Assignment 1
Part-03

Deceptive Path Planning

Quantify path deceptivity
↳ magnitude (at each step)
↳ density (number of steps
↳ extent (distance travelled). *

LDP - last deceptive point

Computing deceptive paths:
↳ Goal recognition for path planning can be achieved without reference to any other observation, given an agent's starting point and current location.
↳ Probability distribution calculated on any node.
↳ remains constant irrespective of the path taken

* Path planning Domain
$D = \langle N, E, c \rangle$
set of nodes, edges, cost of edges.

* path π $\quad \pi = n_0, n_1, \dots, n_k$ s.t. $(n_i, n_{i+1}) \in E \;\forall\; i \in \{0, 1, \dots k-1\}$
π^i ← i^{th} node in π
$|\pi|$ ← length ← total number of edges in π.
↳ $\pi^{|\pi|} = n_k$
$\text{cost}(\pi) = \sum_{i=0}^{k-1} c(\pi^i, \pi^{i+1})$

* Π : set of all paths in the domain
all paths π starting at $\pi^0 = n_1$ and ending at $\pi^{|\pi|} = n_2$: $\Pi(n_1, n_2)$

* Path planning problem, $\langle D, s, g \rangle$ $\quad s, g \in N$
start, goal.

∴ solution path π : starting : s
ending : g
$\in \Pi(s, g)$

* optimal cost from n_i to n_j : $optc(n_i, n_j)$ — A*

* Probabilistic goal regognition problem

$\langle D, G, s, O, Prob \rangle$ — ~~Prob represe~~ prior probs. of the goals.

$G \subseteq N$ — set of goal locations

$O = o_1 \ldots o_k \in N^*, k > 0$ — seq. of observations

* Solut. $G : P(g|O)$

g_r : real goal

$$P(g_r|O) \geq P(g|O) \quad \forall g \in G \setminus \{g_r\}.$$

* determine for each goal: cost difference between the cheapest plan that incorporates the O & cheapest plan that avoids them.

$$costdif_{RG}(s,g,O) = optc(s,O,g) - optc^{\neg}(s,O,g)$$

$\downarrow costdiff \Rightarrow \uparrow Prob.$

* ~~Depecep~~ Deceptive path planning (DPP)

$\langle\langle D, s, g_r\rangle, G, P\rangle$

$P(G|O \cdot n)$: posterior prob. of a goal given a seq. of observations "Model for the observer".

Truthful step: $P(g_r|O\cdot n) > P(g|O \cdot n) \quad \forall g \in G \setminus \{g_r\}$.

otherwise "deceptive".

Simulation: $P(g_r|O\cdot n) < P(g|O\cdot n) \quad \cancel{\nexists}\ \exists g \in G\setminus\{g_r\}$.

$$Simulation(O \cdot n) = \max_{g_i \in G \setminus \{g_r\}} P(g_i|O\cdot n) - P(g_r|O\cdot n)$$

~~Dissimulator~~ Dissimulation.

$$P(g_r|O\cdot n) \leq P(g|O\cdot n) \quad \exists\, g \in G \setminus \{g_r\}$$

$$\text{dissimulation}(O\cdot n) = \sum_{g_i \in G} P(g_i|O\cdot n) \times \log_2\left(P(g_i|O\cdot n)\right)$$

* First truthful point FTP_π is a a node π^i
  π^i : truthful
  $\pi^j \ \forall j \in \{0,1,\ldots,i-1\}$: deceptive.

* Last deceptive ~~point~~ LDP_π
  π^i : deceptive
  $\pi^j \ \forall j \in \{i+1,\ldots,|\pi|\}$: truthful.

* Strongly deceptive
  continually deceptive until $LDP_\pi = \pi^i$ then $FTP_\pi = \pi^{i+1}$
* Weakly deceptive
  truthful steps before LDP, $LDP_\pi = \pi^i$ the $FTP_\pi = \pi^j$ for some $j < i$.

  $\text{density}(\pi) = \dfrac{1}{|N_t|}$ N_t : set of all truthful steps in π.

calculate how close the subopt. path π, has come to achieving its purpose.

* ~~path~~ path completion : capture true work
  $$\text{pcomp}(n,s,g) = \cancel{p(s,g)}\ \text{optc}(s,g) - \text{optc}(n,g)$$
how much is left to do?

* Radius of Maximum prob. possible goal g. RMP_g. $x \in \mathbb{R}$

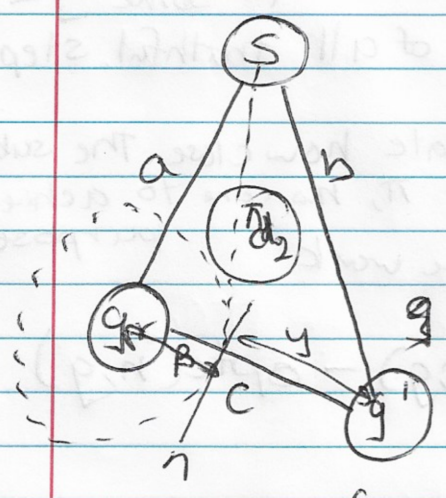
1. $\forall n \in N$ s.t. $optc(n,g) < x$, it is the case that $P(g|n) > P(g'|n)$, $\forall g' \in G \setminus \{g\}$

2. $\exists$ $n' \in N$ s.t. $optc(n',g) = x$ & $P(g|n') \leq P(g'|n')$ for some $g' \in G \setminus \{g\}$.

* $\pi \in \Pi(s, g_r)$ then $optc(LDP_\pi, g_r) \geq RMP_{g_r}$.
  LDP_π cannot lie within the g_r RMP.

* if $RMP_{g_r} = optc(LDP_\pi, g_r)$
  then $pcomp(LDP_\pi, s, g_r) \geq pcomp(LDP_{\pi_i}, s, g_r)$ $\forall \pi_i \in \Pi(s, g_r)$

$\therefore \max_{\pi \in \Pi(s,g_r)} pcomp(LDP_\pi, s, g_r) = optc(s,g_r) - RMP_{g_r}$.



$a = optc(s, g_r)$
$b = optc(s, g')$
$c = optc(g_r, g')$
$y = c - \beta$
n: tipping point
$optc(n, g_r) = \beta$ $optc(n, g') = y$

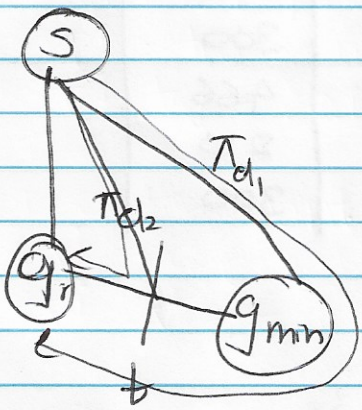
$$costdif(s, g_r, n) = costdif(s, g', n)$$
$$\beta - a = y - b$$
$$y = \beta + b - a$$
$$c = 2\beta + b - a \qquad y : c - \beta$$
$$\beta = \frac{c + a - b}{2}$$

this gives us β: optimal cost from g_r to the point at which the hypothetical node n must occur.

$$\beta_{min} = \min_{g_i \in G} \frac{optc(g_r, g_i) + optc(s, g_r) - optc(s, g_i)}{2}$$

β_{min} represents the optimal cost from g_r to the point at which n_{min} must occur.

* target node $t \in N$: deceptive node s.t. $optc(t, g_r) \approx \beta_{min}$.



π_{d_2} : $\beta = \dfrac{a + c - b}{2}$

~~eg~~

s (3, 1)
g_r (1, 7)
g' (7, 7)

$a = s \to g_r = 8$
$b = s \to g' = 10$
$c = g_r \to g' = 6$

$$\beta = \frac{8 + 6 - 10}{2} = \frac{4}{2} = 2$$

hockful heuristic! π_{d_3}

$h(n, t)$

if $h(n, g_r) < h(n, g_{min})$ then $h(n, t) = \alpha\, h(n, t)$
$\alpha > 1$

3.1 0,1,2,3 4
3 0,1,2 3
2.9 0,1,2 3
2.4 0,1,2 3
2 0,1 2
1.9 0,1 2

		tiny	Med	Med2	big
DFS	SNE	15	146	146	390
	Path cost	10	130	130	210
	score	500	380	380	300
EHC	SNE	14	151	124	720
	Path cost	8	76	56	246
	score	502	434	454	264
IDA*	SNE	8	1676	279	20038
	Path cost	8	68	54	210
	Score	502	442	456	300
A*	SNE	8	78	55	466
	Path cost	8	74	54	210
	score	502	436	456	300