Planning Review

Combinatorial Planning
- Road map, or graph-based

Ex]
- Visibility Graphs
- Voronoi diagrams
- Exact cell decomposition
- Approximate cell decomp.

Pros:
- elegant and complete
- find the solution or report NONE

Cons:
- quickly becomes intractable
- curse of dimensionality

Sample-based Planning
- does not characterize C_{Free} + C_{obs}
    - only has collision detection algorithm

Ex] PRM (Probabalistic Road Maps)
RRT
- Tractable, less computationally intensive
- Not complete

Potential Field Methods

- not graph-based

Field: $U(q) = U_{attractive}(q) + U_{repulsive}(q)$

$\vec{F}(q) = -\vec{\nabla} U(q)$ ← Gradient descent vector field

- problem: local minima
  - use local-minima free navigation fcn

Search

- sequence of actions (a path) that leads to desirable state (a go

Types: uninformed: no information about domain, can only expand nod
- breadth-first, uniform cost, depth-first, bidirectional

Informed: further information about domain through he
- A*, greedy best-first, D*

Performance: measured by
- Completeness
- Optimality
- Time complexity
- Space complexity

D* Search:

- unknown, partially known, or dynamic environments, the replanned path may be blocked
- planned path may be blocked or need to replan
- incrementally repair path keeping its modifications local around robot pose
- D*, D* Lite, Field D*

Collision avoidance

Ex/ Dynamic window approaches
Nearness Diagram Navigation
Vector Field Histogram +
Extended Potential Fields

Markov Decision Process

- uncertainty about actions
  - transition model $T(a, S_i, S_{i+1})$ Markov Property
- Definition of Problem:

States: S
Action: A
initial state: S_0
~~Transition~~ : $T(a, s_i, s_{i+1})$
Reward : $R(s)$

we want to find optimal policy

$$\pi^*(s) = \arg\max_a E[U^*(s)]$$

where $U^*(s) = E\left[\sum_{t=0}^{\infty} R(s_t) \mid \pi\right.$

$= R(s) + U^*(s$