Foundations of Artificial Intelligence: Homework 1

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Problem 1.

(1)

state: Start, B, E, Goal
final path: Start > B > E > Goal

(2)

state: Start, A, B, C, D, E, Goal
final path: Start > A > C > Goal

(3)

state: Start, B, A, E, D, Goal
final path: Start > B > E > D > Goal

(4)

state: Start, A, D, Goal
final path: Start > A > D > Goal

(5)

state: Start, B, E, D, Goal
final path: Start > B > E > D > Goal

(6)

h_1 is admissible if:

$$0 \leq h_1(n) \leq h^*(n)$$

for each node, where h^* is the real cost to the goal.
For node A, $h_1(n) = 6 > h^*(n) = 5$.
Therefore, h_1 is not admissible.

However, A^* still return the optimal solution (least cost).

(7)

h_1 is consistent if:

$$0 \leq h_1(X) - h_1(Y) \leq \text{cost}(X \rightarrow Y)$$

for each arc.
For arc $B \rightarrow E$, $h_1(B) - h_1(E) = 3 > \text{cost}(B \rightarrow E) = 2$.
Therefore, h_1 is not consistent.

(8)

Since h_1 is not admissible, thus there exist one node x such that

$$h_1(x) > h^*(x)$$

Assume that

$$h_1(x) - h^*(x) = c > 0$$

Therefore

$$h_2(x) = 0.5 \times [h_1(x) + h^*(x)] = 0.5 \times [h^*(x) + c + h^*(x)] = h^*(x) + 0.5c > h^*(x)$$

and h_2 is not admissible.

(9)

Apparently, only node A is not admissible.
Therefore we can decrease the value of $h_3(A)$ to the real cost from A to the goal, that is 5.
In conclusion, we make $h_3(A) = 5$.

(10)

No, since for arc $B \rightarrow E$, $h_3(B) - h_3(E) = 3 > \text{cost}(B \rightarrow E) = 2$.
Therefore, h_3 is not consistent.

Problem 2

(1)

- **variables**: A, B, C, D, E, F
- **domains**: 0, 1, 2, 3, 4, 5
- **constraints**:
  - alldiff(A, B, C, D, E, F)
  - $D = 0$
  - $B = (A + 4) \mod 6$
  - $|F - D| > 1$
  - $E \neq (D + 3) \mod 6$
  - $F = (C + 2) \mod 6$

(2)

$A = 3, B = 1, C = 2, D = 0, E = 5, F = 4$

(3)

$A = \{1, 3, 4, 5\}$
$B = \{1, 2, 3, 5\}$
$C = \{1, 2\}$
$D = 0$
$E = \{1, 2, 4, 5\}$
$F = \{3, 4\}$

(4)

$A = 4, B = 2, C = 1, D = 0, E = 5, F = 3$

Problem 3

(1)

- **variables**: A, B, C, D, E
- **domains**:
  - $A \in \{2, 6, 9\}$
  - $B \in \{2\}$
  - $C \in \{7, 9\}$
  - $D \in \{1, 5, 6, 9\}$
  - $E \in \{1, 5\}$
- **constraints**:
  - alldiff(A, B, D, E)
  - alldiff(C, D, E)

(2)

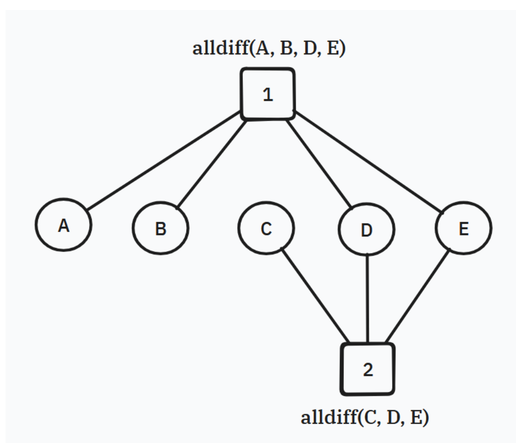

Figure 1: Constraint graph of problem 3.

(3)

The value 2 will be removed from variable B.

(4)

$A = 6, B = 2, C = 7, D = 1, E = 5$

Problem 4

(1)

- **variables**: $X_{11}, X_{31}, X_{41}, X_{51}, X_{52}, X_{53}, X_{55}$
- **domains**: $\{0, 1\}$ where 0 means has no mine, 1 means has one mine.
- **constraints**:
    1. $X_{11} + X_{31} = 1$
    2. $X_{31} + X_{41} = 1$
    3. $X_{31} + X_{41} + X_{51} + X_{52} + X_{53} = 2$
    4. $X_{52} + X_{53} = 1$
    5. $X_{53} + X_{55} = 1$

(2)

$X_{11} = 1, X_{31} = 0, X_{41} = 1, X_{51} = 0$

(3)

We can confirmed variable X_{51} as 0 when $k = 5$.