

ES 335: Machine Learning
Quiz — Trees, Metrics & Ensembles (2023 archive)

Duration: 45 minutes Maximum marks: 9

SET D

Name: _____ Roll No.: _____

Instructions

- Write your name and roll number before starting.
- This paper has 8 questions in 3 parts, for a total of 9 marks.
- Record your final MCQ answers in the answer grid below — the grid is what gets graded.

MCQ Answer Grid

Q	1	2
Ans		

Part A — Multiple Choice

2 marks

- Q1.** In the lectures we saw that `np.std(x)` and `pd.Series(x).std()` give different values *[1 mark]* on the same data. Why?
- (A) They use different definitions of the mean
 - (B) NumPy defaults to the population estimate (divides by N , `ddof=0`) while pandas defaults to the sample estimate (divides by $N - 1$, `ddof=1`)
 - (C) NumPy accumulates in `float32`, losing precision on large arrays
 - (D) pandas rounds the result to six decimal places by default
- Q2.** For the Tennis example the maximum entropy is 1.0 bit. What is the maximum entropy *[1 mark]* of an ImageNet-style classification problem with 1024 classes?
- (A) 512 bits
 - (B) 1024 bits
 - (C) 10 bits
 - (D) 1.0 bit

Part B — Short Answers

4.5 marks

Answer in the space provided; show your working.

- Q3.** Quoting Wikipedia:

[2 marks]

Pre-pruning procedures prevent a complete induction of the training set by replacing a stop criterion in the induction algorithm (e.g. maximum tree depth or information gain $>$ minGain).

Create a decision tree for the classification problem below, and explain why pre-pruning using information gain can be limiting.

x_1	x_2	y
0	0	0
0	1	1
1	0	1
1	1	0

- Q4.** Given the following dataset, which attribute would the decision-tree algorithm split on first? Why? *[1 mark]*

Sample #	Radius	Weight	Color	Quality
1	1	1	1	Good
2	1	1	2	Good
3	1	2	1	Bad
4	1	2	2	Bad
5	2	1	1	Good
6	2	2	2	Good

- Q5.** Create one confusion matrix for 100 total examples where the precision is 0.8 and the recall is 0.5. *[1 mark]*

- Q6.** Create an example ground truth and prediction where the mean absolute error is *[0.5 marks]* 100 and the mean error is 0.

Part C — Ensembles*2.5 marks*

- Q7.** In bootstrap sampling we sample N times with replacement from an original *[1.5 marks]* dataset of N distinct elements (e.g. for $N = 8$, a bootstrap sample may be $\{8, 8, 3, 4, 5, 1, 8, 5\}$, which has 5 unique elements). Show that on average a bootstrap sample contains $\approx 63.2\%$ of N unique elements.

- Q8.** Assume K ensemble members, each with the same error probability $p < 0.5$. The *[1 mark]* binomial argument says the ensemble error shrinks as K grows — yet empirically, adding members may not always reduce the error. Why?

— *End of paper* —