Problem Set 2 (20% of your total score)

Adversarial Search, Bayes Rules, Linearity of Expectation

Deadline: July 24th, 11:55pm.
Perfect score: 100.

Assignment Instructions:

Team Work: The problem set can be completed by a group of maximum two people. There is no solo bonus.

Submission Rules: Submit your reports electronically as a PDF document through Sakai (`sakai.rutgers.edu`). Do not submit Word documents, raw text, or hardcopies etc. Make sure to generate and submit a PDF instead. Each team of students should submit only a single copy of your solutions and indicate all team members on their submission. Failure to follow these rules may result in lower grade for the problem set.

Late Submissions: You are supposed to finish your work before the deadline specified at the top. Submissions after the deadline are not acceptable.

Score Calculation: The total score in the problem set may not sum up to 100. You total score will scale up to 100 and then be multiplied by the weight of the problem set (20 % for this one).

Extra Credit for LaTeX: You will receive 3 extra credit points on your original score (before scale up and multiplication) if you submit your answers as a typeset PDF (using LaTeX, in which case you should also submit electronically your latex source code). Unlike projects, in the problem sets, you are allowed to scan your handwritten work. If you choose to, make sure your scanned work is legible for TAs to grade, otherwise you are responsible for the points lost due to illegibility of your work.

Collusion, Plagiarism, etc.: Each team must prepare its solutions independently from others, i.e., without using common notes, code or worksheets with other students or trying to solve problems in collaboration with other students. You must indicate any external sources you have used in the preparation of your solution. Do not plagiarize online sources and in general make sure you do not violate any of the academic standards of the department or the university. Failure to follow these rules may result in failure in this problem set.

Other rules: For other grading rules, please refer to the homepage of our course website on sakai. Thanks.

Problem 1: [40pts] Consider the game tree in Figure 1. The triangles are the states that either MIN or MAX player will take action (or make decisions). The squares are termination states where the game is over and utility values are shown. The MAX player tries to maximize the utility and the MIN player does the opposite. Perform minimax depth-first search (from left to right) that uses alpha-beta pruning. You need to show the whole game tree with (1) the utility values each non-determination states (triangle) will return (2) branches of trees that will be pruned (using dashed lines to indicate or use noticeable cross on the corresponding branches)

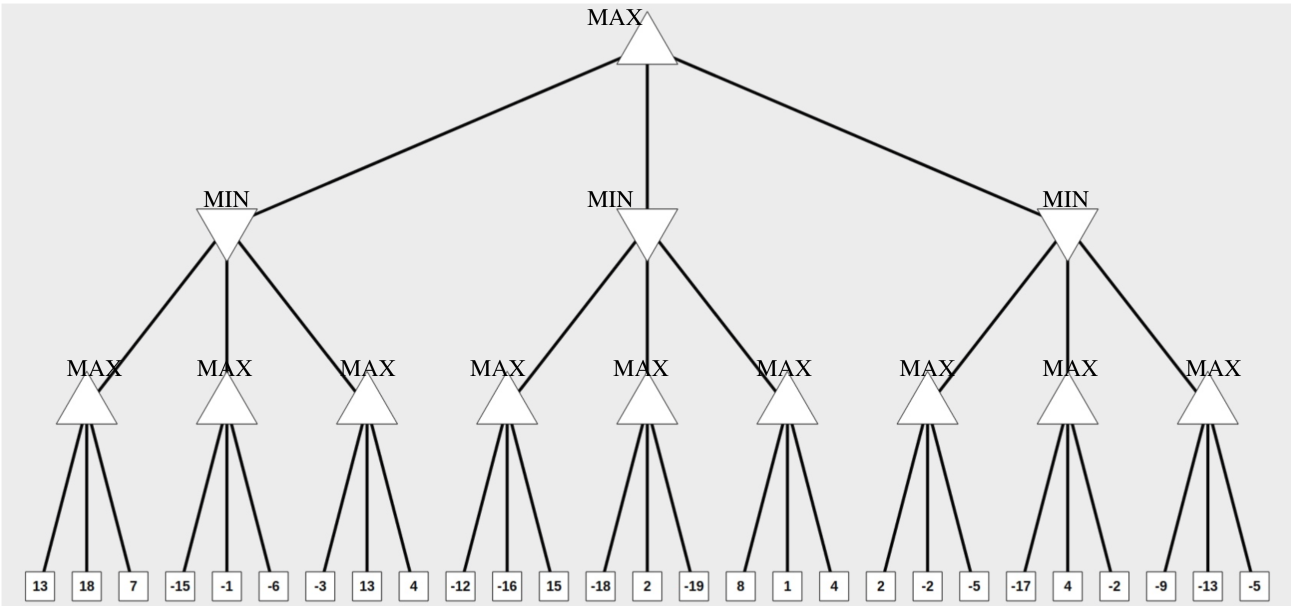

Figure 1: Game Tree

Problem 2: [20pts] Using **Bayes Rules** to solve the following problem.
It is estimated that about 0.8% of the population suffer from Lyme disease. Fortunately, we have a diagnostic system to test if a person has been infected by Lyme disease. The diagnostic system has a probability 0.93 of producing a positive result when it is used on a person who has Lyme disease and a probability 0.16 of producing a positive result when it is used on a person who actually does not have Lyme disease (what is usually called false positive). Suppose the system is now operating on a person about whom we have no knowledge whether he has been infected the disease or not.
Compute: Given the fact that the result produced by the system on this person is positive, what is the probability that this person has the disease?
Note: You need to show the whole process of calculation (include how you define the variables/events in the problem and show the formulas), instead of just giving the final answer. It also helps you get partial credits even if you don't get the final answer correct.

Problem 3: [40pts(20+20)] Use **linearity of expectation**(golden rule 1) and **expected attempts**(golden rule 2) to solve the following problem.
Suppose there are 5 balls with distinct colors(blue, yellow, red, green, pink) in a box. Each time I randomly pick a ball, record what color of the ball I picked and then put it back. I repeat this picking behavior several times. (since I put it back to the box after each picking, I may end up picking the same ball more than once)
(3a) What is the expected number of picking attempts so as to see all colors of balls?
(3b) If I repeat the picking behavior for 6 times, what is the expected number of distinct colors I will see?
Hint: Think of using indicator random variables for problem 3b.
Note: You need to show the whole calculation process instead of writing down the final answer.