

kaggle

March 2, 2025

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[1]: import numpy as np
import scipy
from scipy.io import loadmat
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
import matplotlib.pyplot as plt
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[ ]: data = loadmat("data.mat")
X = data["X"]
y = data["y"]
joined_data = np.column_stack((X, y))
norms = np.linalg.norm(X, axis=1, keepdims=True)
X = X / norms
joined = np.column_stack((X, y))
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[223]: def sigmoid(x):
    return np.clip(scipy.special.expit(x), 1e-15, 1-1e-15)
def next_weight_grad(X, w, y, lam, lr):
    """
    lr = learning rate
    lam = lambda or l2 regularization term parameter
    w = weight vector
    X = training data
    y = labels
    """
    s = sigmoid(X.dot(w))
    # clip so we avoid large oscillating updates to our weight vector
    grad = np.clip(X.T.dot(s - y) + (lam / len(y)) * w, -3, 3)
    w = w - lr * grad
    return w

class LogisticRegression:
    def __init__(self, Xy, X_val, y_val):
        self.Xy = Xy
        # add bias dimension
        self.X = np.column_stack((Xy[:, 0:-1], np.ones(Xy[:, 0:-1].shape[0])))
        self.y = Xy[:, -1]
        # random weight vector and make values small
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self.w = np.random.randn(self.X.shape[1]) * 0.01
self.X_val = np.column_stack((X_val, np.ones(X_val.shape[0])))
self.y_val = y_val
self.scores = []

def eval(self, threshold):
    predictions = self.X_val.dot(self.w)
    threshed_predictions = np.where(predictions > threshold, 1, 0)
    return accuracy_score(threshed_predictions, self.y_val)

def loss(self, w, lam):
    s = sigmoid(self.X.dot(w))
    loss_term = -1 * (self.y.dot(np.log(s)) + (1-self.y).dot(np.log(1-s)))
    l2 = (lam / (2 * len(self.y))) * (np.linalg.norm(w) ** 2)
    return loss_term + l2

def train(self, lam, lr, epochs, method, batch_size=0):
    # keep a stack of our 5 most recent differences in scores so we can end
    ↳ loop early when we converge
    # reset weight vector and loss score array
    prev = []
    self.scores = []
    self.w = np.random.randn(self.X.shape[1]) * 0.01

    if method == "gd":
        for epoch in range(epochs):

            print(f"Epoch: {epoch}")

            next_w = next_weight_grad(X=self.X, w=self.w, y=self.y,
    ↳ lam=lam, lr=lr)
            next_loss = self.loss(next_w, lam)
            prev.append(abs(self.loss(self.w, lam)-next_loss))

            if len(prev) > 5:
                prev.pop(0)

            if (len(prev) == 5 and np.std(prev) < .1):
                print(f"Gradient descent converged in {epoch} epochs")
                self.w = next_w
                break
            else:
                print(abs(self.loss(self.w, lam)-self.loss(next_w, lam)))
                self.scores.append(self.loss(next_w, lam))
                self.w = next_w
        if len(self.scores) >= epochs:

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        print("Maximum epochs reached")

    elif method == "sgd":
        assert batch_size >= 1 and batch_size <= self.X.shape[0], "Invalid_
↪batch size"
        num_batches = self.X.shape[0] // batch_size
        Xy_copy = self.Xy.copy()
        for epoch in range(epochs):
            np.random.shuffle(Xy_copy)
            print(f"Epoch: {epoch}")

            for batch in range(num_batches):
                l = batch * batch_size
                r = min((batch + 1) * batch_size, Xy_copy.shape[0])
                X_batch, y_batch = Xy_copy[l:r, :-1], Xy_copy[l:r, -1]
                # add bias term
                X_batch = np.column_stack((X_batch, np.ones(X_batch.
↪shape[0])))

                next_w = next_weight_grad(X=X_batch, w=self.w, y=y_batch,
↪lam=lam, lr=lr)
                self.w = next_w

            epoch_loss = self.loss(self.w, lam)
            self.scores.append(epoch_loss)

            if len(self.scores) > 1:
                epoch_loss_diff = abs(self.scores[-2] - self.scores[-1])
                print(epoch_loss_diff)
                prev.append(epoch_loss_diff)

                if len(prev) > 5:
                    prev.pop(0)

                if len(prev) == 5 and np.std(prev) < 0.1:
                    print(f"Gradient descent converged in {epoch} epochs")
                    break
            if len(self.scores) >= epochs:
                print("Maximum epochs reached")

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[224]: np.random.seed(189)
np.random.shuffle(joined_data)
X = joined_data[:, 0:-1]
y = joined_data[:, -1]
X_train, X_val, y_train, y_val = train_test_split(X, y, test_size=0.2,
↪random_state=189)

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lr = LogisticRegression(np.column_stack((X_train, y_train)), X_val=X_val,  
↪y_val=y_val)
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[225]: lr.train(lr=.001,lam=0.04, epochs = 20000, method = "gd")
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35.46096791478794  
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4.835268098295728  
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51.964246776714845  
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31.60326014493171  
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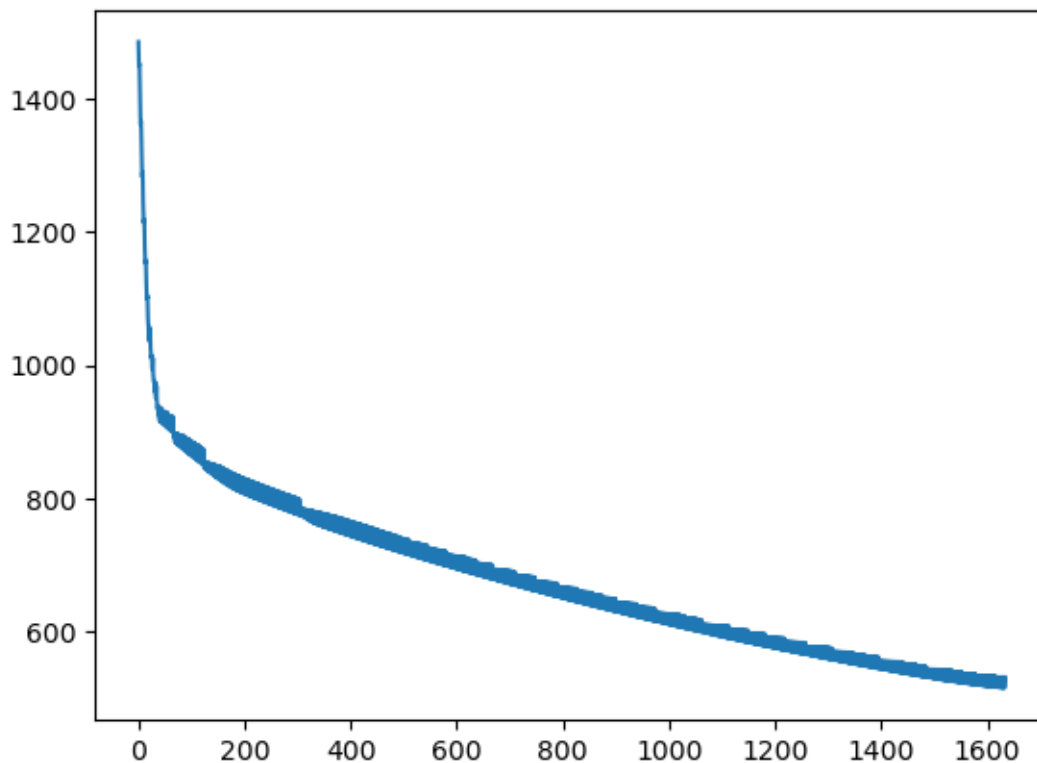
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16.033058875485494
Epoch: 1634
Gradient descent converged in 1634 epochs
```

```
[226]: lr.eval(0.5)
```

```
[226]: 0.953
```

```
[227]: plt.plot(np.arange(len(lr.scores)), lr.scores)
```

```
[227]: [<matplotlib.lines.Line2D at 0x16d992210>]
```



```
[228]: lr.train(lr=.001,lam=0.04, epochs = 20000, method = "sgd", batch_size=10)
lr.eval(0.5)
```


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KeyboardInterrupt

Traceback (most recent call last)

Cell In[228], line 1

```
----> 1 lr.train(lr=.001,lam=0.04, epochs = 20000, method = "sgd", batch_size=1)
      2 lr.eval(0.5)
```

Cell In[223], line 99, in LogisticRegression.train(self, lam, lr, epochs, method, batch_size)

```
    96 if len(prev) > 5:
    97     prev.pop(0)
--> 99 if len(prev) == 5 and np.std(prev) < 0.1:
    100     print(f"Gradient descent converged in {epoch} epochs")
    101     break
```

File /opt/miniconda3/envs/189/lib/python3.13/site-packages/numpy/_core/_fromnumeric.py:4064, in std(a, axis, dtype, out, ddof, keepdims, where, mean, correction)

```
    4061     else:
    4062         return std(axis=axis, dtype=dtype, out=out, ddof=ddof, **kwargs)
-> 4064 return _methods._std(a, axis=axis, dtype=dtype, out=out, ddof=ddof,
    4065                        **kwargs)
```

File /opt/miniconda3/envs/189/lib/python3.13/site-packages/numpy/_core/_methods.py:223, in _std(a, axis, dtype, out, ddof, keepdims, where, mean)

```
    221 def _std(a, axis=None, dtype=None, out=None, ddof=0, keepdims=False, *,
    222            where=True, mean=None):
-> 223     ret = _var(a, axis=axis, dtype=dtype, out=out, ddof=ddof,
    224               keepdims=keepdims, where=where, mean=mean)
    226     if isinstance(ret, mu.ndarray):
    227         ret = um.sqrt(ret, out=ret)
```

File /opt/miniconda3/envs/189/lib/python3.13/site-packages/numpy/_core/_methods.py:171, in _var(a, axis, dtype, out, ddof, keepdims, where, mean)

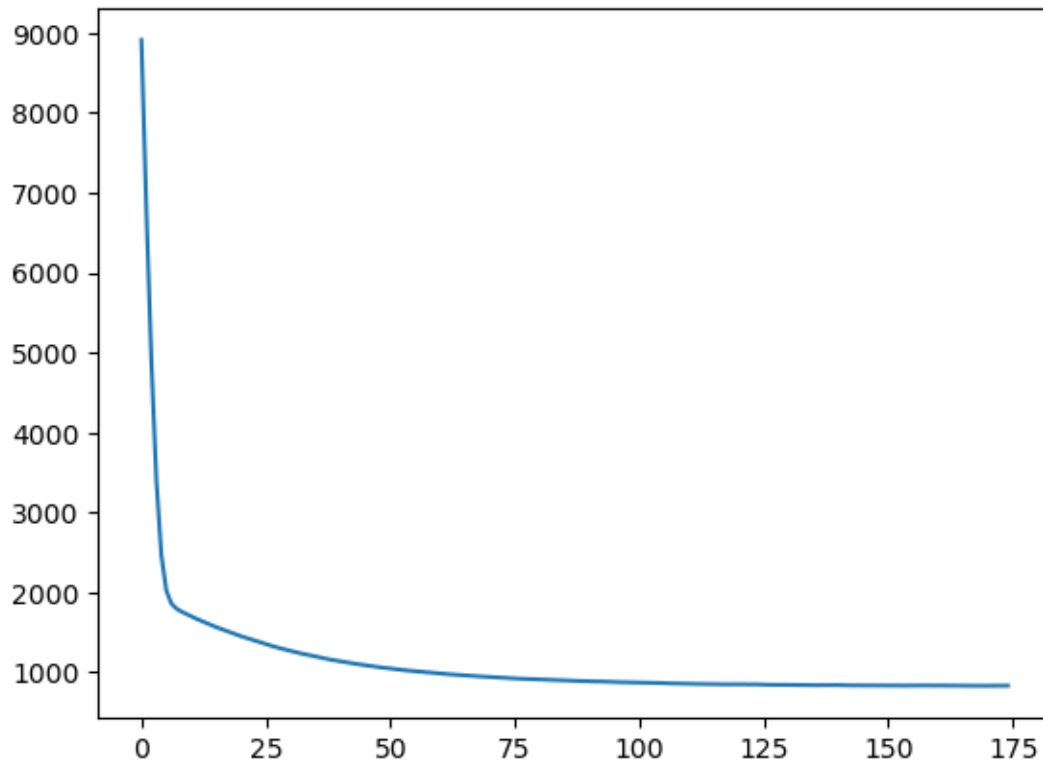
```
    166     arrmean = mean
    167 else:
    168     # Compute the mean.
    169     # Note that if dtype is not of inexact type then arraymean will
    170     # not be either.
-> 171     arrmean = umr_sum(arr, axis, dtype, keepdims=True, where=where)
    172     # The shape of rcount has to match arrmean to not change the shape of
    173     # out in broadcasting. Otherwise, it cannot be stored back to
    arrmean.
```

```
174     if rcount.ndim == 0:  
175         # fast-path for default case when where is True
```

KeyboardInterrupt:

```
[221]: plt.plot(range(len(lr.scores)), lr.scores)
```

```
[221]: [<matplotlib.lines.Line2D at 0x16d8bccd0>]
```



```
[ ]:
```