CS:5101 Machine Learning

Term 3 (Dec 2020 - Feb 2021)

Programming Assignment - 2

Gradient Descent Optimization with Line Search, LASSO Regression

Due Date: 10^{th} Dec 2020 11:59 PM

Follow the instructions given below carefully:

1. You are allowed to use ONLY those python libraries (libraries means numpy etc.) which were shown in today's demo.
2. You must submit your code in a **single** python .ipynb notebook with naming format as follows: Firstname_Lastname_assignment2.ipynb
3. For each question, create a separate text block containing the question followed by a code block containing the solution.
4. Your code must be properly commented explaining each step clearly.
5. If any of the above instructions are not followed, penalty will be there for the same.
6. Your code and answers will be checked for plagiarism and if found plagiarised, zero marks will be provided for assignment 2. So make sure you actually code and solve the questions rather than noting down the answers.
7. You are free to use functions from today's demo.
8. NOTE: The total marks for this assignment is 5 marks. Q2 is a bonus question (optional) for additional 1 mark.

Questions

1. (5 marks) Perform gradient descent with backtracking line search method to solve the following optimization problem as mentioned in detail in the subpoints:
   Objective function is

$$f(\mathbf{x}) = -(x_2 + 47)\sin\left(\sqrt{\left|x_2 + \frac{x_1}{2} + 47\right|}\right) - x_1 \sin\left(\sqrt{|x_1 - (x_2 + 47)|}\right)$$

$$x_i = [-512, 512] \quad \forall i \in \{1, 2\}$$

   (a) Create functions:
      i. *objective*(X): For computing the value of f
      ii. *grad_objective*(X): For computing the gradient of f w.r.t. $\mathbf{x}$

   (b) Plot this objective function on a 3D plot. Your plot must help in visualizing the function clearly. Use appropriate number of points (n) for a smooth plot.

   (c) Plot the contour plot for f.

   (d) Implement the gradient descent with backtracking line search algorithm from scratch and output the value of f and $\mathbf{x}$ at global minimum. Choose initial $\mathbf{x}$ wisely by taking help from contour plot.

   (e) Report the best values of threshold, learning rate and beta for previous question.

   (f) For each of the following initial $\mathbf{x}$ values, report the final $\mathbf{x}$ values after performing gradient descent with backtracking line search on f:

i. $[-100, 100]$
ii. $[10.52, 10.52]$
iii. $[200, 500]$
iv. $[-512, 512]$

2. (BONUS 1 mark) For the dataset patients.csv, column 'A44' is the target and other columns are features. You need to predict the target using LASSO_CV. You are free to use required libraries. You have to predict the target value for the test data given in the file test.csv. You need to create a new column "A44" in test.csv which will contain the target value for each row. Also print the optimal alpha value in your code. Submit the updated test.csv file along with the .ipynb notebook.