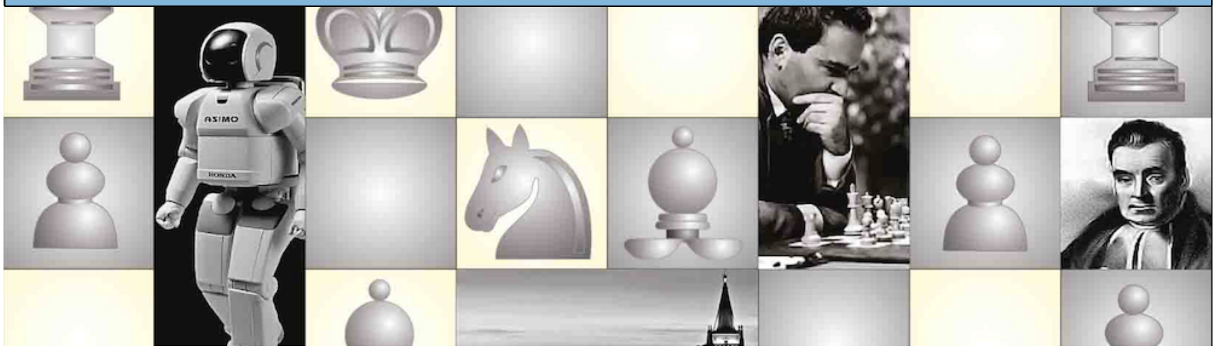
Fall 2024 - CSC545/645 Artificial Intelligence - Assignment 7



Due date: Thursday, October 24, 2024, 2:00 pm. Please create a folder called `assignment7` **in your local working copy of the repository and place all files and folders necessary for the assignment in this folder. Once done with the assignment, add the files and folders to the repo with** `svn add` *`files, folders`* **and then commit with** `svn ci -m ‘‘SOME USEFUL MESSAGE’’` *`files, folders`*.

Exercise 7.1 [20 points]
Read the chapter *Quantifying Uncertainty* of the textbook (chapter 13 in the third edition, chapter 12 in the 4th edition).

1. Would it be rational for an agent to hold the three beliefs $P(A) = 0.4$, $P(B) = 0.3$, and $P(A \lor B) = 0.5$? If so, what range of probabilities would be rational for the agent to hold for $A \land B$? Make up a table like the one in Figure 13.2 on the right and show how it supports your argument about rationality. Then draw another version of the table where $P(A \lor B) = 0.7$. Explain why it is rational to have this probability, even though the table shows one case that is a loss and three that break even. (Hint: what is Agent 1 committed to the probability of each of the four cases, especially the case that is a loss?)
[8 points]

Agent 1		Agent 2		Outcomes and payoffs to Agent 1			
Proposition	Belief	Bet	Stakes	a, b	$a, \neg b$	$\neg a, b$	$\neg a, \neg b$
a	0.4	a	4 to 6	–6	–6	4	4
b	0.3	b	3 to 7	–7	3	–7	3
$a \lor b$	0.8	$\neg(a \lor b)$	2 to 8	2	2	2	–8
				–11	–1	–1	–1

Figure 13.2 Because Agent 1 has inconsistent beliefs, Agent 2 is able to devise a set of bets that guarantees a loss for Agent 1, no matter what the outcome of a and b.

2. Given the full joint distribution shown in the figure below, calculate the following:

   (a) *P(toothache)*
   (b) **P***(Cavity)*
   (c) **P***(Toothache | cavity)*
   (d) **P***(Cavity | toothache ∨ catch)*

	toothache		¬toothache	
	catch	¬catch	catch	¬catch
cavity	0.108	0.012	0.072	0.008
¬cavity	0.016	0.064	0.144	0.576

   Please elaborate on your answer, we would like to see your calculations and the results rather than the results alone. Also note the bold (**P**) and regular (P) as well as upper/lower case writing).
   [4 points]

3. After your yearly checkup, the doctor has good and bad news. The bad news is that you tested positive for a serious disease and that the test is 99% accurate (i.e., the probability of testing

positive given that you have the disease is 0.99, as is the probability of testing negative given that you don't have the disease). The good news is that this is a rare disease, striking only one in 10,000 people of your age. Why is it good news that the disease is rare? What are the chances that you actually have the disease?
[2 points]

4. Deciding to put probability theory to good use, we encounter a slot machine with three independent wheels, each producing one of the four symbols BAR, BELL, LEMON, or CHERRY with equal probability. The slot machine has the following payout scheme for a bet of 1 coin (where "?" denotes that we don't care what comes up for that wheel):

   BAR/BAR/BAR pays 20 coins
   BELL/BELL/BELL pays 15 coins
   LEMON/LEMON/LEMON pays 5coins
   CHERRY/CHERRY/CHERRY pays 3 coins
   CHERRY/CHERRY/? pays 2 coins
   CHERRY/?/? pays 1 coin

   (a) Compute the expected "payback" percentage of the machine. In other words, for each coin played, what is the expected coin return?
   (b) Compute the probability that playing the slot machine once will result in a win.
   (c) Estimate the mean and median number of plays you can expect to make until you go broke if you start with 10 coins. You can run a simulation (a small Python program for example) to estimate this, rather than trying to compute an exact answer.
   [6 points]