

## Importing libraries

In [46]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import os
!pip install tqdm
from tqdm.notebook import tqdm
from keras.datasets import cifar10
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report, accuracy_score
import torch
from google.colab import output
output.enable_custom_widget_manager()
import random
np.random.seed(42)
random.seed(42)
```

Looking in indexes: <https://pypi.org/simple>, <https://us-python.pkg.dev/colab-wheels/public/simple/>  
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/dist-packages (4.64.0)

## Train Validation Test Split

In [47]:

```
(x_train, y_train), (x_test, y_test) = cifar10.load_data()
images = np.append(x_train, x_test, axis=0)
labels = np.append(y_train, y_test)
x, x_test, y, y_test = train_test_split(images, labels, test_size=0.2, train_size=0.8)
x_train, x_val, y_train, y_val = train_test_split(x, y, test_size = 0.25, train_size = 0.75)
```

## Nearest Neighbour Classification

In [48]:

```
def knn(inp,k):
    """
    kNN Classifier based on L2 Distance

    Inputs:
    - inp: vector of input image
    - k: No.of neighbours to consider before assigning class label prediction
    """

    dist = []

    for i in x_train:
        dist.append((np.sum((inp-i)**2)))

    lst = [x for _, x in sorted(zip(dist, y_train))][:k]

    return max(set(lst), key=lst.count) # Return maximally occurring class amongst k nearest neighbours
```

In [49]:

```
def knn_predict(inp,k):
    """
    Prediction function for kNN Classifier

    Inputs:
    - inp: List of vectors of input images
    - k: No.of neighbours to consider before assigning class label prediction
    """

    preds = []
    for i in tqdm(inp):
        preds.append(knn(i,k))
    return preds # List of Prediction Labels
```

In [50]:

```
for k in tqdm(range(1,10)):
    print("For k = {}, accuracy is {} %".format(k,accuracy_score(y_val.flatten()[:10],k
nn_predict(x_val[:10],k))*100))
```

For k = 1, accuracy is 30.0 %

For k = 2, accuracy is 30.0 %

For k = 3, accuracy is 30.0 %

For k = 4, accuracy is 40.0 %

For k = 5, accuracy is 20.0 %

For k = 6, accuracy is 30.0 %

For k = 7, accuracy is 20.0 %

For k = 8, accuracy is 20.0 %

For k = 9, accuracy is 20.0 %

In [60]:

```
print("For k = {}, test accuracy is {} %".format(4,accuracy_score(y_test.flatten()[:10
],knn_predict(x_test[:10],4))*100))
```

For k = 4, test accuracy is 20.0 %

**Results:** k = 4 results in maximum validation accuracy of 40% and testing accuracy of 20%

**NOTE:** Only 10 images were selected during testing to minimize time taken to run.

---

## Hinge loss

In [79]:

```
def hinge_loss(score, labels, idx, i, dW, loss):  
    '''  
    Implementation of Hinge Loss or SVM Loss  
  
    Inputs:  
    - score: Scoring function output  
    - labels: List of training image labels  
    - idx: Index of current image in input batch  
    - i: 3D Image numpy array  
    - dW: Empty gradient array  
    - loss: Value of Loss  
    '''  
  
    for j in range(10): # 10 = No. of classes in Cifar-10  
  
        if j != labels[idx]-1:  
            hinge = score[j] - score[labels[idx]-1] + 1  
  
            if hinge > 0:  
                loss += hinge  
                dW[:, labels[idx]] -= i.flatten()  
                dW[:, j] += i.flatten()  
  
    return dW, loss # Updated gradient and Loss value
```

## Softmax Loss

In [80]:

```
def softmax_loss(score, labels, idx, i, dW, loss):  
    '''  
    Implementation of Softmax Loss  
  
    Inputs:  
    - score: Scoring function output  
    - labels: List of training image labels  
    - idx: Index of current image in input batch  
    - i: 3D Image numpy array  
    - dW: Empty gradient array  
    - loss: Value of Loss  
    '''  
  
    softmax = np.exp(score)/np.sum(np.exp(score))  
    loss += -np.log(softmax[labels[idx]])  
  
    for j in range(10): # 10 = No. of classes in Cifar-10  
        dW[:, j] += i.flatten() * softmax[j]  
  
    dW[:, labels[idx]] -= i.flatten()  
  
    return dW, loss # Updated gradient and Loss value
```

## Model Training

In [81]:

```
def train(W,images,labels,reg,loss_function='softmax'):
    '''
    Training function

    Inputs:
    - W: Weight matrix
    - images: Batch of training images
    - labels: Class labels for training images
    - reg = Regularization
    - loss_function: Type of Loss function to use.
                    2 options - 'softmax' or 'hinge'
    '''

    loss = 0
    dW = np.zeros((3072,10))

    for idx, i in enumerate(images):

        score = (np.dot(i.flatten().reshape(1,-1),W)).ravel()

        if loss_function == 'softmax':
            dW,loss = softmax_loss(score,labels,idx,i,dW,loss)

        else:
            dW,loss = hinge_loss(score,labels,idx,i,dW,loss)

    loss /= images.shape[0]
    dW = dW / images.shape[0]

    loss += reg * np.sum(W * W)
    dW = dW + reg * 2 * W

    return loss, dW # Updated Loss value and gradient
```

## Model Functions

In [82]:

```
def SVM(X,y,learning_rate,reg,epochs,X_val,y_val):  
    '''  
    Inputs:  
    - X: Training images  
    - y: Training labels  
    - learning_rate: Learning rate (alpha) value  
    - reg: Regularization value  
    - epochs: No.of epochs to be trained for  
    - X_val: Validation images  
    - y_val: Validation labels  
    '''  
  
    W = 0.001 * np.random.rand(3072,10)  
    loss_history = []  
    loss_function = 'hinge'  
    print('Loss function used:',loss_function)  
    print("-----")  
    train_acc = 0  
    val_acc = []  
  
    for i in tqdm(range(epochs)):  
        loss, grad = train(W,X,y,reg,loss_function)  
        loss_history.append(loss)  
  
        # learning_rate = lr_scheduler(Learning_rate,i)  
        W = W - learning_rate * grad  
  
        train_preds = predict(W,X)  
        val_preds = predict(W,X_val)  
  
        train_acc = accuracy_score(y,train_preds)  
        val_acc.append(accuracy_score(y_val,val_preds))  
  
        print("EPOCH {}/{} | Training loss: {:.2f} | Training accuracy: {:.2f} | Validation  
accuracy: {:.2f}".format(i,epochs,loss,train_acc,val_acc[-1]))  
  
    print()  
    plt.plot(loss_history)  
    plt.xlabel('Epochs')  
    plt.ylabel('Loss value')  
    plt.show()  
  
    return W, loss_history, val_acc # Model weights, list of loss value history and list  
of validation accuracies
```

In [83]:

```
def Softmax(X,y,learning_rate,reg,epochs,X_val,y_val):  
    '''  
    Inputs:  
    - X: Training images  
    - y: Training labels  
    - learning_rate: Learning rate (alpha) value  
    - reg: Regularization value  
    - epochs: No.of epochs to be trained for  
    - X_val: Validation images  
    - y_val: Validation labels  
    '''  
  
    W = 0.001 * np.random.rand(3072,10)  
    loss_history = []  
    loss_function = 'softmax'  
    print('Loss function used:',loss_function)  
    print("-----")  
    val_acc = []  
  
    for i in tqdm(range(epochs)):  
        loss, grad = train(W,X,y,reg,loss_function)  
        loss_history.append(loss)  
  
        W = W - learning_rate * grad  
  
        train_preds = predict(W,X)  
        val_preds = predict(W,X_val)  
  
        train_acc = accuracy_score(y,train_preds)  
        val_acc.append(accuracy_score(y_val,val_preds))  
  
        print("EPOCH {}/{} | Training loss: {:.2f} | Training accuracy: {:.2f} | Validation  
accuracy: {:.2f}".format(i,epochs,loss,train_acc,val_acc[-1]))  
  
    print()  
    plt.plot(loss_history)  
    plt.xlabel('Epochs')  
    plt.ylabel('Loss value')  
    plt.show()  
  
    return W, loss_history, val_acc # Model weights, list of loss value history and list  
of validation accuracies
```

## Prediction Function

In [84]:

```
def predict(W,images):  
    '''  
    Inputs:  
    - W: Weight matrix  
    - images: Images to run prediction on  
    '''  
    preds = []  
    for idx, i in enumerate(images):  
        score = (np.dot(i.flatten().reshape(1,-1),W)).ravel()  
        preds.append(np.argmax(score))  
  
    return preds # List of prediction labels
```

## LR Scheduler

In [85]:

```
def lr_scheduler(alpha,epoch):  
    '''  
    Learning Rate scheduler. Decreases Learning rate by a factor of 10 every 100 epochs.  
  
    Inputs:  
    - alpha: Learning rate  
    - epoch: Current Epoch  
    '''  
    print(alpha)  
    if epoch%100 == 0:  
        return alpha/(10) # Updated Learning rate  
    else:  
        return alpha # Non updated Learning rate
```

## Model Training



In [68]:

```
svm, svm_loss, svm_val_acc = SVM(x_train[:1000],y_train[:1000],1e-10,0,500,x_val[:100],  
y_val[:100])
```

Loss function used: hinge

-----

[illegible]



[illegible]



[illegible]





[illegible]



[illegible]



[illegible]



[illegible]

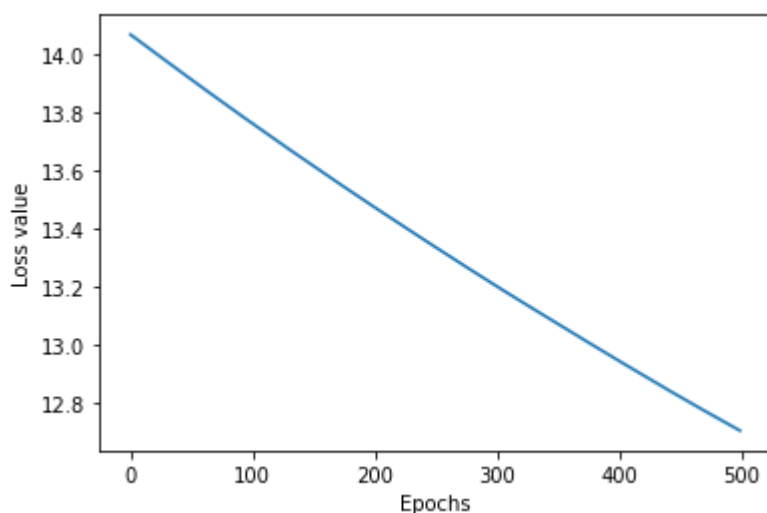




[illegible]



EPOCH 488/500 | Training loss: 12.73 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 489/500 | Training loss: 12.73 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 490/500 | Training loss: 12.72 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 491/500 | Training loss: 12.72 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 492/500 | Training loss: 12.72 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 493/500 | Training loss: 12.72 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 494/500 | Training loss: 12.71 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 495/500 | Training loss: 12.71 | Training accuracy: 0.09 | Validation accuracy: 0.08  
EPOCH 496/500 | Training loss: 12.71 | Training accuracy: 0.09 | Validation accuracy: 0.08  
EPOCH 497/500 | Training loss: 12.71 | Training accuracy: 0.09 | Validation accuracy: 0.08  
EPOCH 498/500 | Training loss: 12.71 | Training accuracy: 0.09 | Validation accuracy: 0.08  
EPOCH 499/500 | Training loss: 12.70 | Training accuracy: 0.09 | Validation accuracy: 0.08



In [69]:

```
softmax, sft_loss, softmax_val_acc = Softmax(x_train[:1000], y_train[:1000], 1e-7, 0, 500, x_val[:100], y_val[:100])
```

Loss function used: softmax

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[illegible]

[illegible]

[illegible]





[illegible]



[illegible]



[illegible]

[illegible]

[illegible]



[illegible]

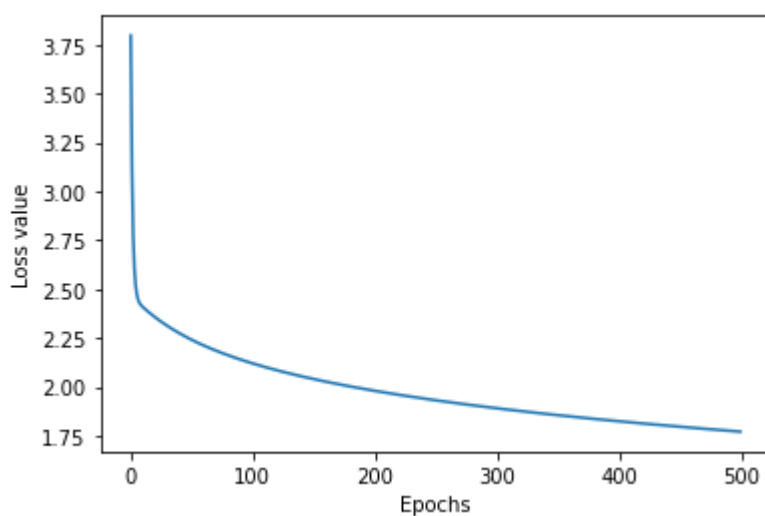
[illegible]



[illegible]

[illegible]

EPOCH 488/500 | Training loss: 1.78 | Training accuracy: 0.36 | Validation accuracy: 0.31  
EPOCH 489/500 | Training loss: 1.78 | Training accuracy: 0.36 | Validation accuracy: 0.31  
EPOCH 490/500 | Training loss: 1.77 | Training accuracy: 0.36 | Validation accuracy: 0.31  
EPOCH 491/500 | Training loss: 1.77 | Training accuracy: 0.36 | Validation accuracy: 0.31  
EPOCH 492/500 | Training loss: 1.77 | Training accuracy: 0.36 | Validation accuracy: 0.31  
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EPOCH 496/500 | Training loss: 1.77 | Training accuracy: 0.36 | Validation accuracy: 0.31  
EPOCH 497/500 | Training loss: 1.77 | Training accuracy: 0.36 | Validation accuracy: 0.31  
EPOCH 498/500 | Training loss: 1.77 | Training accuracy: 0.36 | Validation accuracy: 0.31  
EPOCH 499/500 | Training loss: 1.77 | Training accuracy: 0.36 | Validation accuracy: 0.31



## Test Function

In [70]:

```
def model_test(model):  
    '''  
    Model Testing function  
  
    Inputs:  
    - model: Model weights to test  
    ...  
    predictions = predict(model,x_test)  
  
    print(classification_report(y_test,predictions))
```

In [71]:

```
model_test(svm)
```

	precision	recall	f1-score	support
0	0.25	0.01	0.01	1181
1	0.18	0.05	0.08	1188
2	0.08	0.04	0.05	1232
3	0.15	0.01	0.02	1274
4	0.04	0.00	0.00	1179
5	0.07	0.00	0.00	1230
6	0.10	0.51	0.17	1123
7	0.00	0.00	0.00	1217
8	0.09	0.16	0.11	1189
9	0.06	0.15	0.08	1187
accuracy			0.09	12000
macro avg	0.10	0.09	0.05	12000
weighted avg	0.10	0.09	0.05	12000

In [72]:

```
model_test(softmax)
```

	precision	recall	f1-score	support
0	0.32	0.44	0.37	1181
1	0.29	0.35	0.32	1188
2	0.17	0.15	0.16	1232
3	0.19	0.12	0.15	1274
4	0.21	0.17	0.19	1179
5	0.27	0.32	0.29	1230
6	0.27	0.29	0.28	1123
7	0.25	0.24	0.24	1217
8	0.35	0.35	0.35	1189
9	0.33	0.32	0.33	1187
accuracy			0.27	12000
macro avg	0.27	0.27	0.27	12000
weighted avg	0.26	0.27	0.27	12000

## Grid Search

In [77]:

```
def grid_search(model='softmax'):
    """
    Grid search function to find best Learning rate and regularization coefficient based
    on Validation accuracy

    Inputs:
    - model: Model to grid search on.
      2 options - 'softmax' or 'hinge'

    """

    history = []

    for alpha in [1e-5,1e-6,1e-7,1e-8,1e-9,1e-10]:
        for reg in [1e1,1e2,1e3,1e4,1e5]:
            if model == 'softmax':
                softmax, softmax_loss, val_acc = Softmax(x_train[:100],y_train[:100],alpha,reg,10,x_val[:100],y_val[:100])
                print()

            else:
                svm, svm_loss, val_acc = SVM(x_train[:100],y_train[:100],alpha,reg,10,x_val[:100],y_val[:100])
                print()

            print("Learning Rate: {} | Regularization: {} | Maximum Validation Accuracy: {}".format(alpha,reg,max(val_acc)))
            print()

            history.append((alpha,reg,max(val_acc)))

    best = max(history,key=lambda item:item[2])

    print('Best Hyperparameters: Learning Rate {} | Regularization: {}'.format(best[0],best[1]))
    print()

    return history # List of tuples with elements (Learning Rate, Regularization, Validation Accuracy)
```



In [86]:

```
hist_softmax = grid_search('softmax')
```

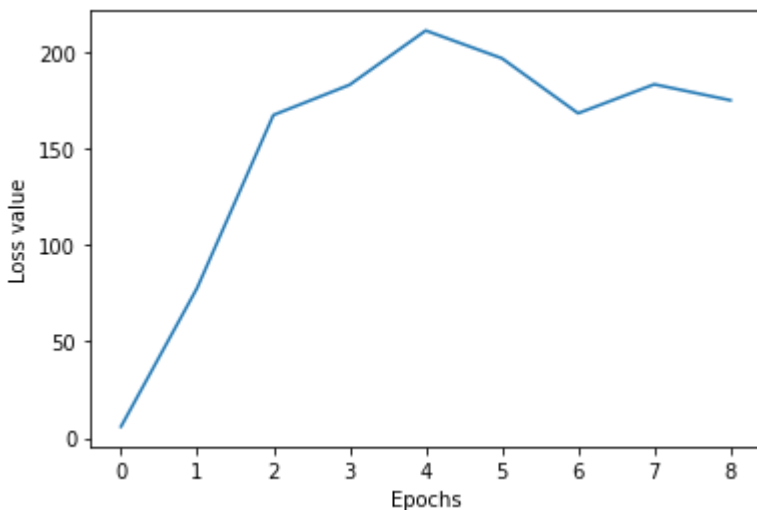
Loss function used: softmax

-----

Epoch	Training loss	Training accuracy	Validation accuracy
0/10	5.91	0.20	0.08
1/10	77.71	0.14	0.10
2/10	167.11	0.13	0.14
3/10	182.73	0.09	0.09
4/10	210.83	0.10	0.07
5/10	196.47	0.11	0.07
6/10	168.03	0.23	0.10
7/10	183.01	0.06	0.14
8/10	174.76	0.14	0.10
9/10	nan	0.14	0.10

/usr/local/lib/python3.7/dist-packages/ipykernel\_launcher.py:14: RuntimeWarning: overflow encountered in exp

/usr/local/lib/python3.7/dist-packages/ipykernel\_launcher.py:14: RuntimeWarning: invalid value encountered in true\_divide



Learning Rate: 1e-05 | Regularization: 10.0 | Maximum Validation Accuracy: 0.14

Loss function used: softmax

EPOCH 0/10 | Training loss: 5.77 | Training accuracy: 0.20 | Validation accuracy: 0.08  
 EPOCH 1/10 | Training loss: 75.83 | Training accuracy: 0.22 | Validation accuracy: 0.09  
 EPOCH 2/10 | Training loss: 135.84 | Training accuracy: 0.10 | Validation accuracy: 0.07  
 EPOCH 3/10 | Training loss: 135.21 | Training accuracy: 0.08 | Validation accuracy: 0.08  
 EPOCH 4/10 | Training loss: 122.51 | Training accuracy: 0.11 | Validation accuracy: 0.15  
 EPOCH 5/10 | Training loss: 98.33 | Training accuracy: 0.23 | Validation accuracy: 0.15  
 EPOCH 6/10 | Training loss: inf | Training accuracy: 0.13 | Validation accuracy: 0.14

```

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:15: RuntimeWarning: divide by zero encountered in log
  from ipykernel import kernelapp as app
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:15: RuntimeWarning: divide by zero encountered in log
  from ipykernel import kernelapp as app
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:14: RuntimeWarning: overflow encountered in exp
  
```

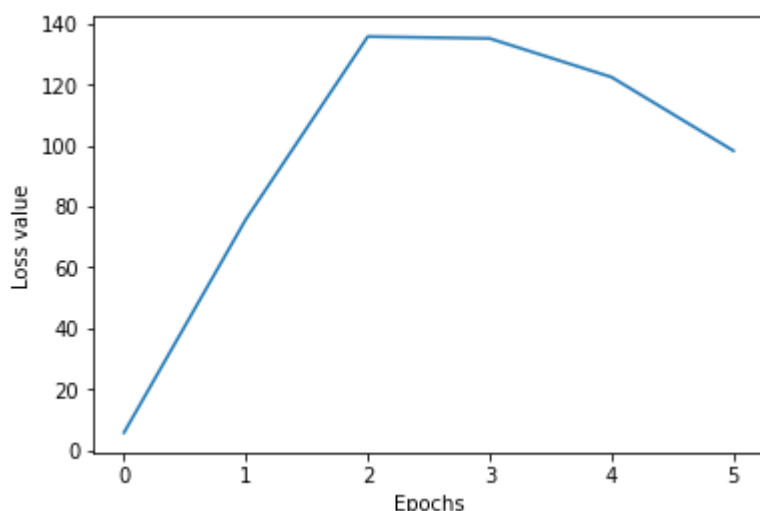
```

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:14: RuntimeWarning: invalid value encountered in true_divide
  
```

```

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:15: RuntimeWarning: divide by zero encountered in log
  from ipykernel import kernelapp as app
  
```

EPOCH 7/10 | Training loss: inf | Training accuracy: 0.22 | Validation accuracy: 0.08  
 EPOCH 8/10 | Training loss: inf | Training accuracy: 0.20 | Validation accuracy: 0.08  
 EPOCH 9/10 | Training loss: nan | Training accuracy: 0.14 | Validation accuracy: 0.10



Learning Rate: 1e-05 | Regularization: 100.0 | Maximum Validation Accuracy: 0.15

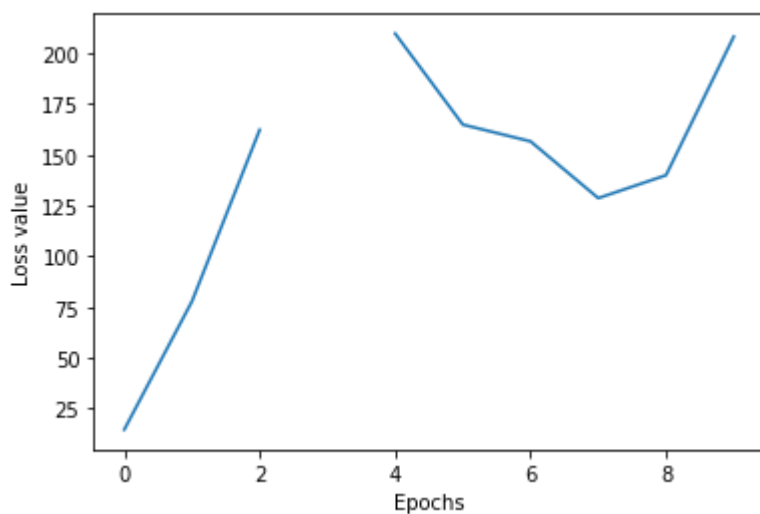
Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 14.70 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 77.86 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 162.33 | Training accuracy: 0.13 | Validation accuracy: 0.14  
EPOCH 3/10 | Training loss: inf | Training accuracy: 0.09 | Validation accuracy: 0.09  
EPOCH 4/10 | Training loss: 209.71 | Training accuracy: 0.09 | Validation accuracy: 0.08

/usr/local/lib/python3.7/dist-packages/ipykernel\_launcher.py:15: RuntimeWarning: divide by zero encountered in log  
from ipykernel import kernelapp as app

EPOCH 5/10 | Training loss: 164.88 | Training accuracy: 0.25 | Validation accuracy: 0.13  
EPOCH 6/10 | Training loss: 156.63 | Training accuracy: 0.17 | Validation accuracy: 0.17  
EPOCH 7/10 | Training loss: 128.69 | Training accuracy: 0.22 | Validation accuracy: 0.09  
EPOCH 8/10 | Training loss: 139.96 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 208.21 | Training accuracy: 0.11 | Validation accuracy: 0.07



Learning Rate: 1e-05 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.17

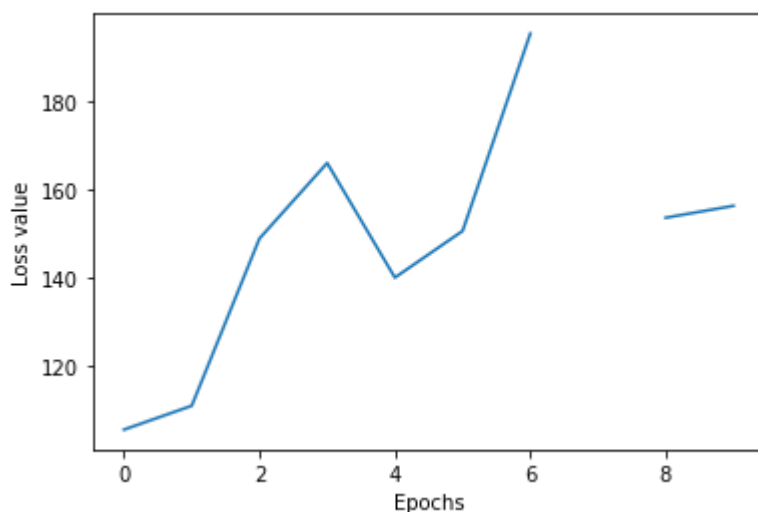
Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 105.43 | Training accuracy: 0.22 | Validation accuracy: 0.11  
 EPOCH 1/10 | Training loss: 110.84 | Training accuracy: 0.13 | Validation accuracy: 0.14  
 EPOCH 2/10 | Training loss: 148.79 | Training accuracy: 0.18 | Validation accuracy: 0.11  
 EPOCH 3/10 | Training loss: 165.93 | Training accuracy: 0.15 | Validation accuracy: 0.08  
 EPOCH 4/10 | Training loss: 139.93 | Training accuracy: 0.20 | Validation accuracy: 0.08  
 EPOCH 5/10 | Training loss: 150.51 | Training accuracy: 0.14 | Validation accuracy: 0.10  
 EPOCH 6/10 | Training loss: 195.30 | Training accuracy: 0.09 | Validation accuracy: 0.09  
 EPOCH 7/10 | Training loss: inf | Training accuracy: 0.09 | Validation accuracy: 0.10  
 EPOCH 8/10 | Training loss: 153.51 | Training accuracy: 0.27 | Validation accuracy: 0.19

/usr/local/lib/python3.7/dist-packages/ipykernel\_launcher.py:15: RuntimeWarning: divide by zero encountered in log  
 from ipykernel import kernelapp as app

EPOCH 9/10 | Training loss: 156.21 | Training accuracy: 0.10 | Validation accuracy: 0.07



Learning Rate: 1e-05 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.19

Loss function used: softmax

EPOCH 0/10 | Training loss: 1029.26 | Training accuracy: 0.20 | Validation accuracy: 0.08  
 EPOCH 1/10 | Training loss: 1182.88 | Training accuracy: 0.08 | Validation accuracy: 0.08  
 EPOCH 2/10 | Training loss: inf | Training accuracy: 0.20 | Validation accuracy: 0.08  
 EPOCH 3/10 | Training loss: inf | Training accuracy: 0.08 | Validation accuracy: 0.08

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:15: RuntimeWarning: divide by zero encountered in log
  from ipykernel import kernelapp as app
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:15: RuntimeWarning: divide by zero encountered in log
  from ipykernel import kernelapp as app
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:14: RuntimeWarning: overflow encountered in exp

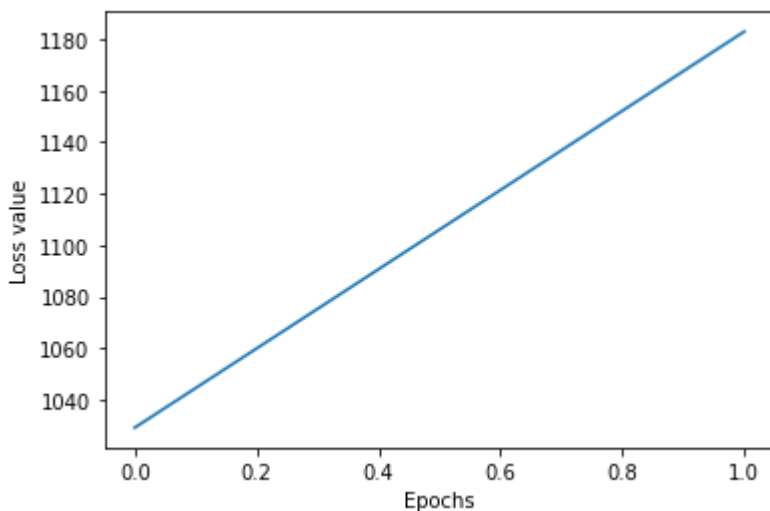
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:14: RuntimeWarning: invalid value encountered in true_divide

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:15: RuntimeWarning: divide by zero encountered in log
  from ipykernel import kernelapp as app
```

```
EPOCH 4/10 | Training loss: nan | Training accuracy: 0.08 | Validation accuracy: 0.08
EPOCH 5/10 | Training loss: nan | Training accuracy: 0.14 | Validation accuracy: 0.10
EPOCH 6/10 | Training loss: nan | Training accuracy: 0.14 | Validation accuracy: 0.10
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:14: RuntimeWarning: overflow encountered in exp
```

```
EPOCH 7/10 | Training loss: nan | Training accuracy: 0.14 | Validation accuracy: 0.10
EPOCH 8/10 | Training loss: nan | Training accuracy: 0.14 | Validation accuracy: 0.10
EPOCH 9/10 | Training loss: nan | Training accuracy: 0.14 | Validation accuracy: 0.10
```

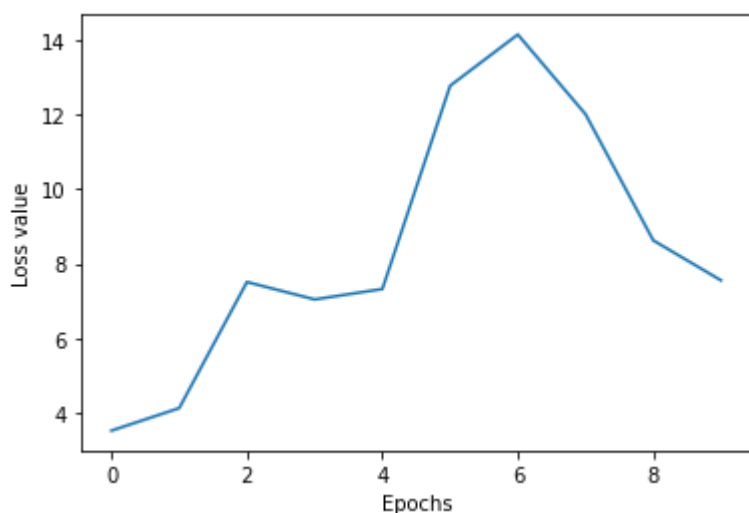


```
Learning Rate: 1e-05 | Regularization: 100000.0 | Maximum Validation Accuracy: 0.1
```

```
Loss function used: softmax
```

-----

EPOCH 0/10 | Training loss: 3.52 | Training accuracy: 0.23 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 4.13 | Training accuracy: 0.14 | Validation accuracy: 0.15  
EPOCH 2/10 | Training loss: 7.51 | Training accuracy: 0.14 | Validation accuracy: 0.08  
EPOCH 3/10 | Training loss: 7.04 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 7.32 | Training accuracy: 0.21 | Validation accuracy: 0.08  
EPOCH 5/10 | Training loss: 12.77 | Training accuracy: 0.13 | Validation accuracy: 0.09  
EPOCH 6/10 | Training loss: 14.15 | Training accuracy: 0.15 | Validation accuracy: 0.14  
EPOCH 7/10 | Training loss: 12.01 | Training accuracy: 0.16 | Validation accuracy: 0.11  
EPOCH 8/10 | Training loss: 8.63 | Training accuracy: 0.27 | Validation accuracy: 0.11  
EPOCH 9/10 | Training loss: 7.55 | Training accuracy: 0.14 | Validation accuracy: 0.11

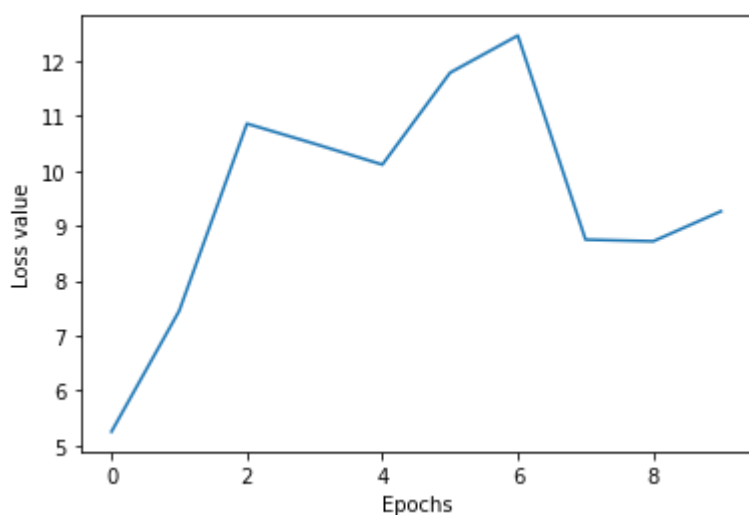


Learning Rate: 1e-06 | Regularization: 10.0 | Maximum Validation Accuracy: 0.15

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 5.25 | Training accuracy: 0.19 | Validation accuracy: 0.09  
EPOCH 1/10 | Training loss: 7.45 | Training accuracy: 0.11 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 10.86 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 10.49 | Training accuracy: 0.11 | Validation accuracy: 0.06  
EPOCH 4/10 | Training loss: 10.11 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 5/10 | Training loss: 11.79 | Training accuracy: 0.08 | Validation accuracy: 0.09  
EPOCH 6/10 | Training loss: 12.47 | Training accuracy: 0.12 | Validation accuracy: 0.14  
EPOCH 7/10 | Training loss: 8.75 | Training accuracy: 0.14 | Validation accuracy: 0.11  
EPOCH 8/10 | Training loss: 8.72 | Training accuracy: 0.24 | Validation accuracy: 0.12  
EPOCH 9/10 | Training loss: 9.26 | Training accuracy: 0.17 | Validation accuracy: 0.13



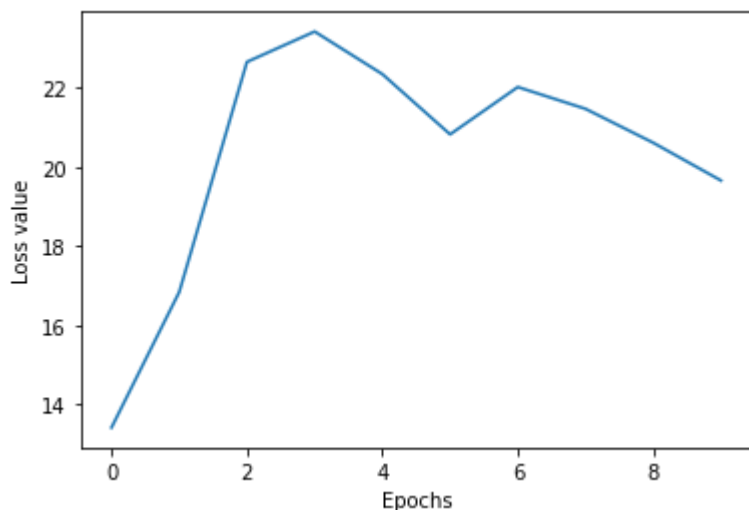
Learning Rate: 1e-06 | Regularization: 100.0 | Maximum Validation Accuracy: 0.14

Loss function used: softmax

-----



EPOCH 0/10 | Training loss: 13.40 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 16.83 | Training accuracy: 0.15 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 22.65 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 3/10 | Training loss: 23.42 | Training accuracy: 0.12 | Validation accuracy: 0.13  
EPOCH 4/10 | Training loss: 22.34 | Training accuracy: 0.16 | Validation accuracy: 0.14  
EPOCH 5/10 | Training loss: 20.82 | Training accuracy: 0.23 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 22.02 | Training accuracy: 0.12 | Validation accuracy: 0.13  
EPOCH 7/10 | Training loss: 21.47 | Training accuracy: 0.15 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 20.61 | Training accuracy: 0.16 | Validation accuracy: 0.13  
EPOCH 9/10 | Training loss: 19.65 | Training accuracy: 0.24 | Validation accuracy: 0.09

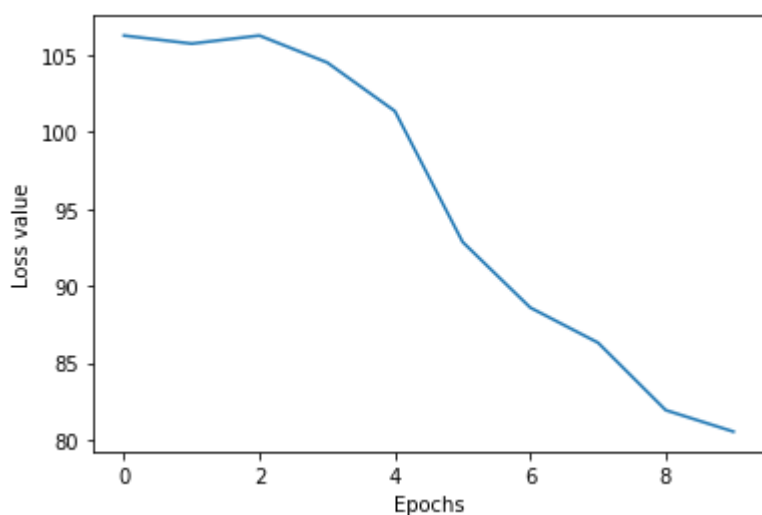


Learning Rate: 1e-06 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.14

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 106.26 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 105.74 | Training accuracy: 0.13 | Validation accuracy: 0.14  
EPOCH 2/10 | Training loss: 106.27 | Training accuracy: 0.15 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 104.52 | Training accuracy: 0.13 | Validation accuracy: 0.08  
EPOCH 4/10 | Training loss: 101.36 | Training accuracy: 0.09 | Validation accuracy: 0.11  
EPOCH 5/10 | Training loss: 92.86 | Training accuracy: 0.28 | Validation accuracy: 0.08  
EPOCH 6/10 | Training loss: 88.59 | Training accuracy: 0.16 | Validation accuracy: 0.12  
EPOCH 7/10 | Training loss: 86.31 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 81.93 | Training accuracy: 0.13 | Validation accuracy: 0.15  
EPOCH 9/10 | Training loss: 80.53 | Training accuracy: 0.27 | Validation accuracy: 0.08

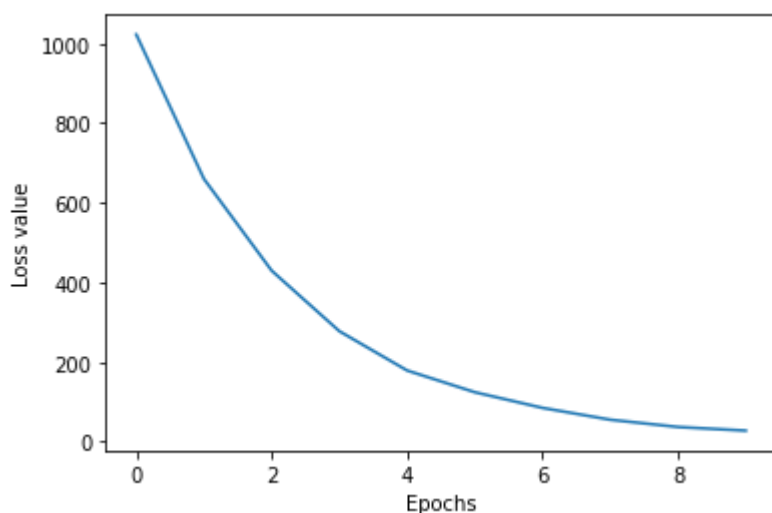


Learning Rate: 1e-06 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.15

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 1022.28 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 659.65 | Training accuracy: 0.14 | Validation accuracy: 0.14  
EPOCH 2/10 | Training loss: 429.30 | Training accuracy: 0.13 | Validation accuracy: 0.08  
EPOCH 3/10 | Training loss: 277.29 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 178.69 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 5/10 | Training loss: 124.11 | Training accuracy: 0.13 | Validation accuracy: 0.13  
EPOCH 6/10 | Training loss: 84.75 | Training accuracy: 0.13 | Validation accuracy: 0.14  
EPOCH 7/10 | Training loss: 55.07 | Training accuracy: 0.27 | Validation accuracy: 0.09  
EPOCH 8/10 | Training loss: 36.82 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 9/10 | Training loss: 27.68 | Training accuracy: 0.14 | Validation accuracy: 0.10

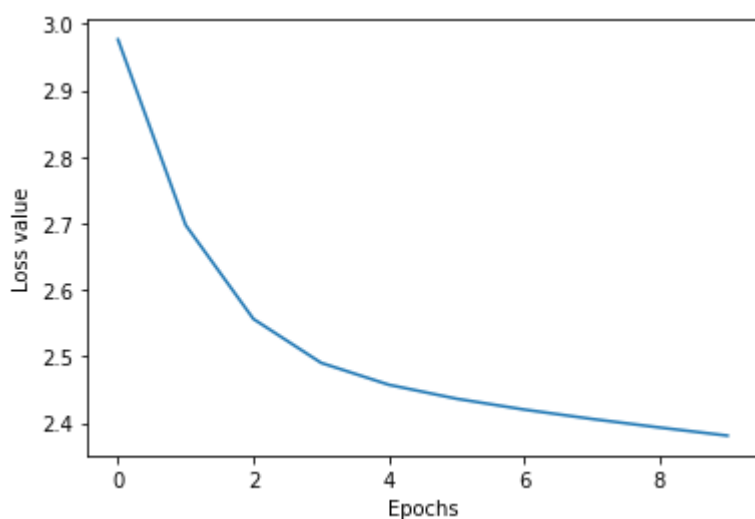


Learning Rate: 1e-06 | Regularization: 100000.0 | Maximum Validation Accuracy: 0.14

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 2.98 | Training accuracy: 0.21 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 2.70 | Training accuracy: 0.23 | Validation accuracy: 0.15  
EPOCH 2/10 | Training loss: 2.56 | Training accuracy: 0.22 | Validation accuracy: 0.13  
EPOCH 3/10 | Training loss: 2.49 | Training accuracy: 0.22 | Validation accuracy: 0.13  
EPOCH 4/10 | Training loss: 2.46 | Training accuracy: 0.22 | Validation accuracy: 0.16  
EPOCH 5/10 | Training loss: 2.44 | Training accuracy: 0.22 | Validation accuracy: 0.16  
EPOCH 6/10 | Training loss: 2.42 | Training accuracy: 0.23 | Validation accuracy: 0.17  
EPOCH 7/10 | Training loss: 2.41 | Training accuracy: 0.23 | Validation accuracy: 0.18  
EPOCH 8/10 | Training loss: 2.39 | Training accuracy: 0.23 | Validation accuracy: 0.17  
EPOCH 9/10 | Training loss: 2.38 | Training accuracy: 0.23 | Validation accuracy: 0.17

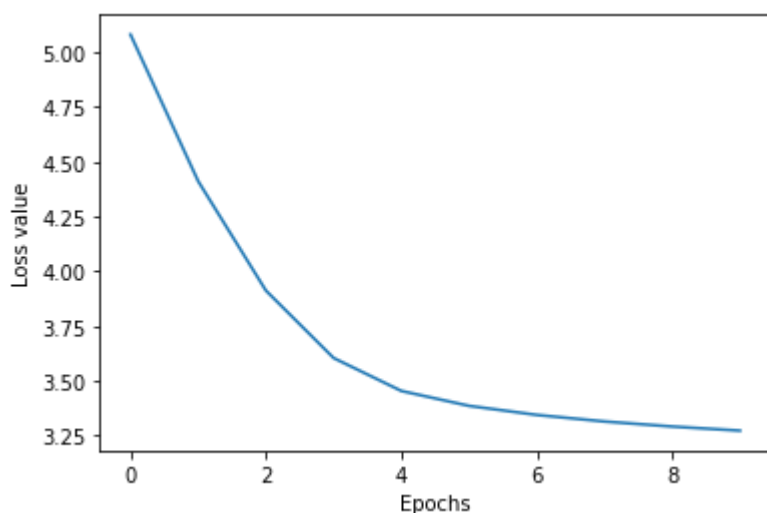


Learning Rate: 1e-07 | Regularization: 10.0 | Maximum Validation Accuracy: 0.18

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 5.08 | Training accuracy: 0.12 | Validation accuracy: 0.15  
EPOCH 1/10 | Training loss: 4.41 | Training accuracy: 0.13 | Validation accuracy: 0.16  
EPOCH 2/10 | Training loss: 3.91 | Training accuracy: 0.20 | Validation accuracy: 0.15  
EPOCH 3/10 | Training loss: 3.60 | Training accuracy: 0.20 | Validation accuracy: 0.16  
EPOCH 4/10 | Training loss: 3.45 | Training accuracy: 0.21 | Validation accuracy: 0.16  
EPOCH 5/10 | Training loss: 3.39 | Training accuracy: 0.21 | Validation accuracy: 0.15  
EPOCH 6/10 | Training loss: 3.35 | Training accuracy: 0.21 | Validation accuracy: 0.14  
EPOCH 7/10 | Training loss: 3.32 | Training accuracy: 0.20 | Validation accuracy: 0.13  
EPOCH 8/10 | Training loss: 3.29 | Training accuracy: 0.20 | Validation accuracy: 0.13  
EPOCH 9/10 | Training loss: 3.27 | Training accuracy: 0.20 | Validation accuracy: 0.15

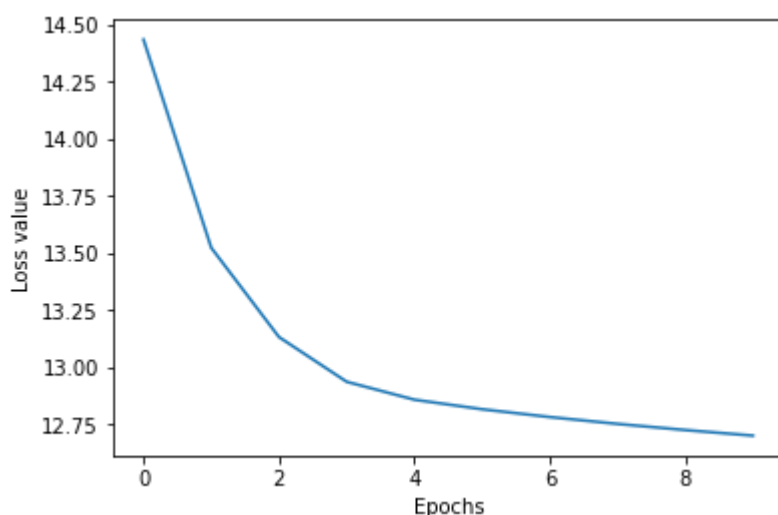


Learning Rate: 1e-07 | Regularization: 100.0 | Maximum Validation Accuracy: 0.16

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 14.43 | Training accuracy: 0.09 | Validation accuracy: 0.09  
EPOCH 1/10 | Training loss: 13.52 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 2/10 | Training loss: 13.13 | Training accuracy: 0.13 | Validation accuracy: 0.08  
EPOCH 3/10 | Training loss: 12.93 | Training accuracy: 0.15 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 12.86 | Training accuracy: 0.17 | Validation accuracy: 0.09  
EPOCH 5/10 | Training loss: 12.81 | Training accuracy: 0.18 | Validation accuracy: 0.09  
EPOCH 6/10 | Training loss: 12.78 | Training accuracy: 0.21 | Validation accuracy: 0.09  
EPOCH 7/10 | Training loss: 12.75 | Training accuracy: 0.22 | Validation accuracy: 0.09  
EPOCH 8/10 | Training loss: 12.72 | Training accuracy: 0.23 | Validation accuracy: 0.09  
EPOCH 9/10 | Training loss: 12.70 | Training accuracy: 0.23 | Validation accuracy: 0.09

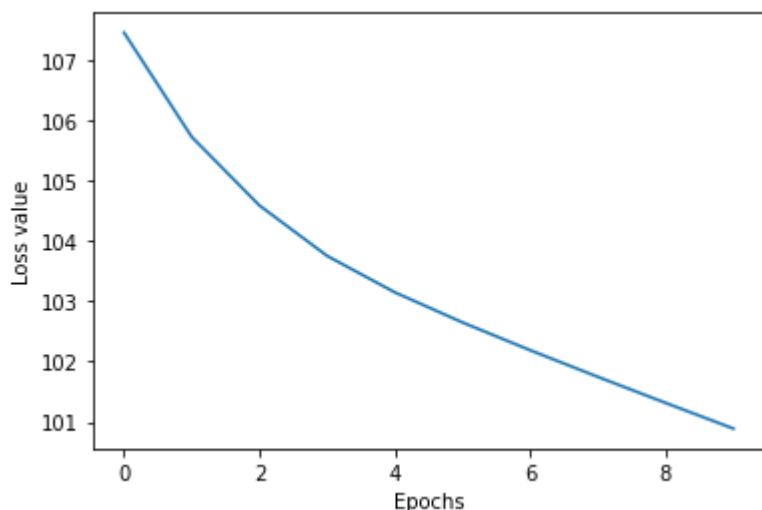


Learning Rate: 1e-07 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.1

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 107.45 | Training accuracy: 0.08 | Validation accuracy: 0.11  
EPOCH 1/10 | Training loss: 105.72 | Training accuracy: 0.06 | Validation accuracy: 0.11  
EPOCH 2/10 | Training loss: 104.59 | Training accuracy: 0.10 | Validation accuracy: 0.09  
EPOCH 3/10 | Training loss: 103.75 | Training accuracy: 0.12 | Validation accuracy: 0.06  
EPOCH 4/10 | Training loss: 103.15 | Training accuracy: 0.14 | Validation accuracy: 0.07  
EPOCH 5/10 | Training loss: 102.65 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 102.19 | Training accuracy: 0.14 | Validation accuracy: 0.11  
EPOCH 7/10 | Training loss: 101.74 | Training accuracy: 0.18 | Validation accuracy: 0.11  
EPOCH 8/10 | Training loss: 101.31 | Training accuracy: 0.18 | Validation accuracy: 0.11  
EPOCH 9/10 | Training loss: 100.89 | Training accuracy: 0.18 | Validation accuracy: 0.11

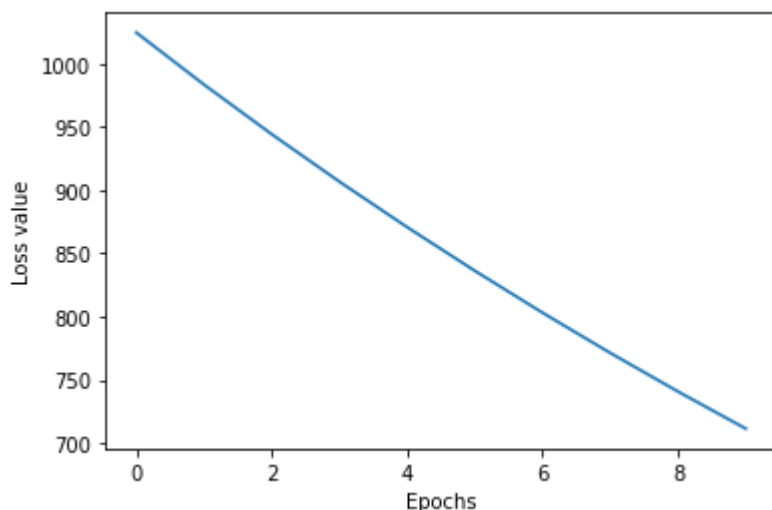


Learning Rate: 1e-07 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.11

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 1024.54 | Training accuracy: 0.06 | Validation accuracy: 0.06  
EPOCH 1/10 | Training loss: 983.42 | Training accuracy: 0.09 | Validation accuracy: 0.06  
EPOCH 2/10 | Training loss: 944.21 | Training accuracy: 0.08 | Validation accuracy: 0.09  
EPOCH 3/10 | Training loss: 906.68 | Training accuracy: 0.05 | Validation accuracy: 0.09  
EPOCH 4/10 | Training loss: 870.72 | Training accuracy: 0.08 | Validation accuracy: 0.08  
EPOCH 5/10 | Training loss: 836.20 | Training accuracy: 0.09 | Validation accuracy: 0.09  
EPOCH 6/10 | Training loss: 803.08 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 771.29 | Training accuracy: 0.15 | Validation accuracy: 0.13  
EPOCH 8/10 | Training loss: 740.77 | Training accuracy: 0.16 | Validation accuracy: 0.14  
EPOCH 9/10 | Training loss: 711.48 | Training accuracy: 0.18 | Validation accuracy: 0.14



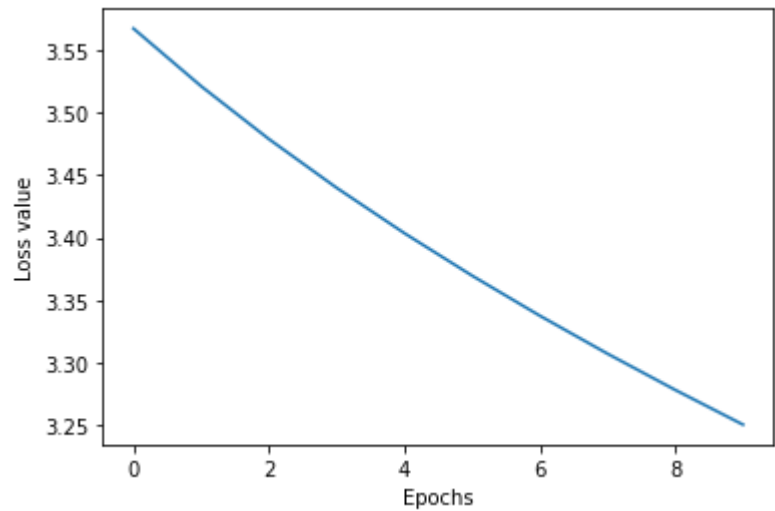
Learning Rate: 1e-07 | Regularization: 100000.0 | Maximum Validation Accuracy: 0.14

Loss function used: softmax

-----



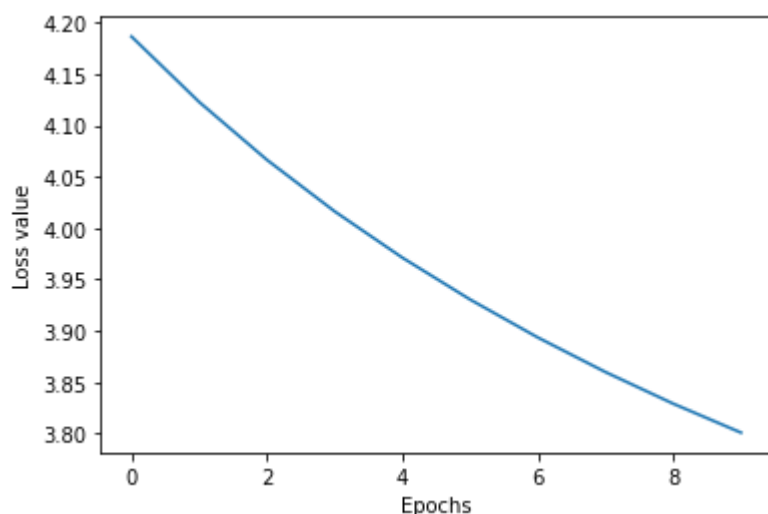
EPOCH 0/10 | Training loss: 3.57 | Training accuracy: 0.14 | Validation accuracy: 0.07  
EPOCH 1/10 | Training loss: 3.52 | Training accuracy: 0.16 | Validation accuracy: 0.07  
EPOCH 2/10 | Training loss: 3.48 | Training accuracy: 0.20 | Validation accuracy: 0.07  
EPOCH 3/10 | Training loss: 3.44 | Training accuracy: 0.20 | Validation accuracy: 0.07  
EPOCH 4/10 | Training loss: 3.40 | Training accuracy: 0.20 | Validation accuracy: 0.07  
EPOCH 5/10 | Training loss: 3.37 | Training accuracy: 0.20 | Validation accuracy: 0.07  
EPOCH 6/10 | Training loss: 3.34 | Training accuracy: 0.20 | Validation accuracy: 0.07  
EPOCH 7/10 | Training loss: 3.31 | Training accuracy: 0.20 | Validation accuracy: 0.06  
EPOCH 8/10 | Training loss: 3.28 | Training accuracy: 0.20 | Validation accuracy: 0.07  
EPOCH 9/10 | Training loss: 3.25 | Training accuracy: 0.20 | Validation accuracy: 0.07



Learning Rate: 1e-08 | Regularization: 10.0 | Maximum Validation Accuracy: 0.07

Loss function used: softmax  
-----

EPOCH 0/10 | Training loss: 4.19 | Training accuracy: 0.10 | Validation accuracy: 0.10  
EPOCH 1/10 | Training loss: 4.12 | Training accuracy: 0.08 | Validation accuracy: 0.12  
EPOCH 2/10 | Training loss: 4.07 | Training accuracy: 0.09 | Validation accuracy: 0.13  
EPOCH 3/10 | Training loss: 4.02 | Training accuracy: 0.10 | Validation accuracy: 0.13  
EPOCH 4/10 | Training loss: 3.97 | Training accuracy: 0.12 | Validation accuracy: 0.14  
EPOCH 5/10 | Training loss: 3.93 | Training accuracy: 0.12 | Validation accuracy: 0.14  
EPOCH 6/10 | Training loss: 3.89 | Training accuracy: 0.12 | Validation accuracy: 0.15  
EPOCH 7/10 | Training loss: 3.86 | Training accuracy: 0.12 | Validation accuracy: 0.14  
EPOCH 8/10 | Training loss: 3.83 | Training accuracy: 0.12 | Validation accuracy: 0.15  
EPOCH 9/10 | Training loss: 3.80 | Training accuracy: 0.12 | Validation accuracy: 0.14

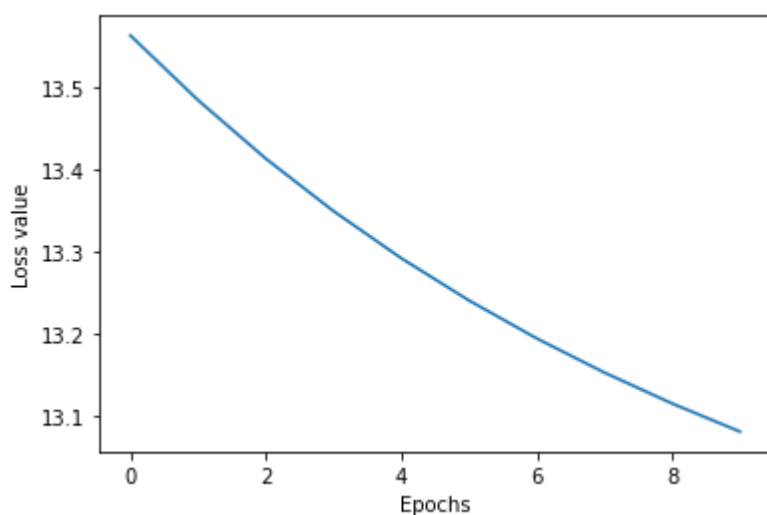


Learning Rate: 1e-08 | Regularization: 100.0 | Maximum Validation Accuracy: 0.15

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 13.56 | Training accuracy: 0.12 | Validation accuracy: 0.14  
EPOCH 1/10 | Training loss: 13.48 | Training accuracy: 0.13 | Validation accuracy: 0.14  
EPOCH 2/10 | Training loss: 13.41 | Training accuracy: 0.13 | Validation accuracy: 0.13  
EPOCH 3/10 | Training loss: 13.35 | Training accuracy: 0.14 | Validation accuracy: 0.12  
EPOCH 4/10 | Training loss: 13.29 | Training accuracy: 0.13 | Validation accuracy: 0.12  
EPOCH 5/10 | Training loss: 13.24 | Training accuracy: 0.15 | Validation accuracy: 0.12  
EPOCH 6/10 | Training loss: 13.19 | Training accuracy: 0.16 | Validation accuracy: 0.13  
EPOCH 7/10 | Training loss: 13.15 | Training accuracy: 0.16 | Validation accuracy: 0.12  
EPOCH 8/10 | Training loss: 13.12 | Training accuracy: 0.16 | Validation accuracy: 0.13  
EPOCH 9/10 | Training loss: 13.08 | Training accuracy: 0.15 | Validation accuracy: 0.12

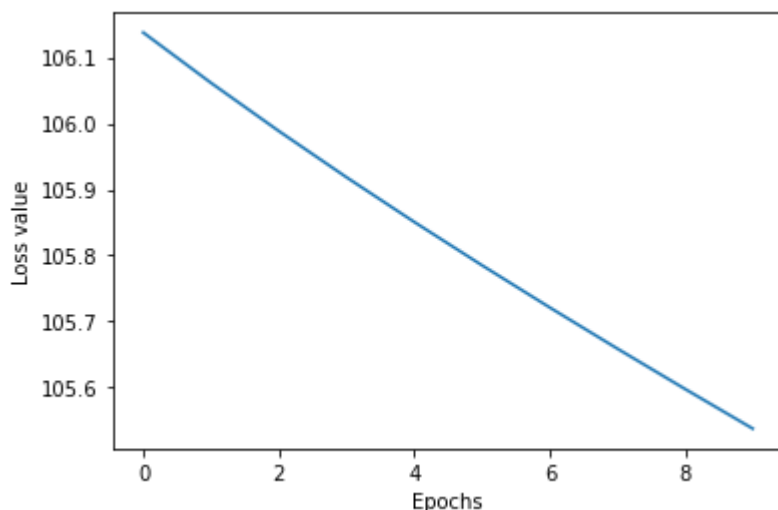


Learning Rate: 1e-08 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.14

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 106.14 | Training accuracy: 0.17 | Validation accuracy: 0.10  
EPOCH 1/10 | Training loss: 106.06 | Training accuracy: 0.16 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 105.99 | Training accuracy: 0.16 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 105.92 | Training accuracy: 0.15 | Validation accuracy: 0.11  
EPOCH 4/10 | Training loss: 105.85 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 105.79 | Training accuracy: 0.14 | Validation accuracy: 0.09  
EPOCH 6/10 | Training loss: 105.72 | Training accuracy: 0.15 | Validation accuracy: 0.07  
EPOCH 7/10 | Training loss: 105.66 | Training accuracy: 0.16 | Validation accuracy: 0.08  
EPOCH 8/10 | Training loss: 105.60 | Training accuracy: 0.16 | Validation accuracy: 0.08  
EPOCH 9/10 | Training loss: 105.54 | Training accuracy: 0.17 | Validation accuracy: 0.09

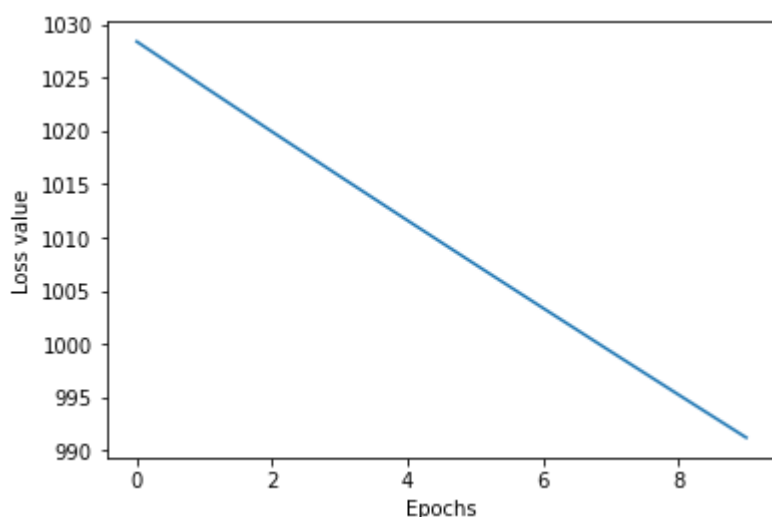


Learning Rate: 1e-08 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.11

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 1028.40 | Training accuracy: 0.09 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 1024.14 | Training accuracy: 0.06 | Validation accuracy: 0.08  
EPOCH 2/10 | Training loss: 1019.93 | Training accuracy: 0.05 | Validation accuracy: 0.07  
EPOCH 3/10 | Training loss: 1015.75 | Training accuracy: 0.05 | Validation accuracy: 0.07  
EPOCH 4/10 | Training loss: 1011.59 | Training accuracy: 0.05 | Validation accuracy: 0.07  
EPOCH 5/10 | Training loss: 1007.47 | Training accuracy: 0.05 | Validation accuracy: 0.07  
EPOCH 6/10 | Training loss: 1003.37 | Training accuracy: 0.04 | Validation accuracy: 0.07  
EPOCH 7/10 | Training loss: 999.30 | Training accuracy: 0.04 | Validation accuracy: 0.07  
EPOCH 8/10 | Training loss: 995.25 | Training accuracy: 0.05 | Validation accuracy: 0.08  
EPOCH 9/10 | Training loss: 991.22 | Training accuracy: 0.06 | Validation accuracy: 0.09

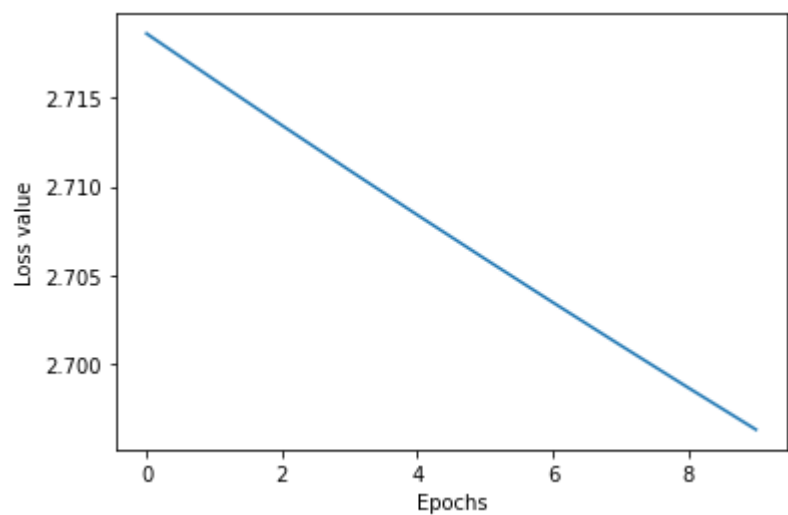


Learning Rate: 1e-08 | Regularization: 100000.0 | Maximum Validation Accuracy: 0.09

Loss function used: softmax

-----

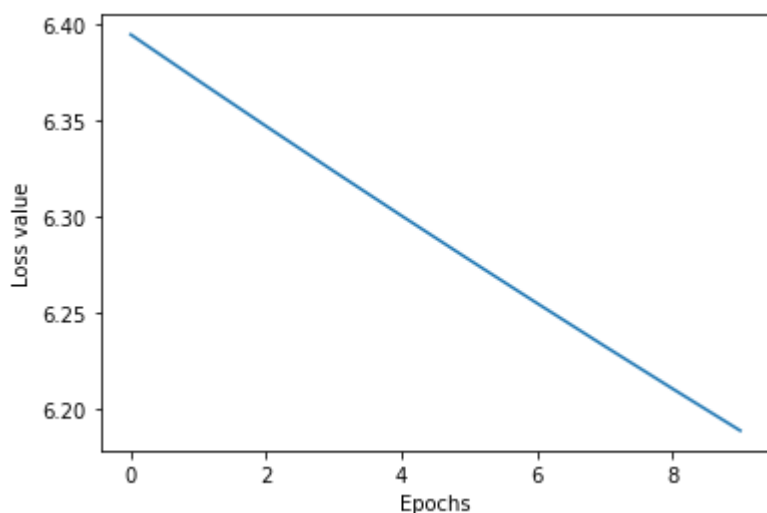
EPOCH 0/10 | Training loss: 2.72 | Training accuracy: 0.16 | Validation accuracy: 0.07  
EPOCH 1/10 | Training loss: 2.72 | Training accuracy: 0.16 | Validation accuracy: 0.07  
EPOCH 2/10 | Training loss: 2.71 | Training accuracy: 0.16 | Validation accuracy: 0.07  
EPOCH 3/10 | Training loss: 2.71 | Training accuracy: 0.16 | Validation accuracy: 0.07  
EPOCH 4/10 | Training loss: 2.71 | Training accuracy: 0.16 | Validation accuracy: 0.07  
EPOCH 5/10 | Training loss: 2.71 | Training accuracy: 0.16 | Validation accuracy: 0.07  
EPOCH 6/10 | Training loss: 2.70 | Training accuracy: 0.16 | Validation accuracy: 0.06  
EPOCH 7/10 | Training loss: 2.70 | Training accuracy: 0.16 | Validation accuracy: 0.06  
EPOCH 8/10 | Training loss: 2.70 | Training accuracy: 0.16 | Validation accuracy: 0.06  
EPOCH 9/10 | Training loss: 2.70 | Training accuracy: 0.16 | Validation accuracy: 0.06



Learning Rate: 1e-09 | Regularization: 10.0 | Maximum Validation Accuracy: 0.07

Loss function used: softmax  
-----

EPOCH 0/10 | Training loss: 6.39 | Training accuracy: 0.04 | Validation accuracy: 0.09  
EPOCH 1/10 | Training loss: 6.37 | Training accuracy: 0.04 | Validation accuracy: 0.09  
EPOCH 2/10 | Training loss: 6.35 | Training accuracy: 0.05 | Validation accuracy: 0.09  
EPOCH 3/10 | Training loss: 6.32 | Training accuracy: 0.05 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 6.30 | Training accuracy: 0.05 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 6.28 | Training accuracy: 0.05 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 6.25 | Training accuracy: 0.05 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 6.23 | Training accuracy: 0.05 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 6.21 | Training accuracy: 0.05 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 6.19 | Training accuracy: 0.05 | Validation accuracy: 0.10

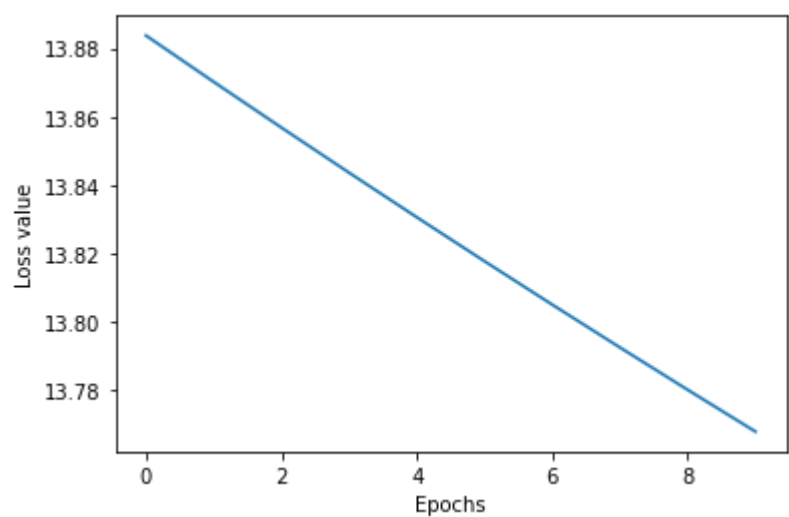


Learning Rate: 1e-09 | Regularization: 100.0 | Maximum Validation Accuracy: 0.1

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 13.88 | Training accuracy: 0.11 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 13.87 | Training accuracy: 0.11 | Validation accuracy: 0.08  
EPOCH 2/10 | Training loss: 13.86 | Training accuracy: 0.11 | Validation accuracy: 0.08  
EPOCH 3/10 | Training loss: 13.84 | Training accuracy: 0.12 | Validation accuracy: 0.08  
EPOCH 4/10 | Training loss: 13.83 | Training accuracy: 0.12 | Validation accuracy: 0.08  
EPOCH 5/10 | Training loss: 13.82 | Training accuracy: 0.12 | Validation accuracy: 0.08  
EPOCH 6/10 | Training loss: 13.81 | Training accuracy: 0.12 | Validation accuracy: 0.08  
EPOCH 7/10 | Training loss: 13.79 | Training accuracy: 0.12 | Validation accuracy: 0.08  
EPOCH 8/10 | Training loss: 13.78 | Training accuracy: 0.11 | Validation accuracy: 0.08  
EPOCH 9/10 | Training loss: 13.77 | Training accuracy: 0.11 | Validation accuracy: 0.08



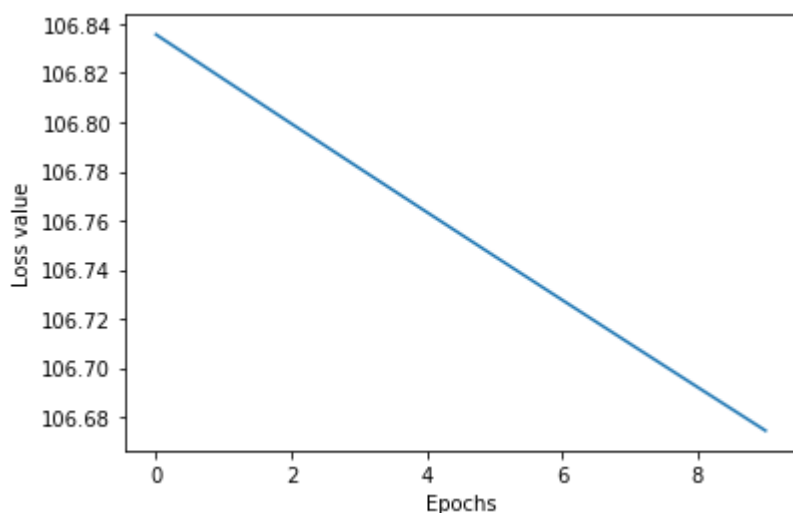
Learning Rate: 1e-09 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.08

Loss function used: softmax

-----



EPOCH 0/10 | Training loss: 106.84 | Training accuracy: 0.06 | Validation accuracy: 0.13  
EPOCH 1/10 | Training loss: 106.82 | Training accuracy: 0.06 | Validation accuracy: 0.13  
EPOCH 2/10 | Training loss: 106.80 | Training accuracy: 0.06 | Validation accuracy: 0.13  
EPOCH 3/10 | Training loss: 106.78 | Training accuracy: 0.06 | Validation accuracy: 0.13  
EPOCH 4/10 | Training loss: 106.76 | Training accuracy: 0.06 | Validation accuracy: 0.13  
EPOCH 5/10 | Training loss: 106.75 | Training accuracy: 0.06 | Validation accuracy: 0.13  
EPOCH 6/10 | Training loss: 106.73 | Training accuracy: 0.06 | Validation accuracy: 0.13  
EPOCH 7/10 | Training loss: 106.71 | Training accuracy: 0.06 | Validation accuracy: 0.13  
EPOCH 8/10 | Training loss: 106.69 | Training accuracy: 0.06 | Validation accuracy: 0.13  
EPOCH 9/10 | Training loss: 106.67 | Training accuracy: 0.06 | Validation accuracy: 0.13

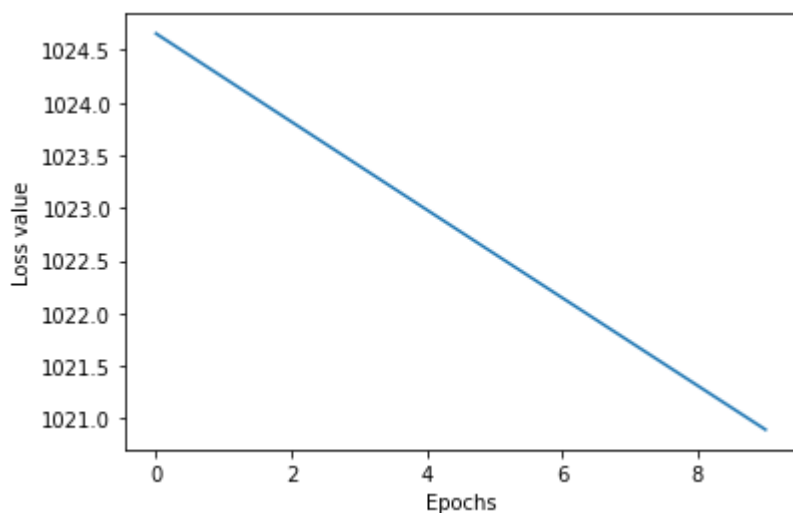


Learning Rate: 1e-09 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.13

Loss function used: softmax

-----

EPOCH 0/10 | Training loss: 1024.66 | Training accuracy: 0.15 | Validation accuracy: 0.15  
EPOCH 1/10 | Training loss: 1024.24 | Training accuracy: 0.15 | Validation accuracy: 0.15  
EPOCH 2/10 | Training loss: 1023.82 | Training accuracy: 0.15 | Validation accuracy: 0.15  
EPOCH 3/10 | Training loss: 1023.40 | Training accuracy: 0.15 | Validation accuracy: 0.15  
EPOCH 4/10 | Training loss: 1022.98 | Training accuracy: 0.15 | Validation accuracy: 0.15  
EPOCH 5/10 | Training loss: 1022.56 | Training accuracy: 0.15 | Validation accuracy: 0.15  
EPOCH 6/10 | Training loss: 1022.15 | Training accuracy: 0.15 | Validation accuracy: 0.15  
EPOCH 7/10 | Training loss: 1021.73 | Training accuracy: 0.15 | Validation accuracy: 0.15  
EPOCH 8/10 | Training loss: 1021.31 | Training accuracy: 0.15 | Validation accuracy: 0.14  
EPOCH 9/10 | Training loss: 1020.89 | Training accuracy: 0.15 | Validation accuracy: 0.14

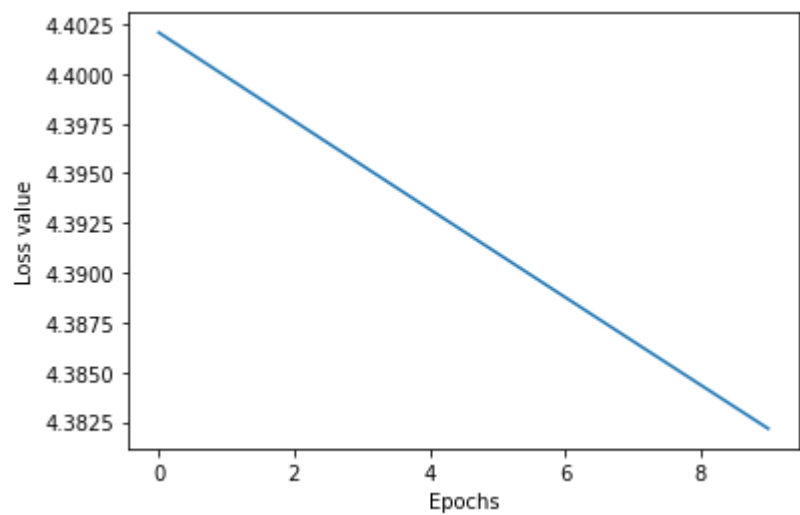


Learning Rate: 1e-09 | Regularization: 100000.0 | Maximum Validation Accuracy: 0.15

Loss function used: softmax

-----

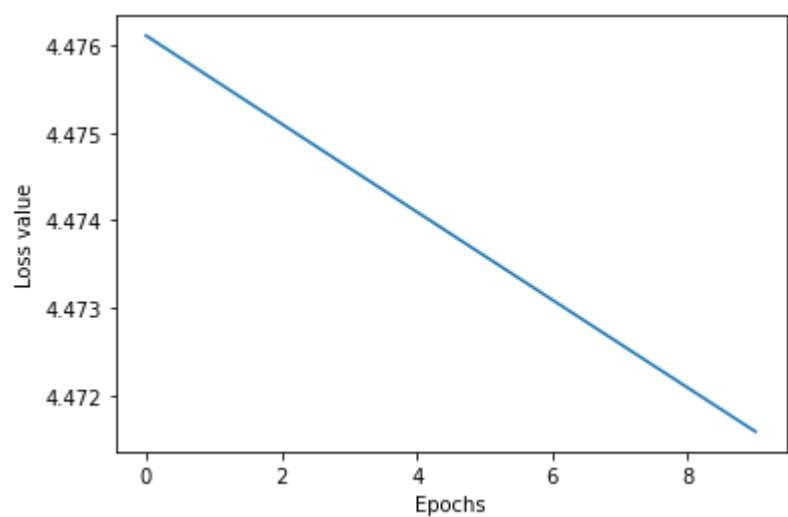
EPOCH 0/10 | Training loss: 4.40 | Training accuracy: 0.07 | Validation accuracy: 0.09  
EPOCH 1/10 | Training loss: 4.40 | Training accuracy: 0.07 | Validation accuracy: 0.09  
EPOCH 2/10 | Training loss: 4.40 | Training accuracy: 0.07 | Validation accuracy: 0.09  
EPOCH 3/10 | Training loss: 4.40 | Training accuracy: 0.07 | Validation accuracy: 0.09  
EPOCH 4/10 | Training loss: 4.39 | Training accuracy: 0.07 | Validation accuracy: 0.09  
EPOCH 5/10 | Training loss: 4.39 | Training accuracy: 0.07 | Validation accuracy: 0.09  
EPOCH 6/10 | Training loss: 4.39 | Training accuracy: 0.07 | Validation accuracy: 0.09  
EPOCH 7/10 | Training loss: 4.39 | Training accuracy: 0.07 | Validation accuracy: 0.09  
EPOCH 8/10 | Training loss: 4.38 | Training accuracy: 0.07 | Validation accuracy: 0.09  
EPOCH 9/10 | Training loss: 4.38 | Training accuracy: 0.07 | Validation accuracy: 0.09



Learning Rate: 1e-10 | Regularization: 10.0 | Maximum Validation Accuracy: 0.09

Loss function used: softmax  
-----

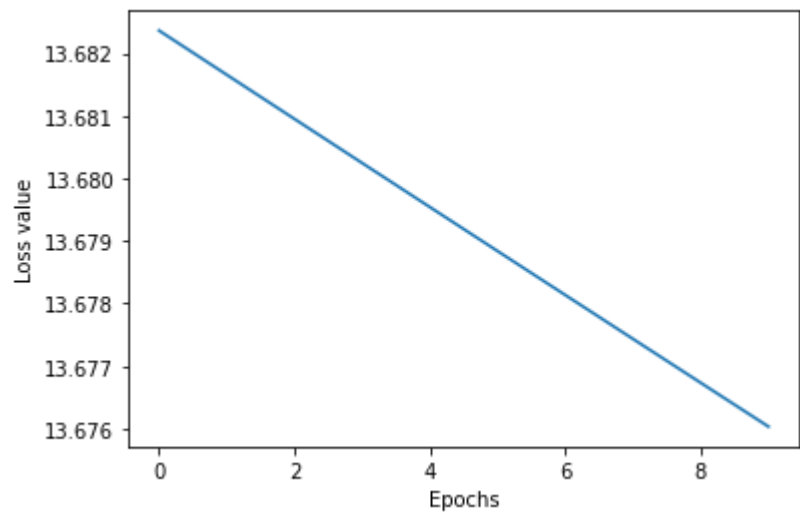
EPOCH 0/10 | Training loss: 4.48 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 1/10 | Training loss: 4.48 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 2/10 | Training loss: 4.48 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 3/10 | Training loss: 4.47 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 4/10 | Training loss: 4.47 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 5/10 | Training loss: 4.47 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 6/10 | Training loss: 4.47 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 7/10 | Training loss: 4.47 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 8/10 | Training loss: 4.47 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 9/10 | Training loss: 4.47 | Training accuracy: 0.09 | Validation accuracy: 0.07



Learning Rate: 1e-10 | Regularization: 100.0 | Maximum Validation Accuracy: 0.07

Loss function used: softmax  
-----

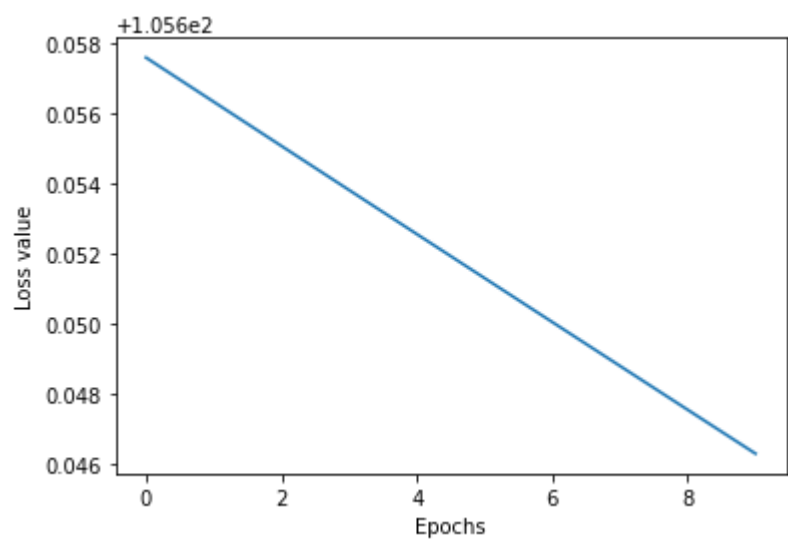
EPOCH 0/10 | Training loss: 13.68 | Training accuracy: 0.13 | Validation accuracy: 0.05  
EPOCH 1/10 | Training loss: 13.68 | Training accuracy: 0.13 | Validation accuracy: 0.05  
EPOCH 2/10 | Training loss: 13.68 | Training accuracy: 0.13 | Validation accuracy: 0.05  
EPOCH 3/10 | Training loss: 13.68 | Training accuracy: 0.13 | Validation accuracy: 0.05  
EPOCH 4/10 | Training loss: 13.68 | Training accuracy: 0.13 | Validation accuracy: 0.05  
EPOCH 5/10 | Training loss: 13.68 | Training accuracy: 0.13 | Validation accuracy: 0.05  
EPOCH 6/10 | Training loss: 13.68 | Training accuracy: 0.13 | Validation accuracy: 0.05  
EPOCH 7/10 | Training loss: 13.68 | Training accuracy: 0.13 | Validation accuracy: 0.05  
EPOCH 8/10 | Training loss: 13.68 | Training accuracy: 0.13 | Validation accuracy: 0.05  
EPOCH 9/10 | Training loss: 13.68 | Training accuracy: 0.13 | Validation accuracy: 0.05



Learning Rate: 1e-10 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.05

Loss function used: softmax  
-----

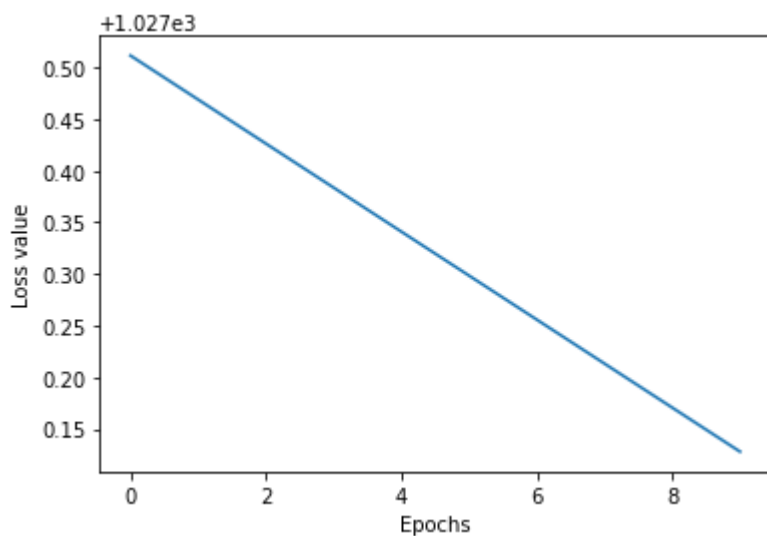
EPOCH 0/10 | Training loss: 105.66 | Training accuracy: 0.09 | Validation accuracy: 0.12  
EPOCH 1/10 | Training loss: 105.66 | Training accuracy: 0.09 | Validation accuracy: 0.12  
EPOCH 2/10 | Training loss: 105.66 | Training accuracy: 0.09 | Validation accuracy: 0.12  
EPOCH 3/10 | Training loss: 105.65 | Training accuracy: 0.09 | Validation accuracy: 0.12  
EPOCH 4/10 | Training loss: 105.65 | Training accuracy: 0.09 | Validation accuracy: 0.12  
EPOCH 5/10 | Training loss: 105.65 | Training accuracy: 0.09 | Validation accuracy: 0.12  
EPOCH 6/10 | Training loss: 105.65 | Training accuracy: 0.09 | Validation accuracy: 0.12  
EPOCH 7/10 | Training loss: 105.65 | Training accuracy: 0.09 | Validation accuracy: 0.12  
EPOCH 8/10 | Training loss: 105.65 | Training accuracy: 0.09 | Validation accuracy: 0.12  
EPOCH 9/10 | Training loss: 105.65 | Training accuracy: 0.09 | Validation accuracy: 0.12



Learning Rate: 1e-10 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.12

Loss function used: softmax  
-----

EPOCH 0/10 | Training loss: 1027.51 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 1/10 | Training loss: 1027.47 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 2/10 | Training loss: 1027.43 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 3/10 | Training loss: 1027.38 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 4/10 | Training loss: 1027.34 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 5/10 | Training loss: 1027.30 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 6/10 | Training loss: 1027.26 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 7/10 | Training loss: 1027.21 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 8/10 | Training loss: 1027.17 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 9/10 | Training loss: 1027.13 | Training accuracy: 0.11 | Validation accuracy: 0.11



Learning Rate:  $1e-10$  | Regularization: 100000.0 | Maximum Validation Accuracy: 0.11

Best Hyperparameters: Learning Rate  $1e-05$  | Regularization: 10000.0

In [87]:

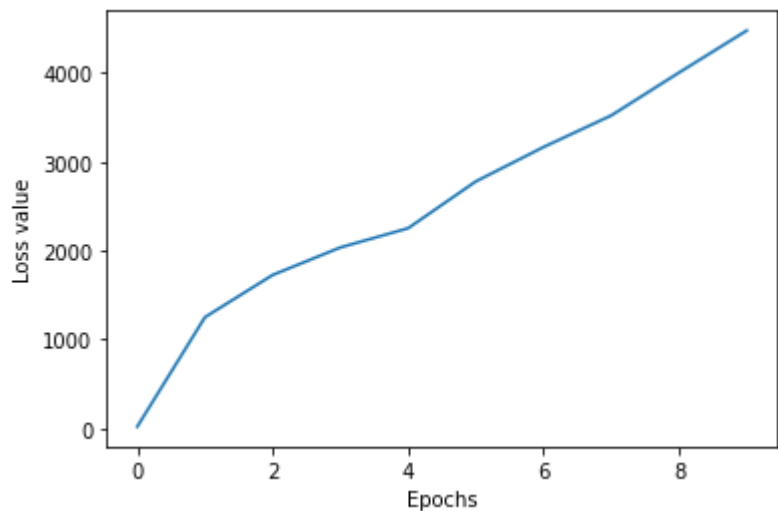
```
hist_svm = grid_search('svm')
```



Loss function used: hinge

-----

EPOCH 0/10	Training loss: 19.87	Training accuracy: 0.20	Validation accuracy: 0.08
EPOCH 1/10	Training loss: 1251.87	Training accuracy: 0.14	Validation accuracy: 0.10
EPOCH 2/10	Training loss: 1727.50	Training accuracy: 0.14	Validation accuracy: 0.10
EPOCH 3/10	Training loss: 2037.24	Training accuracy: 0.14	Validation accuracy: 0.10
EPOCH 4/10	Training loss: 2253.67	Training accuracy: 0.14	Validation accuracy: 0.10
EPOCH 5/10	Training loss: 2780.81	Training accuracy: 0.14	Validation accuracy: 0.10
EPOCH 6/10	Training loss: 3167.52	Training accuracy: 0.14	Validation accuracy: 0.10
EPOCH 7/10	Training loss: 3523.30	Training accuracy: 0.14	Validation accuracy: 0.10
EPOCH 8/10	Training loss: 4005.78	Training accuracy: 0.14	Validation accuracy: 0.10
EPOCH 9/10	Training loss: 4479.14	Training accuracy: 0.14	Validation accuracy: 0.10

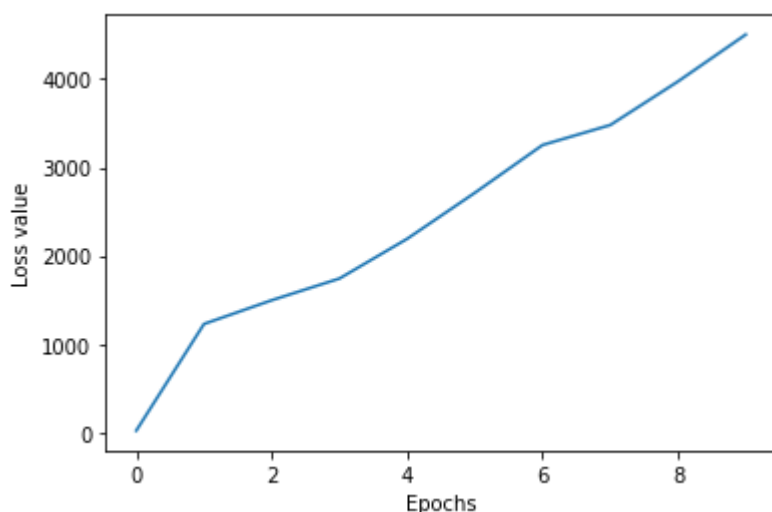


Learning Rate: 1e-05 | Regularization: 10.0 | Maximum Validation Accuracy: 0.1

Loss function used: hinge

-----

EPOCH 0/10 | Training loss: 20.43 | Training accuracy: 0.17 | Validation accuracy: 0.10  
EPOCH 1/10 | Training loss: 1227.86 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 1496.51 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 1742.24 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 2192.02 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 2713.33 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 3254.22 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 3480.34 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 3974.07 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 4504.56 | Training accuracy: 0.14 | Validation accuracy: 0.10

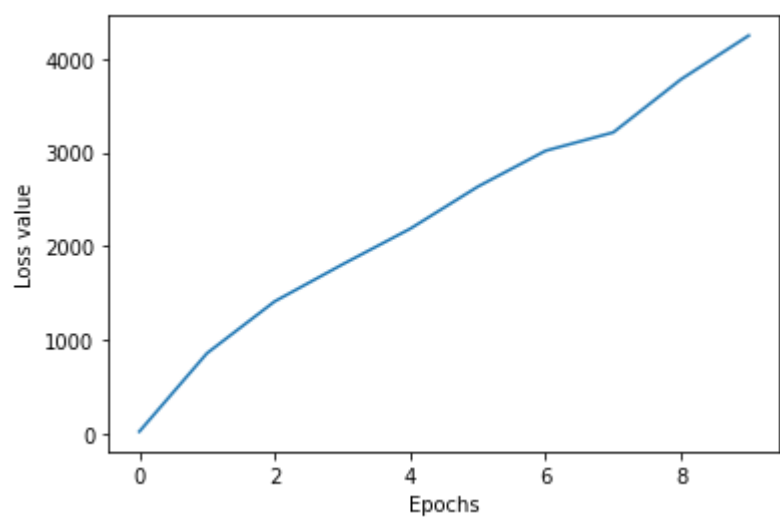


Learning Rate: 1e-05 | Regularization: 100.0 | Maximum Validation Accuracy: 0.1

Loss function used: hinge

-----

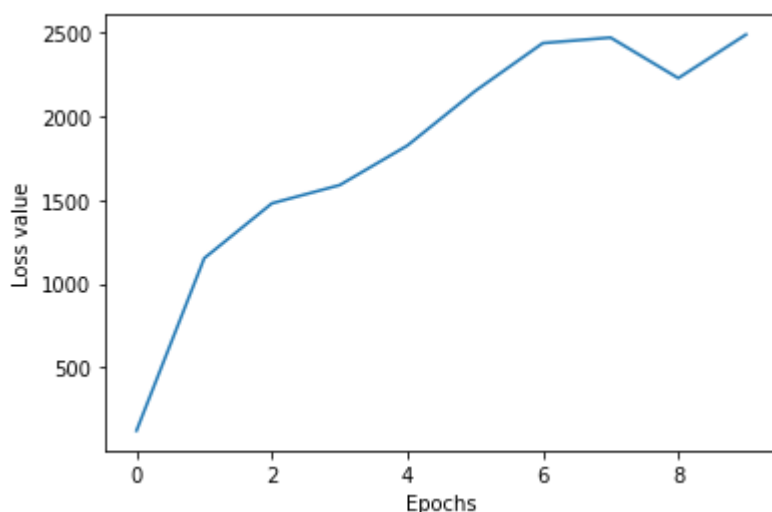
EPOCH 0/10 | Training loss: 25.35 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 1/10 | Training loss: 860.70 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 1412.97 | Training accuracy: 0.23 | Validation accuracy: 0.07  
EPOCH 3/10 | Training loss: 1806.78 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 2186.75 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 2635.79 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 3017.75 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 3213.50 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 3779.02 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 4244.99 | Training accuracy: 0.14 | Validation accuracy: 0.10



Learning Rate: 1e-05 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.1

Loss function used: hinge  
-----

EPOCH 0/10 | Training loss: 121.59 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 1/10 | Training loss: 1151.85 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 1480.12 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 1588.95 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 1825.55 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 2151.10 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 2437.65 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 2470.70 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 2228.38 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 2488.76 | Training accuracy: 0.14 | Validation accuracy: 0.10

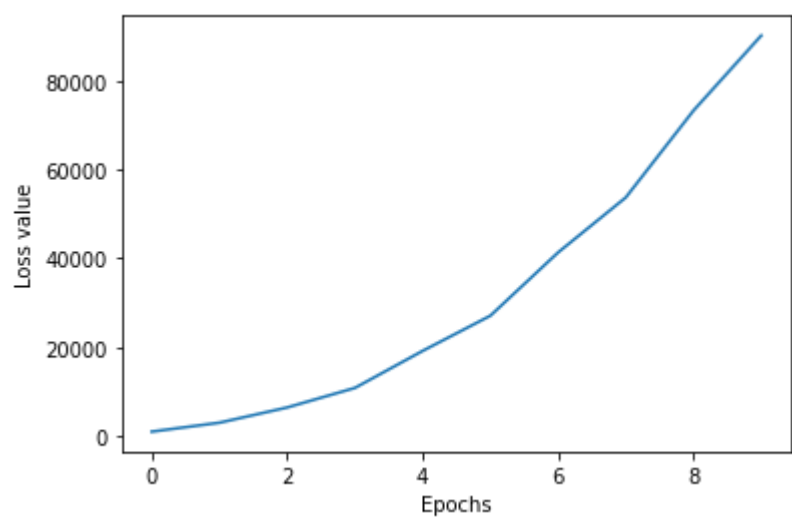


Learning Rate: 1e-05 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.1

Loss function used: hinge

-----

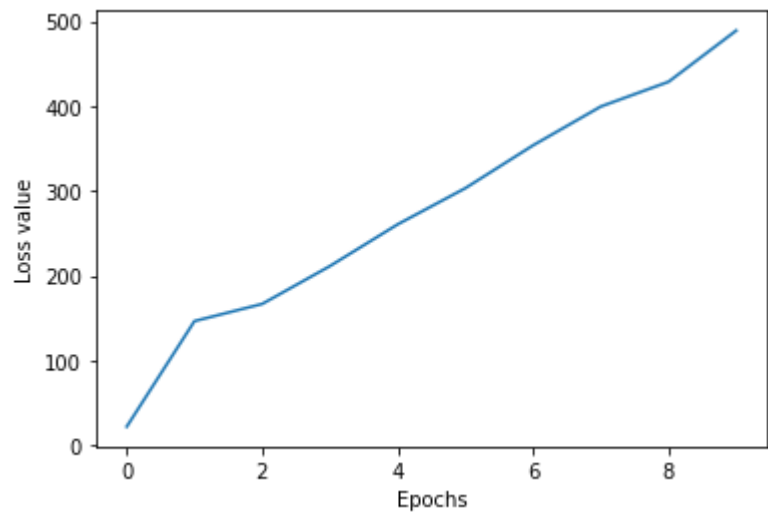
EPOCH 0/10 | Training loss: 1034.67 | Training accuracy: 0.09 | Validation accuracy: 0.09  
EPOCH 1/10 | Training loss: 3044.55 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 2/10 | Training loss: 6470.95 | Training accuracy: 0.09 | Validation accuracy: 0.09  
EPOCH 3/10 | Training loss: 10871.05 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 19206.33 | Training accuracy: 0.09 | Validation accuracy: 0.09  
EPOCH 5/10 | Training loss: 27118.83 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 41353.50 | Training accuracy: 0.09 | Validation accuracy: 0.09  
EPOCH 7/10 | Training loss: 53736.10 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 73293.19 | Training accuracy: 0.09 | Validation accuracy: 0.09  
EPOCH 9/10 | Training loss: 90164.48 | Training accuracy: 0.14 | Validation accuracy: 0.10



Learning Rate: 1e-05 | Regularization: 100000.0 | Maximum Validation Accuracy: 0.1

Loss function used: hinge  
-----

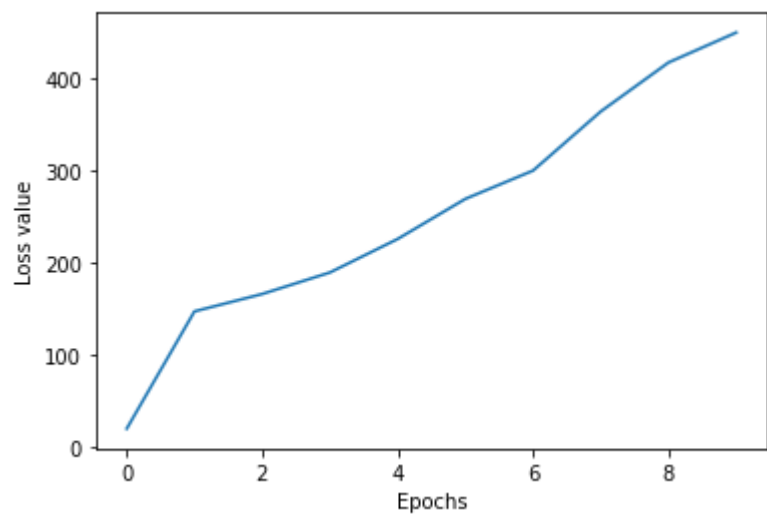
EPOCH 0/10 | Training loss: 21.98 | Training accuracy: 0.20 | Validation accuracy: 0.09  
EPOCH 1/10 | Training loss: 146.41 | Training accuracy: 0.26 | Validation accuracy: 0.12  
EPOCH 2/10 | Training loss: 166.66 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 211.30 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 260.49 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 303.19 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 353.69 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 399.44 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 428.59 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 489.01 | Training accuracy: 0.14 | Validation accuracy: 0.10



Learning Rate: 1e-06 | Regularization: 10.0 | Maximum Validation Accuracy: 0.12

Loss function used: hinge  
-----

EPOCH 0/10 | Training loss: 19.48 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 146.80 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 165.66 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 189.04 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 225.40 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 268.96 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 299.69 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 363.91 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 417.05 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 449.56 | Training accuracy: 0.14 | Validation accuracy: 0.10

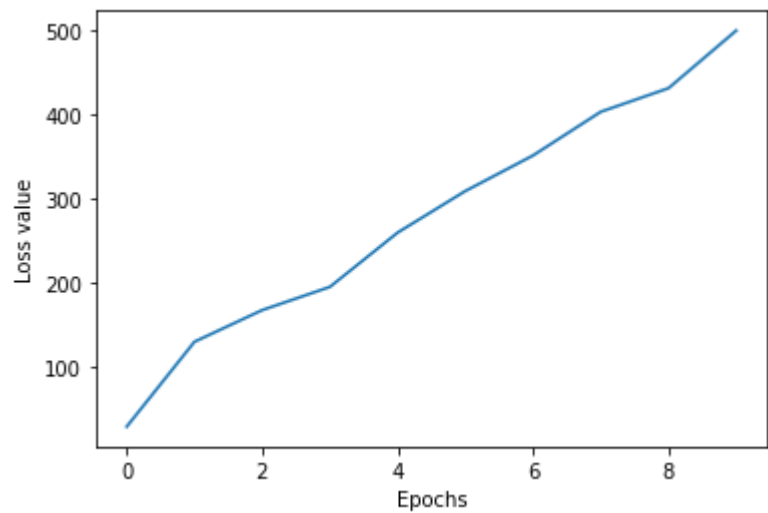


Learning Rate: 1e-06 | Regularization: 100.0 | Maximum Validation Accuracy: 0.1

Loss function used: hinge

-----

EPOCH 0/10 | Training loss: 29.98 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 130.51 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 168.02 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 195.52 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 259.87 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 309.12 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 351.28 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 403.02 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 430.96 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 499.25 | Training accuracy: 0.14 | Validation accuracy: 0.10

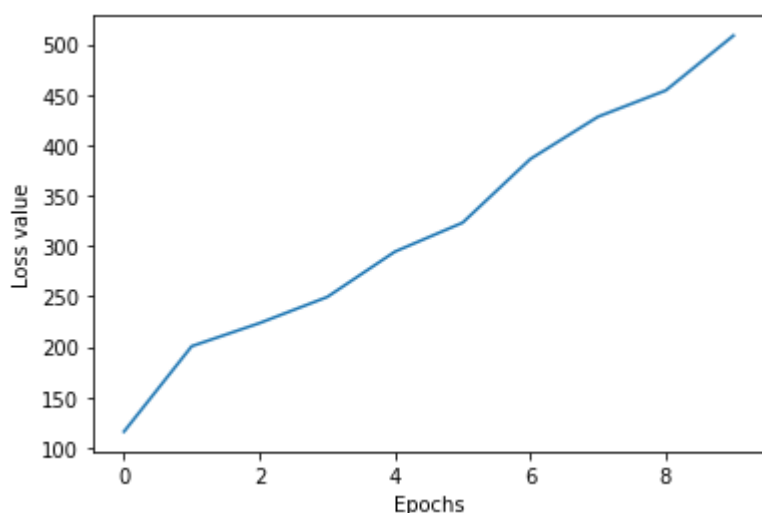


Learning Rate: 1e-06 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.1

Loss function used: hinge  
-----



EPOCH 0/10 | Training loss: 115.77 | Training accuracy: 0.13 | Validation accuracy: 0.14  
EPOCH 1/10 | Training loss: 200.48 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 223.37 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 249.26 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 294.25 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 323.00 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 386.12 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 428.08 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 454.13 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 508.55 | Training accuracy: 0.14 | Validation accuracy: 0.10

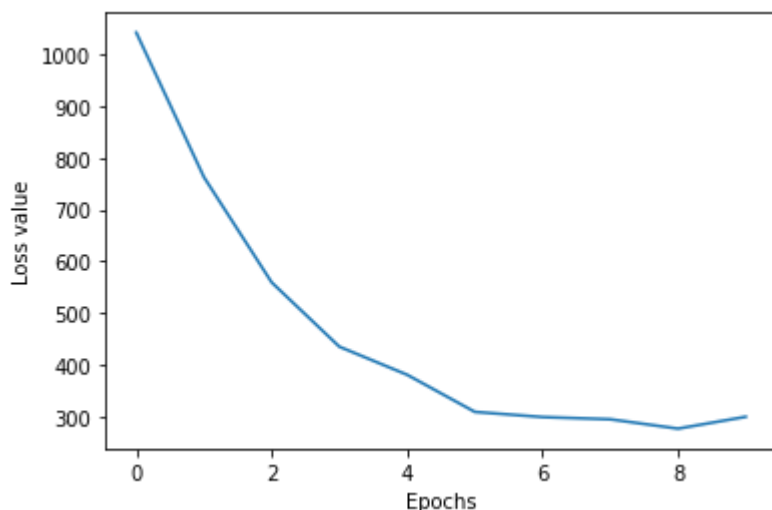


Learning Rate: 1e-06 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.14

Loss function used: hinge

-----

EPOCH 0/10 | Training loss: 1042.13 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 762.77 | Training accuracy: 0.19 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 559.49 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 435.30 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 381.14 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 309.41 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 299.46 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 295.15 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 277.09 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 299.96 | Training accuracy: 0.14 | Validation accuracy: 0.10

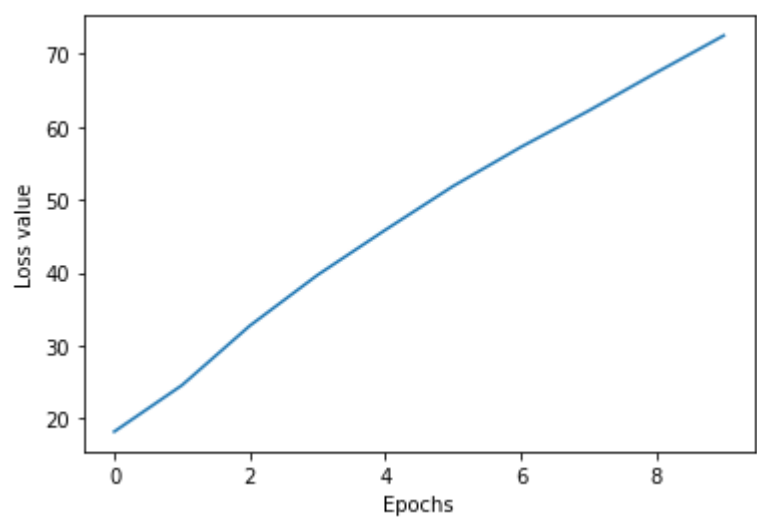


Learning Rate: 1e-06 | Regularization: 100000.0 | Maximum Validation Accuracy: 0.1

Loss function used: hinge

-----

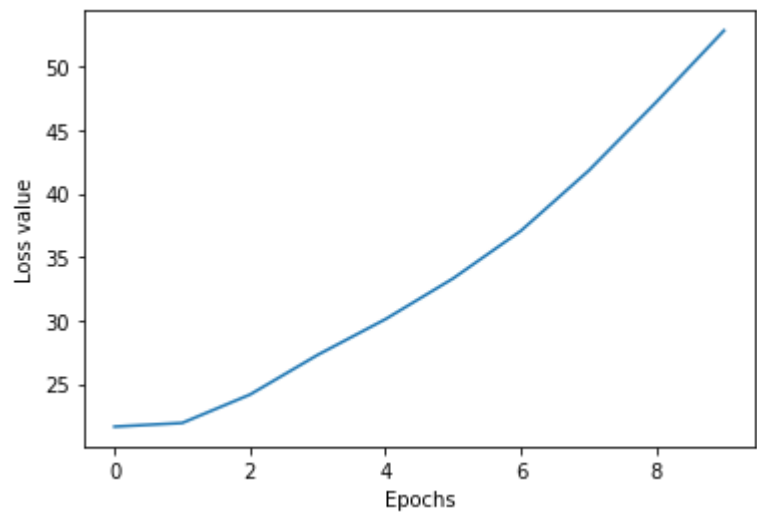
EPOCH 0/10 | Training loss: 18.16 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 24.53 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 2/10 | Training loss: 32.68 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 3/10 | Training loss: 39.65 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 4/10 | Training loss: 45.83 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 5/10 | Training loss: 51.83 | Training accuracy: 0.23 | Validation accuracy: 0.09  
EPOCH 6/10 | Training loss: 57.20 | Training accuracy: 0.15 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 62.18 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 67.42 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 72.53 | Training accuracy: 0.14 | Validation accuracy: 0.10



Learning Rate: 1e-07 | Regularization: 10.0 | Maximum Validation Accuracy: 0.1

Loss function used: hinge  
-----

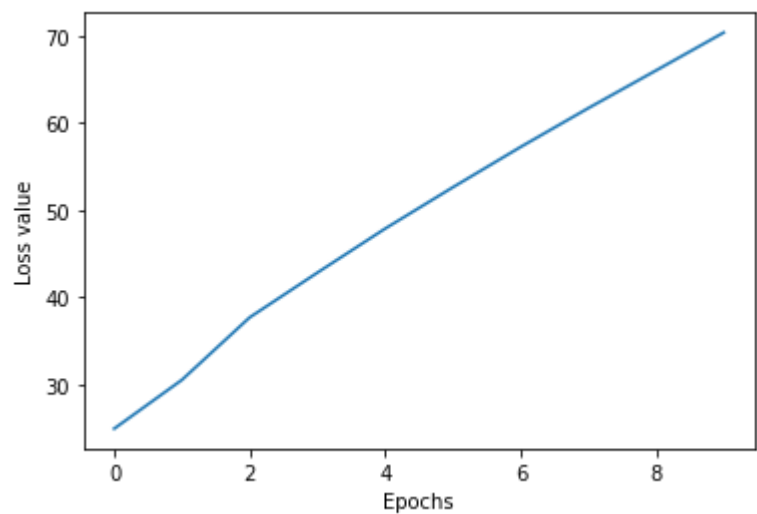
EPOCH 0/10 | Training loss: 21.62 | Training accuracy: 0.20 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 21.91 | Training accuracy: 0.21 | Validation accuracy: 0.06  
EPOCH 2/10 | Training loss: 24.14 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 27.27 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 30.09 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 33.30 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 37.06 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 41.79 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 47.21 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 52.85 | Training accuracy: 0.14 | Validation accuracy: 0.10



Learning Rate: 1e-07 | Regularization: 100.0 | Maximum Validation Accuracy: 0.1

Loss function used: hinge  
-----

EPOCH 0/10 | Training loss: 24.90 | Training accuracy: 0.17 | Validation accuracy: 0.09  
EPOCH 1/10 | Training loss: 30.51 | Training accuracy: 0.17 | Validation accuracy: 0.12  
EPOCH 2/10 | Training loss: 37.68 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 42.82 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 47.87 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 52.62 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 57.25 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 61.71 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 66.03 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 70.39 | Training accuracy: 0.14 | Validation accuracy: 0.10

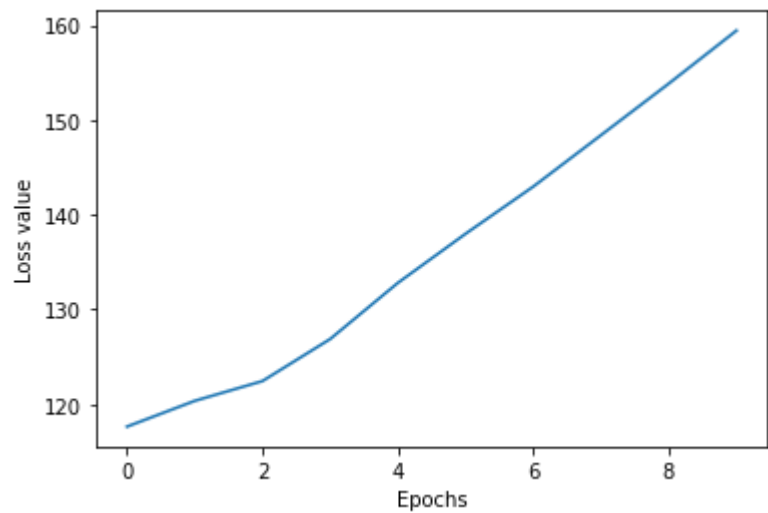


Learning Rate: 1e-07 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.12

Loss function used: hinge

-----

EPOCH 0/10 | Training loss: 117.63 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 1/10 | Training loss: 120.35 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 122.44 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 126.88 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 132.81 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 138.00 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 142.98 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 148.41 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 153.85 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 159.45 | Training accuracy: 0.14 | Validation accuracy: 0.10

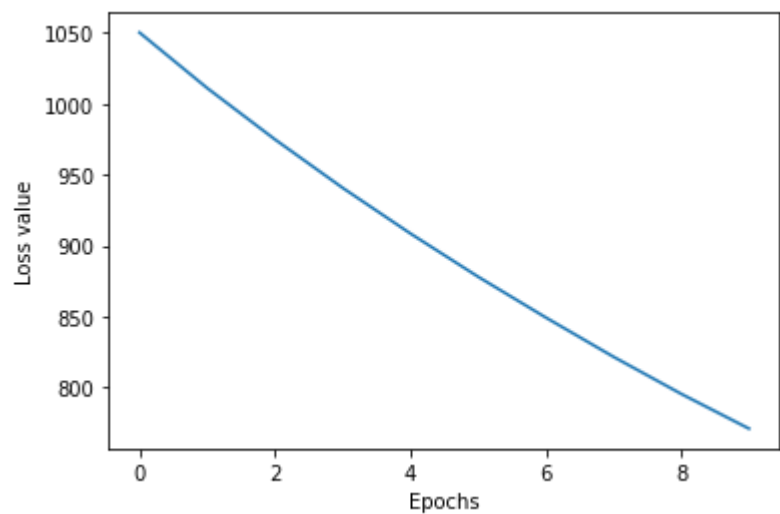


Learning Rate: 1e-07 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.1

Loss function used: hinge

-----

EPOCH 0/10 | Training loss: 1050.13 | Training accuracy: 0.17 | Validation accuracy: 0.13  
EPOCH 1/10 | Training loss: 1011.00 | Training accuracy: 0.14 | Validation accuracy: 0.11  
EPOCH 2/10 | Training loss: 974.87 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 940.74 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 908.60 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 878.14 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 849.41 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 821.72 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 795.61 | Training accuracy: 0.14 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 771.15 | Training accuracy: 0.14 | Validation accuracy: 0.10

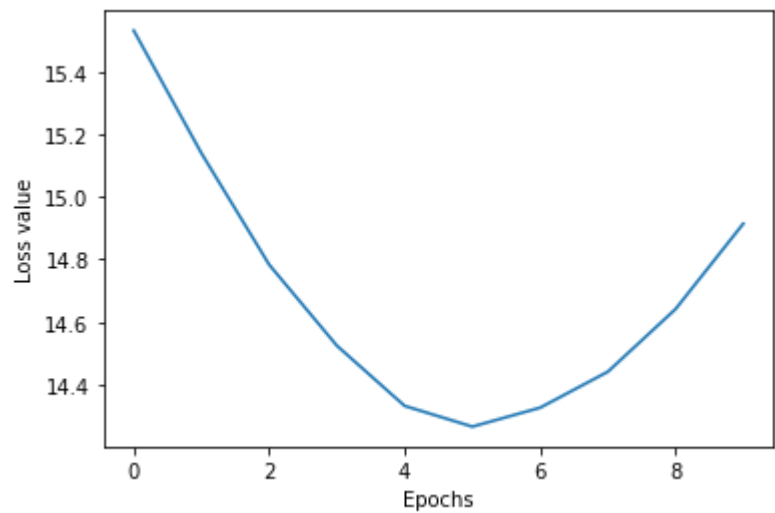


Learning Rate: 1e-07 | Regularization: 100000.0 | Maximum Validation Accuracy: 0.13

Loss function used: hinge

-----

EPOCH 0/10 | Training loss: 15.53 | Training accuracy: 0.08 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 15.14 | Training accuracy: 0.08 | Validation accuracy: 0.08  
EPOCH 2/10 | Training loss: 14.78 | Training accuracy: 0.08 | Validation accuracy: 0.09  
EPOCH 3/10 | Training loss: 14.52 | Training accuracy: 0.09 | Validation accuracy: 0.09  
EPOCH 4/10 | Training loss: 14.33 | Training accuracy: 0.09 | Validation accuracy: 0.09  
EPOCH 5/10 | Training loss: 14.27 | Training accuracy: 0.09 | Validation accuracy: 0.09  
EPOCH 6/10 | Training loss: 14.33 | Training accuracy: 0.13 | Validation accuracy: 0.09  
EPOCH 7/10 | Training loss: 14.44 | Training accuracy: 0.15 | Validation accuracy: 0.08  
EPOCH 8/10 | Training loss: 14.64 | Training accuracy: 0.16 | Validation accuracy: 0.07  
EPOCH 9/10 | Training loss: 14.91 | Training accuracy: 0.19 | Validation accuracy: 0.05



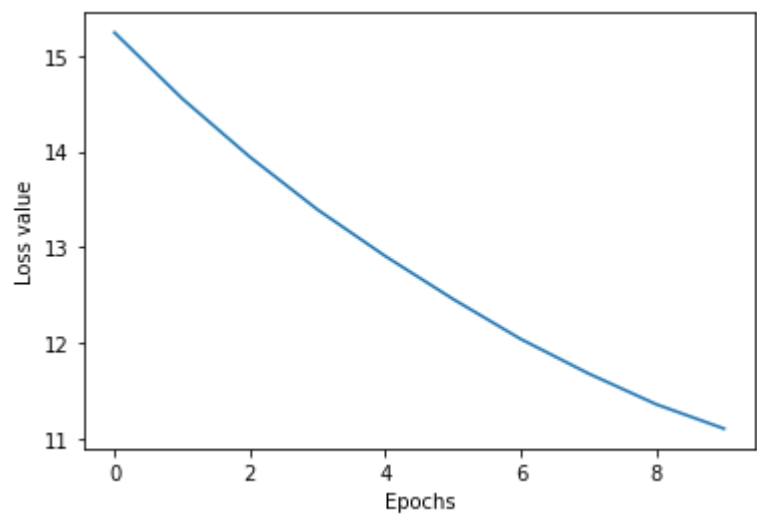
Learning Rate: 1e-08 | Regularization: 10.0 | Maximum Validation Accuracy: 0.09

Loss function used: hinge

-----



EPOCH 0/10 | Training loss: 15.24 | Training accuracy: 0.05 | Validation accuracy: 0.13  
EPOCH 1/10 | Training loss: 14.55 | Training accuracy: 0.05 | Validation accuracy: 0.13  
EPOCH 2/10 | Training loss: 13.94 | Training accuracy: 0.04 | Validation accuracy: 0.13  
EPOCH 3/10 | Training loss: 13.39 | Training accuracy: 0.05 | Validation accuracy: 0.13  
EPOCH 4/10 | Training loss: 12.91 | Training accuracy: 0.04 | Validation accuracy: 0.13  
EPOCH 5/10 | Training loss: 12.46 | Training accuracy: 0.04 | Validation accuracy: 0.12  
EPOCH 6/10 | Training loss: 12.04 | Training accuracy: 0.05 | Validation accuracy: 0.12  
EPOCH 7/10 | Training loss: 11.68 | Training accuracy: 0.06 | Validation accuracy: 0.09  
EPOCH 8/10 | Training loss: 11.36 | Training accuracy: 0.09 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 11.10 | Training accuracy: 0.09 | Validation accuracy: 0.08

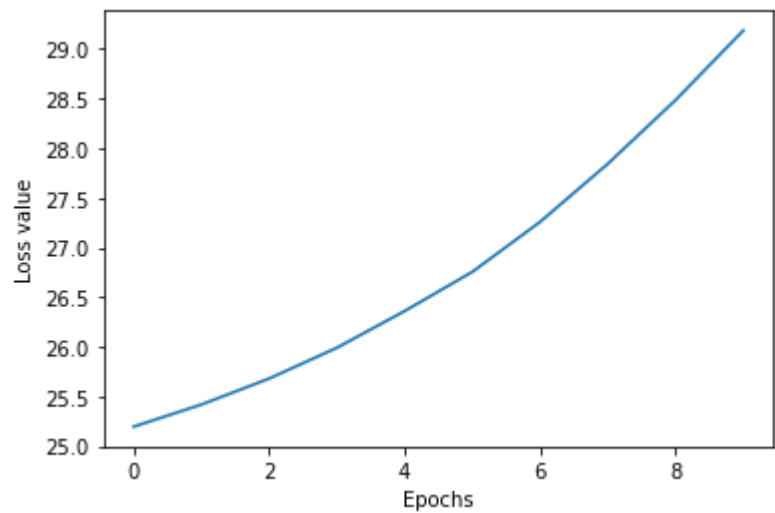


Learning Rate: 1e-08 | Regularization: 100.0 | Maximum Validation Accuracy: 0.13

Loss function used: hinge

-----

EPOCH 0/10 | Training loss: 25.20 | Training accuracy: 0.10 | Validation accuracy: 0.14  
EPOCH 1/10 | Training loss: 25.42 | Training accuracy: 0.09 | Validation accuracy: 0.12  
EPOCH 2/10 | Training loss: 25.68 | Training accuracy: 0.10 | Validation accuracy: 0.12  
EPOCH 3/10 | Training loss: 25.99 | Training accuracy: 0.10 | Validation accuracy: 0.11  
EPOCH 4/10 | Training loss: 26.36 | Training accuracy: 0.09 | Validation accuracy: 0.11  
EPOCH 5/10 | Training loss: 26.76 | Training accuracy: 0.08 | Validation accuracy: 0.09  
EPOCH 6/10 | Training loss: 27.26 | Training accuracy: 0.09 | Validation accuracy: 0.08  
EPOCH 7/10 | Training loss: 27.84 | Training accuracy: 0.09 | Validation accuracy: 0.08  
EPOCH 8/10 | Training loss: 28.49 | Training accuracy: 0.09 | Validation accuracy: 0.08  
EPOCH 9/10 | Training loss: 29.19 | Training accuracy: 0.10 | Validation accuracy: 0.08

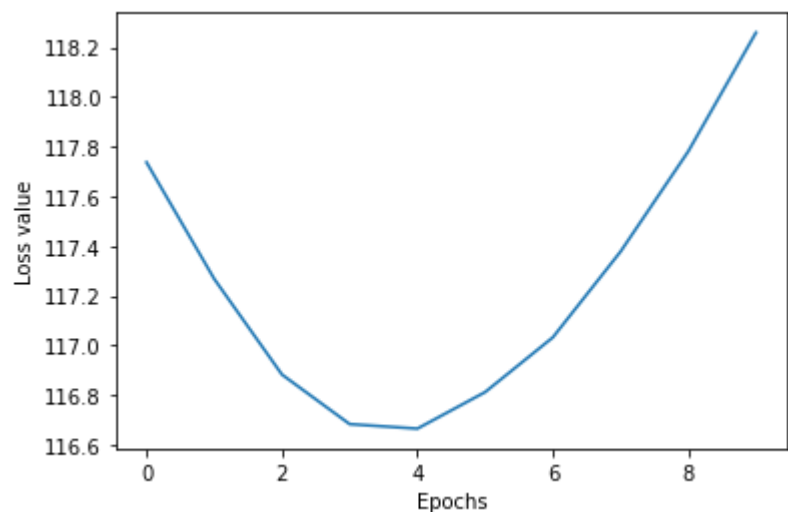


Learning Rate: 1e-08 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.14

Loss function used: hinge

-----

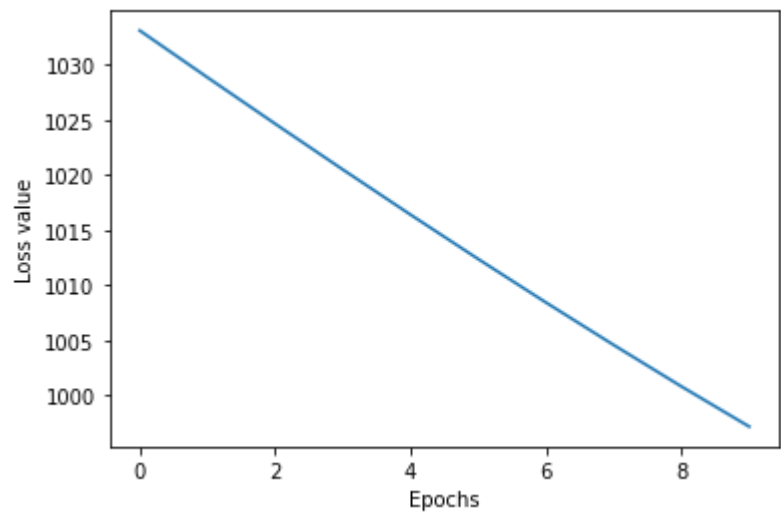
EPOCH 0/10 | Training loss: 117.74 | Training accuracy: 0.10 | Validation accuracy: 0.11  
EPOCH 1/10 | Training loss: 117.27 | Training accuracy: 0.10 | Validation accuracy: 0.09  
EPOCH 2/10 | Training loss: 116.88 | Training accuracy: 0.10 | Validation accuracy: 0.12  
EPOCH 3/10 | Training loss: 116.68 | Training accuracy: 0.11 | Validation accuracy: 0.13  
EPOCH 4/10 | Training loss: 116.67 | Training accuracy: 0.13 | Validation accuracy: 0.13  
EPOCH 5/10 | Training loss: 116.81 | Training accuracy: 0.13 | Validation accuracy: 0.12  
EPOCH 6/10 | Training loss: 117.03 | Training accuracy: 0.14 | Validation accuracy: 0.13  
EPOCH 7/10 | Training loss: 117.38 | Training accuracy: 0.16 | Validation accuracy: 0.14  
EPOCH 8/10 | Training loss: 117.78 | Training accuracy: 0.20 | Validation accuracy: 0.16  
EPOCH 9/10 | Training loss: 118.26 | Training accuracy: 0.18 | Validation accuracy: 0.15



Learning Rate: 1e-08 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.16

Loss function used: hinge  
-----

EPOCH 0/10 | Training loss: 1033.08 | Training accuracy: 0.13 | Validation accuracy: 0.06  
EPOCH 1/10 | Training loss: 1028.82 | Training accuracy: 0.13 | Validation accuracy: 0.08  
EPOCH 2/10 | Training loss: 1024.62 | Training accuracy: 0.10 | Validation accuracy: 0.11  
EPOCH 3/10 | Training loss: 1020.46 | Training accuracy: 0.09 | Validation accuracy: 0.11  
EPOCH 4/10 | Training loss: 1016.37 | Training accuracy: 0.10 | Validation accuracy: 0.12  
EPOCH 5/10 | Training loss: 1012.34 | Training accuracy: 0.11 | Validation accuracy: 0.12  
EPOCH 6/10 | Training loss: 1008.40 | Training accuracy: 0.14 | Validation accuracy: 0.11  
EPOCH 7/10 | Training loss: 1004.55 | Training accuracy: 0.15 | Validation accuracy: 0.11  
EPOCH 8/10 | Training loss: 1000.79 | Training accuracy: 0.14 | Validation accuracy: 0.11  
EPOCH 9/10 | Training loss: 997.15 | Training accuracy: 0.15 | Validation accuracy: 0.11

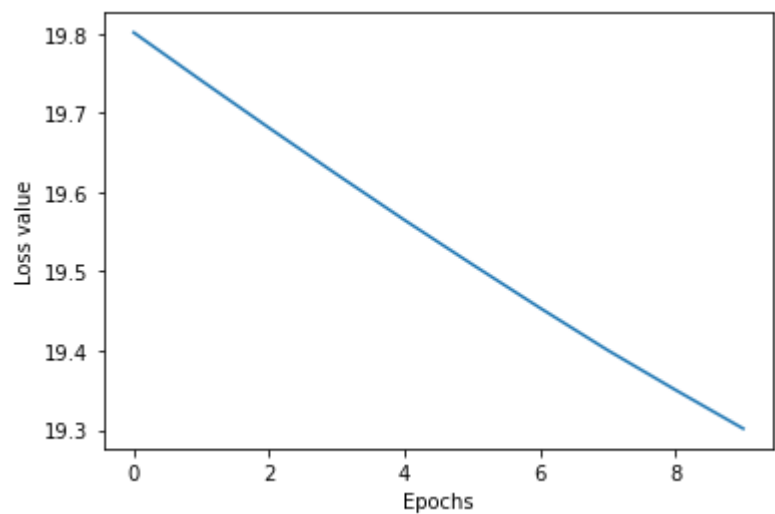


Learning Rate: 1e-08 | Regularization: 100000.0 | Maximum Validation Accuracy: 0.12

Loss function used: hinge

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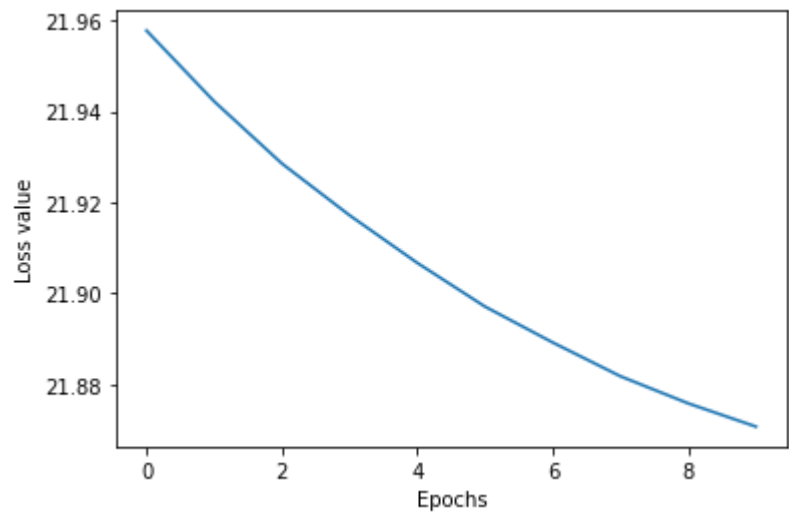
EPOCH 0/10 | Training loss: 19.80 | Training accuracy: 0.09 | Validation accuracy: 0.06  
EPOCH 1/10 | Training loss: 19.74 | Training accuracy: 0.09 | Validation accuracy: 0.06  
EPOCH 2/10 | Training loss: 19.68 | Training accuracy: 0.09 | Validation accuracy: 0.06  
EPOCH 3/10 | Training loss: 19.62 | Training accuracy: 0.11 | Validation accuracy: 0.06  
EPOCH 4/10 | Training loss: 19.56 | Training accuracy: 0.11 | Validation accuracy: 0.06  
EPOCH 5/10 | Training loss: 19.51 | Training accuracy: 0.11 | Validation accuracy: 0.06  
EPOCH 6/10 | Training loss: 19.45 | Training accuracy: 0.12 | Validation accuracy: 0.06  
EPOCH 7/10 | Training loss: 19.40 | Training accuracy: 0.12 | Validation accuracy: 0.05  
EPOCH 8/10 | Training loss: 19.35 | Training accuracy: 0.12 | Validation accuracy: 0.05  
EPOCH 9/10 | Training loss: 19.30 | Training accuracy: 0.12 | Validation accuracy: 0.05



Learning Rate: 1e-09 | Regularization: 10.0 | Maximum Validation Accuracy: 0.06

Loss function used: hinge  
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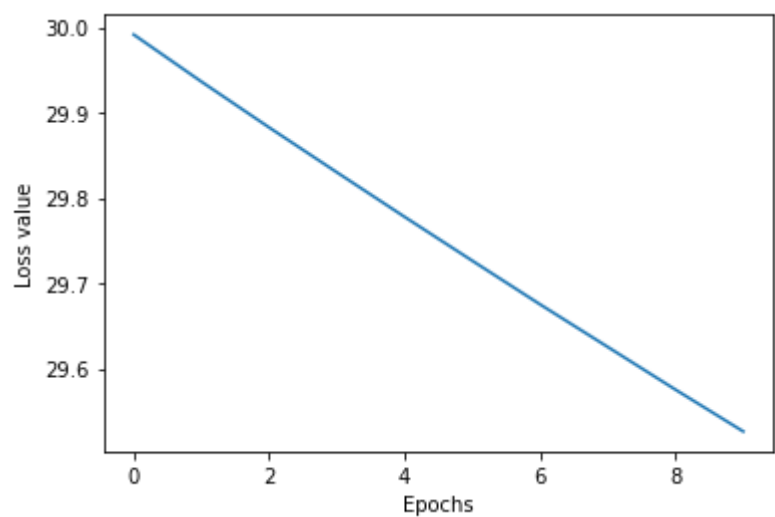
EPOCH 0/10 | Training loss: 21.96 | Training accuracy: 0.20 | Validation accuracy: 0.09  
EPOCH 1/10 | Training loss: 21.94 | Training accuracy: 0.20 | Validation accuracy: 0.09  
EPOCH 2/10 | Training loss: 21.93 | Training accuracy: 0.20 | Validation accuracy: 0.09  
EPOCH 3/10 | Training loss: 21.92 | Training accuracy: 0.20 | Validation accuracy: 0.09  
EPOCH 4/10 | Training loss: 21.91 | Training accuracy: 0.20 | Validation accuracy: 0.09  
EPOCH 5/10 | Training loss: 21.90 | Training accuracy: 0.20 | Validation accuracy: 0.09  
EPOCH 6/10 | Training loss: 21.89 | Training accuracy: 0.20 | Validation accuracy: 0.09  
EPOCH 7/10 | Training loss: 21.88 | Training accuracy: 0.20 | Validation accuracy: 0.09  
EPOCH 8/10 | Training loss: 21.88 | Training accuracy: 0.20 | Validation accuracy: 0.09  
EPOCH 9/10 | Training loss: 21.87 | Training accuracy: 0.20 | Validation accuracy: 0.09



Learning Rate: 1e-09 | Regularization: 100.0 | Maximum Validation Accuracy: 0.09

Loss function used: hinge  
-----

EPOCH 0/10 | Training loss: 29.99 | Training accuracy: 0.10 | Validation accuracy: 0.11  
EPOCH 1/10 | Training loss: 29.94 | Training accuracy: 0.10 | Validation accuracy: 0.11  
EPOCH 2/10 | Training loss: 29.88 | Training accuracy: 0.10 | Validation accuracy: 0.11  
EPOCH 3/10 | Training loss: 29.83 | Training accuracy: 0.10 | Validation accuracy: 0.11  
EPOCH 4/10 | Training loss: 29.78 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 5/10 | Training loss: 29.73 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 6/10 | Training loss: 29.68 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 7/10 | Training loss: 29.63 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 8/10 | Training loss: 29.58 | Training accuracy: 0.11 | Validation accuracy: 0.11  
EPOCH 9/10 | Training loss: 29.53 | Training accuracy: 0.11 | Validation accuracy: 0.11

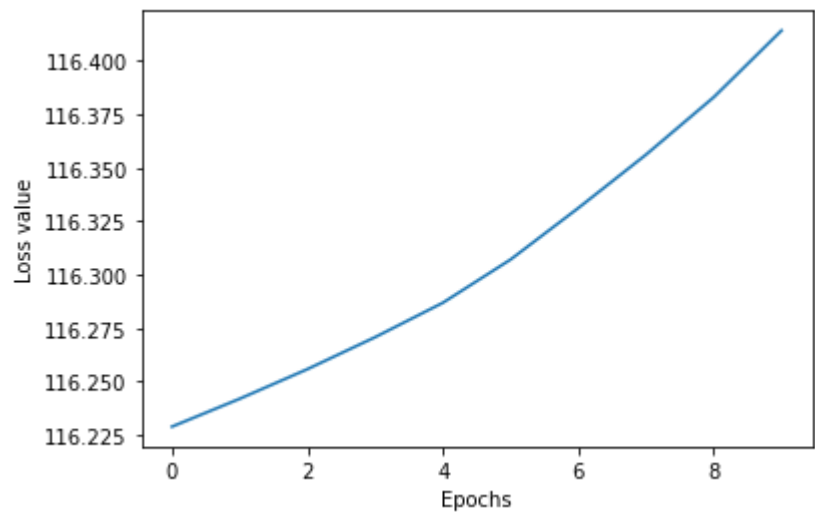


Learning Rate: 1e-09 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.11

Loss function used: hinge

-----

EPOCH 0/10 | Training loss: 116.23 | Training accuracy: 0.08 | Validation accuracy: 0.08  
EPOCH 1/10 | Training loss: 116.24 | Training accuracy: 0.07 | Validation accuracy: 0.08  
EPOCH 2/10 | Training loss: 116.26 | Training accuracy: 0.07 | Validation accuracy: 0.08  
EPOCH 3/10 | Training loss: 116.27 | Training accuracy: 0.07 | Validation accuracy: 0.08  
EPOCH 4/10 | Training loss: 116.29 | Training accuracy: 0.07 | Validation accuracy: 0.08  
EPOCH 5/10 | Training loss: 116.31 | Training accuracy: 0.07 | Validation accuracy: 0.08  
EPOCH 6/10 | Training loss: 116.33 | Training accuracy: 0.07 | Validation accuracy: 0.08  
EPOCH 7/10 | Training loss: 116.36 | Training accuracy: 0.07 | Validation accuracy: 0.08  
EPOCH 8/10 | Training loss: 116.38 | Training accuracy: 0.08 | Validation accuracy: 0.08  
EPOCH 9/10 | Training loss: 116.41 | Training accuracy: 0.07 | Validation accuracy: 0.09

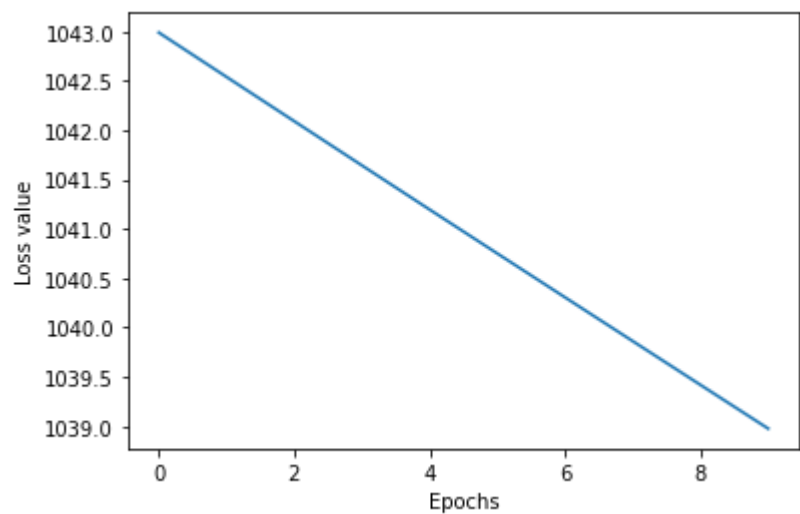


Learning Rate: 1e-09 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.09

Loss function used: hinge  
-----



EPOCH 0/10 | Training loss: 1042.99 | Training accuracy: 0.05 | Validation accuracy: 0.14  
EPOCH 1/10 | Training loss: 1042.54 | Training accuracy: 0.06 | Validation accuracy: 0.14  
EPOCH 2/10 | Training loss: 1042.09 | Training accuracy: 0.06 | Validation accuracy: 0.14  
EPOCH 3/10 | Training loss: 1041.64 | Training accuracy: 0.06 | Validation accuracy: 0.14  
EPOCH 4/10 | Training loss: 1041.20 | Training accuracy: 0.06 | Validation accuracy: 0.14  
EPOCH 5/10 | Training loss: 1040.75 | Training accuracy: 0.06 | Validation accuracy: 0.14  
EPOCH 6/10 | Training loss: 1040.31 | Training accuracy: 0.08 | Validation accuracy: 0.14  
EPOCH 7/10 | Training loss: 1039.86 | Training accuracy: 0.08 | Validation accuracy: 0.14  
EPOCH 8/10 | Training loss: 1039.42 | Training accuracy: 0.08 | Validation accuracy: 0.14  
EPOCH 9/10 | Training loss: 1038.98 | Training accuracy: 0.08 | Validation accuracy: 0.14

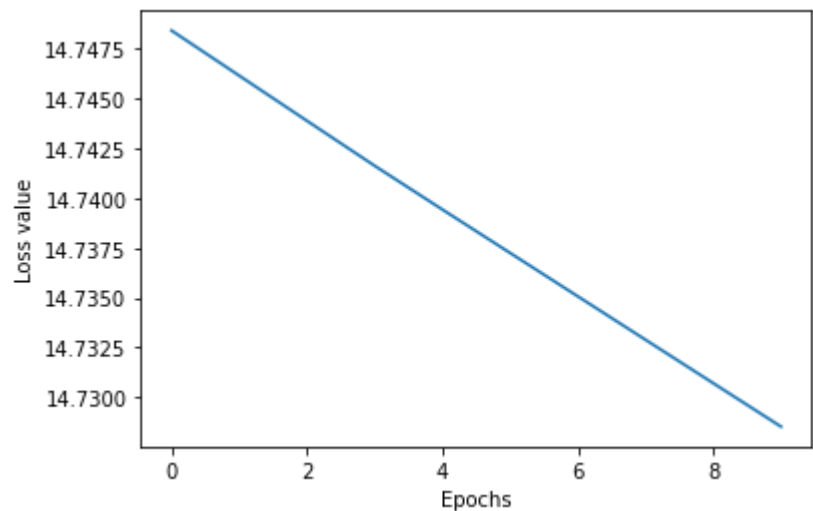


Learning Rate: 1e-09 | Regularization: 100000.0 | Maximum Validation Accuracy: 0.14

Loss function used: hinge

-----

EPOCH 0/10 | Training loss: 14.75 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 1/10 | Training loss: 14.75 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 2/10 | Training loss: 14.74 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 3/10 | Training loss: 14.74 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 4/10 | Training loss: 14.74 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 5/10 | Training loss: 14.74 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 6/10 | Training loss: 14.74 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 7/10 | Training loss: 14.73 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 8/10 | Training loss: 14.73 | Training accuracy: 0.09 | Validation accuracy: 0.07  
EPOCH 9/10 | Training loss: 14.73 | Training accuracy: 0.09 | Validation accuracy: 0.07

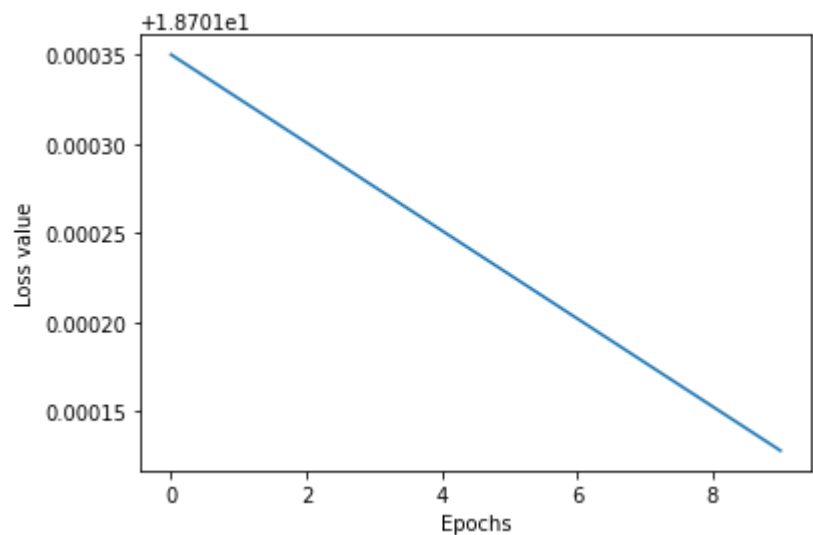


Learning Rate: 1e-10 | Regularization: 10.0 | Maximum Validation Accuracy: 0.07

Loss function used: hinge

-----

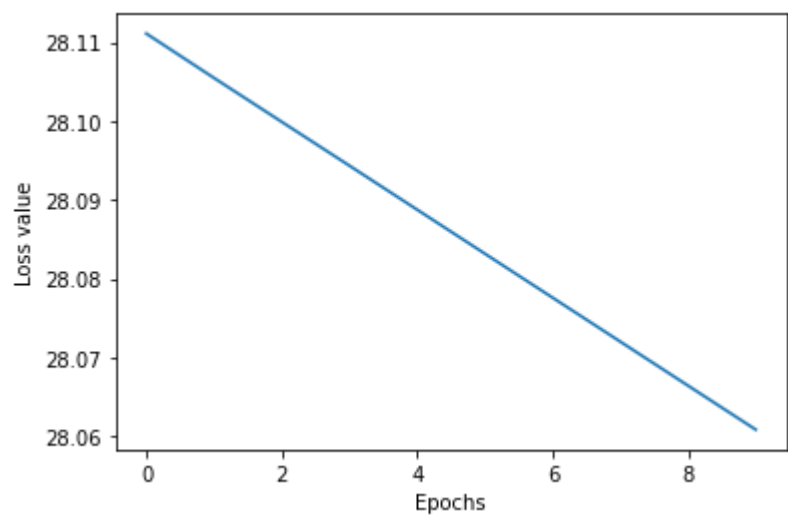
EPOCH 0/10 | Training loss: 18.70 | Training accuracy: 0.05 | Validation accuracy: 0.11  
EPOCH 1/10 | Training loss: 18.70 | Training accuracy: 0.05 | Validation accuracy: 0.11  
EPOCH 2/10 | Training loss: 18.70 | Training accuracy: 0.05 | Validation accuracy: 0.11  
EPOCH 3/10 | Training loss: 18.70 | Training accuracy: 0.05 | Validation accuracy: 0.11  
EPOCH 4/10 | Training loss: 18.70 | Training accuracy: 0.05 | Validation accuracy: 0.11  
EPOCH 5/10 | Training loss: 18.70 | Training accuracy: 0.05 | Validation accuracy: 0.11  
EPOCH 6/10 | Training loss: 18.70 | Training accuracy: 0.05 | Validation accuracy: 0.11  
EPOCH 7/10 | Training loss: 18.70 | Training accuracy: 0.05 | Validation accuracy: 0.11  
EPOCH 8/10 | Training loss: 18.70 | Training accuracy: 0.05 | Validation accuracy: 0.11  
EPOCH 9/10 | Training loss: 18.70 | Training accuracy: 0.05 | Validation accuracy: 0.11



Learning Rate: 1e-10 | Regularization: 100.0 | Maximum Validation Accuracy: 0.11

Loss function used: hinge  
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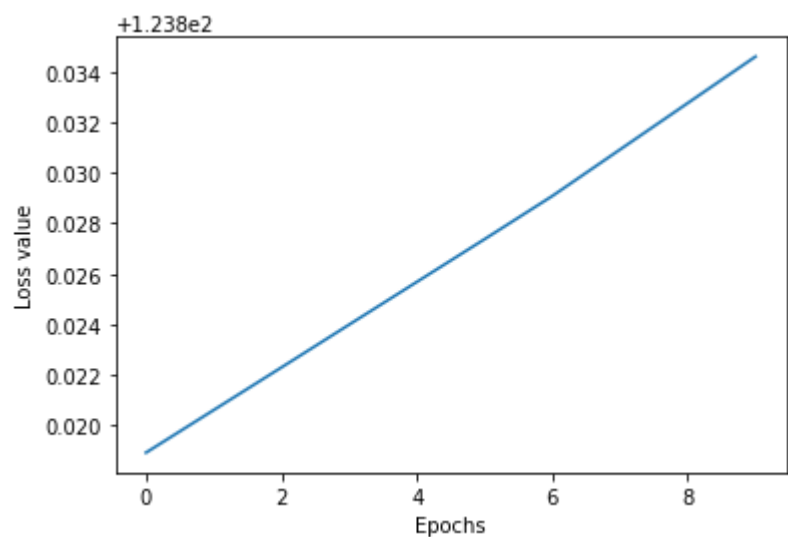
EPOCH 0/10 | Training loss: 28.11 | Training accuracy: 0.05 | Validation accuracy: 0.09  
EPOCH 1/10 | Training loss: 28.11 | Training accuracy: 0.05 | Validation accuracy: 0.09  
EPOCH 2/10 | Training loss: 28.10 | Training accuracy: 0.05 | Validation accuracy: 0.09  
EPOCH 3/10 | Training loss: 28.09 | Training accuracy: 0.05 | Validation accuracy: 0.09  
EPOCH 4/10 | Training loss: 28.09 | Training accuracy: 0.05 | Validation accuracy: 0.09  
EPOCH 5/10 | Training loss: 28.08 | Training accuracy: 0.05 | Validation accuracy: 0.09  
EPOCH 6/10 | Training loss: 28.08 | Training accuracy: 0.05 | Validation accuracy: 0.09  
EPOCH 7/10 | Training loss: 28.07 | Training accuracy: 0.05 | Validation accuracy: 0.09  
EPOCH 8/10 | Training loss: 28.07 | Training accuracy: 0.05 | Validation accuracy: 0.09  
EPOCH 9/10 | Training loss: 28.06 | Training accuracy: 0.05 | Validation accuracy: 0.09



Learning Rate: 1e-10 | Regularization: 1000.0 | Maximum Validation Accuracy: 0.09

Loss function used: hinge  
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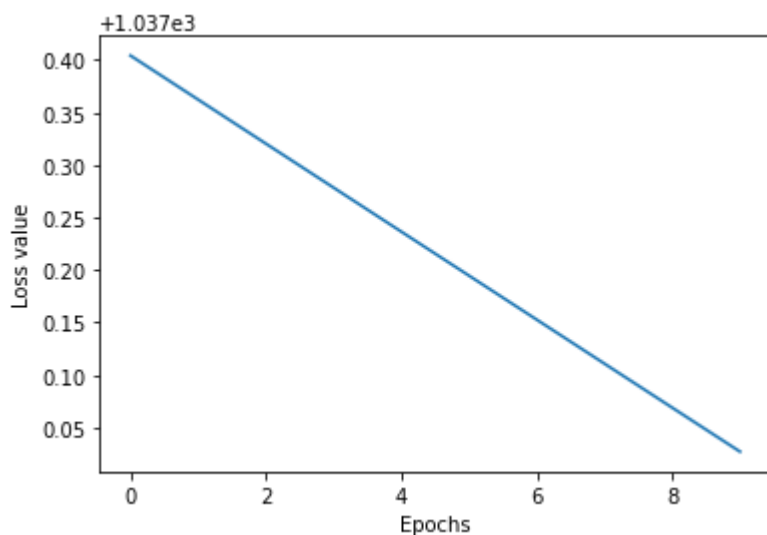
EPOCH 0/10 | Training loss: 123.82 | Training accuracy: 0.12 | Validation accuracy: 0.13  
EPOCH 1/10 | Training loss: 123.82 | Training accuracy: 0.12 | Validation accuracy: 0.13  
EPOCH 2/10 | Training loss: 123.82 | Training accuracy: 0.12 | Validation accuracy: 0.13  
EPOCH 3/10 | Training loss: 123.82 | Training accuracy: 0.12 | Validation accuracy: 0.14  
EPOCH 4/10 | Training loss: 123.83 | Training accuracy: 0.12 | Validation accuracy: 0.13  
EPOCH 5/10 | Training loss: 123.83 | Training accuracy: 0.12 | Validation accuracy: 0.13  
EPOCH 6/10 | Training loss: 123.83 | Training accuracy: 0.12 | Validation accuracy: 0.13  
EPOCH 7/10 | Training loss: 123.83 | Training accuracy: 0.12 | Validation accuracy: 0.13  
EPOCH 8/10 | Training loss: 123.83 | Training accuracy: 0.12 | Validation accuracy: 0.13  
EPOCH 9/10 | Training loss: 123.83 | Training accuracy: 0.12 | Validation accuracy: 0.13



Learning Rate: 1e-10 | Regularization: 10000.0 | Maximum Validation Accuracy: 0.14

Loss function used: hinge  
-----

EPOCH 0/10 | Training loss: 1037.40 | Training accuracy: 0.08 | Validation accuracy: 0.10  
EPOCH 1/10 | Training loss: 1037.36 | Training accuracy: 0.08 | Validation accuracy: 0.10  
EPOCH 2/10 | Training loss: 1037.32 | Training accuracy: 0.08 | Validation accuracy: 0.10  
EPOCH 3/10 | Training loss: 1037.28 | Training accuracy: 0.08 | Validation accuracy: 0.10  
EPOCH 4/10 | Training loss: 1037.24 | Training accuracy: 0.08 | Validation accuracy: 0.10  
EPOCH 5/10 | Training loss: 1037.19 | Training accuracy: 0.08 | Validation accuracy: 0.10  
EPOCH 6/10 | Training loss: 1037.15 | Training accuracy: 0.08 | Validation accuracy: 0.10  
EPOCH 7/10 | Training loss: 1037.11 | Training accuracy: 0.08 | Validation accuracy: 0.10  
EPOCH 8/10 | Training loss: 1037.07 | Training accuracy: 0.08 | Validation accuracy: 0.10  
EPOCH 9/10 | Training loss: 1037.03 | Training accuracy: 0.08 | Validation accuracy: 0.10



Learning Rate:  $1e-10$  | Regularization: 100000.0 | Maximum Validation Accuracy: 0.1

Best Hyperparameters: Learning Rate  $1e-08$  | Regularization: 10000.0

In [ ]: