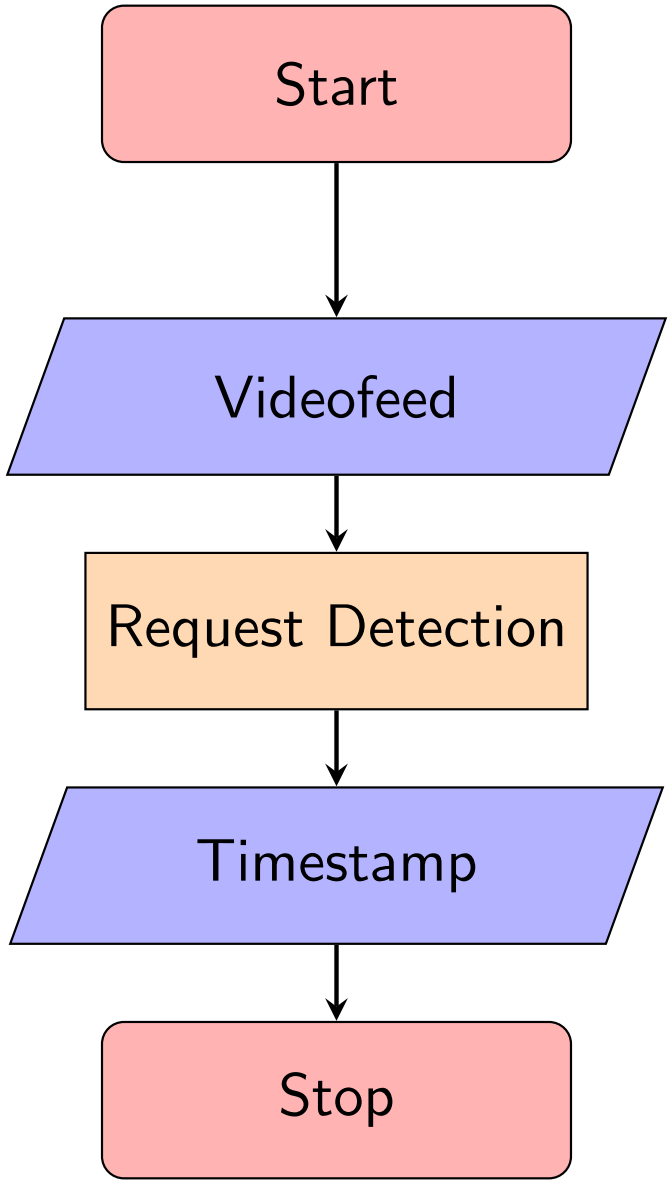
Outline

Perception

- **Request Detection** uses python libraries, mainly OpenCV, to detect hand gesture from the videofeed, the timestamp is send as the output.

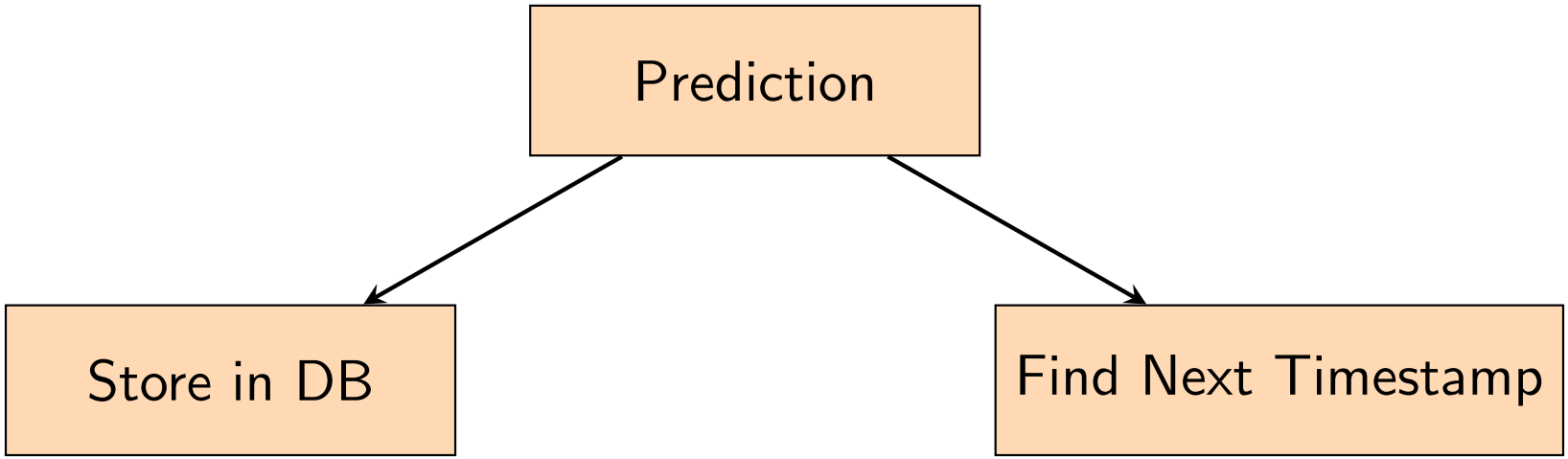


Perception

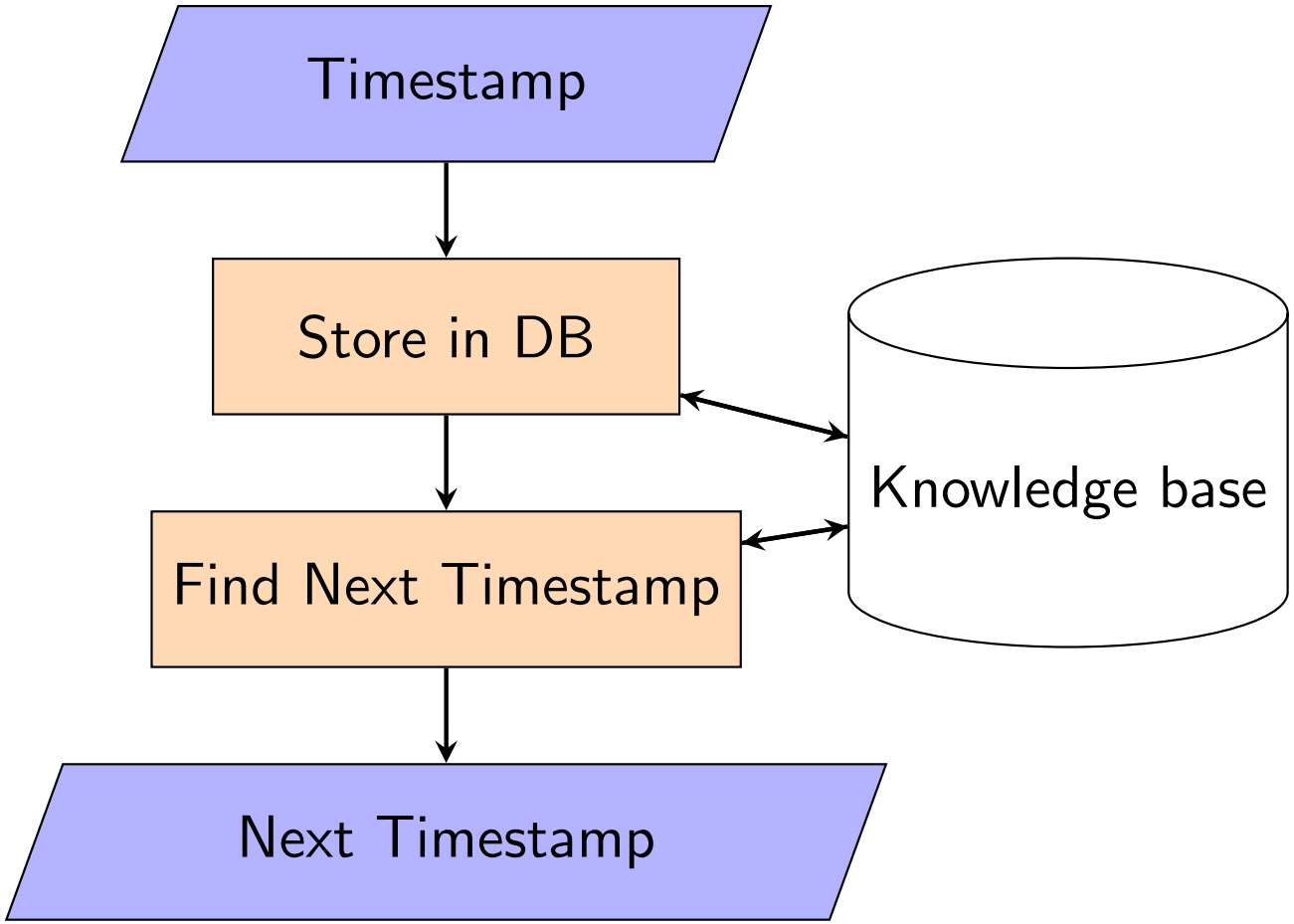


Outline

Prediction



Prediction


Timestamp
Store in DB
Knowledge base
Find Next Timestamp
Next Timestamp

Prediction

DataSet

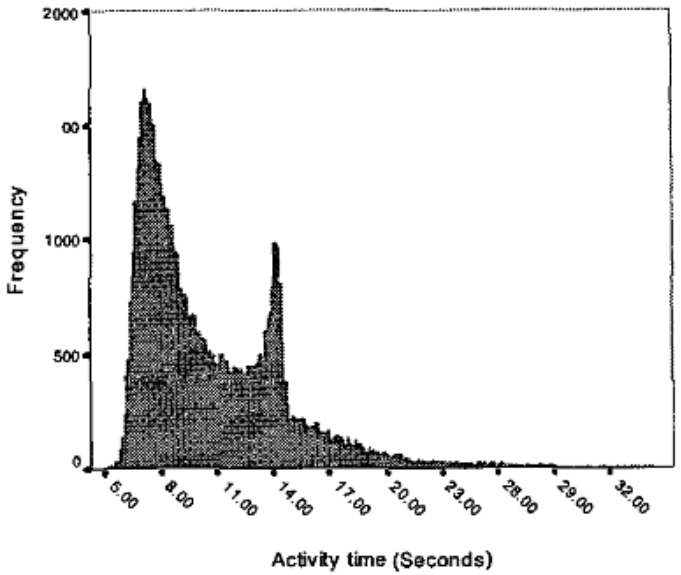


Figure: Activity Time vs Frequency for Operation A

Prediction

DataSet

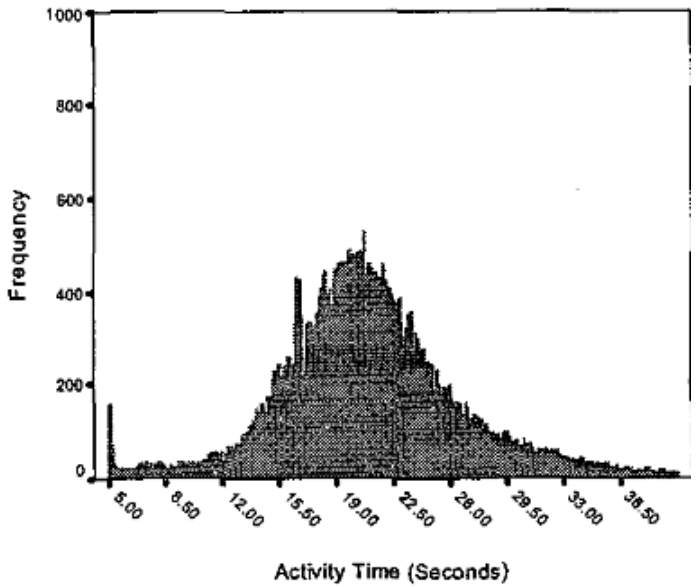


Figure: Activity Time vs Frequency for Operation B

Prediction

DataSet

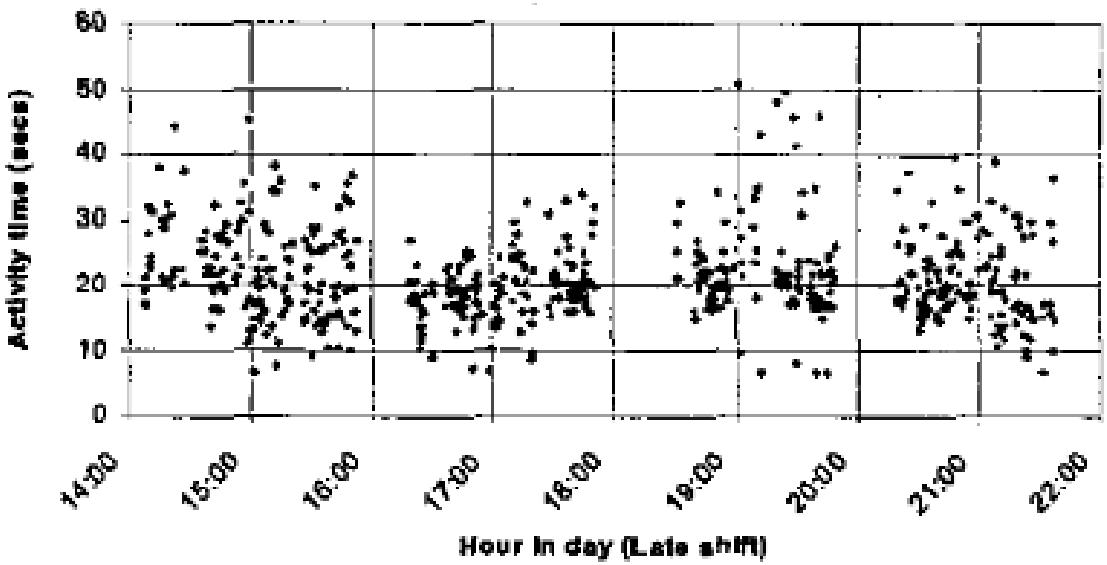


Figure: LateShift vs Activity Time

Prediction

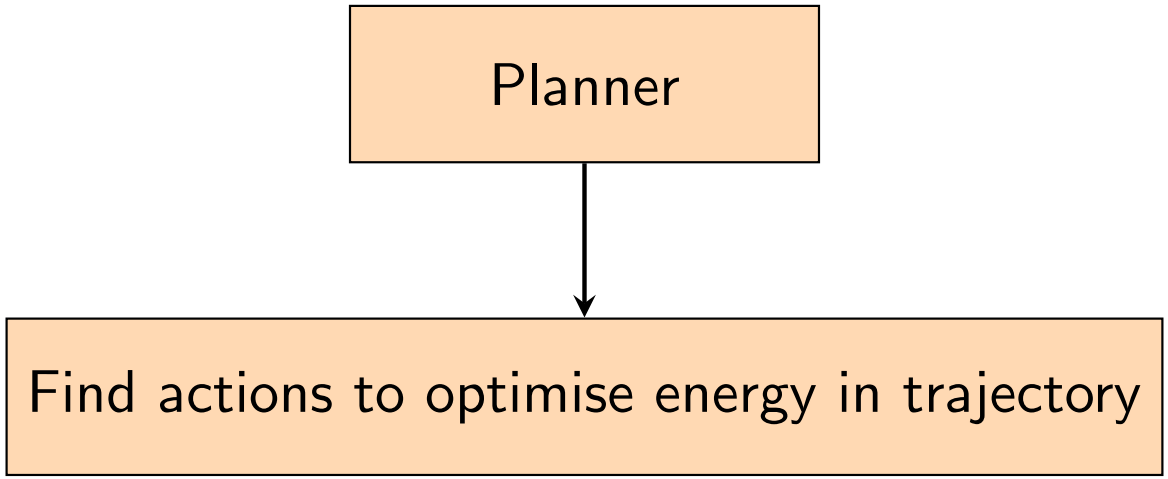
Model

$$X_t = \alpha * X_{t-1} + (1-\alpha) * X_{t-2} + (1-\alpha)^2 * X_{t-3}$$

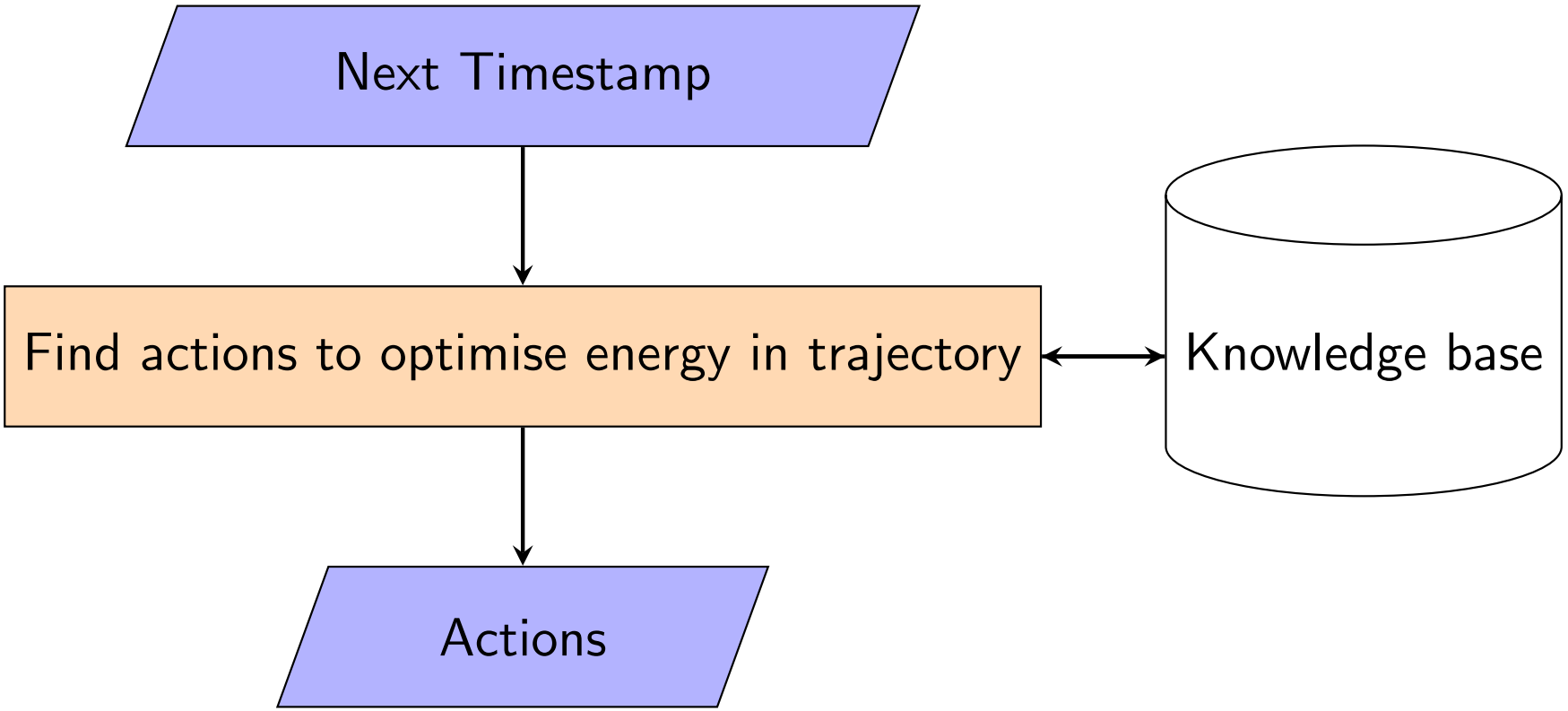
where X_t is the new predicted activity time and α

Outline

Planner



Planner


Next Timestamp
Find actions to optimise energy in trajectory
Knowledge base
Actions

Dynamic Robot Model

- Equations for the torque exerted by various forces are written as a function of joint angles of various arms.
- $$\boldsymbol{\tau} = \mathbf{M}(\mathbf{q})\ddot{\mathbf{q}} + \mathbf{C}(\mathbf{q}, \dot{\mathbf{q}})\dot{\mathbf{q}} + \mathbf{G}(\mathbf{q}) + \boldsymbol{\tau}_f(\dot{\mathbf{q}})$$
- Where M is Mass Matrix, C is effective torque from coriolis forces, G(q) is the torque due to Gravity and T_f is the torque due to friction

Dynamic Robot Model

- $$\boldsymbol{\tau}_f(\dot{\mathbf{q}}) = \mathbf{f}_C \, \mathrm{sign}(\dot{\mathbf{q}}) + \mathbf{f}_v \dot{\mathbf{q}}$$
- Where f_c and f_v are coloumb and viscous friction coefficients