LaValle_Ch1

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7:42 PM

Goal of robot motion planning:

Given a task, determine robot actions to accomplish the task

Needs:

(1) a way to represent tasks

(2) a way to specify robot actions

(3) a way to predict outcomes of actions

(could you drive your car if the outcome of turning the steering wheel was unpredictable?)

Typical representation:

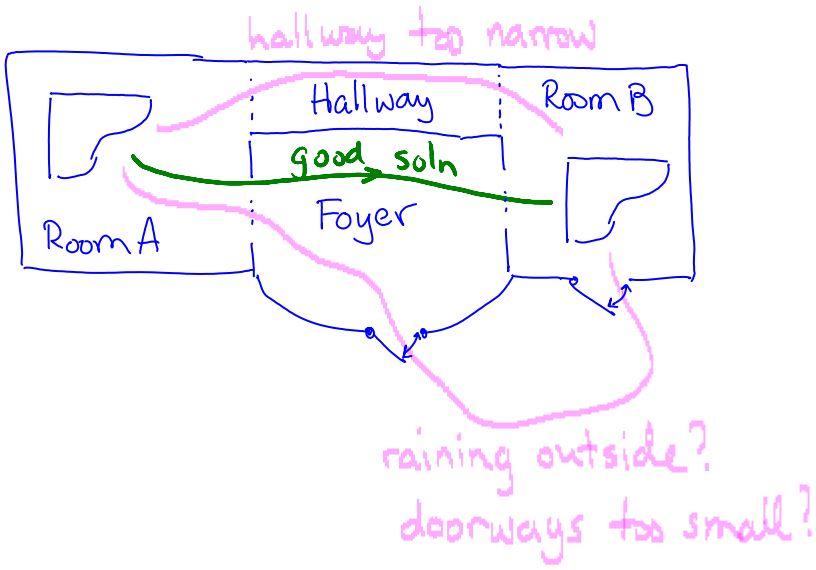
(0) All possible states of world represented as nodes in a graph

(1) A task is represented as a set of starting and goal nodes in the graph

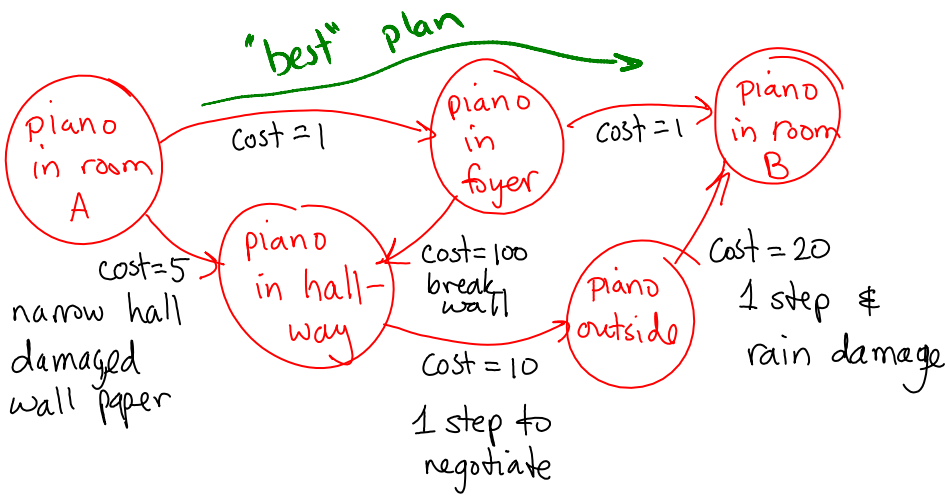
(2) An action is represented as a directed arc in the graph

(3) Prediction is represented by connecting two nodes by a directed arc representing a specific action.

Cannonical Problem - Piano Movers' Problem



Graph representation



The "best" plan is the cheapest, according to your metric.

Important questions for general planning problems

Can the space of possible states of the world be accurately represented?

Can outcomes of actions be predicted?

Does a plan exist?

Can the planning alg. detect plan existence?

Can it do it in finite time?

When are motion planning techniques needed?

Planning can be thought of as a two-point boundary value problem.

* Planning methods are commonly employed when simple computational & closed-form solutions are not applicable, e.g. most robot trajectory following probs. are easily solved by inverse kinematics and simple control algorithms

Examples:

- α-puzzle (ignore finger geom. & joint angles)
- dexterous manipulation (include finger constrs.)
- snap-together assemblies (include dynamics & object flexibility).

Section 1.3: Basic Ingredients

Time - used to order thing

Action - robot effort that changes state

Action space - set of all possible actions

State vector - set of parameters whose values provide all relevant info about the world.

e.g. Robot arm :

- state = joint displacements if slow moving
  (usually called Configuration Space, C-space)
- state = jnt displ. & velocities if fast
- state = " " " " & amplitudes of vibration modes
- state = " "" maybe add temp. & humidity if friction is important.

<u>State Space</u> = set of all possible state vectors.

e.g. slow <u>moving robots</u>

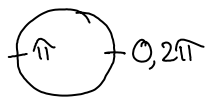
one-dimensional interval in topology

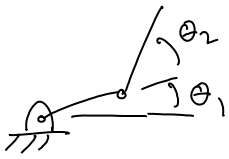
C-space = I^1 if joint limits

C-space = S^1 if no jnt limits

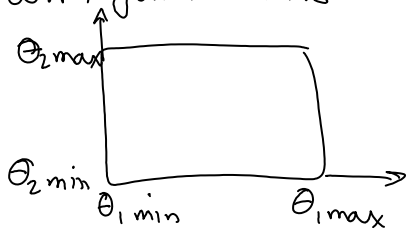
one-D circle

$I^1 =$

$S^1 =$ 



C-space = $I^1 \times I^1$ = the "disk" with joint limits

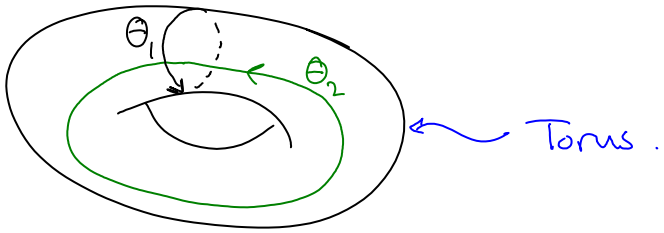


Joint limits on one joint

Not the

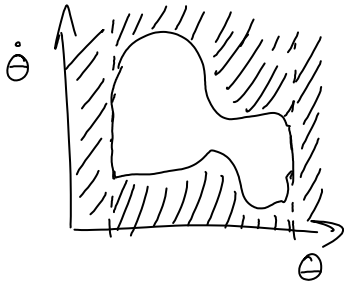
solid. Just the 2D surface.

What if neither joint has limits?



Fast moving robots – X includes velocities

1R or 1P robot w/ joint limits & velocity limits



a.k.a. phase space

Plan – A specific behavior imposed on the decision-maker

Open-loop – no sensory feedback – just an ordered set of actions

Closed-loop – feedback used to adjust/choose actions in real-time.

Feedback is needed when uncertainty is

important.

Can depend on past and present info.

e.g. Kalman filtering

Section 1.4.3

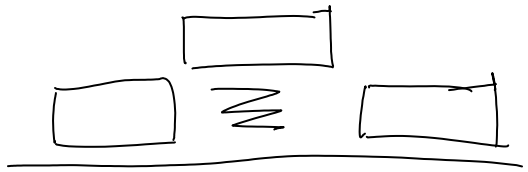
Three uses of plans:

- Execution – if sufficiently detailed
- Refinement – omitted details to get coarse approx.
- Hierarchical Inclusion –

Refinement – parallel parking

1.) Check feasibility based on geom.

2.) Then incorporate nonholonomic constraints.



Hierarchical inclusion

Create a library of primitive tasks.

Planning job is to decompose overall task into a sequence of subtasks.