

1. Suppose  $m=4$  students have taken some class, and the class had a midterm exam and a final exam. You have collected a dataset of their scores on the two exams, which is as follows:

midterm exam	(midterm exam) <sup>2</sup>	final exam
89	7921	96
72	5184	74
94	8836	87
69	4761	78

You'd like to use polynomial regression to predict a student's final exam score from their midterm exam score. Concretely, suppose you want to fit a model of the form  $h_{\theta}(x) = \theta_0 + \theta_1 x_1 + \theta_2 x_2$ , where  $x_1$  is the midterm score and  $x_2$  is (midterm score)<sup>2</sup>. Further, you plan to use both feature scaling (dividing by the "max-min", or range, of a feature) and mean normalization.

What is the normalized feature  $x_1^{(1)}$ ? (Hint: midterm = 89, final = 96 is training example 1.) Please round off your answer to two decimal places and enter in the text box below.

0.32

2. You run gradient descent for 15 iterations with  $\alpha = 0.3$  and compute  $J(\theta)$  after each iteration. You find that the value of  $J(\theta)$  decreases slowly and is still decreasing after 15 iterations. Based on this, which of the following conclusions seems most plausible?

- ☐ Rather than use the current value of  $\alpha$ , it'd be more promising to try a smaller value of  $\alpha$  (say  $\alpha = 0.1$ ).
- ☒ Rather than use the current value of  $\alpha$ , it'd be more promising to try a larger value of  $\alpha$  (say  $\alpha = 1.0$ ).
- ☐  $\alpha = 0.3$  is an effective choice of learning rate.

3. Suppose you have  $m = 23$  training examples with  $n = 5$  features (excluding the additional all-ones feature for the intercept term, which you should add). The normal equation is  $\theta = (X^T X)^{-1} X^T y$ . For the given values of  $m$  and  $n$ , what are the dimensions of  $\theta$ ,  $X$ , and  $y$  in this equation?

- ☐  $X$  is  $23 \times 6$ ,  $y$  is  $23 \times 6$ ,  $\theta$  is  $6 \times 6$
- ☐  $X$  is  $23 \times 5$ ,  $y$  is  $23 \times 1$ ,  $\theta$  is  $5 \times 5$
- ☒  $X$  is  $23 \times 6$ ,  $y$  is  $23 \times 1$ ,  $\theta$  is  $6 \times 1$
- ☐  $X$  is  $23 \times 5$ ,  $y$  is  $23 \times 1$ ,  $\theta$  is  $5 \times 1$

4. Suppose you have a dataset with  $m = 50$  examples and  $n = 200000$  features for each example. You want to use multivariate linear regression to fit the parameters  $\theta$  to our data. Should you prefer gradient descent or the normal equation?

- ☐ Gradient descent, since it will always converge to the optimal  $\theta$ .
- ☐ The normal equation, since gradient descent might be unable to find the optimal  $\theta$ .
- ☐ The normal equation, since it provides an efficient way to directly find the solution.
- ☒ Gradient descent, since  $(X^T X)^{-1}$  will be very slow to compute in the normal equation.

5. Which of the following are reasons for using feature scaling?

- ☐ It is necessary to prevent gradient descent from getting stuck in local optima.
- ☐ It prevents the matrix  $X^T X$  (used in the normal equation) from being non-invertible (singular/degenerate).
- ☒ It speeds up gradient descent by making it require fewer iterations to get to a good solution.
- ☐ It speeds up solving for  $\theta$  using the normal equation.