EEC 289Q Data Analytics for Computer Engineers Homework 2

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Logistic Regression: The following code shows the implementation of the logistic regression function

```
function [f,g] = logistic_regression(theta, X,y)
    m = size(X,2);
    n = size(X,1);
    f = 0;
    g = zeros(size(theta));
%%% YOUR CODE HERE %%%
    h = sigmoid(theta'*X);
    for i=1:m
         f = f - (y(i)*log(h(i)) + (1- y(i))*log(1-h(i)));
    end
    for i=1:m
        g = g + X(:,i)*(h(i)- y(i));
    end
end
```

Using this code, we were able to achieve training accuracy of 100% and test accuracy of 100% while the optimization took 5.258526 seconds.

The following shows the vectorized version of the same implementation which decreased the optimization time to 2.519300 seconds.

```
function [f,g] = logistic_regression_vec(theta, X,y)
    m = size(X,2);.
    f = 0;
    g = zeros(size(theta));
    %%% YOUR CODE HERE %%%

    h = sigmoid(theta'*X);
    f = -sum(y.*log(h) + (1.- y).*(log(1.-h)));
    g = X*(h - y)';
end
```

Linear Regression: The following code shows the initial implementation of the linear regression method (Homework #1) with which the optimization took 0.017464 seconds

```
function [f,g] = linear_regression(theta, X,y)
    m = size(X,2);
    n = size(X,1);
    f = 0;
    g = zeros(size(theta));
%%% YOUR CODE HERE %%%
    err = theta'*X-y;
    for i = 1:m
        f = f + 0.5*err(i)*err(i);
    end
    for i = 1:n
        g(i) = sum(X(i,:).*err);
    end
end
```

The following is the vectorized version of the linear regression. With this code, the optimization took 0.014477 seconds. The different is small between the vectorized and initial implementation since the number of parameters is small i.e., 14.

```
function [f,g] = linear_regression_vec(theta, X,y)
    m=size(X,2);
    f = 0;
    g = zeros(size(theta));
    %%% YOUR CODE HERE %%%
    err=theta'*X-y;
    f=1/2*err*err';
    g=X*err';
end
```

Gradient Checking: We tested the gradient computation for the four methods and compared it against the approximate gradient to calculate the absolute error. Table 1 shows the absolute error for the four methods where our computed gradient matches the approximated gradient with very small error of order 10^{-10}.

	linear regression	linear regression vec	logistic regression	logistic regression vec
Test#1	5.47473e-12	5.08606e-11	3.35132e-13	4.90073e-15
Test#1	5.47473e-12	0	3.25036e-14	4.2404e-12
Test#3	3.18963e-11	2.91038e-11	5.95617e-14	0
Test#4	2.28511e-11	7.28164e-11	6.31256e-14	0
Test#5	1.04592e-11	4.00178e-11	0	7.15943e-14
Test#6	6.87805e-12	2.91038e-11	7.72179e-15	8.13418e-13
Test#7	0	7.28164e-11	0	4.60755e-14
Test#8	1.54614e-11	8.0469e-13	2.75524e-13	4.49618e-14
Test#9	5.47473e-12	7.28164e-11	4.00648e-14	2.12491e-13
Test#10	12.54659e-11	0	2.04076e-12	1.21385e-14

Table 1: Gradient Checking: The absolute error between computed gradient for different methods vs. the approximated gradient.