CS 5703 Machine Learning Practice
Midterm 2
November 10, 2026

General instructions:

- Please wait to open this exam booklet until you are told to do so.
- This examination booklet has 6 pages.
- Write your name and the date, and sign your name below.
- The exam is closed book, notes, and electronic devices. The exception is that you may have one page of personal notes (double sided).
- The exam is worth a total of 150 points (and 15% of your final grade).
- You have 1.25 hours to complete the exam. Be a smart test taker: if you get stuck on one problem, go on to the next.

On my honor, I affirm that I have neither given nor received inappropriate aid in the completion of this exam.

Signature: _____ **Name:** _____

Date: _____

Question	Points	Score
Non-Linear Preprocessing	32	
Over-fitting and Regularization	38	
Cross-Validation and Hyper-parameter Selection	42	
Hypothesis Testing and Model Comparison	38	
Total:	150	

Part I. Non-Linear Preprocessing

1. (8 points) Assume a two-feature input space and a polynomial transformation of degree $d = 3$. How many distinct polynomial features are there?

2. (8 points) Assume a three-feature input space, and a polynomial transformation of degree $d = 2$. How many distinct polynomial features are there?

3. (8 points) Assume a two-feature input space, a $d = 2$ polynomial transformation, and the following coefficients for a classifier. What is the binary output of the classifier (positive or negative) for input $[3, 0]$?

Coefficient	**Term**
2	x_0^2
1	x_1^2
2	$x_0 x_1$
3	x_0
-1	x_1
-20	1

A. positive B. negative

4. (8 points) What is the output of the above classifier for input $[-2, 5]$?

A. positive B. negative

Part II. Over-fitting and Regularization

5. (6 points) What does *over-fitting* refer to?

6. (10 points) A single model is clearly over-fitting its training set. List four approaches you can take to possibly compensate for this.

   1.

   2.

   3.

   4.

7. (6 points) Assuming that alpha is high enough, which of Lasso, Ridge, and Elastic Net will set coefficients to exactly zero? Mark all that are true.

   ◯ Lasso ◯ Ridge ◯ Elastic Net

8. (8 points) Briefly explain why training set performance can decrease as the number of training samples increases.

9. (8 points) Briefly explain why validation set performance can increase as the magnitude of the regularization parameter (e.g., alpha) increases.

Part III. Cross-Validation and Hyper-parameter Selection

10. (6 points) For Holistic $N = 30$ Fold Cross-Validation, what is the maximum number of folds used for testing purposes for a given rotation?

11. (8 points) In N-Fold Cross-Validation, which data set do we use for hyper-parameter selection? Explain why we do not use either of the other two data sets.

12. (8 points) In creating the N folds of data for cross-validation, what must we ensure?

13. (8 points) Sketch typical average training and validation performance as a function of a regularization hyper-parameter. Label your axes.

14. (6 points) Describe where testing performance would be placed on the above figure.

15. (6 points) Suppose a regression model is trained to predict the value of a commodity in US dollars. What are the units of the FVAF measure of model performance?

Part IV. Hypothesis Testing and Model Comparison

16. (8 points) What are the requirements for using a paired sample test in the context of comparing two model types?

17. (6 points) Which one of the following is most true for a probability function?
A. $0 \leq p(y|...)$ B. $p(y|...) \leq 1$ C. Both A and B D. Neither A nor B

18. (8 points) Briefly explain why we formulate our hypothesis testing procedure in terms of a null hypothesis that we want to reject, as opposed to an alternative hypothesis that we want to accept.

19. (8 points) In model comparison, explain briefly why the test statistic for the difference in mean model performance is assumed to follow a t-distribution under the null hypothesis, rather than a standard normal (z) distribution.

20. (8 points) Contrast hold-out cross-validation from holistic cross-validation.