

AI
Übung

Ex 2.1)

2. ÜB

Greedy search: always expand a node n with the least value for $h(n)$ (heuristic function = estimate for the cost to reach the closest goal from n)

- a) $h(n) = g(n) \Rightarrow$ uniform cost search $\left. \begin{array}{l} g(n) = d(n) \\ \text{(all actions have cost 1)} \end{array} \right\}$
- b) $h(n) = d(n) \Rightarrow$ breadth-first search
- c) $h(n) = \frac{1}{1+d(n)} \Rightarrow$ depth-first search

Ex 2.3) $h_1 \hat{=}$ misplaced-tiles heuristic
 $h_2 \hat{=}$ Manhattan-distance heuristic
 $h_3 \hat{=}$ Gaschnig's heuristic } relaxations of the following rule:

"A tile can move to square X if X is adjacent and X is empty/blank"
 $\hookrightarrow \hat{=}$ original rule for 8-puzzle

"A tile can move to square X if X is adjacent" $\hat{=}$ relaxation corresponding to h_2

Example: "A tile can move to a square X " $\hat{=}$ relaxation corresponding to h_1
 "A tile can move to a square if X is blank" $\hat{=}$ " " h_3

Initial state

6	2	8
3	5	7
4	1	7

6	2	3
8	5	7
4	1	7

1	2	3
8	5	7
4	6	7

1	2	3
8	5	7
4	6	5

goal state

$h_1 = 7$

$h_1 = 5$

$h_1 = 3$

$h_1 = 0$

$h_2 = 3+0+2+3+1+3+2+3 = 17$

$h_2 = 3+0+0+3+1+3+2+0 = 12$

$h_2 = 0+0+0+3+1+0+2+0 = 6$

$h_2 = 0$

$h_3 = 9$

$h^* = 19$

$h_3 = 7$

$h_3 = 4$

$h^* = 0$

$h^* = 0$

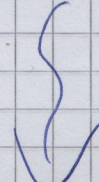
$h^* = 12$

Gaschnig heuristic
 \hookrightarrow cyclic decompos.
 blank $\hat{=}$ 0

$(0)(1)(2) \dots (8)$
 $0+0+0+\dots+0 = 0$

$(083)(16)(2)(475) \quad (0)(16)(2)(3)(475)(8) \quad (0)(17)(2)(3)(475)(6)(8)$
 $2+3+0+4 = 9 = h_3 \quad 0+3+0+0+4+0 = 7 \quad 0+0+0+0+4+0+0 = 4$

Idea: Regard states as permutations of tiles (denoting "blank" by 0),
 identify cyclic decomposition



$$h_3(n) = \#_3(x_1) + \dots + \#_3(x_k) \text{ where } \pi(n) = x_1 \dots x_k$$

$$\#_3(x) = \begin{cases} 0, & \text{if } |x| = 1 \\ |x| - 1, & \text{if } |x| > 1 \text{ and } 0 \in x \\ |x| + 1, & \text{if } |x| > 1 \text{ and } 0 \notin x \end{cases}$$

Note: $\#_n(x) \hat{=}$ number of misplaced tiles in cycle x

$h_n(n) \hat{=}$ " " " in node n

$$h_n(n) = \#_n(x_1) + \dots + \#_n(x_k) \text{ where } \pi(n) = x_1 \dots x_k$$

$$\#_n(x) = \begin{cases} 0, & \text{if } |x| = 1 \\ |x| - 1, & \text{if } |x| > 1 \text{ and } 0 \in x \\ |x|, & \text{if } |x| > 1 \text{ and } 0 \notin x \end{cases}$$

$$\Rightarrow \#_n(x) \leq \#_3(x)$$

$$\Rightarrow h_n(n) \leq h_3(n)$$

$$\underline{\underline{h_3(n) = h_n(n) + |\{x_i \mid |x_i| > 1 \text{ and } 0 \notin x_i\}|}}$$

0	1	2	3	4	5	6	7	8
3	6	2	8	5	7	1	4	0

Note: Computing the cyclic decomposition is cheap (linear time)

$\Rightarrow h_3(n)$ can be computed efficiently.

Note: The $n \times n$ -puzzle is NP-complete.