Optimisation Basics 2 — Coding Practice Questions

CM52054: Foundational Machine Learning
Practice set with fully worked answers

Linear Regression & Gradient Descent

1) **1D linear regression: closed form vs gradient descent.**
Task:

   a) Generate synthetic 1D data from the model $y = 3x + 2 + \varepsilon$ with Gaussian noise.

   b) Fit a linear model $f(x) = w_1 x + w_0$ using:

      i. the normal equation (closed form), and

      ii. batch gradient descent on the squared loss.

   c) Compare the learned parameters to the true ones.

2) **Batch GD vs SGD vs mini-batch GD.**
Task:

   a) Reuse the synthetic linear regression data from Question 1.

   b) Implement:

      i. Batch gradient descent.

      ii. Stochastic gradient descent (SGD).

      iii. Mini-batch gradient descent.

   c) Track the mean squared error over iterations for each method and compare:
   - stability of the loss curve,
   - speed of convergence.