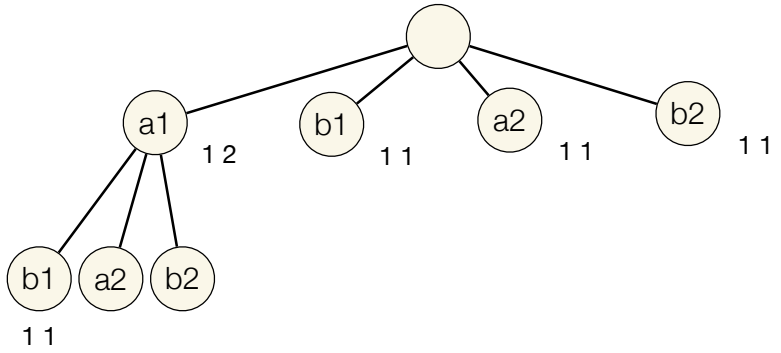
1. The following code is from `hex/hex_vc3.py` in the examples github:

```
1  while len(mustplay) > 0:
2    for move in CELLS:
3      if move in mustplay: break
```

   What is the purpose of lines 2 and 3?

2. Below is the Monte Carlo search tree after the first 5 simulations of running the `g x` command of `mcts/main.py` with a 2×2 board. Show the tree after simulation 6 (output below); explain each change. The indices 5,6,9,10 correspond to positions `a1`, `b1`, `a2`, `b2` respectively.




```
trv_xpnd bu * .8 1.4 1.4 1.4 6
  xpnd_nd * 6 > 5
  xpnd_nd * 6 > 9
  xpnd_nd * 6 > 10
sim 6. * 6 10 roll 9 parent loss
```

3. In the example code `mcts/mcts1.py`:

   (a) What is the difference between `get_best_move` and `best_uct`?

   (b) Consider the following code from the `best_uct` method:

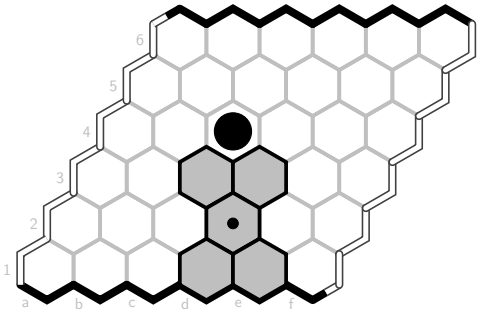
```
# calculate UCT, update if best
mean_res = child.results / child.sims
uct = ___(1)___ + (self.c * sqrt(log(self.root_node.sims) / child.sims))
if best_uct is None or uct > best_uct:
    best_uct, best_child = uct, child
```

   What should missing expression (1) be?

   (c) `self.c` gets initialized to 0.3. What would be the effect of setting it to something much larger (e.g., 50)?

   (d) If you run `mcts/main.py` multiple times and ask for a winning move for Black (using the command `g x`), it will sometimes generate different moves in different runs. Why?

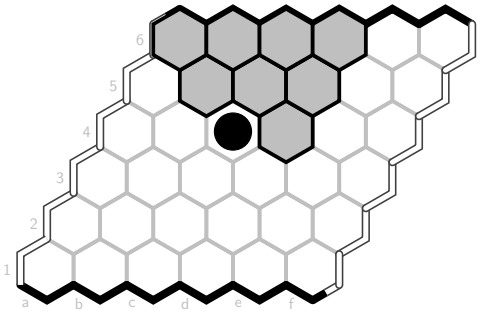
4. Consider the following virtual connection in 6×6 Hex:



   (a) Does this depict a *full connection* or a *semi-connection* between the Black stone and the bottom border? Explain your reasoning.

   (b) Write this connection in logical form as an AND/OR strategy.

5. Consider the following virtual connection in 6×6 Hex:



   (a) Does this depict a *full connection* or a *semi-connection* between the Black stone and the bottom border? Explain your reasoning.

   (b) Write this connection in logical form as an AND/OR strategy.

6. Consider the following AND/OR strategy for the 3×3 Hex position after `1.B[a1]`.

$$b2 \wedge (a2 \vee a3) \wedge (c1 \vee c2)$$

   (a) Draw the strategy as an AND/OR tree.

   (b) Is this is a winning strategy for Black, White, or neither?

7. Consider the following AND/OR strategy for 3×3 Hex:

$$a2 \wedge (b3 \vee c3) \wedge (a1 \vee b1) \wedge (a3 \vee (c2 \wedge (b2 \vee c1)))$$

   (a) Draw the strategy as an AND/OR tree.

   (b) How should Black reply to `1.B[a2] 2.W[c1]`?

   (c) How should Black reply to `1.B[a2] 2.W[a1]`?

8. Recall that in Rock Paper Scissors, the winner gets 1 point, the loser gets -1 points, and both players get 0 in a draw. In the table below, the first utility in each cell is for the Row player, and the second utility is for the Column player.

	R	P	S
R	$0, 0$	$-1, 1$	$1, -1$
P	$1, -1$	$0, 0$	$-1, 1$
S	$-1, 1$	$1, -1$	$0, 0$

Rock Paper Scissors

(a) Is R an optimal strategy for the Row player? Why or why not?

(b) Suppose that the Column player is playing a mixed (randomized) strategy in which they play R with $1/3$ probability, P with $1/3$ probability, and S with $1/3$ probability. What is Row's expected utility for playing R against this strategy?

(c) Suppose that the Column player is playing a mixed (randomized) strategy in which they play R with .5 probability, P with .3 probability, and S with .2 probability. What is Row's expected utility for playing R against this strategy?