Lab Assignment 7: Optimization for Machine Learning

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Write python codes of descent methods with inexact line search technique for the following function:

(1) Solve the following problem using modified Newton method.

$$\min_{x\in\mathbb{R}^2} \quad (1-x_1)^2 + (x_2 - x_1^2)^2$$

Use initial approximation $(0,3)^T$ and stopping criteria $\|\nabla f(x)\| < 10^{-4}$ or max 2000 iterations.

(2) Suppose $D = \{(a^i, y_i) : y_i \in \{1, -1\}\}$ be a data set. To predict whether $\hat{a} = 1$ *or* -1, using logistic regression, we solve the unconstrained problem

$$\min \quad -\left(\sum_{i:y_i=1} \log(p(a^i;x)) + \sum_{i:y_i=-1} \log(1-p(a^i;x))\right)$$

where $p(a;x) = \frac{1}{1+e^{-a^T x}}$.
Using the data set of *diabetics* construct the logistic regression function and solve using modified Newton method.

(3) Purchase frequency y depends on locality score x (in data set 'Customer Purchasing Behaviors') according to the curve $y = e^{\theta_1 x}(\cos(\theta_2 x) + \sin(\theta_3 x)$. Using modified Newton method find the optimal value of θ^* and estimate purchase frequency for $R/10 + 1$, where R is last two digits of your roll number.

(4) Given 'new_data', we want to predict y by $y = \frac{e^{\beta_1 x1 + \beta_2 x_2}}{1+e^{\beta_1 x1+\beta_2 x_2}}$. Find β^* with minimum error using nonlinear least square with modified Newton method.
Hint: total error is $\sum_i \left(\frac{e^{\beta_1 x_1^i + \beta_2 x_2^i}}{1+e^{\beta_1 x_1^i + \beta_2 x_2^i}} - y_i\right)^2$.