

## CS412 Machine Learning - 2023

### HW3-Gradient Descent

50pts

- 1) **50pts** - We are trying to minimize a function  $F(x) = x^2 - 10x + 5$  with respect to its parameter  $x$ . In other words we want to find the  $x$  for which  $f(x)$  is minimum.

Starting from the point  $x=10$  use steepest descent algorithm *for TWO steps* to find the local minimum of the function around this point. You should use a “step size” of  $\alpha = 0.1$  in update, as:  $x = x - \alpha \nabla$

We will use a subscript to indicate the subsequent values of  $x$ , starting from  $x_0$ .

#### Worksheet:

$$F(x_0) = 10^2 - 10 \cdot 10 + 5 = 5 \quad : \text{Just to note at what } F \text{ value we start (5pts)}$$

$$\nabla F = dF/dx = 2x - 10 \quad : \text{Compute the gradient (10pts)}$$

Note: Even though  $F$  is a function of a single variable, you can still write/think of the gradient as a vector of size one.

$$\nabla F |_{x_0} = 2 \cdot 10 - 10 = 10 \quad \text{This is the gradient **evaluated** at } x_0 \text{ (10pts)}$$

$$x_1 = x_0 - \alpha \nabla F(x_0) = 10 - 0.1 \cdot 10 = 9 \quad : \text{Update } x_0 \text{ to find } x_1 \text{ (5pts)}$$

$$F(x_1) = 81 - 90 + 5 = -4 \quad : \text{just checking to see if we are indeed minimizing}$$

**Now do the 2<sup>nd</sup> step similarly and write your results below (no partial so be careful please): :20pts**

$$\text{ANSWER: } x_2 \text{ (x after 2 steps of gradient descent) } = 8.2 \quad f(x_2) = -9.76$$

**Submission:** Write the ANSWER line as inline submission to homework and attach the filled page as a pdf document to Sucourse.