CS 4613 **Fall 2023**
HW 2 Solution **E. K. Wong**

Total # of questions = 7. Total # Points = 120.

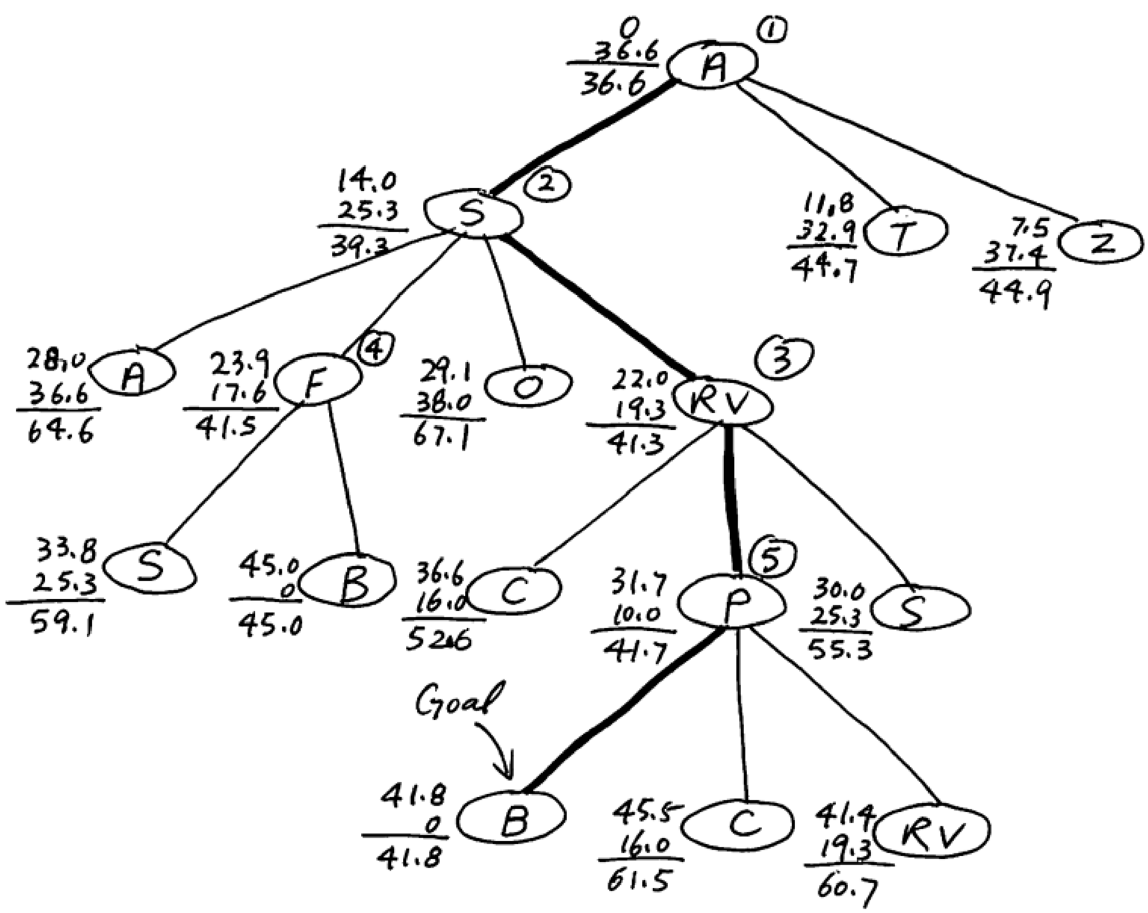
1. [10 points]2.5 points each (a) F (b) F (c) F (d) T

2. [15 points] 2.5 points each.

a) F. Since $g(n_7) + h(n_7) = f(n_7)$ and both n_7 and G_1 are along the optimal path, $f(G_1)$ must be greater than or equal to $f(n_7)$.
b) F. Since n_5 and n_7 are along two different paths, their path costs are unrelated.
c) T. From the definition of consistent functions.
d) T. Since $g(G_1) = f(G_1)$ and G_2 is a suboptimal goal node.
e) T. Since n_5 is a descendent of n_2 along the same path.
f) T. Since n_7 is along the optimal path, $f(n_7) \leq f(G_1) < f(G_3)$.

3. [15 points]

a) 3 points $h(n) = 0.1 \times straight\ line\ distance\ to\ goal.$
b) 12 points Labelling of the goal node is optional.



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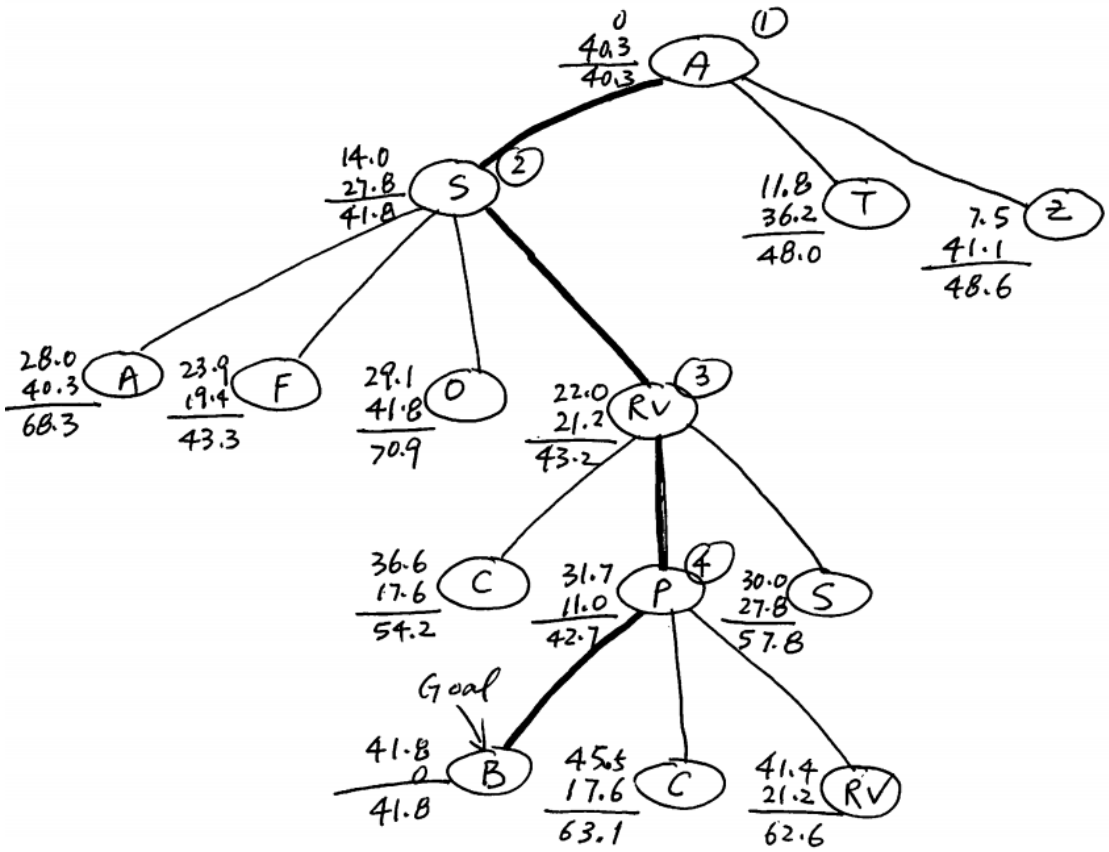
4. [20 points]

a) **12 points** Labelling of the goal node is optional.



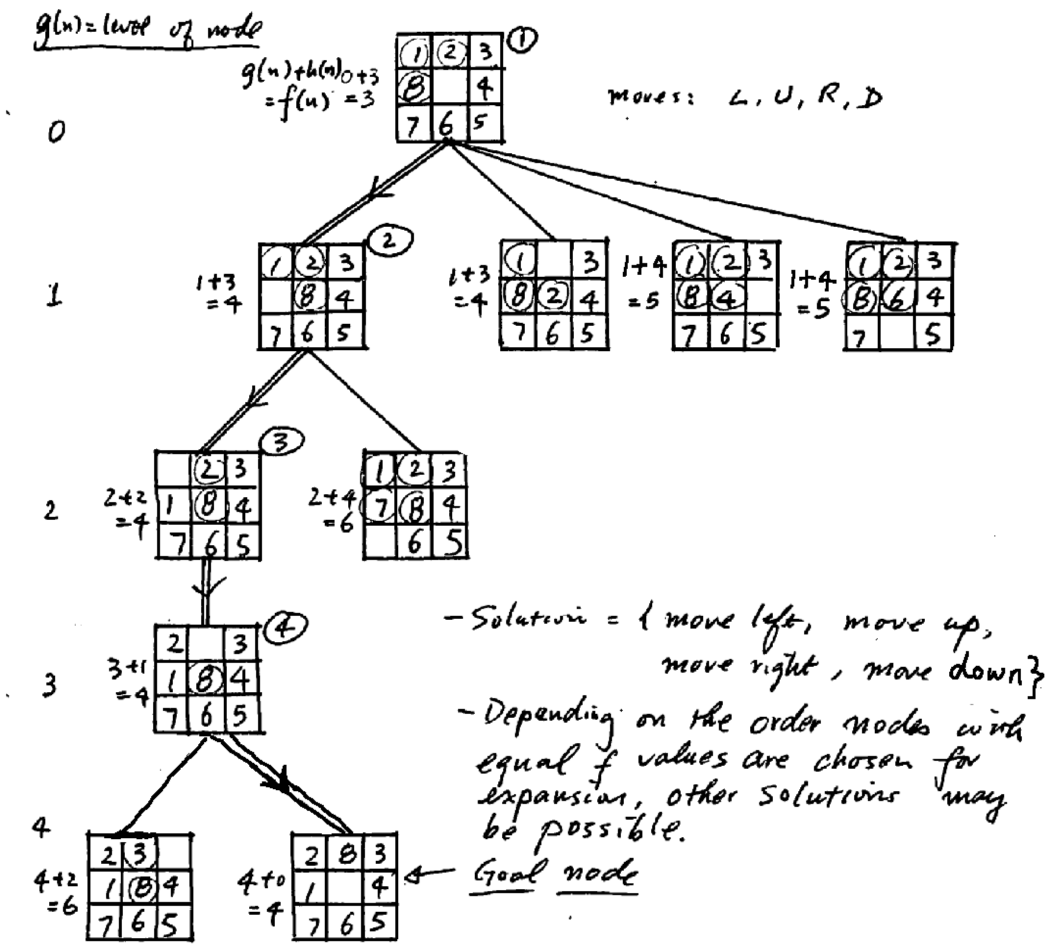
b) 4 points. No, $W \times h(n)$ with $W = 1.1$ is not admissible.

c) 2 points. Yes, the solution is optimal.

d) 2 points. Yes, weighted A* is more efficient in this example since the tree generated by weighted A* has less nodes.

5. [20 points]

a) **15 points.** Labelling of the goal node is optional.



b) **5 points** The number of entries is the same as the number of nodes in the tree = 10.

6. [20 points] Let $n = n_i$. A heuristic $h(n)$ is consistent means that for every node n_i and every successor n_{i+1} of n_i generated by an action a, the following inequality is satisfied

$$h(n_i) \le c(n_i, a, n_{i+1}) + h(n_{i+1})$$

Let the optimal goal node $G = n_g$. Apply the above inequality from node n_i to n_g along the optimal path repeatedly, we have

$$h(n_i) \le c(n_i, a, n_{i+1}) + h(n_{i+1})$$

$$\le c(n_i, a, n_{i+1}) + c(n_{i+1}, a, n_{i+2}) + h(n_{i+2})$$
$$\le c(n_i, a, n_{i+1}) + c(n_{i+1}, a, n_{i+2}) + c(n_{i+2}, a, n_{i+3}) + h(n_{i+3})$$
$$\le \cdots$$
$$\le c(n_i, a, n_{i+1}) + c(n_{i+1}, a, n_{i+2}) + c(n_{i+2}, a, n_{i+3}) + \cdots + c(n_{g-1}, a, n_g) + h(n_g)$$

Since $h(n_g) = 0$, we have

$$h(n_i) \le c(n_i, a, n_{i+1}) + c(n_{i+1}, a, n_{i+2}) + c(n_{i+2}, a, n_{i+3}) + \cdots + c(n_{g-1}, a, n_g)$$
$$= h^*(n_i) = \text{optimal cost from node } n_i \text{ to goal } n_g.$$

Therefore, $h(n)$ is admissible.

7. [20 points] Best action returned is A_3.