

# Markscheme

**May 2025**

**Digital Society**

**Higher level**

**Paper 3**

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1. (a) An applicant's IB Diploma Programme score is an example of a data point.

Identify **two other** examples of data points that may be used by the artificial intelligence (AI)-based decision-making tool. **[2]**

Answers may include:

- Candidate code.
- Individual subject grades / scores e.g. GPA, SAT, TOEFL.
- Age.
- Gender.
- Behavioral traits such as diligence, resilience.
- CAS activities - CAS Project, Hours, school activities or extra curricula.
- Membership to Clubs.
- Ranking in academic or extra-curricular activities.
- Postcode / Zip code.
- Any point that the AI picks up in the video application about the person and the content e.g. facial expression.
- Reason to join University, goals & aspirations.
- Criminal record.
- Work experience e.g. volunteer work, or part time work experience.
- Number of years in education.

*Note: Other examples are accepted if they are found on a university application*

*Note: Do not award a mark if a student only refers to 'Activities' in general without reference to school or clubs*

*Award **[1]** for each appropriate additional data point identified up to **[2]**.*

- (b) Outline the difference between qualitative data and quantitative data. **[2]**

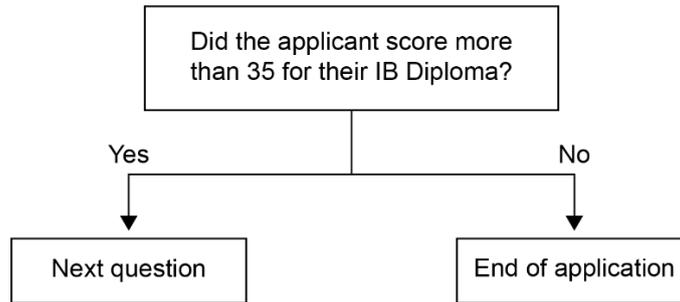
Answers may include:

- Quantitative data is numerical data/countable/measurable/grouped data, yes/no questions.
- Qualitative data is text based / descriptive data (basically not numbers) or examples demonstrating the correct data type, eg. verbal could be collected from the video.

*Award **[1]** for a correct definition of each term identified up to **[2]** or there is a distinction between quantitative and qualitative is clear.*

*Note to examiners: It is not necessary to make a direct comparison for **[2]**.*

2. (a) **Figure 1** shows an example of a condition that could be used in the decision tree for the rule-based decision-making tool.



Explain **two** reasons why the use of this condition in the decision tree may result in some suitable applicants being rejected.

**[4]**

Answers may include:

- The condition may be too crude lacks detail / contains aggregated information.
- And does not give an indication of the applicant's ability for the course they are intending to study.
- There is no contextual information behind the single score – it is a final number that does not indicate how or why it was achieved, or if there were special circumstances at the time of the examination e.g. illness.
- The reason for choosing 35 as the boundary is not explained or justified – the criterion is too simplistic.
- It does not take into account the background of the applicant
- for example, the applicant may come from a more challenging environment and score less than 35 points may but have had to work harder or have a better aptitude for learning may get rejected.
- A single score does not allow for consideration of the different subjects the student studied or does not differentiate between high scoring subjects and low scoring subjects that are appropriate for the course being applied for.
- for example, a student applying to study science and scores 7 in HL Maths and HL Sciences but a grade 3 in languages, could be rejected if the overall score was less than 35.
- The IB Diploma score does not take into account personal pursuits which may be valued by the university.
- A student may be a good fit for the course but not have the 35 points and therefore the application would stop there and not give an opportunity to share this information.
- The condition does not take into account applicants who enrolled on other courses.
- And this does not account for an equivalent score in a different exam board and therefore would reject this student.

*Award **[1]** for identifying a reason why the condition may prevent some suitable applicants moving beyond the website stage of the application and **[1]** for linking it back to the rejection of a suitable candidate or why they should be accepted **[2]**.*

- (b) Explain why a large amount of training data would be needed to train the AI-based decision-making tool.

**[2]**

Answers may include:

- Small data sets for training may lead to the machine-learning algorithms only being able to operate correctly with a narrow set of inputs.
- Therefore, any applicant that is outside of this narrow range may not be processed correctly.
  
- Large data sets are required to generate the models learning curve which plot a model's performance against the amount of training data.
- Learning curves help identify whether a model is suffering from high bias and can guide decisions about how much more data to collect.
  
- Large data sets can lead to improved accuracy.
- As the model sees more varied examples, its predictions become more accurate because it has learned to recognize patterns from a wider scope of data.
  
- Large data sets can lead to a greater diversity of data.
- A large number of data points ensures that a large variety of attributes can be used to better judge the applicant.

*Award **[1]** for identifying a reason why a large amount of training data is used to train the AI tool and **[1]** for a development of that reason up to **[2]**.*

3. An applicant's attributes can be converted into a series of data points.

To what extent is it acceptable for an applicant's attributes to be represented by a series of data points?

[8]

Answers may include: (in brackets are the concepts and intervention evaluation criteria related to the answer)

**Acceptable**

- Need to provide data that can be processed using quantitative methods (systems, feasibility)
- Quantitative methods will allow stereotypes or personae to be developed that mirror the desired attributes, allowing the organization to quickly reduce the number of applicants to a manageable level (values, feasibility, cost)
- Using a set of numbers for each attribute ensures that bias is not present in the assessment of the attributes as it is a quantitative measurement so more objective than a qualitative measurement (power, systems, values, ethics, equity)
- Qualitative descriptions of applicants are difficult to process. (feasibility)
- Comparing the attributes of two people is very difficult as they are complex, and each person is different, so to be able to reach a final judgement they need to be simplified (values, feasibility)

**Not acceptable**

- A person is too complex to be converted into a set of data points (values, ethics)
- When you convert a subjective attribute such as motivation to a data point, or provide it with a weighting in the calculations, how can you guarantee each applicant has exactly the same quality assigned to the same quantitative number for the attribute, or is used in the same way in an algorithm? (values, ethics, equity)
- A complex attribute such as motivation needs to have a number of data points to adequately describe it for a particular person, not just one (systems, values, ethics, feasibility, acceptability)
- It is unjust to simplify a complex person to a set of numbers – too much is left out. (ethics)
- There is a definite chance that some important attributes are over simplified, or not used at all, which is clearly unfair to the applicant (systems, values, ethics, feasibility acceptability, equity)
- There may be inherent biases in the machine learning models that process the applications (values, ethics).
- These biases may perpetuate inequities in the screening process (values, ethics).
- Poor quality and insufficient quantity of the training data could negatively impact the process and the result could be incorrect or imprecise in a number of ways. (feasibility)

**Other Considerations**

- Some use of data points can lead to discrimination and should not be used to represent the applicant e.g. gender, race, religion (ethics)
- Some data points maybe optional and therefore this set of data would not be complete and therefore may not be acceptable to be analysed accurately

**Evaluation:**

A final evaluation needs to be provided, **as a conclusion, or in the body of the response – structured or integrated**, based on a balanced analysis of the reasons for and against. The conclusion may also contain ways to ensure the negative impacts of issues with the results can be checked and remedied, and to enhance the positive results. For example:

- It is acceptable to simplify a person to a set of numbers to reach a tentative judgement of their application, BUT to ensure fairness, and to provide transparency and trust, their needs to be a step after the judgement to do a more detailed and nuanced assessment of an applicant if the judgement is not clearly for or against the application.
- What is the impact of errors in the conversion of the applicant's attributes into a set of data points?
- The main reason is to provide an efficient process and an objective comparison that is enough to make a judgement, so it is acceptable for a broad comparison of many applicants even though there may be inherent flaws within both tools.
- It is not acceptable as the assessment will impact a person for a long time and so it needs to be more carefully considered.
- The Admissions Department needs to find a way of separating people with uncommon attributes to be assessed separately, and the remainder can have an initial screening based on the intervention too.
- It is justified to simplify a complex person to a set of numbers for the purpose of a more efficient process. It is a pragmatic compromise.
- Ensuring high quality and sufficient quantity of training data is an important consideration to the extent that the conclusion can be accepted.
- Also, the results of the algorithm need to be checked and verified using other processes, usually manual, to ensure that it is working properly and can be trusted to provide a correct result.

Acceptable reasons should be a mixture of pragmatic considerations, AND ethical implications as 'acceptable' implies the presence of harm/benefit which is an ethical consideration. If the ethical considerations are not included the response lacks an understanding of the requirements of the question.

Keywords: power, systems, ethics, value, data, information, subjectivity, judgement, algorithms, bias, transparency, trust.

*Please see generic markband on page 8.*

The following markband should be used with responses to question 3.

HL Paper 3, question 3	
Marks	Level descriptor
0	The work does not reach a standard described by the descriptors below.
1–2	<ul style="list-style-type: none"> <li>• The response shows a limited understanding of the demands of the question.</li> <li>• The response is of limited relevance. The response is descriptive and consists mostly of unsupported generalizations.</li> <li>• The response has limited organization.</li> </ul>
3–4	<ul style="list-style-type: none"> <li>• The response shows some understanding of the demands of the question.</li> <li>• The response is primarily descriptive with some evaluation demonstrated but this is not sustained or fully supported.</li> <li>• The response is partially organized.</li> </ul>
5–6	<ul style="list-style-type: none"> <li>• The response shows adequate understanding of the demands of the question.</li> <li>• The response demonstrates adequate evaluation that is relevant and supported.</li> <li>• The response is adequately organized.</li> </ul>
7–8	<ul style="list-style-type: none"> <li>• The response is focused and shows an in-depth understanding of the demands of the question.</li> <li>• The response demonstrates sustained evaluation that is relevant and well-supported throughout.</li> <li>• The response is well-structured and effectively organized.</li> </ul>

4. Border University has to choose between two interventions to address the challenge of improving the selection process for future students:
- **Intervention 1:** A rule-based decision-making tool
  - **Intervention 2:** An AI-based decision-making tool

Recommend which of the interventions Border University should choose.

[12]

Answers may include:

**Advantages of rule-based systems**

- Require less development time and cost than AI systems (cost, feasibility).
- Are more likely to be developed ‘in house’ so modifications are probably more straight forward to make (cost, feasibility).
- Greater transparency than an AI system (transparency, trust) as the steps in the decision making can be observed. (ethics)
- All data relating to the applicants is held by Border University (privacy, acceptability, accountability, trust, ethics).

**Disadvantages of rule-based systems**

- Rigid as all decisions are binary which do not match the qualitative data that is included in the data points from the applicant (cost, feasibility).
- Unable to cope with situations that have not been planned by the developers (feasibility).
- May need to be updated every time a new course is added, or entry requirements change (cost, feasibility).
- The domain expert may not have sufficient knowledge to develop the system (feasibility).
- The nature of chaining the decisions in the algorithm used may not produce appropriate outcomes, either they are almost pre-determined or? the range of acceptable outcomes is too broad (feasibility)

**Advantages of AI systems**

- The AI system can learn over time and provide better outcomes each year (innovations).
- Training data can be used to ensure the accuracy of the results of the machine learning algorithms are maintained (cost, feasibility).
- May be able to determine patterns that are not apparent to the developers of a rule-based system (cost, feasibility, innovation).

**Disadvantages of AI systems**

- Is there sufficient data to make the training data set usable? (feasibility).
- Is the cost of developing the system for a single university prohibitive? (cost, feasibility).
- The system may be outsourced, so unless the information provided to the developer is sufficiently detailed the system may not provide accurate information (cost, feasibility).
- Is there a danger the decision making has been outsourced too much? (I.e., the team at Border University do not have sufficient input into who is accepted on to the course (power, ethics, acceptability, accountability).
- Who is ultimately accountable for the outcomes of the decision-making process, will the partnership between Border University and the AI developer cause a blurring of accountabilities? (power, systems, ethics, acceptability, accountability)

**Comments that apply to both systems**

- Both systems may be developed with inherent (algorithmic) biases (power, systems, ethics, acceptability, equity)
- To what extent is the human element required in selection of applicants? (power, systems, values, ethics).
- Neither system has the ethical implications of the decisions made included in their processes – these need to be considered in a ‘review of the decision’ process. (power, systems, values, ethics).
- Neither system takes into account the overall goals of the university selection process, e.g. the increase of diversity in the applicants selected. (power, systems, values, ethics).
- In this case the numbers may be small, but if a number of universities worked together the data could be pooled to increase the usability of an AI system (power, systems, cost).
- The AI system will provide much more accurate/ detailed / relevant information, but the costs of implementing the system may not be cost effective (systems, cost)

**Keywords:** change, power, systems, ethics, value, data, algorithm, machine learning, supervised learning, artificial intelligence, equity, acceptability, accountability, transparency, trust, feasibility, cost, innovation

*Please see generic markband on page 11.*

*Notes for examiners:*

*Please pay attention to responses that appear to be pre-rehearsed or generic.*

*When evaluating the interventions, the ‘Evaluation Framework’ should be used. The six criteria are– Equity, Acceptability, Cost, Feasibility, Innovation and Ethics.*

The following markband should be used with responses to question 4.

HL Paper 3, question 4	
Marks	Level descriptor
0	<ul style="list-style-type: none"> <li>The work does not reach a standard described by the descriptors below.</li> </ul>
1–3	<ul style="list-style-type: none"> <li>The response shows a limited understanding of the demands of the question.</li> <li>The response consists mostly of unsupported generalizations with limited relevant knowledge.</li> <li>No recommendations are presented or those that are presented have only limited support.</li> <li>The response has limited organization.</li> </ul>
4–6	<ul style="list-style-type: none"> <li>The response shows some understanding of the demands of the question.</li> <li>The response demonstrates some knowledge, but this is not always relevant or accurate and may not be used appropriately or effectively.</li> <li>Recommendations are presented with some support although this is not sustained and only partially effective.</li> <li>The response is partially organized.</li> </ul>
7–9	<ul style="list-style-type: none"> <li>The response shows adequate understanding of the demands of the question.</li> <li>The response is adequately supported with relevant and accurate knowledge.</li> <li>Recommendations are presented and effectively supported.</li> <li>The response is adequately organized.</li> </ul>
10–12	<ul style="list-style-type: none"> <li>The response is focused and shows an in-depth understanding of the demands of the question.</li> <li>The response is well-supported throughout with relevant and accurate knowledge.</li> <li>Recommendations are presented and well-supported with a clear consideration of possible trade-offs and implications.</li> <li>The response is well-structured and effectively organized.</li> </ul>

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