Lecture 12

Note Title 10/5/2006

1. Explicit comp. of c-space obs. is intractable for practical cases
   ROT, articulated arms...

   $R^2 \times SO(2)$ ⟶

2. Approx cell decomp. but only for low-dim c-space useful

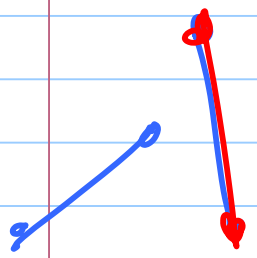
3) Sampling based planners

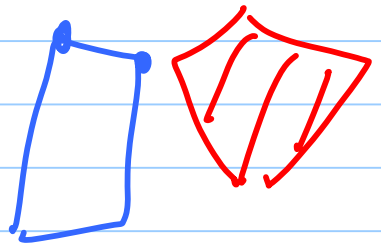
   "avoid explicit construction of c-obs."

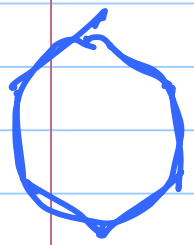
Note Title 2/4/2010

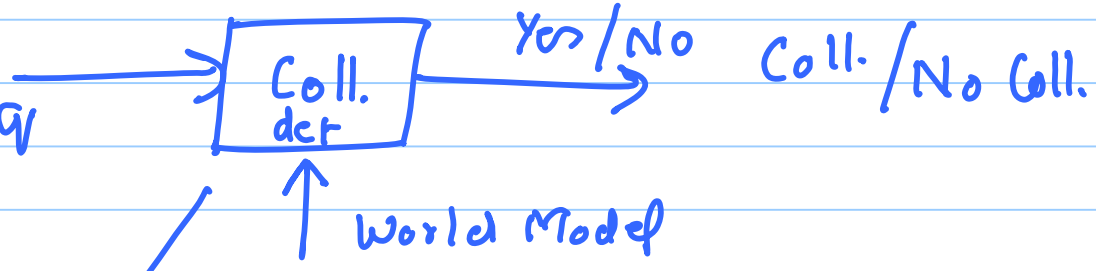
Sampling based Path Planners

① Coll. detection as a tool



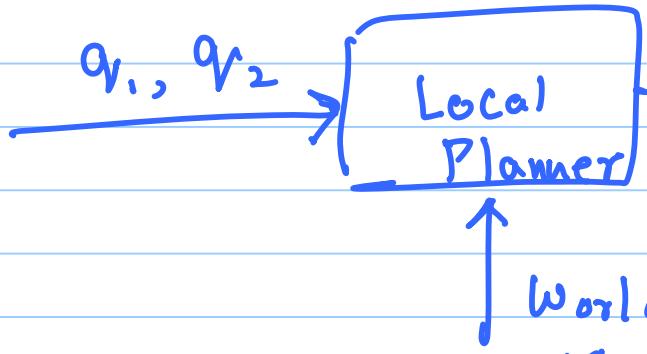






key significant computation. so its efficiency is criti cal.

(2)



yes
if q_1, q_2 can be connected by Local Planner with a coll. free path

no otherwise

→ 1) use a "probe" to sample C_{free}.

"Collision or not" "collision checker"

for more efficient ways of doing it key comp: directly in phys. space

decide if a sample is in C_{free} or C_{obs}

try to construct an "accurate" rep of c-space via these "samples"

→ 2) if two samples are "connected"

deterministic local planning method (LPM)

3) Metric in C-space : Can use any one of the metrics we studied earlier.

→ diff. approaches:

1) Single shot / Single query ⇒ RRT, RRA (incremental)

2) Multiple query ⇒ a lot of pre-processing

- pre-proc. off-line phase
- query "

→ PRM (probabilistic road map)

people tried lot of distributions don't have to remember paths.

PRM: prob. road map:
Capture the connectivity of Cfree in a graph composed of samples as nodes, edges as "LPM"

Pre-proc. phase:

for i = 1, N ? = choose a random q

deterministic

black box

check-coll.(q)

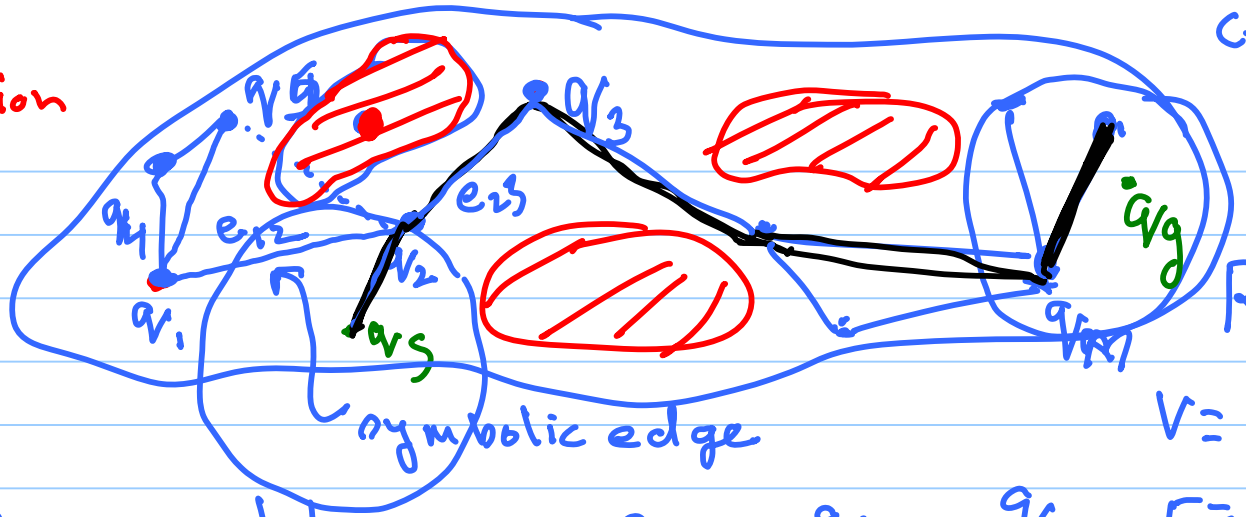
if yes skip to end
else connect all existing sample q' within dist. $\leq r$: $d(q, q') \leq r$
using LPM

black box

Complexity of LPM = fast

q_1 q_2 St. line.

C-obs are for visualization only. They are not computed.



$R = (V, E)$

$V = \{q_0, \dots q_n\}$

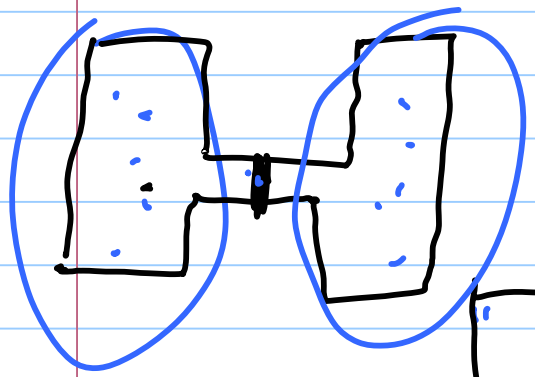
$E = \{e_{12}, \dots\}$

Query phase: Given q_s, q_g

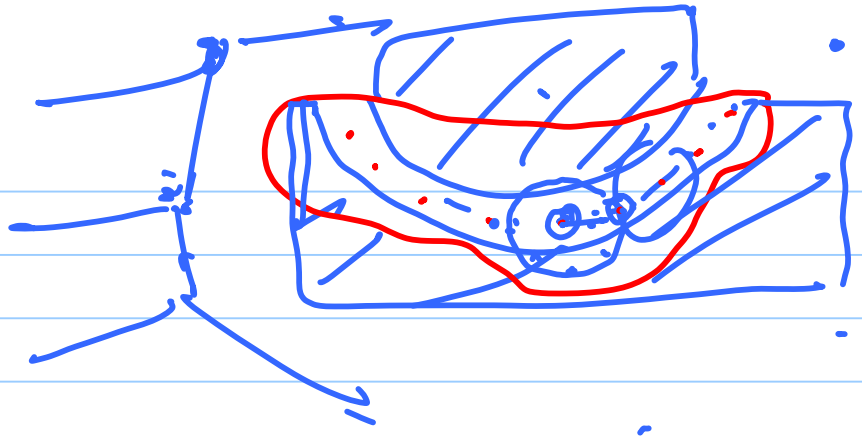
1) try connect q_s to nodes in closer R

q_s' q_g'

2) Search R for a path from q_s' to q_g'



"Narrow passage problem" → "finer sampling"



issues:

prob. of a node in $S \subset C_{free}$

$$\propto \left[\frac{Vol(S)}{Vol(C_{free})}\right]^{exp}$$

assume a collision free path γ exists.

$Pr(q_s, q_g \not\to, success)$

$= 1 - Pr(q_s, q_g, failure)$

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

$\sigma = \frac{Vol(unit\ Ball)}{2^d \cdot Vol(C_{free})}$

$n = \#$ of samples

$\rho = clr(\gamma)$

$L = length(\gamma)$

IN Practice: "Narrow range" phase
finer sampling phase in pre-proc.

No clear way when to stop. clq(node): in a measure of connectedness

"no good termination Criteria"

term. by "elapsed Comp. time"
or "No. of nodes"

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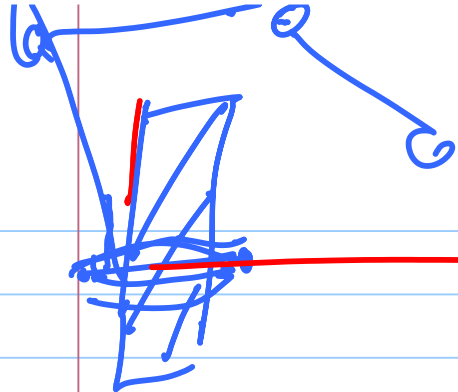
by Cnt: Collisions checks



"$\alpha-\beta$ lookout" ⇐ Read "paper"

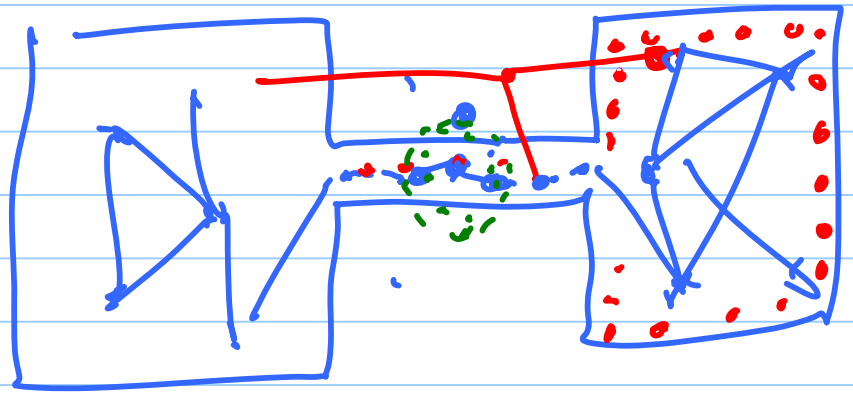
analysis "How →"

Narrow passage: how to identify them

No good practical / systematic way of identifying guaranteed way

"Various sampling techniques have been tried to identify them"

① Refinement strategy :

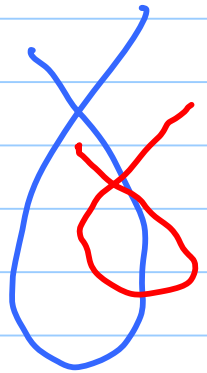


② OBPRM

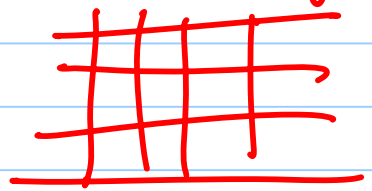
③ Bridge test

Single query Planner:

RRT (Randomized Reachable Trees)



Lavalle → pseudo random sequences generated over



a lattice (grid)