

## Homework 2: Gradient Descent

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In this homework you will code gradient descent and use it to find the minimizer of a function, i.e., to solve an optimization problem of the form:

$$\arg \min_{\mathbf{x} \in \mathbb{R}^D} f(\mathbf{x}).$$

Recall that given a function  $f(\mathbf{x})$  to be minimized, gradient descent can be summarized as follows:

- (i) Select an initial point  $\mathbf{x}_0$ .
- (ii) For every  $t > 0$ , repeat:

$$\mathbf{x}_t = \mathbf{x}_{t-1} - \eta \nabla f(\mathbf{x}_{t-1})$$

until convergence, where  $\eta > 0$  is a step size (parameter).

Implement gradient descent in your favorite coding language, and use it to identify the solution to

$$\arg \min_{\mathbf{x} \in \mathbb{R}^5} \|\mathbf{Ax} - \mathbf{b}\|_2^2,$$

where

$$\mathbf{A} = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 2 & 4 & 8 & 16 \\ 1 & 3 & 9 & 27 & 81 \\ 1 & 4 & 16 & 64 & 256 \\ 1 & 5 & 25 & 125 & 625 \end{bmatrix}, \quad \mathbf{b} = \begin{bmatrix} 5 \\ 31 \\ 121 \\ 341 \\ 781 \end{bmatrix}.$$

Deliver your code, solution, and choice of  $\eta$ .