Coursework commentaries 2015–2016

CO3310 Artificial intelligence

General remarks

Coursework assignment 1

Some students avoidably lost marks by failing to follow the guidance given in the coursework rubric or in previous years' coursework commentaries.

- You should list all references at the end of your work, and they should be properly cited whenever referred to. Note that any answers which consist entirely or mostly of quoted material are unlikely to get high marks even if properly cited and referenced.
- Where you are asked to 'explain your answer', unless otherwise stated, you should write no more than one or two sentences. **Some students ignored this and wrote whole paragraphs; others ignored the requirement to explain**.
- Please submit your work as a single PDF file, with an appendix including any Prolog code you have written and the results of running your code. **Some students submitted their work as a doc(x) file only. This is a nuisance when marking, and in future there may be an explicit penalty for using the wrong format.**

In what follows, AIMA refers to Russell and Norvig's *Artificial intelligence: a modern approach*.

Comments on specific questions

Question 1

This question concerns agent-based computing. [25 marks]

a. This sub-question was **bookwork**, which asked for explanations of various technical terms. Most students did reasonably well, although some answers were unclear or uninformative and showed little evidence of having consulted the subject guide or textbooks. Some students just gave intuitive interpretations of these terms without reference to the course readings or dictionary definitions, like **'Utility: A state of being serviceable'** or **'utility = happiness'**. Circular answers, such as **'rationality is a measure of rational behaviour',** were not acceptable, nor is **'rationality is about doing the correct thing'**.

b. This question required students to show an understanding of Russell and Norvig's 'dimensions' of autonomous agent environments by applying them to the duties of **hospital orderlies**, **nurse assistants** or **porters** in no more than approximately 500 words. Good answers would begin by considering what the relevant types of percepts and actions would be, and the implications for a robot agent's percepts and actuators. The word limit does not allow for all duties to be discussed in depth, but you should pick a representative selection and give well-motivated classifications along the listed dimensions. A tabular answer may be appropriate as long as there is some justification

for the classification. This question required careful reading of the relevant section of AIMA. Some answers showed confusion about observable, deterministic versus stochastic properties, and whether these terms referred to the task, the environment or even the agent. Some students gave thoughtful answers showing a good understanding of the issues, while other answers were too brief and unfocused with little discussion of actual concrete tasks.

Question 2

This question concerns search. [35 marks]

a. This question was **bookwork**, testing students' understanding of some basic properties of standard search techniques. Most students did reasonably well. Note that the question says 'explain'; students who failed to do so lost marks. It is wrong to say an algorithm 'may not be optimal' – the algorithm is either optimal or it isn't; that is, it will always find the optimal solution or it may sometimes return a nonoptimal one. Many answers failed to note that Greedy best-first search (GBFS) uses a heuristic.

b. Explain in your own words the difference between **tree search** and **graph search**. This question was also **bookwork**. Most students did fairly well, but some chose to discuss the formal properties of graphs and trees rather than the specific issue of comparing a tree search with a graph search.

c. This was a practical question applying various search algorithms to a route-finding problem. Marks were awarded for correct solutions, working and presentation. Wrong solutions might also receive good marks if they show sound understanding of algorithms but go astray in calculations. Some students got obvious nonoptimal solutions for U-C and/or A*. This should have alerted them to the fact that something had gone wrong in their calculations. Some used the actual path length rather than heuristics for a greedy search, or calculated the total path length by adding all the straight-line distance (SLD) figures for each town on the route. Some answers confused **nodes** in the search tree with **locations** on the map. Several students gave very good or excellent answers, while others lost marks by giving correct solutions but not showing any working, or through poor presentation. A number of students failed to attempt this sub-question.

Question 3

This question concerns formal logic, knowledge representation and reasoning. [40 marks]

a. This question was **bookwork**, asking for explanations of various terms from formal logic. The point of questions like this is for students to show that they understand the terms, so it is not helpful to offer answers like '$\Sigma \vdash \Phi$ implies $\Sigma \models \Phi$'. Note that answers were supposed to be given 'in your own words': generally, if you're asked to define some technical term, answers are expected to be in a **less** technical vocabulary and not in terms of other undefined technical terms, such as 'validity'.

b. This question concerned the use of truth tables in Boolean (propositional) logic. Many students failed to explain their answers; some simply displayed a truth table as if the answer were self-evident. A few students had trouble constructing correct truth tables. Note that some students wrongly took 'entails' to mean 'iff' even if this contradicted their answer to 3a(iii).

c. This question tested students' understanding of Predicate Calculus. There were some good answers, but some showed confusion about the proper use of existential versus universal quantifiers, and several students only gave one version of each formula. Some points for attention, which seem to recur each year, are: whether to use 'arrow' or 'conjunction'; proper bracketing; correct use of negation; proper explanation of predicate interpretations (do not assume the intended meaning is obvious); and the difference between **constants** and **variables**. Note that 'not all' is not equivalent to 'some' as it is consistent with 'none'; 'anything containing seeds is a fruit' is not equivalent to 'all fruits contain seeds'. Answers without proper bracketing were marked charitably, but you should take a warning from this. Be careful not to express 'all tomatoes contain seeds' with a formula that means 'everything in the universe is a tomato which contains seeds'. This is a topic that you should revise thoroughly before the examination.

d. For this question, students were expected to use Prolog to perform simple logical inference. The code and results should be included in the body of the answer. It is annoying to be referred to an appendix for essential parts of the answer. Answers should give some explanation and show query results. Some students did not explicitly give results, others showed no evidence of running Prolog; however, happily, there were also several good answers. The highest-marked answers incorporated answers from 3(c), so that some inference was involved. The lowest-marked answers simply hard-coded the required results. Several students did not attempt this sub-question.

Coursework commentaries 2015–2016

CO3310 Artificial intelligence

General remarks

Coursework assignment 2

In what follows, AIMA refers to *Artificial intelligence: a modern approach* (3rd edition) by Stuart Russell and Peter Norvig, which is the essential textbook for this module.

Students should pay particular attention to these points from the rubric:

- You should list all references at the end of your work, and they should be properly cited whenever referred to. References to websites should include title and author if available, and date last visited. **References should be restricted to scholarly or authoritative sources rather than Wikipedia, YouTube, HowStuffWorks, newspaper stories, magazine articles, movies and the like.**
- Answers should be expressed in your own words: **an answer consisting entirely or largely of quotes is unlikely to get good marks, whether or not the sources are properly referenced**. In particular, students should not rely on quotes for explanations of key concepts. Some students seem to have disregarded this advice.
- Please submit your work as a single PDF file (**not** a zip file). Any additional files will be disregarded.
- We make allowances where possible for imperfect written English. However, there were occasions when the Examiner simply could not work out what was meant.
- Students should avoid circular answers such as 'Reward function specifies a reward for each state, whereas the value function is the overall value'.

Comments on specific questions

Question 1

Machine learning **[35 marks]**

a. This question was **bookwork** and required careful reading of Chapter 7 of the subject guide and Chapter 1 of Sutton and Barto's *Reinforcement Learning: an introduction*.

There were several good answers that showed thorough reading and confident understanding, but many students either did not attempt this sub-question or gave answers that were too short, unclear, lacking in detail or that excessively relied on quoted material. There was some confusion about the concept of a 'negative reward', which some students described as a 'punishment' for making 'wrong' decisions. In this example, the agent cannot avoid choosing states with negative rewards so the notion of 'punishment' is not appropriate.

b. Consider Figure 21.1 in AIMA (p.832) which shows a **policy** π for the 4×3 world and the utilities of the states in this world, given the policy π. Explain how these utilities are calculated.

Note that this question does not ask how an optimal **policy** is calculated, but the **utilities** of states given a policy. Also, the question does not specify that you need to show calculations for every state, as long as you show a good understanding of the basis for the calculations. Section 17.1.2 of the AIMA shows how to derive the expected utility obtained by executing policy π starting in state 'S'. It is not enough to simply reproduce the equations; the explanations should give enough detail to show your understanding.

Some students confused **negative rewards** with **discounting**. Others chose not to discuss this particular example, but made up their own instead, for which they obtained few marks. As with 1(a), there were some strong, well-referenced answers, but many were rather terse and lacked explanatory detail.

Question 2

Natural language processing **[35 marks]**

a. This question required students to identify various phrasal categories from the *UCL internet grammar of English* in a sample text, and to discuss cases where the category was unclear. Students who omitted any discussion lost marks.

b. This was a reasonably straightforward – if tedious – task, although some judgements needed to be made without guidance from the *UCL internet grammar of English;* for example, do proper names have a head/complement structure? Marks were awarded for reasonable annotation and for appropriate discussion. Students who gave 'wrong' annotations could still have received credit if they had made a fair attempt at motivating their decisions. Some students could have received more marks by labelling the brackets, as most did.

c. At least one student said that parts of the original needed to be recast; however, this was not required by the question. Some students showed uncertainty about precisely where to place phrase boundaries, and uncertainty between the main and subordinate clauses. Many also omitted embedded NPs; for example, within conjoined or other complex NPs, or they marked up a single verb as VP. There was much confusion about what qualifies as a subordinate clause. Answers were of quite a variable standard, with some students showing a good understanding, while others did not attempt this question or showed a weak understanding of concepts, such as 'clauses'.

d. This question required you to add more fine-grained rules to the phrase structure grammar shown on page 42 of the subject guide, distinguishing between transitive and intransitive verbs.

This could be answered in different ways, and any reasonable, well-supported answer would be accepted. Note that students were expected to define new categories; for example, TV and IV. Several students did not do this, but offered rules with a single verb category instead.

Some verbs may come in both categories; for example, 'the wumpus smells', 'John smells a wumpus'; compared to 'the wumpus stinks,' but not 'John stinks a wumpus'.

Shoe-horning all verbs into one or the other categories risked over- and under-generation.

Students who did not offer any revised VP rules lost marks, although most did reasonably well on this sub-question.

e. This question required you to extend the augmented grammar in the subject guide (p.45) to handle verbs with direct and indirect objects, such as 'Mary bought John a drink'.

Students tackling this may conclude that the original grammar is over-simplified and can't easily be scaled up without either adding more complex rules or cutting corners. Credit was given for any reasonable attempt. It is advisable to show a full derivation to be sure that the proposed rules actually work. This was a relatively challenging exercise and was marked charitably. Several students gave reasonably good answers which showed a sound understanding of the problem, but many lost marks by failing to show a derivation or by giving a derivation that did not match their proposed grammar rules.

Question 3

Philosophical, social and ethical dimensions of AI **[30 marks]**

This question required you to write an essay of 1,000–1,200 words on the topic: 'The technological singularity: plausible prediction or science fiction?' incorporating a literature review of some relevant articles. These articles were available for free download from a special review edition of the journal *Artificial Intelligence*, Volume 171, Issue 18, pp.1093–1186 (December 2007).

Good answers will argue for one point of view while critically appraising the opposing view, and reach a conclusion. They will identify relevant points in the suggested readings and marshal them in aid of their thesis, using proper scholarly practice throughout. You should avoid phrases like 'I believe,' 'in my opinion' or 'I feel'. Marks were awarded for:

a. **Content**: knowledge displayed, understanding of source material and of basic problems. Must discuss at least the required readings for a good mark.

b. **Presentation**: argumentation, clarity of expression, evidence of novel/critical thinking, selection of material.

c. **Scholarly practice**: references to online material should give author and title if available and date last visited, not just a URL. Wikipedia should not be treated as an authoritative source and nor should YouTube. Citations should include page numbers for quoted material.

Essays should be aimed at readers whose background includes knowledge of AI roughly equivalent to the content of this module; do not waste the word count with a laborious exposition of fundamental concepts and technologies. The essay should begin by elucidating the question, briefly setting out the history and meaning of the term 'singularity' in the context of AI and sketching the different stances that have been taken.

Students were expected to refer to at least the recommended readings; extra credit was given for independent reading beyond these papers, but not instead of them (especially if only non-scholarly sources were consulted).

There were some good answers that showed understanding of the required readings and evidence of independent reading, which were cogently argued and well referenced. Other students did not attempt this question or lost marks through at least one of the following shortcomings: failure to discuss the required readings or only superficial engagement with them; lack of clarity in argumentation; poor referencing; lack of detail; and over-reliance on non-scholarly sources.