Credit Guarantee

I am familiar with the principles of examination and relevant provisions of the regulations of the disciplines; I will surely conform to the rules of the examination, and be an honest student.

Sign Here ： _____

Number： _____

Exam questions （paper） of Northwestern Polytechnical University（NPU）

Scores	

2020 －2021 school year 1st semester

Class-taking college 10 **Subject** Artificial Intelligence **Class period** 40

Exam Date 2020/12/29 **Exam Time** 2 **hour** **Exam Form** (open / closed) (A / B) **paper**

Class		Student number		Name	

I Check whether the statements are true or false and make your choice(30 points, 1 point for each）

1. In order to pass the Turing Test, the machine has to be conscious. ○true ○false
2. According to Searle, “strong AI” claims that in order to understand how the mind works, we need to know how the brain works. ○true ○false
3. Artificial intelligence is a science of knowledge and skill. ○true ○false
4. Artificial neural network is not all what we called artificial intelligence. ○true ○false
5. To understand biological systems is one goal of AI. ○true ○false
6. Systems based on the “classical AI” are typically slow when embedded in real robots because they work on the basis of complex models of the environment. ○true ○false
7. Expert system is an ideal model of knowledge based problem solving. ○true ○false
8. An agent that senses only partial information about the state cannot be perfectly rational. ○true ○false
9. Given sentence P and Q, $(P \Rightarrow Q) \equiv (\neg P \wedge Q)$. ○true ○false
10. $\forall x\ P(x) \vee \neg P(x)$ ○true ○false
11. There exist task environments in which no pure reflex agent can behave rationally. ○true ○false

Note: 1. Generally, there is no space left for answering the questions on the paper used for setting questions, please print out the exam questions using “little four” in Arial and take care not to be out of the frame.
2.The teachers who set questions and review the paper should sign up name when the exam paper is kept on file.

12. The input to an agent program is the same as the input to the agent function. ○true ○false
13. The "Sense-Think-Act" cycle is fundamental to the "classical paradigm" of AI. ○true○false
14. Human expertise cannot be adequately modeled as a set of rules. ○true ○false
15. Complete Agents exploit their body properties to keep the computational load on their brain low. ○true ○false
16. Intelligence requires a body, e.g., if the material properties of an agent's muscle-tendon system is exploited, rapid locomotion is easily achieved. ○true ○false
17. Systems that are not embodied suffer from the symbol-grounding problem, because there is always a human interpreter in the loop. ○true ○false
18. Bi-pedal walking for robots is possible without computer control. ○true ○false
19. Embodiment is prerequisite for any kind of intelligence. ○true ○false
20. Language is a good example for "scaffolding". ○true ○false
21. Deep neural networks are omniscience except for challenging from interpretability. ○true ○false
22. Uniform-cost search is a special case of A* search. ○true ○false
23. Depth-first search is a special case of best-first tree search. ○true ○false
24. h(n) = 0 is an admissible heuristic for the 8-puzzle. ○true ○false
25. Q-learning is one typical deep reinforcement learning. ○true ○false
26. The frame of reference problem states that an observer should be careful when deducing internal mechanisms from external behavior. ○true ○false
27. In the real world, in contrast to virtual ones, there is always a higher level of uncertainty present. ○true ○false
28. The "dualist view" has created the "mind-body problem" which is essentially about the relation between the mind and the body, in particular the brain. ○true ○false
29. Chess programs have been so successful because in the game of chess there are only few possible states. ○true ○false
30. ***AlphaGo*** by Google as an AI robot has passed the famous Turing Test. ○true ○false

II Short Questions （20 points）

1. Agent (8 points)

(1) Fill in an appropriate terminology in each of the three blank boxes in the conceptual "Agent", as shown in figure 1. **(3 pts)**

(2) According to the conceptual agent, to explain what is a **rational agent**. **(3 pts)**

(3) Suppose we keep the agent program fixed but speed up the machine by a factor of two. Does that change the agent function? **(2 pts)**

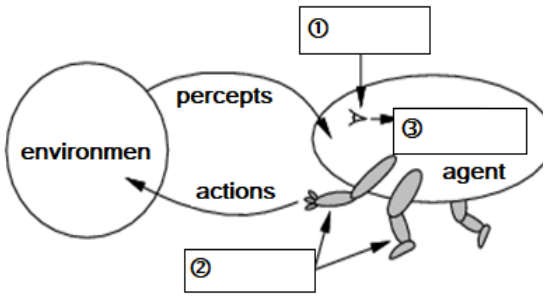

Figure 1 Conceptual Agent interacting with environment

2. Logic (8 points, 4 points for each)

Represent the following sentence in first-order logic

(1) A person born in the UK, each of whose parents is a UK citizen or a UK resident, is a UK citizen by birth.

(2) A person born outside the UK, one of whose parents is a UK citizen by birth, is a UK citizen by descent.

Let the predicates based be as follows: **Person(x)**: x is a person, **Born(x, c)**: person x is born in country c, **Parent(x, y)**: x is a parent of y, **Citizen(x, c, r)**: x is a citizen of country c for reason r, **Resident(x, c)**: x is a resident of country c

3. Neural Networks and Morphological computation (4 points)

The Braitenberg vehicle in figure 2 implement its controllers with a simple neural network which has two layers of neurons; starting from the top sides, the first layer receives inputs from the sensors and sends its outputs to the second layer, while the neurons in the second layer drive the motors of the robot. The picture shows a schematic representation of a mobile robot. Assume that it is moving at a default (slow) speed. In order to implement the obstacle avoidance behavior (i.e., while moving in the environment, the robot avoids the obstacle that it senses by means of the distance sensors), you are asked to implement a simple neural network by connecting the neurons (small circles). You do not need to specify the weights of the connections; just express whether each connection is excitatory (+) or inhibitory (–). There are several ways to achieve this, just come up with ONE solution, and to express the each connection and its attribute in figure 2, give some necessary explanation.

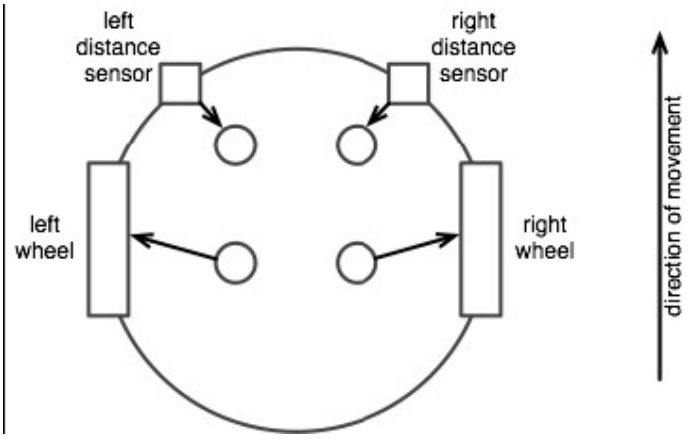

Figure 2 The Braitenberg vehicle controlled through neural network

III Calculation based questions (34 points)

1. Decision Tree (12 points)

Consider the 3-Parity function with following data set comprised of three binary input attributes

(A1,A2, and A3) and one binary output (Y) as shown in Table 1:

(1) To learn a decision tree for the 3-Parity function, show the computations made to determine the attribute to split at each node. **(10 points)**

(2) Draw a minimal-sized decision tree for the 3-parity function. **(2 points)**

Hint: the formula for information gain

$$IG(S,A) \equiv Entropy(S) - \sum_{v \in Values(A)} \frac{|S_v|}{|S|} Entropy(S_v)$$

$$Entropy(S) \equiv -p_+ \log_2 p_+ - p_- \log_2 p_- \qquad S_v = \{s \in S | A(s) = v\}$$

The chosen attribute A divides the training set S into subsets S_1, ..., S_v according to their values for A, where A has v distinct values, $|S_v|$ represents the element number of set S_v, p_+ represents the number of positive examples and p_- represents the number of negative examples.

Table 1 truth table for 3-parity

Example	A_1	A_2	A_3	Y
X_1	0	0	1	1
X_2	0	1	0	1
X_3	0	1	1	0
X_4	1	0	0	1
X_5	1	0	1	0
X_6	1	1	0	0
X_7	1	1	1	1
X_8	0	0	0	0

2. Neural Networks (8 points)

Consider a two-input XOR function realized by a 2-layer ***Perceptron*** neural network as shown in Figure 3. The neuron model expressed as $O(\vec{x}) = sgn(\vec{w} \cdot \vec{x})$,

$$O = \begin{cases} 1 & if \ \sum_{i=0}^{n} w_i \cdot x_i > 0 \\ 0 & otherwise \end{cases},$$

here w_0 stands for bias of a neuron.

Try to compute and specify a set of weights for this two-input XOR neural network.

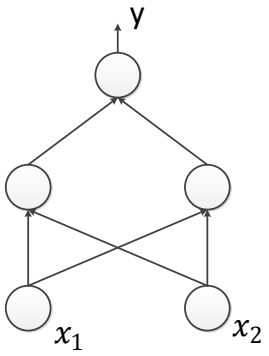

Figure 3 XOR NN

3. Bayes rule and Reasoning (14 points)

Consider a medical diagnosis problem in which there are two alternative hypotheses: that the patient has a particular form of cancer (cancer), and the patient does not (¬cancer). The available data is from a particular laboratory test with two possible outcomes: positive (+) and negative (-). We have prior knowledge that over the entire population of people only 1% people have this disease. Furthermore, the lab test is only an imperfect indicator of the disease. The test returns a correct positive result in only 96% of the cases in which the disease is actually present and a correct negative result in only 98% of the cases in which the disease is not present. In other cases, the test returns the opposite result.

Now, please answer the following questions according to your calculation based on Bayes rule and Bayesian inference.

(1) Suppose we now observe a new patient for whom the lab test returns a positive result. Should we diagnose the patient as having cancer or not? **(10 points)**

(2) Suppose the doctor decides to order a second laboratory test for the same patient, and suppose the second test returns a positive result as well. What are the posterior probabilities of cancer and ¬cancer following these two tests? Assume that the two tests are independent. **(4 points)**

Hint: the formula for Maximum a posteriori hypothesis $\boldsymbol{h_{MAP}}$ $h_{MAP} = \arg\max_{h \in H} P(h \mid D)$

IV General questions (16 points)

It is clear that computers can do many things as well as or better than humans, including things that people believe require great human insight and understanding. This does not mean that computers use insight and understanding in performing these tasks. Of course, there are many tasks at which computers do not yet excel. In recent 2 decades, the landmarks in Artificial Intelligence include from ***Deep Blue*** (a chess-playing computer developed by IBM that defeated world champion Garry Kasparov in 1997) to ***Watson*** (an IBM supercomputer which won the game show *Jeopardy* in 2011), then to ***AlphaGo*** and ***AlphaGo Zero***(a computer program developed by Google DeepMind to play the board game *Go* that firstly beat Lee Sedol, one of the best professional *Go* players in the world in March 2016). **Robot Soccer**, another landmark challenge project, which ultimate goal set by **RoboCup** Initiative was stated as follows:

> ***"By mid-21st century, a team of fully autonomous humanoid robot soccer players shall win the soccer game, complying with the official rule of the FIFA, against the winner of the most recent World Cup."***

For the following questions, please give your answer and briefly present your viewpoints or reasons:

(1) According to the development of artificial intelligence, what do you consider the possibility to accomplish the ultimate goal of RoboCup? **(4 points)**

(2) In order to realize the ultimate goal of robot soccer, what kind of ways of artificial intelligence we really need to use: artificial brain-like intelligence or human brain-like intelligence? **(4 points)**

(3) If one day the ultimate goal of robot soccer is realized, does it mean we human will never play soccer game with humanoid robots? **(4 points)**

(4) Based on the assertion "The success of AI might mean the end of the human race. ", comment on whether we human need worry about the potential dangers from AI. **(4 points)**

Important notes:

- Please put your student ID on the desk, we will check it during the exam.
- Write your name and student ID on top of every sheet. **Do this RIGHT NOW**! When the 120 minutes are over, you will not get additional time to write your name on the sheets.
- You are not allowed to use any books or notes, except for 1 (one) non-electronic dictionary if necessary.
- Most of the questions are multiple-choice questions. Mark whether a statement is true or false using the respective check box (i.e., there should be exactly one check mark per line).
- If you change your mind, draw new checkboxes and make clear which solution is the one to be counted. For example:

  

  if you change your mind, or

  

  if you change again and are not sure what to select.
- For every incorrect mark within a multiple-choice question you will lose as many points as you would get for a correct mark. A negative point balance will result in zero points for the respective question. Unmarked answers will result in zero points for that specific answer.
- In those questions where you have to write something, please write legibly. If we cannot decipher your answer, we cannot give you points.
- Write with a dark (black, blue) ball-point pen. Do not use a pencil or a pen with red color.
- In case you need note paper, use the back sides of these exam sheets, or ask the supervisors for more paper. You are not allowed to use your own note paper.
- The duration of the exam is **120 minutes**.
- The total points: 100 points

Good luck!