Lecture 14

Note Title 2/28/2012

Narrow passage problem:

a) how to identify them?

b) " " place samples in them?

"Various sampling schemes"

"heuristic approaches"

① "Connection Sampling": for each

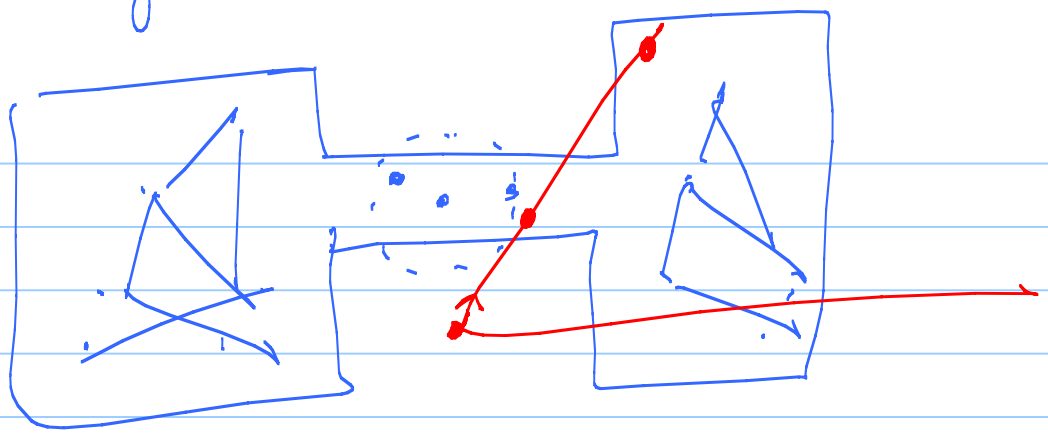
node q in Roadmap, associate a weight $w(q)$ that indicates "difficulty" of region. $w(q) \uparrow$ for difficult regions

$\deg(q)$ = # of other nodes it is connected to

$$w(q) = \frac{\frac{1}{\deg(q)+1}}{\sum_{q' \in V} \frac{1}{\deg(q')+1}}$$

Select a node q with prob $\propto$ to $w(q)$ and place new samples in a local neighborhood

of it



2) OBPRM: keep nodes that $\in C_{obs}$

q_{coll}

generate random dir. from q_{coll} and

det. if $\exists$ a free sample q along

this dir. if yes, then proceed from q_{coll} along v until first q_{free} is found. add q_{free} to road map

③ Bridge test: generate $q' + q''$ randomly such that both $\in C_{obs}$.

$$q_{mid} = \frac{q' + q''}{2}$$

if $q_{mid} \in C_{free}$, then add to road map.

"effective in generating samples in narrow regions"

For high dim C-spaces, sampling based

approaches have been shown effective

for six-dim C-space: six link arm

$\# V \approx 6,000$

Run time few seconds to few minutes

Probabilistic Completeness:

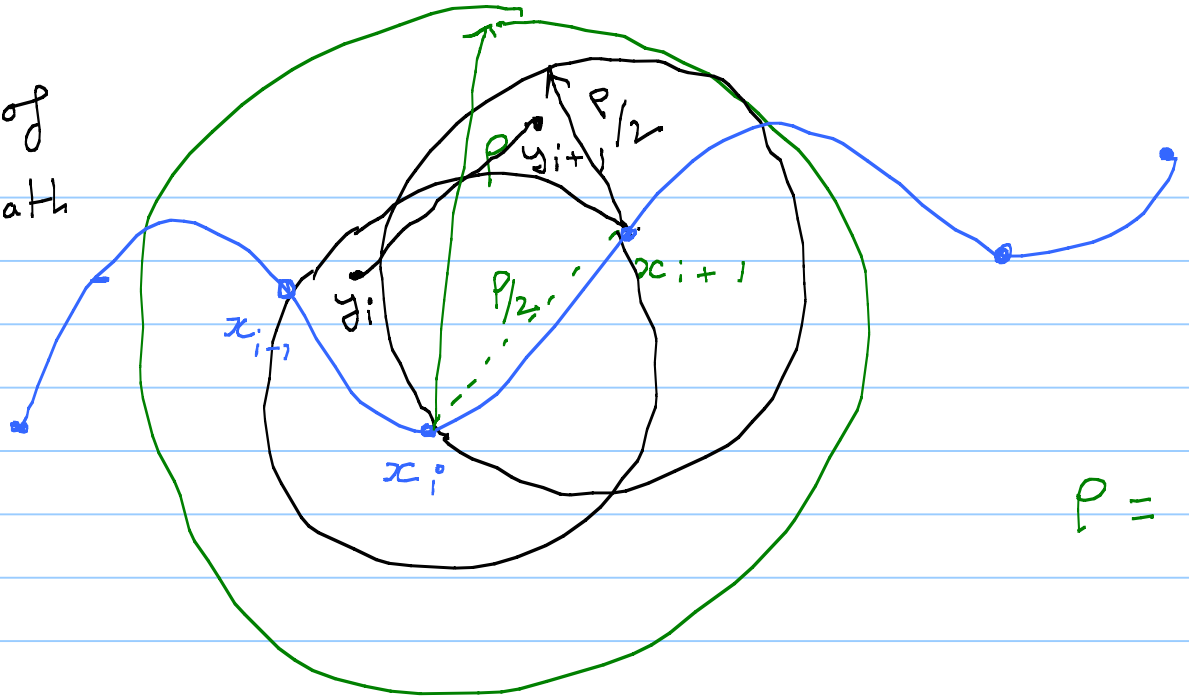
if a coll. free path exists,

$Pr[\text{path}] \to 1$ as planner keeps running

L = length of the path

$m = \left\lceil \frac{L}{\rho/2} \right\rceil$

$= \left\lceil \frac{2L}{\rho} \right\rceil$



ρ = clearance to nearest obs. (c-space)

I_i = event such that a sample $y_i \in V$ & $y_i \in B_{\rho/2}(x_i)$ is placed

$$P_r[\text{failure}] \leq P_r\left[\bigvee_{i=1}^{m} I_i = \phi\right]$$

$$\leq \sum_{i=1}^{m} Pr[I_i = 0]$$

$$\leq m \cdot \left[1 - \frac{Vol\left(B_{\rho/2}(x_i) \right)}{Vol\left(C_{free} \right)} \right]$$

$$Pr(\text{success}) = 1 - \left[\frac{2L}{\rho} \right] e^{-\sigma \rho^d n}$$

γ = Coll. free path

ρ = clearance (γ)

L = Length (γ)

n = # of samples in

d = dim of C-space

roadmap

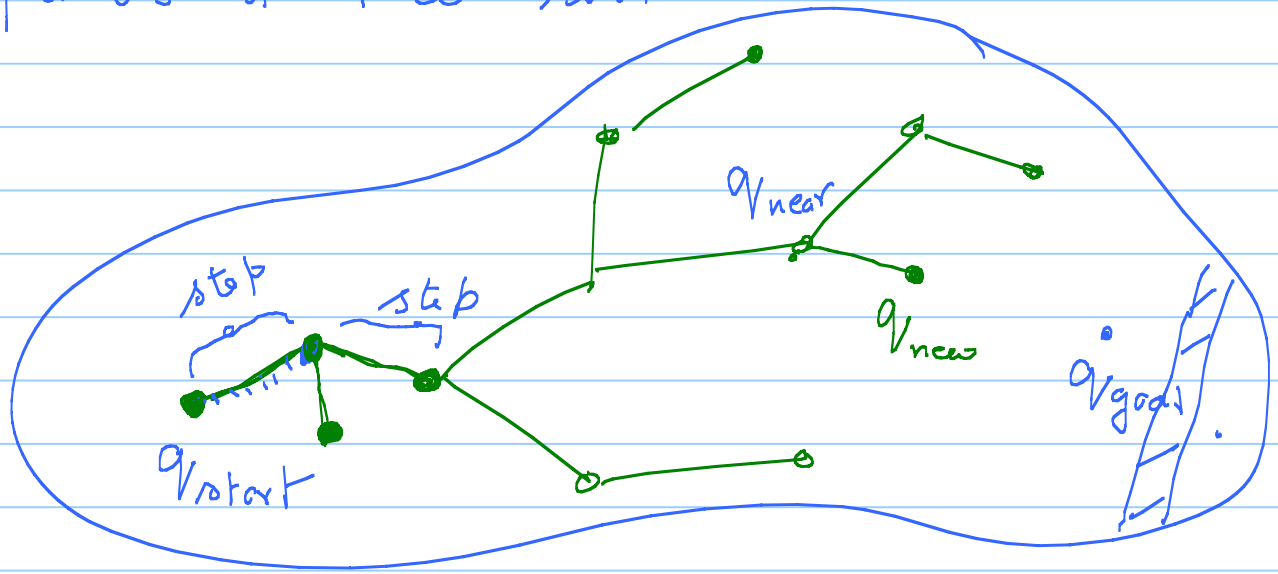
$Pr[a, b, \text{success}] \to 1$ as $n \to \infty$

hence it is probabilistically complete.

Single query planner :

RRT : Randomized Reachable Trees

expands a tree rooted at q_{start}.



Throw a random sample q_{rand}. Det. the closest node in the tree to q_{rand}. Call this q_{near}.

Extend q_{near} towards q_{rand} in a step size "step". If the new node along step size is reachable (and is free) call it q_{new} and add it as a child of q_{near}. (q_{near}, q_{new}) is an edge in the tree.

"Connect"

Variation: