# Homework Assignment 3

# 601.464/664 Artificial Intelligence Spring 2020

# Due: April 10, 2020

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## Game Playing

In the past weeks, we discussed intelligent agents and how they can use tree searching techniques to solve abstracted problems. In this assignment, you will implement chess-playing agent and answer some theoretical questions.

**Question 1.** Open the following [google colaboratory notebook.](https://colab.research.google.com/drive/1YACJcgN_fA_1j2ABI2Jk2imCIV9rsz-6) Follow all the steps specified in it. Include link to your solved notebook in your submission. Optional: implement your own chess-playing agent and we will run a small competition between agents of other students (you can work in teams).

<https://drive.google.com/open?id=1QfxhGnMP-V42sJCeGcY44sPETeUKx818>

**Question 2.** Why do we assume that we play against an optimal opponent in the minimax algorithm. What happens otherwise?

**Question 3.** What kind of node exploration is the minimax algorithm using? Depth-first or breadth-first?

Depth-first search.

**Question 4.** What is the time complexity of the naive minimax algorithm? Prove it.

O(bm)

**Question 5.** Explain why minimax algorithm with *α*−*β* pruning is more efficient than naive minimax. What is the complexity and why it depends on the ordering of the elements?

**Question 6.** Why did we introduce EVAL function instead of UTILITY for some games? Explain what is a good EVAL function for chess and how it affects the minimax algorithm.

**Question 7.** What is a Horizon effect and Quiescence?

**Question 8.** Under what kind of transformation the behaviour of minimax algorithm is preserved in case of a game with no chance nodes? In case of a game with chance nodes?

## Logic

**Translate the following English sentences into** *propositional logic*

**Question 9.** A and B are both true.

**Question 10.** If A is true, then B must be true as well.

**Question 11.** If a student studies for a test, they will do well on it. We can also tell that if a student did well on a test, then they must have studied for it.

**Question 12.** If a student is completely dry and it is raining outside, it is because they have an umbrella or a hoodie and it is not raining heavily.

**Question 13.** Simplify and translate the following *propositional logic* sentence into English: *A*∨(*A*∧*B*) ⇐⇒

¬(*A*∧*B*∧*C*)

**Question 14.** Is the following sentence valid? *A*∨*B*

**Question 15.** Is the following sentence satisfiable? *A* =⇒ *B*

**Question 16.** Is the following sentence unsatisfiable? (*A*∧ (*B*∨*C*)) ∧ ((*A*∧*B*) ∨ (*A*∧*C*))