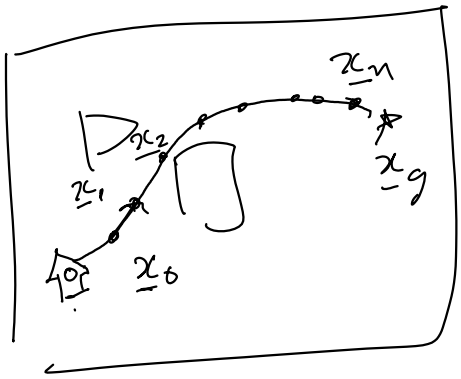
Control vs Planning

Planning

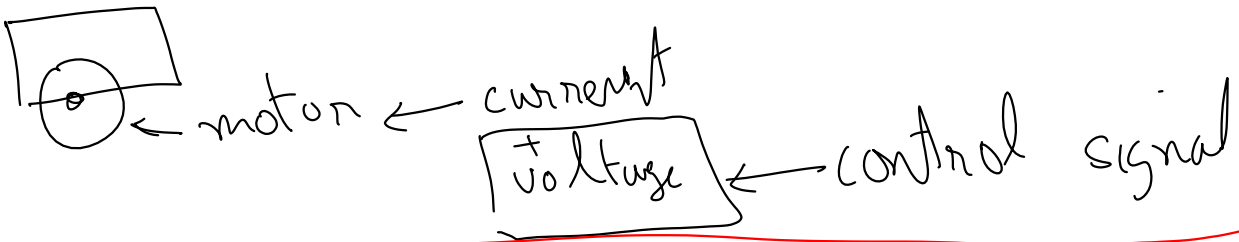


Finding a sequence of states that take a robot from initial state to a goal state while avoiding obstacles and minimizing some kind of cost (distance, time, energy)

Control

Input to the robot? Jetbot

cmd_vel ← control signals



Find a sequence of control inputs to the robot take a robot from initial state to a goal state while avoiding obstacles and minimizing some kind of cost (distance, time, energy)

Planner (RRT / A-star)

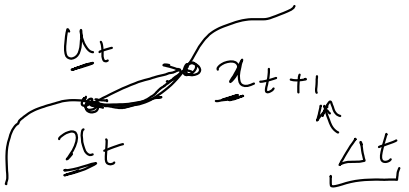
Controller

Path tracking

Typical combination of planning and control

State transition function / table

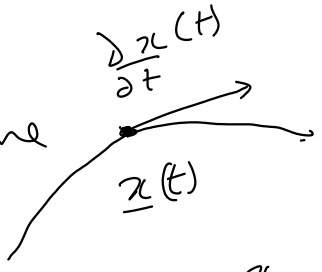
$$\underline{x}_{t+1} = f(\underline{x}_t, \underline{u}_t)$$



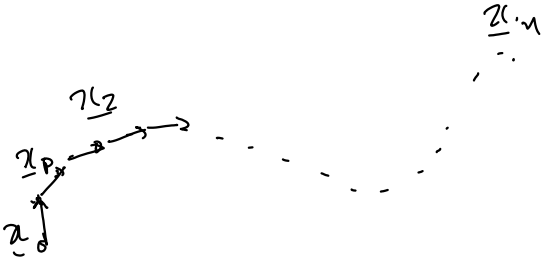
System dynamics in discrete time

$$\frac{\partial \underline{x}(t)}{\partial t} = g(\underline{x}(t), u(t))$$

System dynamics in continuous time



$$\underline{x}_{t+1} = \int_t^{t+\Delta t} \frac{\partial \underline{x}(t)}{\partial t} dt + \underline{x}_t$$



$$\underline{x}_{t+1} = \int_t^{t+\Delta t} g(\underline{x}(t), \underline{u}(t))\, dt + \underline{x}_t \qquad x_t = x(t)$$

$$x_{t+1} = x(t+\Delta t)$$

$$\underline{x}_{t+1} = f(\underline{x}_t, \underline{u}_t)$$

$$f(\underline{x}_t, \underline{u}_t) = \int_t^{t+\Delta t} g(x(t), u(t))\, dt + \underline{x}_t$$

discrete ⟵ continuous

$$\frac{d\,\underline{x}(t)}{dt} = \lim_{\Delta t \to 0} \frac{\underline{x}(t+\Delta t) - \underline{x}(t)}{\Delta t} \approx \frac{\underline{x}(t+\Delta t) - \underline{x}(t)}{\Delta t}$$

$$= \frac{\underline{x}_{t+1} - \underline{x}_t}{\Delta t} = \frac{f(\underline{x}_t, \underline{u}_t) - \underline{x}_t}{\Delta t}$$

$$g(x(t), u(t)) \approx \frac{f(\underline{x}_t, \underline{u}_t) - \underline{x}_t}{\Delta t}$$

continuous ⟵ discrete