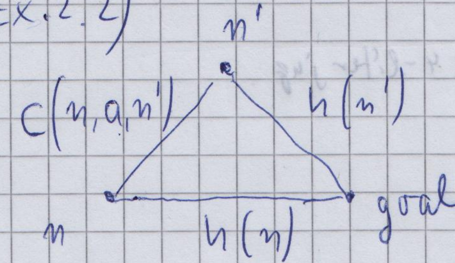
AI Globalübung

ÜB2

Ex. 2.2)



$h(n) \le c(n,a,n') + h(n')$

$\Longrightarrow h(n) \le h^*(n)$

case 1) Let $n_0 \xrightarrow{a_1} n_1 \xrightarrow{a_2} n_2 \to \dots \to n_\ell$ be a cheapest path from n_0 to a goal, $\ell \ge 1$

$\Longrightarrow$ i) $h(n_\ell) = 0$

ii) $h^*(n_0) = \sum_{i=1}^{\ell} c(n_{i-1}, a_i, n_i) \ge \sum_{i=1}^{\ell} \left(h(n_{i-1}) - h(n_i)\right)$

(by assumption: $c(n,a,n') \ge h(n) - h(n')$)

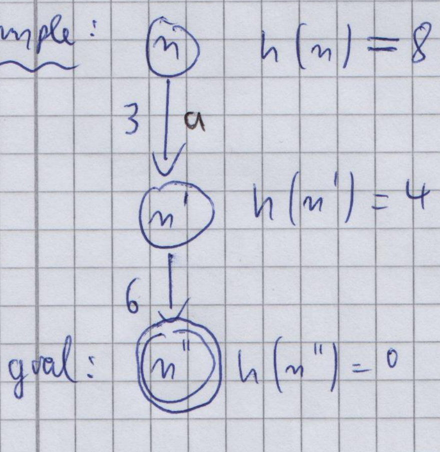
$= \sum_{j=0}^{\ell-1} h(n_j) - \sum_{i=1}^{\ell} h(n_i) = h(n_0) - \underbrace{h(n_\ell)}_{\overset{i)}{=}\,0} = h(n_0)$ ✓

case 2) No path from n_0 to a goal exists.

$\Longrightarrow h^*(n_0) = \min\{c \mid c = \text{cost of a path from } n_0 \text{ to a goal}\}$

$= \min\{\} = \infty \ge h(n_0)$ □

Example:



$$\left.\begin{array}{l} h^*(n) = 9 \ge 8 = h(n) \\ h^*(n') = 6 \ge 4 = h(n') \\ h^*(n'') = 0 \ge 0 = h(n'') \end{array}\right\} \Longrightarrow h \text{ is admissible}$$

But: $h(n) = 8 > 7 = 3 + 4 = c(n,a,n') + h(n')$

$\Longrightarrow$ h is not consistent

In general: If n' is a child of n on a cheapest path from n to a goal s.t. $h^*(n') - h(n') > h^*(n) - h(n)$, then h is not consistent

Proof: $h(n) > \underbrace{h^*(n)}_{= c(n,a,n') + h^*(n')} - h^*(n') + h(n') = c(n,a,n') + h(n')$

□

Ex 2.4) a) initial state $(0,0)$ — 3 liter jug, 4-liter jug

operations:

empty jug 3/4:
$$e3 : (x,y) \mapsto (0,y) \text{ with } x \neq 0$$
$$e4 : (x,y) \mapsto (x,0) \text{ with } y \neq 0$$

fill jug 3/4:
$$f3 : (x,y) \mapsto (3,y) \text{ with } x \neq 3$$
$$f4 : (x,y) \mapsto (x,4) \text{ with } y \neq 4$$

pour
$$g3 : (x,y) \mapsto (x-z, y+z) \text{ with } x \neq 0 \text{ and } y \neq 4 \text{ and } z = \min\{x, 4-y\}$$
$$g4 : (x,y) \mapsto (x+z, y-z) \text{ with } y \neq 0 \text{ and } x \neq 3 \text{ and } z = \min\{y, 3-x\}$$

state space: = set of states reachable from the initial state

$$= (\{0,3\} \times \{0,1,2,3,4\}) \cup (\{1,2\} \times \{0,4\})$$
$$= (\{0,1,2,3\} \times \{0,1,2,3,4\}) \setminus (\{1,2\} \times \{1,2,3\})$$

goal test: = (x,y) is a goal iff $y = 2$

path cost = length of path

b) Define a heuristic function:

state [n]	h(n)
$(x,2)$	0
$(0,0)$	5
$(3,4)$	5
$(0,y), y \in \{0,2\}$	4
$(3,y), y \in \{2,4\}$	3
else	1

not 0, because then the heuristic will not deliver any information

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Ex 2.4) c)

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(0,0)

$g(n) + h(n) = 0 + 5 = f(n) = 5$

$\boxed{f3}$ $\boxed{f4}$

max path-correction

$f(n') = \max(f(n), g(n') + h(n'))$

(3,0) 4<5 => h is not consistent

$1+3 = 4 \rightarrow 5$

(0,4)

$1+4=5$

⋮

(cf. photo)