Work alone. Discussion with other(s) is allowed but **must** be acknowledged. Sharing of details in **any** way (written, electronic, etc) is not allowed. There are penalties for breaking these rules.

1. Acknowledge all resources (discussions, papers, urls, etc). Read the UAlberta document Understanding Plagiarism

   `http://www.osja.ualberta.ca/Students/UnderstandingPlagiarism.aspx`

   and answer these questions:

   (i) When you hand something in, what is presumed?

   (ii) Are you allowed to use other people's ideas in your work?

   (iii) In deciding whether plagiarism has occurred, does it matter whether the student intended to plagiarize?

2. Read *A Puzzling Hex Primer*

   `http://webdocs.cs.ualberta.ca/~hayward/papers/puzzlingHexPrimer.pdf`

   For Hex and the 5×5 position below, assume White to play.

   (i) Find two different Black win-sets (see §3).

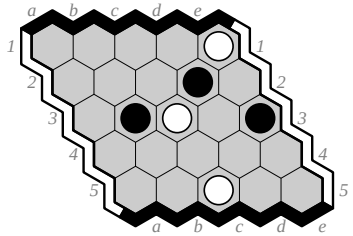
   (ii) Find the White mustplay region associated with (i).

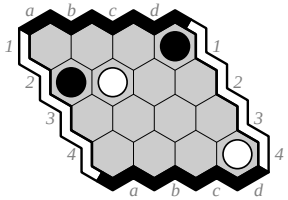
   (iii) Find a winning move for White. Justify briefly.

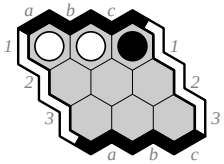
   (iv) Consider a simple automated solver that answers (iii) by constructing the continuation tree (or dag, your choice) and proceeds in breadth-first fashion. So, first it looks at all 19 White moves, and checks each to see if White wins. Then, for each of those 19 positions, it checks all 18 Black moves, and checks to see if Black wins. Etc.

   The only knowledge that the solver has is that it can tell when a game has ended. Estimate the number of tree nodes (or dag nodes) that are considered before a win is found.

   (v) For Hex and the 4×4 position below, explain (a) why a1 is Black-captured (b) why c1 is dead (c) why, if it is White to play, the move to c4 is inferior to the move to b4.







3. For Darkhex and the 3×3 position above, assume players can see these 3 stones, and now play continues. Assume each player plays randomly. (i) Give the probability that Black wins if Black plays next. Justify briefly. (ii) Give the probability that Black wins if White plays next. Justify briefly. (iii) Repeat (i) and (ii) if each player plays minimax instead of randomly.

4. Consider the MCTS tree under the heading `Backpropation` near the top of this page:

   `https://en.wikipedia.org/wiki/Monte_Carlo_tree_search`

   (The root node is labelled 11/22; white nodes indicate player to move; dark nodes indicate opponent to move; all scores on all nodes are for P, the root node player.)

   (i) Show the four trees (selection, expansion, simulation, backpropagation) for the next iteration of MCTS. Assume that selection always chooses the child with maximum win rate; if more than one child has max win rate, the child with fewest trials is picked; if more than one such child exists, one of these is picked at random. Assume that the simulation result is a loss for P.

   (ii) Show the tree after 10 more iterations have finished. Assume that the result of each simulation is a loss for P.

   (iii) Now modify the MCTS algorithm so that during expansion, 2 children are generated, and repeat (ii).

   (iv) Now modify the MCTS algorithm so that during expansion, 2 children are generated, and each is initialized with a value of 1 win and 1 trial.

5. Read (or skim) the survey of MCTS.

   `http://www.cameronius.com/cv/mcts-survey-master.pdf`

   If you had to do an exploratory project on MCTS, what (sub)section of this paper would you find most interesting as a starting point? Explain briefly (50-200 words).