

8.2: You are building a linear model  $y = \beta_0 + \beta_1 x + \beta_2 x^2$  using the following data:

$x$	$y$
1	4
2	5
-1	2

Compute the total quadratic loss for your model when  $\beta_0 = 1$ ,  $\beta_1 = 0.2$ , and  $\beta_2 = -0.1$ .

8.4: You are building a linear model  $y = \beta_0 + \beta_1 x + \beta_2 x^2$  using the following data:

$x$	$y$
1	4
2	5
-1	2

Write out a system of equations in a matrix formalism using your model and the above data.

8.5 Without using the `pinv` function in Matlab, calculate the pseudoinverse of the design matrix and the least-squares estimates of the parameters  $\beta_0$ ,  $\beta_1$ , and  $\beta_2$ .

**9.2.1:** In §8.3.2 we fit the model  $y = \beta_0 + \beta_1 x$  to the data in the following table.

$x$	$y$
0.07	-0.05
0.16	0.40
0.48	0.66
0.68	0.65
0.83	1.12

The best parameter estimates were  $y = 0.020 + 1.21x$ . What is the RMSE for this model?

**9.5:** Linearize the model  $y = \sqrt{\beta_0 + \beta_1 x}$ .

Write out a system of matrix equations using your linearized model and the following data.

$x$	$y$
1	4
2	5
-1	2

**10.5:** Calculate the Jacobian matrix of the function

$$\mathbf{g}(\mathbf{x}) = \begin{pmatrix} \cos x_2 \\ \log x_1 \\ x_1 x_2 x_3 \end{pmatrix}$$

**12.1:** Start at  $x = 0$ , calculate two iterations of gradient descent for the function  $y = (x - 3)^2 + 4$  using a step size of  $\alpha = 0.1$ .

**13.1:** A bag contains five red balls and three green balls. What are the odds that a randomly selected ball will be red?

**13.4:** You fit a logistic regression model that predicts the probability of Illinois' basketball team winning given the number of fouls committed by the opposing team. The best fit model is

$$\log(\text{odds}(\text{win})) = 0.3 + 0.2[\text{fouls}]$$

What is the odds ratio of the number of fouls? What is the interpretation of the odds ratio?



**15.1:** How far is the plane  $x_1 - 2x_2 + 0.3x_3 = 5$  from the origin?

**15.2:** What is the intersection of the lines  $2x_1 + x_2 = 4$  and  $x_1 - x_2 = 3$ ?

**15.2:** What is the intersection of the planes  $x_1 - x_2 + 3x_3 = 1$ ,  $3x_1 + x_2 - 4x_3 = 2$ , and  $-2x_1 + 2x_2 - 6x_3 = -2$ ?

**16.2:** You want to build an SVM classifier that predicts if a cell line will respond to a drug based on the expression of three genes. Write a quadratic program based on the following four observations.

Gene 1	Gene 2	Gene 3	Response
1.6	2.4	0.1	yes
2.3	1.4	0.6	no
1.0	0.8	0.2	yes
1.9	2.1	0.4	no