piecewise_testing

April 19, 2017

```
In [1]: import os
        import pyopencl as pcl
        import numpy as np
        import scipy.stats as ss
        import pandas as pd
        import math
        from sklearn.model_selection import train_test_split
        import matplotlib.pyplot as plt
```

```
In [ ]: clfile = os.path.join('..','src','glm_gpu','cl','logistic.cl')
        os.path.isfile(clfile)
```

```
In [ ]: os.environ['PYOPENCL_COMPILER_OUTPUT'] = '1'
        device = pcl.get_platforms()[0].get_devices()[2]
        cntx = pcl.Context([device])
        queue = pcl.CommandQueue(cntx)

        with open(clfile, 'r') as f:
            programs = pcl.Program(cntx, f.read()).build()
```

```
In [ ]: device.name
```

```
In [ ]: theta = np.array([0.5, 0.5], dtype=np.float32)
```

```
In [ ]: theta.dtype
```

```
In [2]: x0_1 = ss.norm(loc=10.0, scale=2.0)
        x0_0 = ss.norm(loc=7.0, scale=2.0)
        x1_1 = ss.norm(loc=5.0, scale=3.0)
        x1_0 = ss.norm(loc=-5.0, scale=3.0)

        nsamps=1024

        X_1 = pd.DataFrame(index=range(nsamps),
                           columns=['x0','x1', 'y'])
        X_0 = pd.DataFrame(index=range(nsamps),
                           columns=['x0','x1', 'y'])
        X_1.loc[:, 'x0'] = x0_1.rvs(size=(nsamps,)).astype(np.float32)
        X_1.loc[:, 'x1'] = x1_1.rvs(size=(nsamps,)).astype(np.float32)
        X_1.loc[:, 'y'] = np.ones(shape=(nsamps,)).astype(np.float32)

        X_0.loc[:, 'x0'] = x0_0.rvs(size=(nsamps,)).astype(np.float32)
        X_0.loc[:, 'x1'] = x1_0.rvs(size=(nsamps,)).astype(np.float32)
        X_0.loc[:, 'y'] = np.zeros(shape=(nsamps,)).astype(np.float32)


        X_all = pd.concat((X_1, X_0), ignore_index=True)

        X_all = X_all.reindex(np.random.permutation(X_all.index))

        X = X_all.loc[:, ['x0', 'x1']]
        y = X_all.loc[:,'y']

In [ ]: X.values

In [ ]: cost_arr = np.zeros(shape=(X.shape[0],)).astype(np.float32)
        temp_avg = np.zeros(shape=(4,)).astype(np.float32)

In [ ]: # compute cost
        X_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_ONLY | pcl.mem_flags.COPY_HOST_PTR, hostbuf=
        y_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_ONLY | pcl.mem_flags.COPY_HOST_PTR, hostbuf=
        theta_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_ONLY | pcl.mem_flags.COPY_HOST_PTR, host
        cost_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_WRITE | pcl.mem_flags.COPY_HOST_PTR, host
        temp_buf = pcl.Buffer(cntx, pcl.mem_flags.WRITE_ONLY, size=temp_avg.nbytes)
        scratch_buf = pcl.LocalMemory(np.float32().nbytes * 256)

        nrows = np.int32(X.shape[0])
        ncols = np.int32(X.shape[1])

        out = np.zeros(shape=(X.shape[0],), dtype=np.float32)
        out_buf = pcl.Buffer(cntx, pcl.mem_flags.WRITE_ONLY, size=out.nbytes)

In [ ]:

In [ ]: sig_event = programs.sig(queue,
                                 X.shape,
                                 None,
                                 X_buf,
                                 theta_buf,
                                 out_buf,
                                 nrows,
                                 ncols)

        cost_event = programs.logistic_cost_ols(queue,
                                                X.shape,
                                                None,
                                                X_buf,
                                                theta_buf,
                                                y_buf,
                                                cost_buf,
                                                nrows,
                                                ncols)

        # reduction_event = programs.matrix_row_mean(queue,
        #                                             (1024,),
        #                                             (256,),
        #                                             cost_buf,
        #                                             temp_buf,
        #                                             scratch_buf,
        #                                             nrows,
        #                                             np.int32(1))
```

```
In [ ]: nrows, ncols, theta.shape
```

```
In [ ]: sig_event.wait()
        pcl.enqueue_copy(queue, out, out_buf).wait()

        cost_event.wait()
        pcl.enqueue_copy(queue, cost_arr, cost_buf).wait()

        # reduction_event.wait()
        # pcl.enqueue_copy(queue, temp_avg, temp_buf).wait()
```

```
In [50]: def sig(X, theta):
             lin = X.dot(theta)
             sig = 1.0 / (1.0 + np.exp(-lin))
             return sig


         def lr_cost(X, theta, y):
             est = sig(X, theta)
             log_est = np.log(est)
             cost = y*log_est + (1-y) * (1-log_est)
             cost *= -1
             return cost

         def cost_ss(est, actual):
             cost = ((est - actual)**2.0)
             cost /= 2.0
             return cost
```

```
In [ ]: my_out = sig(X.values, theta)
        my_cost = cost(my_out, y)
```

```
In [ ]: my_out.shape, out.shape
In [ ]: x = list(range(len(my_out)))
        plt.scatter(x, my_out)
        plt.scatter(x, out, color='r')
        plt.show()
```

```
In [ ]: x = list(range(len(my_cost)))
        plt.scatter(x, my_cost)
        plt.scatter(x, cost_arr)
        plt.show()
```

```
In [ ]: my_cost == cost_arr
```

```
In [ ]: X.values.dot(theta)
```

```
In [ ]: X.values
```

```
In [ ]: (7.93563604 + 5.08651495)/2.0
```

```
In [ ]: theta
```

```
In [ ]: out
```

```
In [ ]: my_out.reshape((my_out.size, )) == out
```

```
In [ ]: out == my_out
```

```
In [29]: # ok now let's check the gradient stuff
         def grad(X, theta, y):
             diff = y - sig(X, theta)
             g = np.zeros(X.shape)
             for i in range(X.shape[0]):
                 for j  in range(X.shape[1]):
                     g[i,j] = diff[i] * X[i,j]
             return g
```

```
In [ ]: y
```

```
In [ ]: theta = theta.reshape((theta.size,))
        grad(X.values, theta, y.values), sig(X.values, theta), y.values
```

```
In [ ]: gradient = np.zeros(shape=X.shape, dtype=np.float32)
```

```
In [ ]: X_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_ONLY | pcl.mem_flags.COPY_HOST_PTR, hostbuf=
        y_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_ONLY | pcl.mem_flags.COPY_HOST_PTR, hostbuf=
        theta_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_ONLY | pcl.mem_flags.COPY_HOST_PTR, host
        grad_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_WRITE | pcl.mem_flags.COPY_HOST_PTR , hos
```

```
In [ ]: grad_event = programs.logistic_gradient_ols(queue,
                                                    X.shape,
                                                    None,
                                                    X_buf,
                                                    theta_buf,
                                                    y_buf,
                                                    grad_buf,
                                                    nrows,
                                                    ncols)
```

```
In [ ]: gradient
```

```
In [ ]: grad_event.wait()
```

```
In [ ]: pcl.enqueue_copy(queue, gradient, grad_buf).wait()
```

```
In [ ]: gradient
```

```
In [ ]: gradient == grad(X.values, theta, y.values)
```

```
In [ ]: gradient
```

```
In [ ]: grad(X.values, theta, y.values)
```

```
In [ ]: # let's double check I can get this to work
```

```
In [61]: def sig(X, theta):
             lin = X.dot(theta)
             sig = 1.0 / (1.0 + np.exp(-lin))
             return sig


         def lr_cost(X, theta, y):
             est = sig(X, theta)
             log_est = np.log(est)
             cost = y*log_est + (1-y) * (1-log_est)
             cost *= -1
             return cost

         def cost_ss(est, actual):
             cost = ((est - actual)**2.0)
             cost /= 2.0
             return cost

         def grad(X, theta, y):
             diff = y - sig(X, theta)
             g = np.zeros(X.shape)
             for i in range(X.shape[0]):
                 for j  in range(X.shape[1]):
                     g[i,j] = diff[i] * X[i,j]
             return g
         def fit_params(X, y, theta):
             tol = 1e-5
             learning_rate = 1e-2
             costs = [np.inf]
             for i in range(0, 1000):
                 my_cost = lr_cost(X, theta, y)
                 my_cost = my_cost.sum()
                 costs.append(my_cost)
                 if abs(my_cost - costs[-2]) < tol:
                     break
                 else:
                     my_gradient = grad(X, theta, y)
                     my_gradient = my_gradient.mean(axis=0)
                     theta = theta + learning_rate * my_gradient

             return theta, costs
```

```
In [66]: X_train, X_test, y_train, y_test = train_test_split(X, y, train_size=0.6)
         new_t = np.random.normal(size=(X_train.shape[1], )).astype(np.float32)
         fitted_theta, outcost = fit_params(X_train.values, y_train.values, new_t)
```

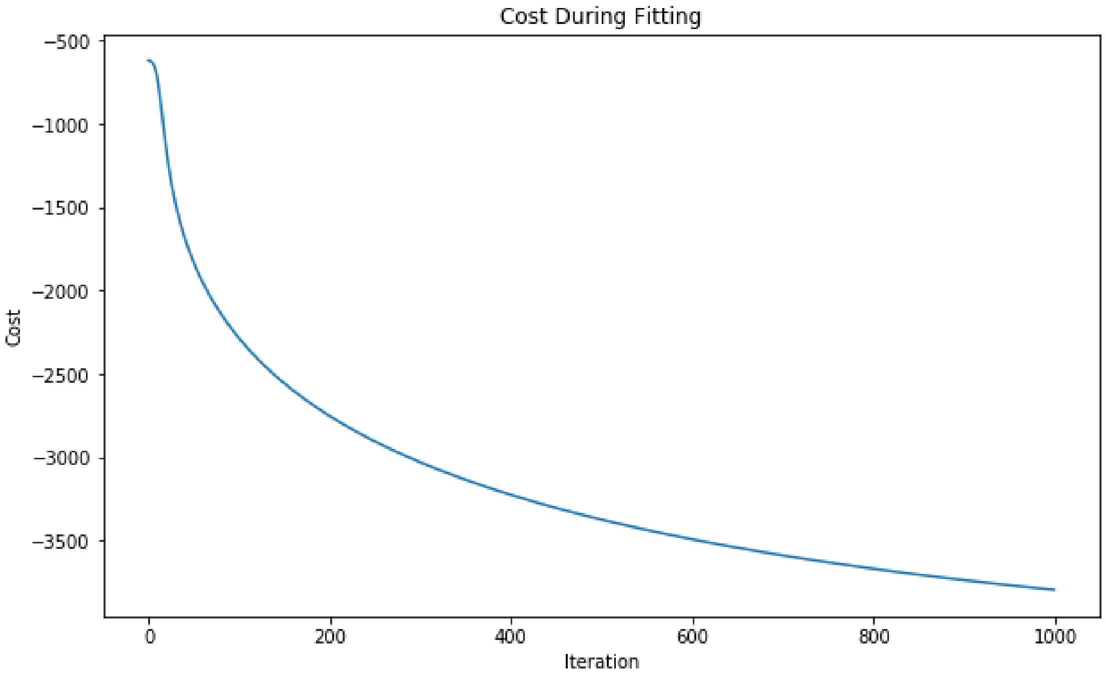
```
In [67]: fitted_theta
```

```
Out[67]: array([ 0.03598584,  1.04095844])
```

```
In [68]: lr_cost(X_test.values, fitted_theta, y_test.values).sum()
```

```
Out[68]: -2363.4378906858246
```

```
In [69]: plt.figure(figsize=(10,6))
         plt.plot(outcost[1:])
         plt.xlabel('Iteration')
         plt.ylabel('Cost')
         plt.title('Cost During Fitting')
         plt.show()
```



```
In [44]: ssc = cost_ss(sig(X_test.values, fitted_theta), y_test.values)

In [47]: ssc.sum()/X_test.shape[0]

Out[47]: 0.016629054794092435

In [ ]: cost(sig(X.values, fitted_theta), y).sum()

In [ ]: cost(sig(X.values, np.random.normal(size=theta.shape)), y).sum()

In [ ]: # ok that works, let's see if I can get this to work with the gpu code
        def fit_gpu(X, y, theta, queue, cntx):
            tol = 1e-5
            learning_rate = 1e-2
            nrows = np.int32(X.shape[0])
            ncols = np.int32(X.shape[1])
            for i in range(0, 1000):
                cost_arr = np.zeros(shape=(X.shape[0],), dtype=np.float32)
                X_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_ONLY | pcl.mem_flags.COPY_HOST_PTR,
                y_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_ONLY | pcl.mem_flags.COPY_HOST_PTR,
                theta_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_ONLY | pcl.mem_flags.COPY_HOST_P
                cost_buf = pcl.Buffer(cntx, pcl.mem_flags.READ_WRITE | pcl.mem_flags.COPY_HOST_P

                cost_event = programs.logistic_cost_ols(queue,X.shape,None,X_buf,theta_buf, y_bu
                cost_event.wait()
                pcl.enqueue_copy(queue, cost_arr, cost_buf)
                cost_arr = cost_arr.sum()
                cost_arr /= 2.
                if cost_arr < tol:
                    break
                else:
                    grad_buf = pcl.Buffer(cntx, pcl.mem_flags.WRITE_ONLY , size=X.nbytes)
                    grad_event = programs.logistic_gradient_ols(queue,X.shape,None,X_buf,theta_b
                    grad_event.wait()
                    grad_arr = np.zeros(shape=X.shape, dtype=np.float32)
                    pcl.enqueue_copy(queue, grad_arr, grad_buf)
                    grad_arr = grad_arr.mean(axis=0)
                    theta = theta + learning_rate * grad_arr

            return theta
```

```
In [ ]: X_train, X_test, y_train, y_test = train_test_split(X, y, train_size=0.6)
        new_t = np.random.normal(size=theta.shape).astype(np.float32)
        fitted_t_gpu = fit_gpu(X_train.values, y_train.values, new_t, queue, cntx)
```

```
In [ ]: fitted_t_gpu
```

```
In [ ]: fitted_theta = fit_params(X.values, y.values, new_t)
```

```
In [ ]: fitted_theta
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```
In [ ]: fitted_t_gpu - fitted_theta
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In [ ]:
```