Modelling and Evaluation

Standard difficulty · 20 questions · 40 marks · Time: 40 minutes

Name: _____ Date: _____ Score: ____ / 40

Show your working for Sections B and C. Answers are on the last page — try every question first!

Section A — Choose the correct answer — 8 × 1 = 8 marks

1. A true positive is when:

(a) the model makes no prediction

(b) the case is positive and the model predicts negative

(c) the case is negative and the model predicts positive

(d) the case is positive and the model predicts positive

2. A decision tree picks a sports activity:
• Is it raining? Yes → Chess. No → next question.
• Is the temperature above 29 °C? Yes → Swimming. No → next question.
• Is the wind above 25 km/h? Yes → Football. No → Badminton.
What does it pick on a day that is not raining, 29 °C, wind 31 km/h?

(a) Badminton **(b)** Chess **(c)** Swimming **(d)** Football

3. Labelled points: A(4, 1) blue, B(0, 7) blue, C(3, 6) blue, D(5, 5) blue, E(8, 1) blue. New point Q(2, 5). Which labelled point is nearest to Q? (Compare $(x_1 - x_2)^2 + (y_1 - y_2)^2$.)

(a) A **(b)** D **(c)** C **(d)** B

4. Labelled points: A(2, 0) cat, B(9, 6) dog, C(2, 7) cat, D(1, 7) dog, E(8, 4) dog. New point Q(5, 8). How many of the 3 nearest neighbours of Q are labelled cat?

(a) 2 **(b)** 1 **(c)** 0 **(d)** 3

5. A model predicts whether a mango is ripe (positive = ripe). For one case the actual answer is unripe and the model predicts ripe. This is a:

(a) False Negative **(b)** True Positive **(c)** False Positive **(d)** True Negative

6. A model predicting whether a mango is ripe is tested on 50 cases: TP = 14, TN = 3, FP = 18, FN = 15. What is its accuracy?

(a) 66% **(b)** 28% **(c)** 34% **(d)** 17%

7. Which kind of machine learning is grouping news articles by topic without being told the topics?

(a) reinforcement learning **(b)** data cleaning

(c) unsupervised learning **(d)** generative AI

8. A model predicts whether it will rain tomorrow. Its results on 10 test cases:
1. actual rain, predicted rain
2. actual no rain, predicted no rain
3. actual no rain, predicted no rain
4. actual rain, predicted rain
5. actual no rain, predicted no rain
6. actual rain, predicted rain
7. actual rain, predicted rain
8. actual rain, predicted no rain
9. actual rain, predicted rain
10. actual no rain, predicted no rain

How many predictions are wrong?

(a) 9 **(b)** 1 **(c)** 0 **(d)** 2

Section B — Short answer 8 × 2 = 16 marks

9. Define TP, FP, TN and FN.

10. A model predicts whether an email is spam (positive = spam). Its results:
1. actual spam, predicted spam
2. actual not spam, predicted spam
3. actual spam, predicted spam
4. actual spam, predicted spam
5. actual not spam, predicted not spam
6. actual not spam, predicted not spam
7. actual spam, predicted not spam
8. actual spam, predicted not spam
9. actual spam, predicted spam
10. actual not spam, predicted not spam
11. actual not spam, predicted spam
12. actual spam, predicted spam

Count the (a) true positives (b) false positives (c) true negatives (d) false negatives.

11. A model is tested on 20 cases: TP = 8, TN = 8, FP = 4, FN = 0. What is its accuracy?

12. A decision tree picks a sports activity:
• Is it raining? Yes → Chess. No → next question.
• Is the temperature above 28 °C? Yes → Swimming. No → next question.
• Is the wind above 15 km/h? Yes → Football. No → Badminton.
What does it pick on each day? (a) raining, 31 °C, wind 4 km/h (b) not raining, 20 °C, wind 12 km/h

13. Labelled points: A(8, 8) fail, B(1, 3) pass, C(0, 1) fail, D(5, 6) pass, E(0, 5) pass. New point Q(6, 4). Which labelled point is nearest to Q?

14. Labelled points: A(1, 8) blue, B(4, 9) red, C(4, 5) red, D(4, 4) red, E(0, 6) blue. New point Q(7, 1). Using the 3 nearest neighbours (k = 3) and a majority vote, which label does Q get?

15. Labelled points: A(1, 3) red, B(4, 1) red, C(8, 9) blue, D(5, 7) red, E(6, 5) red. New point Q(8, 7). Find the squared distance $(x_1 - x_2)^2 + (y_1 - y_2)^2$ from Q to A.

16. Which kind of machine learning is each? (a) finding clusters of similar songs in a music collection (b) a game-playing program that improves by getting points for good moves

Section C — Word problems — 4 × 4 = 16 marks

17. A model screens 100 eye scans: TP = 20, FN = 5, FP = 10, TN = 65. Find the accuracy and explain which error matters more here and why.

18. A model predicting whether a mango is ripe is tested on 100 cases: TP = 44, TN = 17, FP = 24, FN = 15. (a) How many predictions are correct? (b) What is the accuracy, in %? (c) How many predictions are wrong? (d) Which kind of error is more common, false positives or false negatives?

19. Labelled points: A(0, 6) cat, B(4, 5) dog, C(1, 4) dog, D(5, 9) cat, E(8, 5) cat. New point Q(1, 2). (a) Write the squared distances from Q to A, B, C, D and E, in that order. (b) Which point is nearest? (c) With k = 3 and a majority vote, which label does Q get?

20. A decision tree picks a sports activity:
• Is it raining? Yes → Chess. No → next question.
• Is the temperature above 28 °C? Yes → Swimming. No → next question.
• Is the wind above 10 km/h? Yes → Football. No → Badminton.
Four days: (1) raining, 22 °C, wind 33 km/h; (2) not raining, 30 °C, wind 19 km/h; (3) raining, 29 °C, wind 8 km/h; (4) not raining, 26 °C, wind 24 km/h. (a) Write the activity for each day, in order. (b) On how many days is Chess picked? (c) Is this tree rule-based or learning-based once it is written down?

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Answer key

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Q	Answer	Working
1	**(d) the case is positive and the model predicts positive**	—
2	**(d) Football**	follow the questions from the top
3	**(c) C**	A: 20, B: 8, C: 2, D: 9, E: 52
4	**(b) 1**	squared distances: A 73, B 20, C 10, D 17, E 25
5	**(c) False Positive**	True/False: was the prediction right? Positive/Negative: what did the model predict?
6	**(c) 34%**	(14 + 3) ÷ 50 × 100
7	**(c) unsupervised learning**	—
8	**(b) 1**	false positives 0 + false negatives 1
9	**TP: positive predicted positive; FP: negative predicted positive; TN: negative predicted negative; FN: positive predicted negative.**	—
10	**(a) 5; (b) 2; (c) 3; (d) 2**	right and positive = TP; wrong and predicted positive = FP; right and negative = TN; wrong and predicted negative = FN
11	**80%**	(8 + 8) ÷ 20 × 100
12	**(a) Chess; (b) Badminton**	follow the questions from the top
13	**D**	A: 20, B: 26, C: 45, D: 5, E: 37
14	**red**	nearest three: red, red, red
15	**65**	$(1 - 8)^2 + (3 - 7)^2$
16	**(a) unsupervised learning (b) reinforcement learning**	—
17	**Accuracy (20 + 65) ÷ 100 = 85%; false negatives matter more, because people who need care are missed.**	—
18	**(a) 61; (b) 61; (c) 39; (d) false positives**	(44 + 17) ÷ 100 × 100
19	**(a) 17, 18, 4, 65, 58; (b) C; (c) dog**	nearest three: dog, cat, dog
20	**(a) Chess, Swimming, Chess, Football; (b) 2; (c) rule-based: it follows fixed questions (it may first have been learned from data)**	follow the questions from the top for each day

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