1. BFS, DFS, UCS
    a. BFS: S,A,B,C,D,E,G
    b. DFS: S,A,C,B,D,E,G
    c. UCS: S,B,D,E,G
2. Q2
    a. The average $(h\_1(n) + h\_2(n))/2$ is always consistent. A heuristic function is consistent if $h(n) - h(n') <= c(n->n')$. Let $h(n) = (h\_1(n) + h\_2(n))/2$. Then, to determine if it is consistent, we can plug into the heuristic consistent function and get $(((h\_1(n) + h\_2(n))/2) - ((h\_1(n') + h\_2(n'))/2))) <= c(n->n')$. Rearranging this equation we can get
    $(((h\_1(n) - h\_1(n'))/2) + ((h\_2(n) - h\_2(n'))/2))) <= c(n->n')$.

    First, we know that $h\_1(n) - h\_1(n') <= c(n->n')$. Since $(h\_1(n) - h\_1(n'))/2 < h\_1(n) - h\_1(n')$, $(h\_1(n) - h\_1(n'))/2$ is also $<= c(n->n')$.
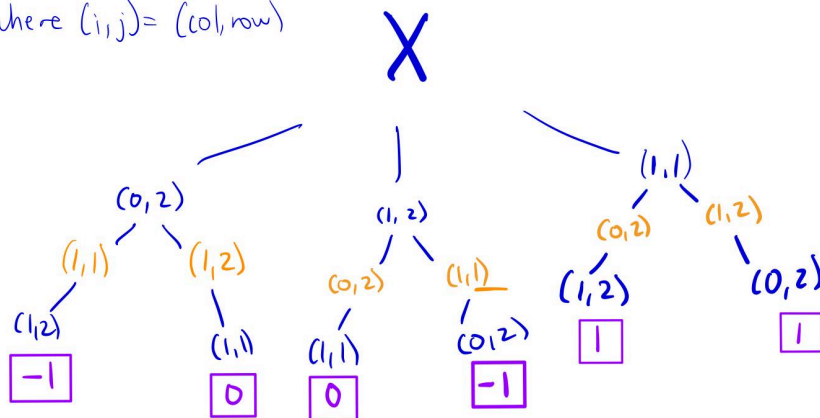
    The same reasoning can be applied to $h\_2(n)$. The same reasoning can be applied to $h\_2(n)$. We know that $h\_2(n) - h\_2(n') <= c(n->n')$. Since $(h\_2(n) - h\_2(n'))/2 < h\_2(n) - h\_2(n')$, $(h\_2(n) - h\_2(n'))/2$ is also $<= c(n->n')$.

    So, $(((h\_1(n) + h\_2(n))/2) - ((h\_1(n') + h\_2(n'))/2))) <= c(n->n')$, and thus it is always consistent.
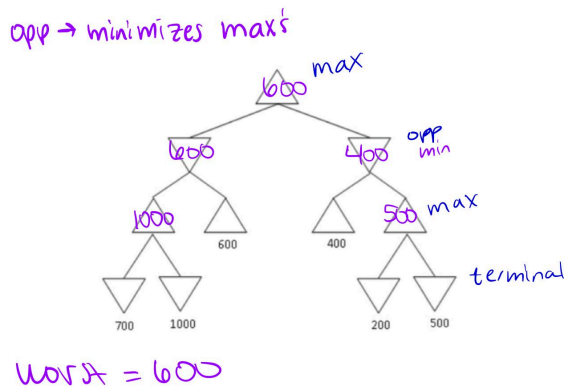
3. Q3
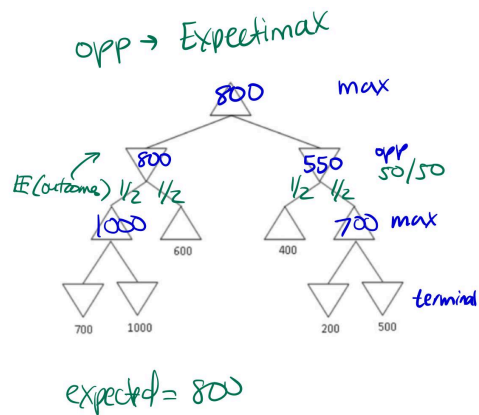
answer:

where $(i,j) = (col, row)$

4. Q4
   We do not know what algorithm the opponent uses. We consider 3 strategies: a) the opponent minimizes our moves, b) we guess what the opponent might play and compute the expected utility value of each move the opponent may take, c) the opponent maximizes our moves.
   a. Assume the opponent works to minimize our (max's) moves. Following the tree, we get that the outcome for us would be 600.

   opp → minimizes max's

   600 max

   600   400 opp min

   1000   600   500 max   400

   700 1000   200 500 terminal

   worst = 600

   b. Let's take the expectimax to get the expected value the opponent might play. Following the tree, we get an outcome of 800.

   opp → Expectimax

   800 max

   800   550 opp 50/50

   E(outcome) ½ ½   ½ ½

   1000   600   400   700 max

   700 1000   200 500 terminal

   expected = 800

c. Suppose the opponent doesn't know what they are doing and they actually maximize our results for us. Following the tree, we get outcome 1000.
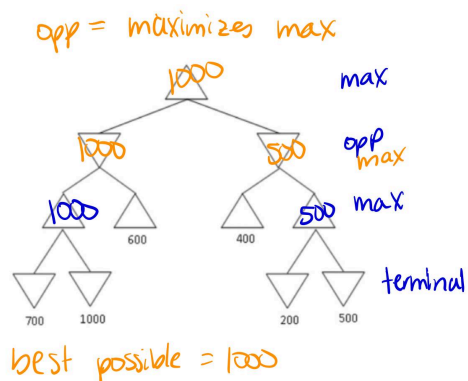
The best possible outcome of playing the full game for the MAX player would be 1000 - in the event that our opponent works in our favor. The worst possible outcome of playing the full game for the MAX player would be 600 - where our opponent works completely against our favor.

5. Q5

   a. Transition function: T(s,a,s')
      T(s, "draw", s') = ⅓ , where s' = 2, 3, 4
      T(s, "draw", done) = 0
              Since the game continues after a draw
      T(s, "stop", done) = 1

      Reward function: R(s,a)
      R(s,"draw") = 0
      R(s, "stop) = s, where s = 2,3,4
      R(done, a) = 0 for all a in actions (actions = draw, stop)

States	0	2	3	4	5
V_0	0	0	0	0	0
V_1	0	2	3	4	5
V_2	0	4	6	8	10
V_3	0	6	9	12	15
V_4	0	8	12	16	20

b.

States	0	2	3	4	5
π^*	draw	draw	stop	stop	stop

c.

States	0	2	3	4	5
π_i	Draw	Draw	Draw	Stop	Stop
V^π	3	3	3	4	4
π_{i+1}	draw	draw	draw	Stop	Stop

d.

6. Q6
   a.
      i. Q(B,STOP) = (1-0.5)*0+0.5*(0+1*max(Q,A,Stop),Q(A,Go))) = **0.5**
      ii. Q(B, Go) = (1-0.5)*0+0.5*(-4+1*max(Q,C,Stop),Q(C,Go))) = **-2**

   b.
      i. W1 = w1 + 0.5 * (4-w1-w2) = 0 + 0.5 * (4-0-0) = 2
      ii. W2 = w2 + 0.5 * (4-w1-w2) = 0 + 0.5 * (4-2-0) = 1
      iii. W1 = 2 + 0.5 * (-2-(2-1)) = 0.5
      iv. W2 = 1 + 0.5 * (-2-(2-1)) = -0.5