# Examiners' commentary 2018–2019

## CO3310 Artificial intelligence – Zone A

### 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 Astute candidates might have observed that these all date from the 20th century and may well be outdated following developments such as the explosive growth of machine learning and the rise of enactivism.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 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) concerned the criteria for considering a computer system or 'agent' to be autonomous. It was expected that candidates would frame

their answers with reference to the statement in the subject guide (p.6) *'The extent to which the agent uses prior knowledge (instilled in it by its designer) rather than its own experience, is the extent to which that agent lacks autonomy'.* However, not all candidates seemed to recall this simple definition, though most obtained reasonably good marks.

c. Part (c) required candidates to show understanding of the agent task dimensions that are listed and explained in section 2.3 of the subject guide, and to show how they apply in two specific scenarios (i and ii). These scenarios have some similarities, but also significant differences which candidates needed to bring out. Marks were awarded for showing good understanding of the task dimensions, clearly distinguishing the two environments in terms of the challenges they pose, quality of argumentation, and clarity of expression. Some candidates obtained good or very good marks for this question while others showed limited understanding.

## 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 of the goal, initial states and actions in terms of preconditions and effects, and also use correct syntax. For example, they would need to insert an action to disable the alarm first. Actions should be specified at an appropriate level of granularity, e.g. one cannot simply teleport from bedroom to kitchen. Answers to (ii) should indicate location of any control panel for the alarm. 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. 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. Candidates were given a small fragment of English (taken from the course subject guide) and asked to decide whether particular strings were in the language of the grammar, and construct parse trees. Some candidates obtained excellent marks here, but several answers showed a lack of attention to detail, failed to provide more than one analysis of syntactically

ambiguous sentences or included made-up rules that were not in the provided grammar.

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 (sections 4.5 and 7.3). Most answers were assessed as very good or excellent, though as with other questions, a small number showed limited understanding.

b. Part (b) was a combination of bookwork and problem solving. Candidates were required to know what is meant by a joint probability distribution and be able to calculate probabilities. Many candidates seemed unaware that a probability distribution must sum to 1.0. Candidates generally did better on (i) than (ii), but this is clearly an area where more practice and revision are required.

c. Part (c) involved decision trees. Many candidates did not attempt (i), about information gain, while others stated that it has to do with entropy but without explaining what this means. Marks for (ii) were variable though quite a few obtained full marks. Answers to (iii) were expected to suggest that some surprising properties of the tree were due to incomplete data. There were some good answers, though again, many did not attempt this part of the question.

## Question 5: Philosophy of AI

The question involved philosophical issues relating to AI. The question required a combination of book knowledge and more imaginative, reflective writing. Very few candidates attempted this question and the marks were the lowest for all questions in the examination.

a. Part (a) dealt with topics such as 'strong' and 'weak' AI, the Turing Test and the Chinese Room scenario, 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. The point of part (b) was that Darwin's theory threatened the sense of human uniqueness, by blurring distinctions between us and the animal kingdom, and there might be a similar impact if AI were to succeed in producing human-level intelligence. There were some thoughtful answers given, but most failed to engage with the point of the question.