Spring 2024

Assignment – Gradient Descent Algorithm

Due date

Friday, April 5th, 2024.

Please note that no late submissions will be accepted.

Assignment description

The objective of this assignment is to exercise the implementation of the gradient descent algorithm. The main deliverables for this assignment are 1) a report documenting your efforts on this assignment and 2) simulation codes you developed. All deliverables must be a joint effort, meaning that your team will need to distribute the different tasks amongst the members to share the workload fairly and effectively. Please note that one student from your team should submit materials on behalf of the entire team.

Team

Students will work in a team of two or three students with the aim of developing teamwork skills while working with other students. The entire team will receive the same base grade; however, I will ask each of you to submit your own peer assessment in which you evaluate the contributions of your teammates; therefore, the grade may be changed as needed. The purpose of this peer assessment is to find ways to work well together and contribute equally to the overall product.

Problem statement

Suppose that you are asked to find the minimum point of the objective function within $-4 \leq x \leq 3$:

$$f(x) = x^4 + x^3 - 6x^2 + 4x + 12$$

Deliverables for this problem are as follows:

- Create a plot showing the objective function within $-4 \leq x \leq 3$.
- Explain how you design your own gradient descent algorithm from scratch
- Discuss with your teammates and answer the following question:
  - Suppose that you implement a stopping criterion where the algorithm terminates when the number of iterations exceeds the maximum number of iterations. When the following

conditions are given, what is the optimal solution? Do you think that it is a global optimum within the pre-determined range? If not, what is your strategy to improve the fidelity of the solution provided by the algorithm?

- ✓ Initial point $x = 2.5$
- ✓ Step size = 0.01
- ✓ The maximum number of iterations = 10

- ➢ Suppose that you implement a stopping criterion where the algorithm terminates when the number of iterations exceeds the maximum number of iterations. When the following conditions are given, do you think that the algorithm provides a global optimum within the pre-determined range? If not, what is your strategy to improve the fidelity of the solution provided by the algorithm? You could set up a different initial point; however, it is assumed that the initial point cannot be changed. You are only allowed to control either step size or the maximum number of iterations. Which option would like to choose? What is the reason why you end up choosing the option?
  - ✓ Initial point $x = 0.35$
  - ✓ Step size = 0.01
  - ✓ The maximum number of iterations = 10

Please note:

It is possible to solve this problem with various built-in libraries; however, this is not the point. You are asked to write your own gradient descent algorithm code based on what you have learned in the class.

Citation

Please ensure that all codes and materials originating from other sources including ChatGPT must be clearly documented.