Examiners' commentary 2017–2018

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, and gave candidates an opportunity to show knowledge they may have gained from 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 workings on any questions that involve calculation or the application of a process, as a mistake midway may lead to a wrong answer. You may still get partial marks if the examiners can see from your answer that you have some understanding of the problem.

Comments on specific questions

Question 1

Natural Language

Part (a) of this question was bookwork, concerning differences between formal and natural languages. Some characteristics of the latter are ambiguity, idioms and context-dependence of meaning. Please note, the question says *describe* not *list*; good answers would have given examples of each of these.

Part (b) used "toy" grammars to assess candidates' understanding of different classes of formal grammars. These distinctions are fundamental to NLP, while formalisms equivalent to context free and regular grammars are found throughout Computer Science, such as BNF specifications and regular expressions. It is important for candidates to be comfortable with these formalisms, which are clearly explained in the subject guide.

Part (c) asked students to construct a set of formal rules to handle various grammatical constructions. It was not essential to use technical terms for the constructions as long as the meaning was clear. For full marks, grammars should be concise and general rather than tailored to individual examples in an adhoc manner. It is often helpful to consider whether *recursive* rules are appropriate.

Question 2

Search and Planning

Part (a) was essentially bookwork which should have been answerable by candidates who had read the subject guide and recommended readings carefully.

Part (b) concerned heuristic functions. Candidates sometimes appear confused between heuristic *functions* and heuristic *search methods* such as A* and greedy search. Only examples of the former were acceptable answers to this question, e.g. straight line distance for route-planning problems. A heuristic function is often a solution to a simpler problem, with fewer constraints.

Part (c) assessed candidates' understanding of the PDDL language and of the difference between progressive and regressive planning. When answering questions like this it is important to explain your answer and to stick to the actions, predicates and states used in the problem statement rather than making up your own.

Question 3

Theory and Philosophy of AI

Part (a) asked candidates to consider various definitions of Artificial Intelligence. There is no clearly correct answer and candidates would be 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 may observe that these all date from the 20th century, and may well be outdated following such developments as the explosive growth of machine learning and the rise of enactivism.

Part (b) addressed an increasingly topical question about liability for injuries or fatalities caused by self-driving cars. Again, there is no obviously correct answer. Some possible arguments are:

- Anyone operating a machine is responsible for the consequences of its use.
- Designers are responsible for the correct action of an artefact.
- An autonomous machine may act in ways which are not expected or understood by its operator, or fully predictable by designers – e.g. if the system has been trained using ML.
- AI systems may in future be legally recognised as responsible "persons", responsible for their own actions, though this still belongs to science fiction.

Marks were given for display of technical knowledge and understanding of theoretical/ethical issues; constructing arguments to defend/rebut a thesis; clarity of expression and good use of English.

Question 4

Logic and reasoning

Part (a) involved two ways of reasoning with propositional (Boolean) logic: "syntactic" using *reasoning patterns*, and "semantic" using *truth tables*. This is dealt with in the subject guide, section 4.3, but many candidates did not appear to know what was meant by literals or reasoning patterns. Some credit was given for showing the ability to construct truth tables – however when answering this kind of question, it is not enough to construct a table, candidates must also *explain* how it manifests certain inferences.

Part (b) involved predicate calculus or FOPC, referred to as First-Order Logic (FOL) in the subject guide. This is a topic that candidates sometimes struggle with, for example using a "wrong" connective with the universal or existential quantifier. It is important to revise this topic thoroughly, from the subject guide and other resources such as Oxford University's online tutorial cited in the first coursework assignment for this session. FOL is an important topic to study not just as an intellectual exercise but because it underlies symbolic AI approaches to knowledge representation and automated reasoning.

Part (c) involved probabilistic reasoning and Bayes' Rule. This is a topic which regularly comes up in examinations, and is a fundamental tool for probabilistic reasoning in many fields of study. To get full marks, candidates needed to remember the formula correctly and understand it, decide how to instantiate the variables with values from the question, carry out the calculations and explain their solutions. Partial marks could be gained from incomplete answers, for example if candidates misremembered the formula or went awry in the calculation.

Question 5

Agents and Learning

Part (a) was bookwork and should have been answerable by candidates who had familiarised themselves with the subject guide.

Part (b) probed candidates' understanding of the notion of *rationality* as defined in the subject guide. Examples such as the thermostat and ballcock (or "float valve") raise questions of whether an agent can be termed rational entirely on the basis of its behaviour, or if some internal "mental" states are required: if rationality is to be assessed purely on behavioural or operational criteria, it may be hard to see how we can avoid calling a purely mechanical device "rational".

Part (c) involved machine learning and decision trees. This question combined book knowledge and problem-solving. Part of the question asked candidates to make intuitive choices, so different answers were possible. Candidates may have had some surprising results, indicating that the data did not cover all possible choices. Depending on branching choices, results may have been highly granular, e.g. with paths accounting for just one example – indicative of *overfitting* results which may not generalise well.