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I declare the following statements to be true:

- The work I submit here is entirely my own.
- I have not shared and will not share any of my code with anyone at any point.
- I have not posted and will not post my code on any public or private forum or website.
- I have not discussed and will not discuss the contents of this assessment with anyone at any point.
- I have not posted and will not post the contents of this assessment and its solutions on any public or private forum or website.
- I will not search for assessment solutions online.
- I am aware that misconduct related to assessments can result in significant penalties, possibly including failure in the course and suspension. This is covered in Policy 71: https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71.

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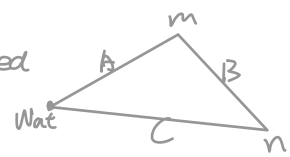
1.

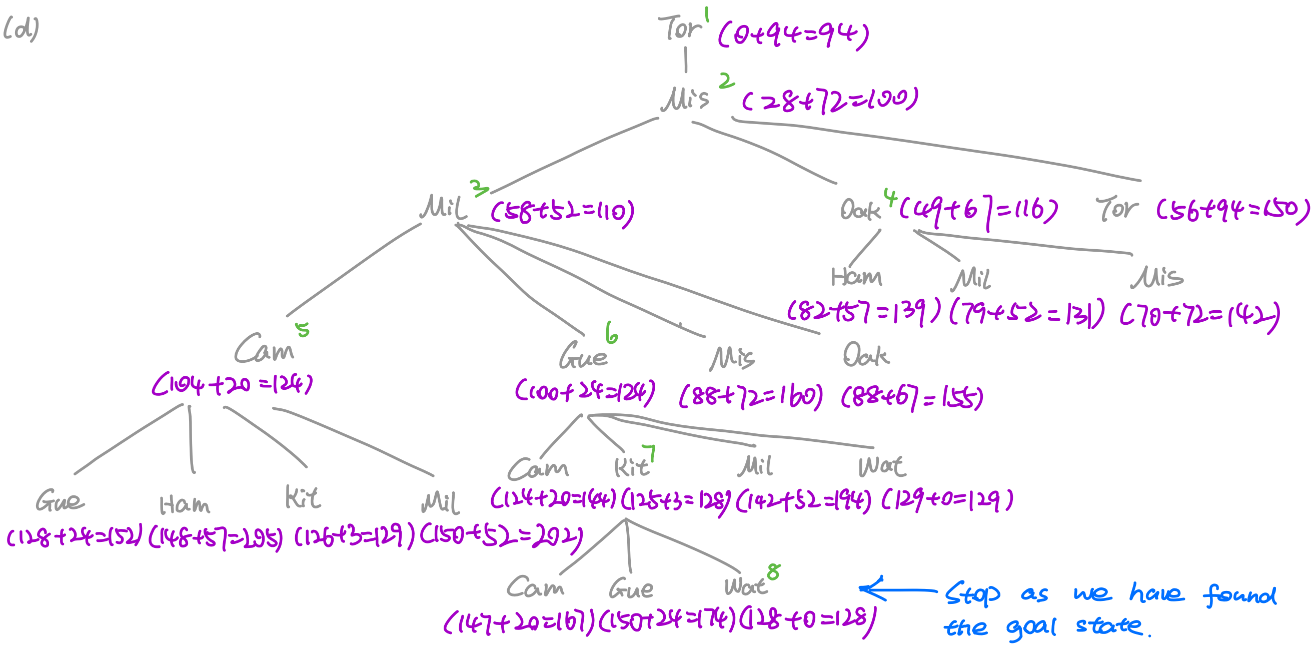
(a) By using Euclidean distance as the heuristic function, we know that Euclidean distance $h(c) = \sqrt{(X_c - X_{wat})^2 + (Y_c - Y_{wat})^2}$; This is the straight line distance between any two nodes. By knowledge we know that this is the shortest distance between any two nodes. Therefore $h(c) \leq cost(c, wat)$ for all the nodes c. $h(wat) = \sqrt{0^2 + 0^2} = 0$, Thus $h(c) - h(wat) \leq cost(c, wat)$ for any node c, where wat is the goal node. We have showed that for any node m and any goal node g, $h(m) - h(g) \leq cost(m, g)$, by definition, Euclidean distance to the destination is an admissible heuristic function.

(b) We need to prove that: For any two nodes m and n, $h(m) - h(n) \leq cost(m, n)$.
$h(m)$ = Euclidean distance between Wat and m = edge A
$h(n)$ = Euclidean distance between Wat and n = edge C
$cost(m, n) \geq$ edge B because if m, n are not directly connected then $cost(m, n)$ will be larger than edge B (MN is the shortest distance between m and n).
Obviously, $B + C \geq A \Rightarrow A - C \leq B \Rightarrow h(m) - h(n) \leq B \leq cost(m, n)$.
By def, it's a consistent heuristic function.



(c) Say that m is the predecessor state of n on the consistent function. n is the goal state Wat. Consistent function says that $h(m) - h(n) \leq cost(m, n)$, $h(n) = 0 \Rightarrow h(m) \leq cost(m, n)$. Thus m is admissible because it never over-estimates the cost of the cheapest path from node m to the goal node n ($h(m) \leq cost(m, n)$).
Similarly, for all the other predecessor states of n that are on the consistent function m_i, we still have $h(m_i) - h(n) \leq cost(m_i, n) \Rightarrow h(m_i) \leq cost(m_i, n)$. By def, m_i is always admissible.
Therefore all the states on the heuristic function are admissible. Thus the consistent heuristic function is also admissible.

(d)


Tor 1 (0+94=94)
Mis 2 (28+72=100)
Mil 3 (58+52=110)
Oak 4 (49+67=116)
Tor (56+94=150)
Ham (82+57=139)
Mil (79+52=131)
Mis (70+72=142)
Cam 5 (104+20=124)
Gue 6 (100+24=124)
Mis (88+72=160)
Oak (88+67=155)
Gue (128+24=152)
Ham (148+57=205)
Kit (126+3=129)
Mil (150+52=202)
Cam (124+20=144)
Kit 7 (125+3=128)
Mil (142+52=194)
Wat (129+0=129)
Cam (147+20=167)
Gue (150+24=174)
Wat 8 (128+0=128)
Stop as we have found the goal state.

2.(b) When using blocking heuristic, $h(m)$ = number of cars blocking exit +1 if m is not the goal state.
$h(m)-h(n)$ calculates the difference of number of cars blocking the exit in state m and the number of cars blocking the exit in state n. Moving a car costs at least 1 step. Therefore moving from state m to n, we need to move at least $h(m)-h(n)$ cars, therefore the cost is at least $h(m)-h(n)$.
$\therefore$ For any edge from m to n, $h(m)-h(n) \leq cost(m,n) \Rightarrow$ By def, blocking heuristic is a consistent heuristic function.