MODULE J HARDWARE AND EMERGING TECH · J8

Machine learning: mark scheme

22 marks · Cambridge 0478 syllabus 6.3.2 (main characteristics of AI: the collection of data and the rules for using that data, the ability to reason, the ability to learn and adapt) and 6.3.3 (basic operation and components of AI systems, limited to expert systems and machine learning; machine learning is when a program has the ability to automatically adapt its own processes and/or data)

How to use. One mark per creditworthy point up to the maximum shown. **/** separates alternative words; **//** separates alternative answers. Words in (brackets) are not needed for the mark. "..." at the start of a point means it builds on the point before. Credit any other valid answer that shows the same understanding. In the scenario questions (3(b), 4 and 5), an answer that is not linked to the scenario is capped as shown in the guidance.

QUESTION	ANSWER	MARKS	GUIDANCE
1(a) 0478 6.3.3	Any two from: A program / (AI) system that can adapt / change its own processes // its own data // its own rules ... automatically // by itself // without a programmer rewriting / reprogramming it It learns from data // from experience // from the results of its past decisions / mistakes It finds / identifies patterns in data ... so that its performance improves // it makes better decisions / predictions over time	**2**	max 2. "It learns" alone, with no reference to data, experience or adapting, is too vague. Do not credit "a robot" or "a computer that thinks like a human".
1(b) 0478 6.3.2	The ability to learn // the ability to adapt // the ability to learn and adapt	**1**	Do not credit "the ability to reason" or "the collection of data and rules".
2 0478 6.3.3	One mark for each correct row: Facts gathered from human experts, stored in a knowledge base: expert system Automatically changes its own processes as it is given more data: machine learning Inference engine applies a rule base to the facts: expert system Finds patterns in the results of past decisions to make better decisions: machine learning	**4**	A row with both boxes ticked scores 0.

QUESTION	ANSWER	MARKS	GUIDANCE
3(a) 0478 6.3.2	Any two from: The photos (taken by the cameras) // features in the photos, e.g. the size / shape / colour / markings of the animal The species it identified for each photo // its past identifications The corrections made by the volunteer // the correct species for a photo // whether each identification was right or wrong The time / date / season a photo was taken The location / which camera / which part of the forest took the photo	**2**	max 2. Credit any other valid item of data that the software could have in this scenario. Two answers that are the same item (e.g. "colour of the animal" and "shape of the animal", both features in the photo) score 1. Do not credit "data" or "information" alone.
3(b) 0478 6.3.3	Any four from: The software collects / stores data from (each new) photo // stores its identifications It uses the volunteer's corrections to find out which identifications were wrong // stores successful / unsuccessful identifications It finds / identifies patterns, e.g. features that a species has in common // features that led to mistakes It (automatically) adapts / changes its own processes // its own data // its own rules for identifying a species ... without a programmer having to rewrite / reprogram the software ... so it does not repeat the same mistake // it makes fewer wrong identifications The more photos / corrections it receives, the more data it has to learn from // it keeps improving as new photos arrive	**4**	max 4. Max 2 if the answer is not linked to the photos, species or corrections in the scenario. Do not credit "the volunteer reprograms the software": correcting an identification gives the software data, it does not rewrite the program.

QUESTION	ANSWER	MARKS	GUIDANCE
4 0478 6.3.2	One mark for each different characteristic (max 3): Collection of data // stores data Rules for using the data // has rules Ability to reason // makes decisions / predictions // solves problems Ability to learn / adapt One mark for each matching description in context (max 3): **Collection of data:** stores data about the vans (e.g. route / space / weight limit) and the parcels (e.g. size / weight / address) // records which parcels were late **Rules:** has rules such as which area each van covers // a parcel must fit in the van's free space **Reason:** applies the rules to the data (about a new parcel) to decide which van it goes on // works out the best van for each parcel **Learn and adapt:** uses the record of late deliveries to change how it chooses vans // adapts its own rules / data so fewer parcels are late // does not repeat a choice that led to a late delivery	**6**	max 6. Characteristics may be given in any order. A description is credited only if it matches the characteristic in the same row and is linked to the parcel depot. A characteristic repeated in two rows is credited once. Collection of data and rules for using the data may be given as two separate characteristics or as one; if both are given in one row, credit one characteristic mark for that row. Do not credit "it is intelligent" or "it thinks like a human" as a characteristic.
5 0478 6.3.3	Any three from: It collects / records data about when staff arrive / leave // the temperature (inside the building) // how long the building takes to warm up It finds / identifies patterns in the data, e.g. staff usually arrive at the same time on weekdays // nobody arrives at weekends It uses the patterns to predict when staff will arrive ... and switches the heating on early enough that the building is warm when staff arrive // does not heat the building when it is empty It (automatically) adapts / changes its own processes // its own data // its heating times when the pattern changes, e.g. staff start arriving earlier ... without anyone having to program / enter heating times	**3**	max 3. Max 1 for a generic description of machine learning that is not linked to the heating, the staff or the temperature. Do not credit "a person sets the heating times".

Total: 22 marks