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**Chapter 1. AI Foundations. 16 points total**

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

AI is the concept of creating machines that think and act rationally and like humans; whereas machine learning is an application of AI, which as mentioned in the course textbook, means to program a computer so that it can learn from the patterns in the data provided.

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?

The latter statement is not true because animals are able to do more than they are genetically programmed to do. For instance, certain animals such as dogs, are able to be trained and therefore not genetically determined, to act in certain ways in certain situations. A specific example would be when dogs are trained to carry slippers to their owner when they come home. Being able to learn, remember and act in these certain ways requires a certain level of intelligence, and therefore animals are intelligent.

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?

The latter statement is true because computers truly only do what their programmers tell them to do. Even when a computer has machine learning capabilities, it is only doing what the programmer programmed the computer to do; nonetheless, it is somewhat intelligent in a sense that it can dynamically “learn” and remember while the computer is running. If we consider phone applications as a computer application in a broad sense, consider Google’s Android keyboard; it can learn new words based on what the user usually types and puts it as a suggested word the next time a similar word is typed by the user. The application is “learning”, remembering, and reproducing what it remembers, therefore, would be somewhat intelligent.

4.

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

**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 |
|---|---|---|---|---|---|
| Fully | Multiagent<br><br>because there are "lifelines" which interacts with other | Deterministic | Episodic | Semi-dynamic | Discrete |

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

| Agent Type | Performance Measure | Environment | Actuators | Sensors |
|---|---|---|---|---|
| Question Answerer | Fast generation of answers,<br><br>Correct answers | Audience/friend (lifelines)<br><br>Host | Display screen<br><br>Voice synthesizer | Keyboard<br><br>Microphone |

**Game Types. 10 points total**

1. Coordination game

   Player 1: u'(x) = $\frac{1}{3} * u(x)$ Player 2: u'(x) = $\frac{1}{3} * u(x)$

2. Prisoner's Dilemma

   Player 1: u'(x) = $\frac{1}{2} * (u(x) - 2)$ Player 2: u'(x) = $\frac{1}{2} * (u(x) - 2)$

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**Nash Equilibrium Analysis. 16 points**

1. a. [B,R] is the only deterministic Nash equilibrium.

   b. Let row player "T" has probability p and row player "B" has probability 1-p

   Let column player "L" has probability q and row player "R" has probability 1-q

| | | q = -1 | 1-q = 2 |
|---|---|---|---|
| | | L | R |
| p = -1 | T | 0,0 | -2,2 |
| 1-p = 2 | B | 2,-2 | -1,-1 |

Row player: $p(T) = 0(q) + -2(1-q)$ $p(B) = 2q + -1(1-q)$
$0(q) + -2(1-q) = 2q + -1(1-q) \rightarrow -2 + 2q = 2q - 1 + q \rightarrow q = -1$

Column player: $p(L) = 0(p) + -2(1-p)$ $p(R) = 2(p) + -1(1-p)$
$0(p) + -2(1-p) = 2(p) + -1(1-p) \rightarrow -2 + 2p = 2p - 1 + p \rightarrow p = -1$

Unless deterministic Nash equilibriums are a special case of mixed Nash equilibriums, which in that case would be [p(B) =2 , p(R) = 2], the probability would otherwise be meaningless as it is not between 0 and 1. Therefore, a mixed Nash equilibrium does not exist because both players will never be indifferent with their decisions; in other words, both players will not switch to other strategies because switching will result in a poorer outcome. As a result, there only exists a deterministic Nash equilibrium, with the row player always playing B and the column player always playing R.

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2. a. [Keep Going, Turn] and [Turn, Keep Going] are both deterministic Nash equilibriums.

b. Let row player "Keep Going" has probability p and row player "Turn" has probability 1-p

Let column player "Turn" has probability q and row player "Keep Going" has probability 1-q

| | | q = 12/17 | 1-q = 5/17 |
|---|---|---|---|
| | | Turn | Keep Going |
| p = 5/17 | Keep Going | 5, 2 | -10, -10 |
| 1-p = 12/17 | Turn | 0, 0 | 2, 5 |

Row player: p(Keep Going) = 5(q) + -10(1-q) p(Turn) = 0(q) + 2(1-q)

5(q) + -10(1-q) = 0(q) + 2(1-q) -> 5q -10 + 10q = 2 – 2q -> 17q = 12 -> q = $\frac{12}{17}$

Column player: p(Turn) = 2(p) + 0(1-p) p(Keep Going) = -10(p) + 5(1-p)

2(p) + 0(1-p) = -10(p) + 5(1-p) -> 2p = -10p + 5 – 5p -> 17p = 5 -> p = $\frac{5}{17}$

[p(Turn) = $\frac{12}{17}$, p(Turn) = $\frac{12}{17}$ ] is a mixed Nash equilibrium.

3. a. [Superior Technology, Superior Technology] and [Inferior technology, Inferior technology] are both deterministic Nash equilibriums.

   b. Let row player "Superior Technology" has probability p and row player "Inferior technology" has probability 1-p

   Let column player "Superior Technology" has probability p and row player "Inferior technology" has probability 1-p

| | | q = 1/5 | 1-q = 4/5 |
|---|---|---|---|
| | | User 2 | |
| | User 1 | Superior technology | Inferior technology |
| p = 1/5 | Superior technology | 4, 4 | 0, 0 |
| 1-p = 4/5 | Inferior technology | 0, 0 | 1, 1 |

Row player: p(Superior Technology) = 4(q) + 0(1-q)

p(Inferior technology) = 0(q) + 1(1-q)

4(q) + 0(1-p) = 0(q) + 1(1-q) -> 4q = 1 - q -> 5q = 1 -> q = $\frac{1}{5}$

Column player: p(Superior Technology) = 4(p) + 0(1-p)

p(Inferior technology) = 0(p) + 1(1-p)

4(p) + 0(1-p) = 0(p) + 1(1-p) -> 4p = 1 - p -> 5p = 1 -> p = $\frac{1}{5}$

[p(Inferior technology) = $\frac{4}{5}$, p(Inferior technology) = $\frac{4}{5}$] is a mixed Nash equilibrium.

**Dominance. 6 points total**

For the row player, M weakly dominates B.

For the column player, C strongly dominates R.