

COGNITIVE ROBOTICS (29/08/2017)

Prof. Matteo Matteucci

The exam will be graded IFF the following recommendations have been taken into account:

- Write clearly so that the teacher can easily understand your answers
- Write your name, surname, and student id on each sheet you deliver for evaluation
- For each exercise/question report clearly the number and sub-number (if present)
- You are not allowed to use any programmable device (e.g., smartphone, calculator, etc.)
- You can use pen or pencil, paper will be provided, you cannot use notes or books

Exercise 1 (Cognitive Architectures) (1+2+3+1 points)

Two main paradigms for the design of cognitive systems have been presented during classes, with hybrid approached, among the two resulting in being the most common ones. Answer the following:

- a) How planning could be use in a hybrid architecture including deliberative and reactive components?
- b) What is planning? Formalize a planning problem and its components.
- c) Using PDDL , define the planning problem of a sailor moving a wolf, a goat, and a cabbage across a river (you might need to use conditional effects in actions ...):
 - The boat is tiny and can only carry one passenger at a time
 - If the sailor leaves the wolf and the goat alone together, the wolf will eat the goat.
 - If the sailor leaves the goat and the cabbage alone together, the goat will eat the cabbage.
- d) Is the previous problem solvable using pure STRIPS definitions instead of ADL? Explain why.

Exercise 2 (Natural Language Processing) (1+2+1 points)

With reference to the Part of Speech (POS) tagging problem answer the following questions:

- a) What is POS tagging about? Describe it shortly add make an example
- b) Describe what is a Hidden Markov Model and how it can be used for POS tagging
- c) Could LSTM networks be used for POS tagging? How?

Exercise 3 (Human Robot Interaction) (2+3+1+1 points)

Let's assume you are designing an interactive sliding door to make "more interesting" the lobby entrance at the "Mighty Magic Motel" in Cernusco sul Naviglio.

- a) What kind of sensors and actuators might be needed for the interaction? For each of them describe its purpose. Provide also a sketch of the door with the sensors and discuss their placement.
- b) Not to be predictable, i.e., boring, the sliding door should have different patterns of behaviors and generate different reactions. Provide 3 of such patterns, describe which reactions they are supposed to induce, and how sensors are used in each of those.
- c) Discuss the role of time in human robot interaction in general.
- d) Discuss the role of time in the suggested cases.

Exercise 4 (Neural Networks) (2+2+1+2 points)

With reference to the lectures on Feed Forward Neural Networks and Deep Learning answer the following:

- a) Describe the perceptron model, draw it, provide its output formula and its training algorithm.
- b) Describe the backpropagation algorithm and discuss the difference w.r.t. the perceptron learning algorithm. Derive the backpropagation formula for the output layer in a FFNN with SSE loss function.
- c) Describe in details the issue of vanishing gradient in recurrent neural networks
- d) How Long-Short Term Memories face the issues of vanishing gradient, provide a description of the LSTM model and some possible examples of structural learning problems