Examiners' commentaries 2016–17

CO3310 Artificial Intelligence

Zone A

General remarks

As in previous years, this examination was set as a combination of questions that tested your basic knowledge and understanding of the subject ('bookwork'); problem-solving questions that require you to apply your knowledge; and reflective essay questions that involved argumentation and consideration of how Artificial intelligence (AI) can be applied to real-life concerns.

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. Chomsky 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. If all that is given is the incorrect answer, no marks can be awarded. If examiners see workings showing what you understand, then partial marks may be awarded.

It is important to write legibly as marks may be lost where examiners are unable to decipher what you have written. You should number your answers clearly and correctly, and write legibly throughout. Examiners will do their best, but if they cannot read or make sense of something, it is very hard to award marks.

Furthermore, if you attempt a question that you do not want to be marked, then simply cross it out. Examiners will mark the first three answers only; some candidates had attempted four questions.

Examiners appreciate you crossing rough work through, so it is not inadvertently marked. Simply strike it through, as examiners may look at it to see if any extra marks can be found where an answer needs additional support.

Question 1: Learning agents

This question focused on the issues in using machine learning in intelligent agents.

a. This question provided an opportunity for candidates to identify classification and regression problems. Good answers included both identification and explanation. Candidates generally answered this well.

b. This question explored the differences between supervised, unsupervised and reinforcement learning. Good answers captured concisely both what is learned and what information is used (e.g. labels, rewards, etc.). It is important to note that descriptions of specific methods were not required. Again, candidates generally answered this well.

c. i. This question asked candidates to characterise an agent's task environment in terms of relevant dimensions (section 2.3 of the subject guide). Good answers not only did so, but also included an explanation. Candidates generally answered this well. Marks were lost for lack of rationale or misunderstanding the scenario and how it related to the dimensions.

ii. This question focused on agent performance measures. Good answers clearly proposed measures that related well to the scenario, and noted their trade-offs (e.g. speed versus safety/legal constraints).

iii. This question invited candidates to argue whether it was better to train learning agents in the actual or a virtual (simulated) environment. The key here is to note both have advantages and shortcomings, to describe them, showing appropriate technical knowledge and provide reasonable argument to support the answer. Excellent answers explored how the two could be combined to best effect.

Question 2: Logic and reasoning

This question focused on logic and probabilistic reasoning.

a. This question was not always answered well. There was some confusion about what the concepts meant and as a result the explanations were lacking in clarity.

b. This question was generally answered poorly; common errors included:

- Not defining constants, predicates, etc.
- Proposing incorrect predicate logic sentences (including writing notation incorrectly).
- Not providing a (brief) explanation of how the above was arrived at.

c. This question was generally answered well; most candidates were able to produce correct truth tables.

d. This question was generally answered well; most candidates were able to recall and apply the appropriate form of Bayes' rule. The most common errors were:

- Using the wrong form of Bayes' rule.
- Incorrectly assigning the numbers given in the question to the calculation.
- Not showing working/calculations clearly.

Question 3: NLP

This question focused on natural language processing.

a. This question was generally answered adequately in terms of definitions. Weaker answers showed problems in terms of explaining the differences, say, between parsers and recognisers.

b. This question was generally answered well; areas where marks were lost included:

- Identifying the wrong grammar type.
- Not giving a (brief) explanation for the choice of grammar type.
- Errors in the proposed shortest string for each grammar.

c. i. The quality of answers for this question was variable; areas where marks were lost included:

- The proposed sentence was not the shortest legal sentence for that grammar (there may be more than one in such questions).
- The proposed parse tree was either not consistent with the grammar or was very untidy and thus hard to understand.
- Not giving a (brief) explanation for the above.

ii. The quality of answers for this question was also variable. Areas where marks were lost included:

- Not clearly stating the proposed extensions to the grammar (this was surprisingly common).
- The parse trees were either not consistent with the extended grammar or were very untidy and thus hard to understand.
- Failing to check if the cases given are solvable (or excluded in two cases).
- Not giving any explanation for the above.

Outstanding candidates gave rules that were both compact and generalisable (e.g. allowing an arbitrary number of adjectives).

d. This question highlighted a common lack of understanding of the Lambda calculus. Figure 6.3 in the subject guide and its commentary should be read to address this, and for guidance on how similar questions should be answered. It is also important in questions of this type to state the specimen grammar rules clearly, and provide an explanation/rationale.

Question 4: Search and planning

This question aimed to test understanding of heuristic search and planning using PDDL.

a. i&ii These two questions are essentially bookwork, and should not have caused much difficulty. However, a substantial minority of candidates struggled with the completeness and optimality requirements for breadth-first search.

b. This question involved discussing heuristics for solving an eight-puzzle problem. As noted in previous commentaries, it is important to keep in mind the distinction between a heuristic function and heuristic search: the former is a means of providing information to a search to choose how to get to a goal, such as choosing the node with the shortest straight-line distance to the goal in a route-finding problem; while the latter is a common term for informed search algorithms that use heuristic techniques.

i. For this question most candidates proposed and justified two sensible heuristics.

ii. For this question some candidates had problems with the concept of admissibility and how to argue whether a heuristic function exhibits this property.

iii. For this question marks were lost through calculation error and/or not clearly showing working.

c. i. This question involved writing out a plan and operators in planning domain definition language (PDDL) to solve a blocks-world problem.

Some candidates provided incomplete specifications of operations, for example, not giving all preconditions and effects (especially clear ()).

Another common mistake was not specifying a full set of operators; for example if you have a block-to-table operator, you will need its reverse.

ii. For this question most candidates included a plan but failed to provide the effects at each step, as specified in the question, thus losing marks.

The structure and application of PDDL operations is described in the subject guide, and the problems provided as 'learning activities' should have prepared candidates to tackle this question well.

It bears repeating from last year's Examiners' commentary, that it is important to practise for questions like these by working through sample questions, using both the subject guide and past examination papers.

Question 5: Philosophy of AI and social issues

This question covered some well-known issues in the philosophy of AI, and asked candidates to address some social and ethical implications of applications of AI techniques. Marks for both parts were given according to: demonstration of familiarity with the source texts and other relevant specialist knowledge; clarity of expression; organisation of material and argumentation; presenting evidence for and against a thesis; and reaching a conclusion.

a. This question is essentially bookwork involving some anticipated counter arguments against Turing's argument for thinking machines. This was adapted from a learning activity in the subject guide, so candidates should have been well prepared. Sadly, answers were generally rather weak, with poor awareness and understanding of the counter arguments.

b. This question focuses on the consideration in Russell and Norvig's Artificial intelligence: a modern approach. (Chapter 26) of a number of potential risks arising from the continuing development and deployment of AI systems. Answers here were generally stronger than those for (a), but still disappointing overall. Many answers showed the level of understanding that might be expected of an 'intelligent layperson' from reading science magazine coverage, rather than degree level study.

   Candidates who achieved the highest marks generally showed awareness of social and ethical issues beyond the scope of the required reading for this course. They also drew upon examples of AI systems or mentioned other sources and arguments to support their arguments.

It was evident that some candidates struggle to express themselves in an essay format, and perhaps have not had much practice. There are resources on the internet on academic English (English for academic purposes) and examination essay writing that candidates may wish to explore.

It is worth repeating from last year's Examiners' commentary that questions of this nature are not 'easy options' but instead require appropriate specialist knowledge as well as an ability to construct arguments and express relatively complex topics clearly and concisely.

You are advised that you will not gain any marks simply for filling space; for example, by repeating the body of the question before embarking on an answer.

Examiners' commentaries 2016–17

CO3310 Artificial intelligence

Zone B

General remarks

As in previous years, this examination was set as a combination of questions that tested your basic knowledge and understanding of the subject ('bookwork'); problem-solving questions that require you to apply your knowledge; and reflective essay questions that involved argumentation and consideration of how Artificial intelligence (AI) can be applied to real-life concerns.

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. Chomsky says that…) without explaining the substance of the arguments.

Some questions explicitly ask you to show working 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. If all that is given is the incorrect answer, no marks can be awarded. If examiners see workings showing what you understand, then partial marks may be awarded.

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Question 1: Logic and reasoning

This question focused on logic and probabilistic reasoning.

a. This question was not always answered well. There was some confusion about what the two concepts meant and as a result the explanations were lacking in clarity.

b. This question was generally answered poorly; common candidate errors included:

   - Not defining constants, predicates, etc.

- Proposing incorrect predicate logic sentences (including writing notation incorrectly).
- Making errors in converting between universally and existentially quantified logical sentences (hint: learn and practise the key logic identities to convert between the two).
- Not providing any (brief) explanation of how the above was arrived at.

c. Answers to this question showed occasional confusion between the concepts of prior and conditional probability. Those who were clear about that were generally able to perform the calculation. Most candidates also thankfully remembered to show working.

d. This question was generally answered well; most candidates were able to recall and apply the appropriate form of Bayes' rule. The most common candidate errors were:

- Using the wrong form of Bayes' Rule.
- Incorrectly assigning the numbers given in the question to the calculation.
- Not showing working/calculations clearly.

Question 2: Search and planning

This question aimed to test candidates' understanding of search and planning using PDDL.

a. This question was essentially bookwork, and candidates were generally able to give examples of informed and uninformed search, though the clarity of explanation of the concepts was not always strong.

b. This question was essentially bookwork, and candidates were generally able to describe progressive and regressive planning clearly, though the discussion of their strengths and weakness was significantly weaker.

c. This question involved discussing heuristics for solving an eight-puzzle problem. As noted in previous commentaries, it is important to keep in mind the distinction between a heuristic function and heuristic search: the former is a means of providing information to a search to choose how to get to a goal, such as choosing the node with the shortest straight-line distance to the goal in a route-finding problem, while the latter is a common term for informed search algorithms that use heuristic techniques.

   Most candidates were able to propose two sensible heuristics. Marks were lost through calculation error and/or not clearly showing working.

d. This question involved writing out a plan and operators in planning domain definition language (PDDL) to solve a blocks-world problem.

   i. For this question some candidates gave incomplete specifications of operations, for example, not giving all preconditions and effects (especially clear ()). Another common mistake was not specifying a full set of operators, for example if you have a block-to-table operator, you will need its reverse.

   ii. For this question most candidates gave a plan but forgot to provide the effects at each step, as specified in the question, thus losing marks.

   The structure and application of PDDL operations is described in the Subject guide, and the problems provided as 'learning activities' should have prepared candidates to tackle this question well.

   It bears repeating from last year's Examination commentary, that it is important to practise for questions like these by working through sample questions, using both the Subject guide and past examination papers.

Question 3: Learning agents

This question focused on the issues in using machine learning in intelligent agents.

a. This question provided an opportunity for candidates to describe (not just list) the two types of supervised learning and give an application for each. Candidates generally answered this well. The main loss of marks was due to lack of clarity.

b. Answers to this question were mixed, with candidates more often than not able to describe overfitting (albeit with varying clarity). Answers tended to be vague regarding measures to prevent it.

c. This question was generally answered well, requiring mostly bookwork.

d. i. This question asked candidates to characterise an agent's task environment in terms of relevant dimensions (section 2.3 of the Subject guide). Good answers not only did so, but also included an explanation. Candidates generally answered this well. Marks were lost for lack of rationale or misunderstanding the scenario and how it related to the dimensions.

ii. This question focused on agent performance measures. Good answers clearly proposed measures that related well to the scenario, and noted their trade-offs (e.g. speed vs safety/legal constraints).

Question 4: NLP

This question focused on natural language processing.

a. This question was generally answered adequately in terms for two out of three types of ambiguity; after that point responses became more vague. Candidates are advised to look again at the subject guide on this topic.

b. This question was generally answered well; areas where candidates lost marks included:

- Identifying the wrong grammar type.
- Not giving a (brief) explanation for the choice of grammar type.
- Errors in the proposed shortest string for each grammar.

c. i. The quality of answers for this question was generally variable; areas where candidates lost marks included:

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- Similarly failing to check if the cases given are solvable (or excluded in two cases).
- Not giving any explanation for the above.

Outstanding candidates gave rules that were both compact and generalisable. In many cases, the distinction between transitive and intransitive verbs needed to be better understood.

d. This question highlighted a common lack of understanding among candidates of the Lambda calculus. Figure 6.3 in the subject guide and its commentary should be read to address this, and for guidance on how similar questions can be answered. It is also important in questions of this type to state the specimen grammar rules clearly, and provide an explanation/rationale.

Question 5: Philosophy of AI and social issues

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a. This question is essentially bookwork involving Searle's Chinese room argument, and strong and weak AI. This is a central argument in the philosophy of AI, so candidates should have been well prepared. Sadly, answers were generally rather weak, with poor awareness and understanding of the detail of the concepts.

b. This question focuses on a phrase by G.K. Chesterton that could be addressed in a number of ways (examiners were open to varying interpretations). Answers here were generally stronger than those for (a), but still disappointing overall. Many answers showed the level of understanding that might be expected of an 'intelligent layperson' from reading science magazine coverage, rather than degree level study.

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