
Examiners' commentary

2018–2019

CO3310 Artificial intelligence – Zone B

General remarks

As in previous years, this examination was set as a combination of questions that tested basic knowledge and understanding of the subject ('bookwork'); problem-solving questions that required application of knowledge gained during the course; and reflective essay questions that involved argumentation and consideration of how Artificial Intelligence (AI) can be applied to real-life concerns. This also gave candidates an opportunity to show knowledge they may have gained from wider independent reading.

You are reminded to read each question carefully and address all aspects of it. In particular, when asked to 'explain', 'describe' or 'justify' something, you should make sure you have done so. Answers should not say: 'I believe/feel' or 'my opinion is...' but should be justified with evidence and argumentation. You should not argue from authority (e.g. 'Bryson says that...') without explaining the substance of the arguments.

Some questions explicitly ask you to show workings and/or give an explanation for an answer, and marks are allocated accordingly. It is good practice to show your workings on any questions that involve calculation or the application of a process, as a mistake midway may lead to a wrong answer, but you may still get partial marks if the examiners can see that you have some understanding of the problem.

The range of marks obtained for most questions was quite variable. There were several very good or excellent attempts but also a sizeable number who showed limited understanding and appeared not to have thoroughly revised for the examination.

Comments on specific questions

Question 1: Theory of AI and agents

Only about a third of candidates attempted this question, and the results were quite variable.

- a. Part (a) asked candidates to consider various definitions of AI. There is no clearly correct answer and candidates were marked on the quality of their argument and display of relevant technical knowledge and understanding. For full marks, answers should explain why some alternative definitions have been dismissed. Astute candidates might have observed that these all date from the 20th century and may well be outdated following developments such as the explosive growth of machine learning and the rise of enactivism.

Answers were not of a high standard overall. Candidates generally seemed to have difficulty in giving reasons for preferring any particular definition. The previous year's examination included a very similar question, so candidates might have been expected to have given this topic more thought.

- b. Part (b) required candidates to apply book knowledge to a particular instance, an automated medical diagnosis system. (i) asked candidates to explain what it means to be rational, which has a precise and narrow definition in this context, though it can be understood in many different ways in non-specialist language. Any reasonable, well-motivated answers to (ii) were accepted, as long as they were clearly relevant to the healthcare scenario.
- c. Part (c) concerned the 'task dimensions' for agents described in the subject guide, section 2.3. It can be hard to decide on the appropriate characteristics for some tasks, but chess ought to be fairly clear-cut as it is a clearly defined activity with explicit rules and a standard type of environment in which it is played. Most candidates had no problems with (i), but most had more difficulty answering (ii) – what difference it makes if a clock is used – and in fact nearly half did not attempt this sub-question.

Question 2: Search and planning

- a. Part (a) was essentially bookwork which should have been answerable by candidates who had read the subject guide and recommended readings carefully. Most candidates did well on this question, with many obtaining full marks, and almost all providing very good or excellent responses.
- b. Part (b) was also a bookwork question, which asked candidates to explain three terms (i–iii) in the context of AI planning. Although there were only three marks available on this question, the range of outcomes was extremely variable, with only a few candidates obtaining full marks while others showed poor understanding.
- c. Part (c) assessed candidates' understanding of the PDDL language and their ability to write a formal specification based on an informal description of a problem. This question addressed one of the course learning outcomes (subject guide, section 5.6) '*Write a PDDL specification for a given problem*'. For full marks, candidates needed to provide precise specifications for the goal, and initial states and actions in terms of preconditions and effects, to specify actions at an appropriate level of granularity, and also to use correct syntax. Partial marks were given for answers that did not use correct syntax but were sufficiently explicit for the intentions to be clear.

Question 3: Knowledge representation and natural language

- a. Part (a) assessed learning outcomes from the subject guide (section 4.7):
 - Represent knowledge using propositional and first-order logic.
 - Apply an inference procedure to determine whether a given statement is entailed by a given knowledge base.

The first part (i) was bookwork, with most candidates showing some understanding of the concepts of 'soundness' and 'completeness' in the context of formal logic, although a number did not attempt this sub-question. Many candidates replied using phrases memorised from the subject guide, such as '*the resulting sentences are actually entailed by the knowledge base*' or '*any sentence entailed by the knowledge base can be inferred*', which are insufficient out of context: resulting from what? Inferred how?

Most candidates obtained full marks for (ii), but significantly fewer showed confidence in using reasoning patterns as required in (iii). This indicated that more practice and revision of these techniques is needed. Note: the literal 'C' was not involved in the problem in (ii) and was included in error. The examiners were satisfied that this did not hinder candidates in finding a solution.

- b. Part (b) assessed candidates' ability to interpret formal grammar rules, decide whether particular strings were in the language of the grammar and construct parse trees. Some candidates obtained excellent marks, but

several answers showed a lack of attention to detail or failed to provide more than one analysis of syntactically ambiguous sentences. Some answers showed that candidates did not have a good understanding of recursive rules.

- c. Part (c) involved the λ -calculus in an augmented grammar adapted from an example in the subject guide (section 6.4). An added complication given in the examination was the use of conjunction, which is not handled in the subject guide example. Answers tended to be either excellent or very weak, with several candidates skipping this sub-question altogether.

Question 4: Learning and reasoning

- a. Part (a) was a bookwork question about terms that are explained in the subject guide (section 4.5). Most answers were assessed as very good or excellent, though as with other questions, a small number showed limited understanding.
- b. Part (b) asked how one might apply machine learning techniques to career decisions. Candidates needed to show knowledge of learning algorithms such as ID3 and to discuss appropriate sources of historical data. Generally, answers were disappointing, though some obtained very good or excellent marks. Many answers failed to suggest suitable sources of data, while some candidates simply drew what purported to be a decision tree with no real explanation of how it had been constructed.
- c. Part (c) involved Bayes' Rule, which is fundamental to modern AI and regularly features in examination questions. Candidates mostly tackled this question well, but some lost marks for failing to show their working or fully explain their results. It is important to do so to be sure of getting at least partial marks, even if your final answer contains mistakes, e.g. if you misremember the formula or make slips in the calculation.

Question 5: Philosophy and ethics of AI

This question gave candidates an opportunity to show some knowledge and reflection beyond the more narrowly technical content of the course. Very few attempted this question and the marks were the lowest for all questions in the examination.

- a. Part (a) deals with topics such as 'strong' versus 'weak' AI and the Turing Test, which are clearly and succinctly explained in the subject guide (chapter 8). As such, the examiners expected that candidates would be well prepared to answer this. Unfortunately, this was not always the case.
- b. Part (b) dealt with a question that is much discussed in the media nowadays: will developments in computing technologies lead to super-intelligent systems that will supersede or even eliminate the human race?

This can be approached in various, yet equally valid ways. One idea is that AI may threaten the sense of human uniqueness if artificial entities are perceived as conscious, possessing a concept of self, capable of moral judgments, and so on. Humans may be affected by ethical, even life-or-death decisions arrived at by automated reasoning. Super-intelligent entities may see no utility in preserving human life, particularly if they have a general mandate to mitigate climate change, which largely results from human actions. An alternative approach would be to argue that the prospect of computers attaining human-like intelligence is fanciful. The general standard of answers was disappointing, and in most cases, candidates did not manage to construct insightful and persuasive arguments drawing on their learning from this course.