Intelligent Systems 2019/2020

Take-home Resit Questions

*– Good luck! –*

Ahmad Mohammad

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First name, Surname:

Student ID:

**Program:** Bachelor Data Science and Knowledge Engineering

**Course code:** KEN3430

**Examiner:** dr. ir. Kurt Driessens

**Date/time:** Tuesday, July 2nd, 2020, 3 hours in the time window 09:00 – 17:00

**Format:** Open book, take-home exam

**Allowed aides:** Pretty much all besides secondary Intelligent Systems, natural or artificial!

**Instructions to students:**

* **Print and fill out the Declaration of Integrity on page 2. If you can’t print, please copy the whole page by hand. Scan/photograph the signed page and upload with the exam.**
* The exam consists of 7 questions. Please type in your answer in the provided text box.
* Almost all questions are based on questions suggested by students during the regular exam. I would like to thank them for their contribution but will not mention their names to safeguard their privacy (and possibly safety?).
* Even though the main identification used will be the account under which you upload, still fill in your name on each page, including the cover page.
* Each question is indicated with a suggestion for answer length. This is a guideline. Some of you are quite verbose and use more words than others to communicate the same information.
* The most important prerequisite for a good grade is that you properly motivate your answers.
* If you think a question is ambiguous, or even erroneous, explain this in detail in the space reserved for the answer to the question.
* If you have not registered for the exam, your answers will not be graded, and handled as invalid.

**The following table will be filled by the examiner:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Question: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total |
| Maximum points: | 10 | 5 | 5 | 10 | 10 | 5 | 5 | 50 |
| Achieved points: |  |  |  |  |  |  |  |  |

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**Question 1.** **(10 Points, Reproduction + Application – 300 words)** (Student suggested question)

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An important trade-off in agent oriented programming is the reconsideration rate of the intentions/plans of the agent given the rate of change of the environment. Explain the difference between the same totally bold and totally cautious agent, illustrate their behaviour in an example environment and discuss and motivate how you would approach the trade-off for that environment.

A given agent has a certain ratio of boldness and cautiousness. As the environment that the agent lives in changes a lot, it becomes more beneficial to the score of the agent to be more cautious and less bold. This means the agent will stop more often to reconsider the next action that it’s going to take.

The opposite holds as well. If we are in a very static environment, it becomes more beneficial to be more bold and less cautious, as the environment will not continuously change the decision-making process. This means that the agent will never stop to reconsider.

For the example we will use a modified game of frogger. The agent (frog) will have to make it to the other side of the park safely without getting hit by incoming vehicles on the street. For this problem, vehicles on the street approach at a constant velocity, in a pattern known to the frog.

We will modify the game so that every now and then for a period of time, random potholes start appearing on the road, we will refer to this as “state 2”. After this period of time, the potholes disappear and the game returns to normal (we will call the normal state “state 1”). If the frog steps on a pothole, he loses.

While we are in state 1, we are not expecting a lot of sudden change in the environment since we know cars approach at a constant velocity and a in known pattern. Therefore, while we are in state 1, our agent will be more bold and less cautious, as he knows what to expect and there is no real need to reconsider his next actions.

However, the moment we enter state 2 the environment will start to change rapidly (and therefore our rate of change will be higher) , since the roads start filling with random potholes. This is when the agent notices the sudden change in the environment. As a response, it will reduce its boldness, and increase its cautiousness parameters. This is done so the agent can take the changing environment into account, and make more educated decisions on what the next move should be such that he does not loses the game.

For the entirety of the duration of the game, the environment is constantly switching back and forth between state 1 and state 2. As a response to this, our cautiousness and boldness parameters of the agent will change accordingly.

**Question 2. (5 Points, Application & Analysis – 100 words)** (Student suggested question)

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Explain why building an AI player for Heads-Up[[1]](#footnote-1) Poker is different from building one for the board game GO. Which one would you consider more difficult and why?

GO is a game that has perfect information (we know all possible moves, and the game state), while Heads-Up Poker has imperfect information as players have only partial knowledge about the game (they don’t know each other’s hand or strategies) . Both these games consist of decision-making problems with two agents.

In GO the game is fully deterministic, meaning we can at any point compute the possible permutations of best moves, and use an heuristic to get to the final solution (even though the search space is very large).

It is relatively simple to build an AI that beats average poker opponents. But the hidden information in poker makes it so that the search space of our poker AI grows immensely fast for each unknown card. Another problem that greatly increases complexity is the amount of strategies (like bluffing holding a certain hand) the opponent could be employing. The number of possible strategies grows of course as our opponents get more skilled. All of these factors contribute heavily to the complexity of a (expert) poker AI.

The huge search space of the poker AI is why I consider a Heads-Up Poker AI to be more difficult than a GO AI.

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**Question 3. (5 Points, Evaluation – 150 words)** (This one is just tradition.)

The following 4 statements are grabbed from “recent” internet articles. Pick one and give your opinion on it. To get a good grade on this question, it is important to motivate your opinion using topics and concepts covered in class. (All articles from: Healthcare IT News)

1. “A modernized 'butler bell': How a virtual bedside assistant can better help patients”
2. “Machine learning can give healthcare workers a ‘superpower’”
3. “Lunit’s AI solution for breast cancer detection gets CE certification”

“Machine learning can give healthcare workers a ‘superpower’”:

I think calling the use of ML in healthcare for healthcare workers a “superpower” is very appropriate. It gives healthcare workers a way to deal with the massive overhead that unorganized data like medical records and clinical documents introduce.

This data is often unstructured, and finding relevant data and deriving useful knowledge in the midst of it is challenging and time-consuming. In the past (and also the present for a large part) healthcare experts would have to go through a large amount of unstructured data with at most help from some rudimentary software.

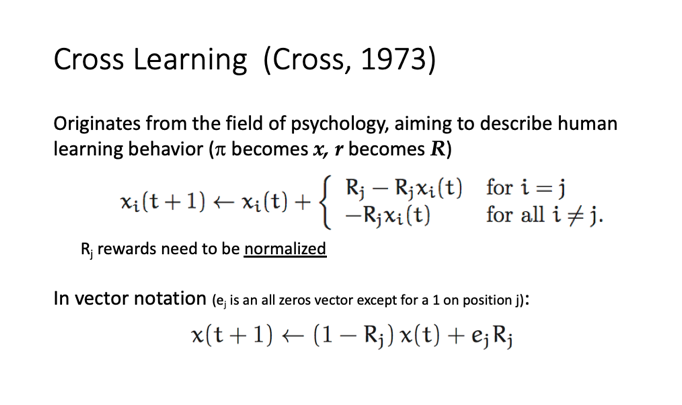
If we delegate the data processing procedure to a dedicated system that employs ML methods, healthcare workers will have more time to devote themselves to other, more pressing, tasks. Of course, a system like this would have to be trained first on a lot of data to ensure validity. While training this system, a human expert can then check the outcomes of the ML system for validity, at which point (if the results are satisfactory) we can use it on our medical data.

One example of an application of ML in healthcare is using it for detecting patterns and abnormalities in medical imaging data that come from radiology or pathology.

**Question 4. (10 Points, Application – 250 words)** (Student suggested question)

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****Suppose that a psychologist has recently seen the Cross learning algorithm and (s)he is not happy with it since people learn faster or slower depending on the type of activity.

Therefore (s)he would like to introduce a learning rate a and make the algorithm more adaptable to different scenarios.

Is the suggestion of the psychologist viable? How would you accomplish this, i.e. where and how should the learning rate a be used?

What are the consequences?

It would be viable to introduce a learning rate.

We can multiple every reward for a given action Rj alpha in the algorithm with the learning rate alpha. By doing this we can manually tune the speed at which the algorithms learns, adjusted according to the needs of the patients. If we want to adjust the algorithm to work for a slow learner, we use a smaller learning rate. If we have a patient that learns faster, we can increase the learning rate. The consequence is that the x-vector will change at a different rate, depending on what we choose for alpha. This is because xi-t+1 is calculated as xi(t) + the Rj terms. So when we multiply the Rj terms with the learning rate, the next xi will be a scaled version of the original solution.

**Question 5. (10 Points, Application – 350 words)** (Student suggested question)

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One question in the regular exam was to pick a game and illustrate how all three types of interdependencies manifest in the game: pre-requisites, shared resource, simultaneity. As expected, a popular answer was based on a team sport such as football:

1. Before an agent can shoot, an action which resulted in the agent having possession of the ball would have to be executed
2. Shared resource: All the actions that handle the ball: shooting, passing, dribbling, depend on the agent having possession of the ball and will not be executable otherwise.
3. Simultaneity: Scoring out of an assist or center is only possible if at least two agent simultaneously execute the actions involved, e.g. kicking the ball in front of the goal and running towards the place where the ball will land.

Now think Robotic Football: which of the coordination techniques seen in class would you recommend to allow the robotic agents to coordinate the last type of action, namely “scoring out of an assist”, or scoring as a result of a well-executed pass? Motivate the use of your suggested techniques. (Hint: offering the use of more than one technique and comparing the alternatives based on their strengths and drawbacks is probably a good idea. Also, don’t just list these, but apply them to the specifics of the domain.)

We want to score out of an assist. This means we need to get the ball to the agent who is most likely to score. There are 2 main agents at play in this scenario. Agent 1 who is going to make the final pass. and Agent 2 who is going to shoot the ball at the goal.

We can use a Control Net Protocol to determine what the process leading up to the final shot will be. Agent 2 will be the manager, announcing that he wants to pass the ball to the agent that is most likely to score a goal. The contractors in this system will be all the other agents (soccer players) that are on the field. They will all bid for the right to carry out the task. The bid they offer is p = P(Goal), which is a value ranging from 0-1 that indicates how likely an agent is to score a goal at some point in the game. This variable is calculated by taking team composition, team strategy, current position, defenders near goal, ball possession etc. into account for both the friendly and opposing team.

Agent 2 will then select the contractor with the highest p, and this agent is then designated to be Agent 1. Agent 2 will then pass the ball to Agent 1, who will (attempt to) score the goal.

Using the Control Net Protocol has the advantage of having distributed control, as well as dynamic roles. We could change up who has to be the contractor or manager depending on the problem we are currently solving. However the design of such a system can also be quite complex, as we need to know what tasks need to be announced, why a contractor should be bidding in the first place, and how to decide what agent receives what task specifically.

**Answer to question 5 can continue here:**

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An alternative is to use the Client-Server technique. We have a client who sends its request to another process. In this football game the client is the agent that is going to pass the ball to the agent who will shoot the ball at the goal.

Then, we have a server that receives the clients request from another process, and will keep them stored to execute the corresponding service later. In our case this is where we would store all the moves that the agents want to execute.

Then the server executes the service that is needed to fulfill the clients request. In this case, our service would be the passing of the ball to the agent that is going to take the final shot.

While using the Client-Server technique is effective because of its simple structure, it has a pressing list of problems to go along with it. The server that stores all the incoming requests from the agents on the field can be a bottleneck because of so many requests piling up. It is also possible that by the time the server wants to execute a service for a certain request (here for example, pass the ball to the player most likely to score a goal) we have gotten a much better service that would do a better job at this particular request. So for us, we could get someone who has an even higher probability p of scoring a goal (p = P(Goal)) .

Therefore I would recommend the Control Net Protocol over the Client-Server technique to coordinate this particular action of passing the ball to the agent who is going to score.

**Question 6. (5 Points, Analysis – 150 words)** (Student suggested question)

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Terms like Artificial Intelligence, Machine Learning and Deep Learning can be confusing to the general public. How would you explain that Deep Learning can both be considered as intelligent and not intelligent?

The main thing to note is that deciding whether Deep Learning is intelligent or not, completely depends on our definition of intelligence. Since there is no real commonly accepted definition of intelligence, there are multiple ways to express (and test) intelligence.

We can say that DL is an imitation of the human brain, which processes data and creates patterns that are used to make decisions. In this sense we could consider DL to be (somewhat) intelligent, as it attempts to imitate the inner workings of the human brain – and we all know humans (more specifically, human brains) are in fact intelligent.

But if we define intelligence to be strictly emotional intelligence, we can say that Deep Learning is not necessarily intelligent since it could be incapable of recognizing emotion, discern between feelings and label them accordingly etc. Besides, all a DL algorithm does is a series of calculations, the results of which are used to make decisions. This does not automatically imply that it is (emotionally) intelligent in this case. This is assuming that we take human emotional intelligence as the baseline.

Moreover, it is possible that if we make a similar argument using the definitions for social or senso-motoric intelligence, we could call Deep Learning intelligent. It is also possible that we define intelligence as a combination of these subcategories, in which case our results could differ again.

The main takeaway is, that deciding whether DL is intelligent or not depends on our definition of intelligence.

**Question 7. (5 Points, Analysis, 100 words)** (Teacher suggested question)

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Given that natural evolution gave rise to both good genes, but also the format of the genotype for humans, do you think that the genotype of humans should follow the guideline of “optimal genotype encodings” as seen in class, i.e. “each gene is completely independent”, given that mutation can only take place in human DNA by substituting a random value for a gene through a copying error? Motivate your answer!

We are given that mutations can only take place in human DNA by substituting a random value for a gene though a copying error. So should the genotype of humans follow the principles of optimal encodings i.e. each gene is independent? The answer is no, because we can not guarantee that we have all independent genes after a certain amount of mutations (through copying errors) have happened. For example, if we have a gene that has binary values [0 0 0 0 1]. Then the gene gets copied, and a value gets changed through a copying error. The new gene is [0 0 0 0 0]. Now, that same gene gets copied again, and another mutation occurs at the same location. Our new gene is [0 0 0 0 1]. But this is the same as the original gene! Therefore our genes are not independent. If our genes are not independent, we do not follow the guideline of optimal genotype encodings.

1. Two players playing against each other. [↑](#footnote-ref-1)