# CS3244 Exam 1: Part 2

## 28 Sep 2020

Please do not turn to the next page until you are told to do so by your proctor.

- This exam part is worth **25** marks out of a **75** mark total for all three parts.
- This exam part is estimated to take you about **25** minutes to complete.
- This exam part has a total of **7** questions.
- This exam part contains only multiple choice questions (MCQs) and multiple response questions (MRQ). Please key these into the assessment system.
- You can visit `http://www.comp.nus.edu.sg/~cs3244/2010/e1.part2.html` to reach the entry form for this survey if you lose your browser window.
- Do remember that you will need to key in and submit your answers to the according assessment system as designated by your proctor or by exam central.

# ANSWERS VERSION 1

1. (MRQ with 4 options; 3 marks) Bias–Variance. Mark all statements that are true.

   (a) A model with high variance will tend to have low test error over different samples of training data.
   (b) An $\mathcal{H}$ with high complexity will tend to exhibit high variance.
   (c) High variance models tend to have low bias.
   (d) An $\mathcal{H}$ with low bias will generally improve over one with high bias, given sufficient training data.

   **Correct answers:** (b), (c), (d)

2. (MCQ; 2 marks) Which of the following statements is true of **Logistic Regression**?

   (a) The sigmoid function is differentiable everywhere except at $x = 0$.
   (b) The output interval of logistic regression will be $[-1, 1]$.
   (c) When using gradient descent for the training of logistic regression at Step $t$ to update $\theta$, we update in same direction as $\nabla J_{train}(\theta(t))$.
   (d) It is used as a linear classifier by setting a cutoff value to the output of the sigmoid function.

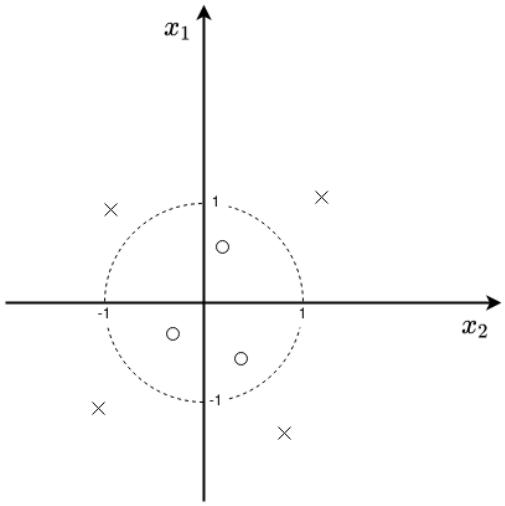
   **Correct answers:** (d)

3. (MCQ; 2 marks) In lecture, we have seen the Bias–Variance decomposition for squared loss; i.e., $J(f(x), h(x)) = (f(x) - h(x))^2$. Let us now define the error as $J(f(x) - h(x)) = (|f(x) - h(x)|^p)$. Given this, choose the correct Bias–Variance decomposition.

   (a) $Bias^p + Variance^{p/2}$.
   (b) $Bias^{p/2} + Variance^p$.
   (c) $Bias^p + Variance^p$.
   (d) $Bias^{p/2} + Variance^{p/2}$.
   (e) None of the above.

   **Correct answers:** (a)

4. (MRQ with 5 options; 3 marks) Which set of features can result in zero training loss on the following training examples when using a linear model?




(a) $x_1^2, x_2^2, -1$.
(b) $x_1^2, x_2^2, 1$.
(c) $x_1, x_2, 1$.
(d) $x_1, x_2, x_1^2, x_2^2, 1$.
(e) $x_1, x_2, x_1^2, x_2^2, -1$.

**Correct answers:** (a), (b), (d), (e)

**Explanation:** Coefficients required for:
(b) $1, 1, -1$
(c) $1, 1, 1$
(d) $0, 0, 1, 1, -1$
(e) $0, 0, 1, 1, 1$

[Questions 5–7] [These questions not admissible for AY21/22S1] Consider the instance space consisting of integer points in the range $\{0, 1, ..., 10\}$ in the $x, y$ plane and the set of hypotheses $\mathcal{H}$ consisting of rectangles with sides parallel to the $x$-axis and $y$-axis; i.e., $h \in \mathcal{H}$ is of the form $a \leq x \leq b, c \leq y \leq d$, where $a, b, c$, and $d$ is also restricted to the range $\{0, 1, ..., 10\}$, and an $h(x, y) = 1$ if lies within or touches the rectangle defined by $h$, and 0 otherwise.

5. (MCQ; 7 marks) Given the input below, what does **Candidate-Elimination algorithm** output for $G$?

| Example | Input Instance | Target Concept |
|---|---|---|
| 1 | (6,4) | 1 |
| 2 | (8,7) | 0 |
| 3 | (4,7) | 1 |
| 4 | (2,2) | 0 |

(a) $\{(3, 10, 0, 6), (0, 10, 3, 6), (0, 7, 3, 10), (3, 7, 0, 10)\}$
(b) $\{(2, 10, 0, 6), (0, 10, 2, 6), (0, 7, 2, 10), (2, 7, 0, 10)\}$
(c) $\{(0, 7, 3, 10), (3, 7, 0, 10)\}$
(d) $\{(0, 7, 2, 10), (2, 7, 0, 10)\}$

**Correct answers:** (c)

6. (MCQ; 4 marks) Given an arbitrary target concept $f$ of the same form as $h$ (e.g., $3 \leq x \leq 5, 2 \leq y \leq 9$), what is the fewest number of training examples you must provide so that Candidate-Elimination learns it perfectly?

   (a) 6
   (b) 2
   (c) 4
   (d) 5
   (e) 8

   **Correct answers:** (a)

7. (MCQ; 4 marks) Suppose we are given several input instances and obtain the $S$ and $G$ boundary sets after running Candidate-Elimination:

   $$\text{S: } \{(6 \leq x \leq 8, 3 \leq y \leq 5)\}$$
   $$\text{G: } \{(2 \leq x \leq 9, 2 \leq y \leq 7), (3 \leq x \leq 9, 2 \leq y \leq 9)\}$$

   Which new instance below will reduce the number of hypotheses remaining in the version space?

   (a) (6, 5)
   (b) (4, 6)
   (c) (2, 9)
   (d) (7, 4)
   (e) None of the above. It will also depend on the instance's label.

   **Correct answers:** (b)

**This marks the end of this part of the exam.**
**These is no additional material beyond this point.**