King Mongkut's University of Technology

Machine Learning

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Take Home Quiz 4 due Sun Feb 18, 2024

Name: ______________________

I.D. Number: ________________

Score: ______ **/ 50**

1. The following points (x_i, y_i) are discrete samples from a function $f(x) = ax^3 + bx^2 + cx + d$.

   a. *5 points.* 0.5 hrs. Show the update rule equation used to find the current a, b, c, and d after each iteration. Make sure you show the mathematics on how this is derived.

   b. *15 points.* 2 hrs. Write a python program to find the best fit a, b, c, and d using gradient descent. You must write the gradient descent loop yourself and not use any gradient descent libraries. Attach the source code as well. *Hint*: You should get a, b, c, and d close to 2, -1, 1.3, and 6, respectively.

x_i	y_i
-6	-470
-5	-276
-4	-143
-3	-61
-2	-17
-1	2
0	6
1	8
2	21
3	55
4	123
5	238
6	410

2. *10 points.* 1 hrs. Redo problem 1b, but use the numerical method to calculate all your partial derivatives, where $h = x_i\sqrt{\epsilon}$.

$$\frac{\partial}{\partial x_i} f(x_1, \ldots, x_i, \ldots, x_n) = \frac{f(x_1, \ldots, x_i + h, \ldots, x_n) - f(x_1, \ldots, x_i - h, \ldots, x_n)}{2h}$$

3. *10 points.* 1 hrs. Solve problem 1b using Pseudo-Inverse Linear Regression to find (a, b, c, d). You can use numpy or other libraries to invert matrices.

4. *10 points.* Change the function in "Simulated Annealing.ipynb" shown in class to the one in our lecture: $f(x,y) = x^2 + y^2$. Change the program to show more intermediate states (x1, x2, f) instead of only accepted states. Show the output movement image for (x1, x2) as a blue line.