CMPT 310
Artificial Intelligence Survey

Simon Fraser University
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Assignment 1: Chapters 1, 2, Game Theory.

Instructions: The university policy on academic dishonesty and plagiarism (cheating) will be taken very seriously in this course. *Everything submitted should be your own writing.* You must not let other students copy your work. On your assignment, put down your **name**, the **number of the assignment** and the **number of the course**. Spelling and grammar count.

Group Work: Discussions of the assignment is okay, for example to understand the concepts involved. If you work in a group, put down the name of all members of your group. There should be no group submissions. Each group member should write up their own solution to show their own understanding.

For the due date please see our course management server https://coursys.sfu.ca. The time when you upload your assignment is the official time stamp. If your assignment is late because you did not figure this out soon enough, you will lose marks according to the syllabus policy.

Terminology: The questions are not self-explanatory. Even ordinary English words (e.g., "rationality") may not have their ordinary meaning in an AI context. Part of your task is to learn the AI terminology required to understand the questions.

Handing in the Assignment. Please use the submission system on coursys.sfu.ca. You should post a single pdf document that contains your written answers.

Getting Help. Check the syllabus for communication policy. You have the textbook, the lecture notes, the discussion forum, and you can ask us in office hours or class sessions. We do not provide individual email support.

Chapter 1. AI Foundations. 16 points total.

1. (1) In your own words, describe the difference between AI and machine learning.

2. (4) “Surely animals cannot be intelligent---they can do only what their genes tell them”. Is the latter statement true, and does it imply the former?

3. (4) “Surely computers cannot be intelligent---they can do only what their programmers tell them”. Is the latter statement true, and does it imply the former?

4. (7) Match the following concepts/statements with a discipline related to AI.
Give your answer by filling in letters in the table provided. For example, if you think that "Statistics" best matches "Decision Theory", put a "b" into the empty square next to "Decision Theory".

	a. Psychology
	b. Computers
	c. Economics
	d. Mathematics
	e. Philosophy
	f. Homeostasis
	g. Statistics
The mind operates according to rules.	
Decision Theory	
Laws of probability	
Artifacts	
Behaviourism	
Computation Theory	
Control Theory	

Chapter 2. Agents. 14 points total.

1. a. (6) Fill in the table below for Watson to describe its environment if Watson were deployed to play Who Wants to be a Millionaire (U.S. rules see Wikipedia on Who Wants to be a Millionaire). This question refers to Watson as we observed the system in the Jeopardy Youtube video.

Observable	Agents	Deterministic	Episodic	Static	Discrete

1.b. (8) Specify a PEAS model for IBM's Watson system when playing Who Wants to be a Millionaire.

Game Types. 10 points total.

Summary. Different payoff numbers can represent the same type of game. What matters is not so much the exact numbers, but qualitative relationships, like which numbers are bigger than others, what the equilibria and dominant strategies are. To transform a game matrix into another equivalent one, you can always change a player's utility function *u* by a positive linear transformation: add constants or multiply by a positive number. For example, if *u* is the utility function of a rational agent, then the linear transformation

$u'(x) = -5 + 3u(x)$

defines a new utility function. If you can transform one game matrix into another using a positive linear transformation, then they represent the same game.

1. (5) What type of game (i.e., BoS, PD, etc. – see lecture notes) does the following game matrix represent? Write down a positive linear transformation for each player that transforms the game matrix shown into the one shown in the lecture notes.

	L	R
T	3,3	0,0
B	0,0	3,3

2. (5) What type of game (i.e., BoS, PD, etc. – see lecture notes) does the following game matrix represent? Write down a positive linear transformation for each player that transforms the game matrix shown into the one shown in the lecture notes.

	L	R
T	2,2	-2,6
B	6,-2	0,0

Nash Equilibrium Analysis. 16 points.

Summary. Finding the Nash equilibria of a game is the first step in game-theoretic analysis.

1. (8) PD: Find all deterministic Nash Equilibria, and at least one mixed Nash equilibrium if any exist.

	L	R
T	0,0	-2,2
B	2,-2	-1,-1

Sample Answer (not necessarily the solution):

[B,L] is the only deterministic Nash equilibrium.
[p(T) = ½, p(L) = ½] is a mixed Nash equilbirum.

2. (4) The Game of Chicken (featured in movies “Rebel Without a Cause”, and “Charlie’s Angels”.). Two drivers are heading towards each other. Whoever turns away first, loses. A historical example is the Cuba crisis between the USSR and the USA.

	Turn	Keep Going
Keep Going	5, 2	-10, -10
Turn	0, 0	2, 5

a. (2) Find all deterministic Nash Equilibria.

b. (2) Find at least one mixed Nash equilibrium in the Game of Chicken.

Sample Answer (not necessarily the solution):

[Keep Going,Turn] is the only deterministic Nash equilibrium.
[p(Keep Going) = ⅓, p(Turn) = ⅓] is a mixed Nash equilbrium.

3. (4) An issue that arises in technology industries is that an inferior standard may become entrenched even if a better one is available. A historical example is the use of VHS tapes vs. Beta. Or Facebook vs. GooglePlus? This illustrates *network effects*: users like to use technology used by others. Let's consider a simple game-theoretic model of this situation.

	User 2	
User 1	Superior technology	Inferior technology
Superior technology	4, 4	0, 0
Inferior technology	0, 0	1, 1

a. (2) Find all deterministic Nash Equilibria.

b. (2) Find at least one mixed Nash equilibrium in this game.

Sample Answer (not necessarily the solution):

[Superior Technology, Superior Technology] is the only deterministic Nash equilibrium. [p(Superior Technology) = ½, p(Superior Technology) = ½] is a mixed Nash equilbrium.

Dominance. 6 points total.

Summary. If dominant strategies exist, knowing how to find them is useful in predicting the outcome of a game.

Consider the following game matrix.

	L	C	R
T	3 , 2	1 , 3	1 , 2
B	1 , 2	2 , 1	0 , 0
M	2 , 0	2 , 2	0 , 0

- For the row player, find a pair of strategies (s1,s2) such that s1 weakly dominates s2.
- For the column player, find a pair of strategies (s1,s2) such that s1 strongly dominates s2.

Sample Answer (not necessarily the solution):

For the row player, T weakly dominates M.
For the column player, L strongly dominates C.

Optional Study Questions (not graded)

- Given a fixed machine architecture, does each agent program implement exactly one agent function?

- Can there be more than one agent program that implements a given agent function? Give an example, or show why one is not possible.

- Are there agent functions that cannot be implemented by any agent program?