[COM6513] Assignment 1: Sentiment Analysis with Logistic Regression

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The goal of this assignment is to develop and test a **text classification** system for **sentiment analysis**, in particular to predict the sentiment of movie reviews, i.e. positive or negative (binary classification).

For that purpose, you will implement:

- Text processing methods for extracting Bag-Of-Word features, using
  - n-grams (BOW), i.e. unigrams, bigrams and trigrams to obtain vector representations of documents where n=1,2,3 respectively. Two vector weighting schemes should be tested: (1) raw frequencies (**1 mark**); (2) tf.idf (**1 mark**).
  - character n-grams (BOCN). A character n-gram is a contiguous sequence of characters given a word, e.g. for n=2, 'coffee' is split into {'co', 'of', 'ff', 'fe', 'ee'}. Two vector weighting schemes should be tested: (1) raw frequencies (**1 mark**); (2) tf.idf (**1 mark**). **Tip: Note the large vocabulary size!**
  - a combination of the two vector spaces (n-grams and character n-grams) choosing your best performing wighting respectively (i.e. raw or tfidf). (**1 mark**) **Tip: you should merge the two representations**

- Binary Logistic Regression (LR) classifiers that will be able to accurately classify movie reviews trained with:
  - (1) BOW-count (raw frequencies)
  - (2) BOW-tfidf (tf.idf weighted)
  - (3) BOCN-count
  - (4) BOCN-tfidf
  - (5) BOW+BOCN (best performing weighting; raw or tfidf)

- The Stochastic Gradient Descent (SGD) algorithm to estimate the parameters of your Logistic Regression models. Your SGD algorithm should:
  - Minimise the Binary Cross-entropy loss function (**1 mark**)
  - Use L2 regularisation (**1 mark**)
  - Perform multiple passes (epochs) over the training data (**1 mark**)
  - Randomise the order of training data after each pass (**1 mark**)
  - Stop training if the difference between the current and previous development loss is smaller than a threshold (**1 mark**)
  - After each epoch print the training and development loss (**1 mark**)

- Discuss how did you choose hyperparameters (e.g. learning rate and regularisation strength) for each LR model? You should use a table showing model performance using different set of hyperparameter values. (**2 marks).** Tip: Instead of using all possible combinations, you could perform a random sampling of combinations.**

- After training each LR model, plot the learning process (i.e. training and validation loss in each epoch) using a line plot. Does your model underfit, overfit or is it about right? Explain why. (**1 mark**).

- Identify and show the most important features (model interpretability) for each class (i.e. top-10 most positive and top-10 negative weights). Give the top 10 for each class and comment on whether they make sense (if they don't you might have a bug!). If you were to apply the classifier into a different domain such laptop reviews or restaurant reviews, do you think these features would generalise well? Can you propose what features the classifier could pick up as important in the new domain? (**2 marks**)

- Provide well documented and commented code describing all of your choices. In general, you are free to make decisions about text processing (e.g. punctuation, numbers, vocabulary size) and hyperparameter values. We expect to see justifications and discussion for all of your choices (**2 marks**).

- Provide efficient solutions by using Numpy arrays when possible (you can find tips in Lab 1 sheet). Executing the whole notebook with your code should not take more than 5 minutes on a any standard computer (e.g. Intel Core i5 CPU, 8 or 16GB RAM) excluding hyperparameter tuning runs (**2 marks**).

Data

The data you will use are taken from here: http://www.cs.cornell.edu/people/pabo/movie-review-data/ and you can find it in the `./data_sentiment` folder in CSV format:

- `data_sentiment/train.csv` : contains 1,400 reviews, 700 positive (label: 1) and 700 negative (label: 0) to be used for training.
- `data_sentiment/dev.csv` : contains 200 reviews, 100 positive and 100 negative to be used for hyperparameter selection and monitoring the training process.
- `data_sentiment/test.csv` : contains 400 reviews, 200 positive and 200 negative to be used for testing.

Submission Instructions

You should submit a Jupyter Notebook file (assignment1.ipynb) and an exported PDF version (you can do it from Jupyter: `File–>Download as–>PDF via Latex` or you can print it as PDF using your browser).

You are advised to follow the code structure given in this notebook by completing all given funtions. You can also write any auxilliary/helper functions (and arguments for the functions) that you might need but note that you can provide a full solution without any such functions. Similarly, you can just use only the packages imported below but you are free to use any functionality from the [Python Standard Library](#), NumPy, SciPy (excluding built-in softmax funtcions) and Pandas. You are not allowed to use any third-party library such as Scikit-learn (apart from metric functions already provided), NLTK, Spacy, Keras etc..

There is no single correct answer on what your accuracy should be, but correct implementations usually achieve F1-scores around 80\% or higher. The quality of the analysis of the results is as important as the accuracy itself.

This assignment will be marked out of 20. It is worth 20\% of your final grade in the module.

The deadline for this assignment is **23:59 on Mon, 14 Mar 2022** and it needs to be submitted via Blackboard. Standard departmental penalties for lateness will be applied. We use a range of strategies to **detect unfair means**, including Turnitin which helps detect plagiarism. Use of unfair means would result in getting a failing grade.

In [156…
```
!export PATH=/Library/TeX/texbin:$PATH
```

In [8]:
```python
import pandas as pd
import numpy as np
from collections import Counter
import re
import matplotlib.pyplot as plt
from sklearn.metrics import accuracy_score, precision_score, recall_score,
import random

# fixing random seed for reproducibility
random.seed(123)
np.random.seed(123)
```

Load Raw texts and labels into arrays

First, you need to load the training, development and test sets from their corresponding CSV files (tip: you can use Pandas dataframes).

In [9]:
```python
#load data into dataframe using pandas
train_data = pd.read_csv('data_sentiment/train.csv',header=None)

train_data.columns=['raw_text','label']

test_data = pd.read_csv('data_sentiment/test.csv',header=None)

test_data.columns=['raw_text','label']

dev_data = pd.read_csv('data_sentiment/dev.csv',header=None)

dev_data.columns=['raw_text','label']
```

In [10]:
```python
train_data.head()
```

Out[10]:

	raw_text	label
0	note : some may consider portions of the follo...	1
1	note : some may consider portions of the follo...	1
2	every once in a while you see a film that is s...	1
3	when i was growing up in 1970s , boys in my sc...	1
4	the muppet movie is the first , and the best m...	1

In [11]:
```python
test_data.head()
```

Out[11]:

	raw_text	label
0	wild things is a suspenseful thriller starring...	1
1	i know it already opened in december , but i f...	1
2	what's shocking about " carlito's way " is how...	1
3	uncompromising french director robert bresson'...	1
4	aggressive , bleak , and unrelenting film abou...	1

In [12]:
```python
dev_data.head()
```

Out[12]:

	raw_text	label
0	if he doesn=92t watch out , mel gibson is in d...	1
1	wong kar-wei's " fallen angels " is , on a pur...	1
2	there is nothing like american history x in th...	1
3	an unhappy italian housewife , a lonely waiter...	1
4	when people are talking about good old times ,...	1

If you use Pandas you can see a sample of the data.

The next step is to put the raw texts into Python lists and their corresponding labels into NumPy arrays:

In [13]:
```python
#converting the data to list and labels to numpy array

train_text = train_data['raw_text'].tolist()
train_labels = train_data['label'].to_numpy()
test_text = test_data['raw_text'].tolist()
test_labels = test_data['label'].to_numpy()
dev_text = dev_data['raw_text'].tolist()
dev_labels = dev_data['label'].to_numpy()
```

Vector Representations of Text

To train and test Logisitc Regression models, you first need to obtain vector representations for all documents given a vocabulary of features (unigrams, bigrams, trigrams).

Text Pre-Processing Pipeline

To obtain a vocabulary of features, you should:

- tokenise all texts into a list of unigrams (tip: using a regular expression)
- remove stop words (using the one provided or one of your preference)
- compute bigrams, trigrams given the remaining unigrams (or character ngrams from the unigrams)
- remove ngrams appearing in less than K documents
- use the remaining to create a vocabulary of unigrams, bigrams and trigrams (or character n-grams). You can keep top N if you encounter memory issues.

```
In [14]:   stop_words = ['a','in','on','at','and','or',
                         'to', 'the', 'of', 'an', 'by',
                         'as', 'is', 'was', 'were', 'been', 'be',
                         'are','for', 'this', 'that', 'these', 'those', 'you', 'i',
                         'it', 'he', 'she', 'we', 'they', 'will', 'have', 'has',
                         'do', 'did', 'can', 'could', 'who', 'which', 'what',
                         'his', 'her', 'they', 'them', 'from', 'with', 'its']
```

In [15]:

```python
#Train Data preprocessing
x_raw_train=[]
x_raw_test=[]
x_raw_dev=[]
x_raw_train_char=[]
x_raw_test_char=[]
x_raw_dev_char=[]
for i in range(0,len(train_data)):
    y=train_data['raw_text'][i]
#replace special characters with space for word ngrams
    x_raw = re.sub(r'[^a-zA-Z0-9\s]', ' ', y)
#just remove \ symbol because it has no meaning (i have left the other spec
#they have some meaning in char ngrams)
    x_raw_char = re.sub(r'\+','',y)
    x_raw_train_char.append(x_raw_char)
#replace mulitple spaces with single space for word ngrams
    x_raw_t = re.sub(r' +',' ',x_raw)
    x_raw_train.append(x_raw_t)



 #Dev Data preprocessing
for i in range(0,len(dev_data)):
    y=dev_data['raw_text'][i]

#replace special characters with space
    x_raw = re.sub(r'[^a-zA-Z0-9\s]', ' ', y)
#just remove \ symbol because it has no meaning (i have left the other spec
#they have some meaning in char ngrams)
    x_raw_char = re.sub(r'\+','',y)
    x_raw_test_char.append(x_raw_char)
#replace mulitple spaces with single space
    x_raw_d = re.sub(r' +',' ',x_raw)
    x_raw_dev.append(x_raw_d)



#test Data preprocessing
for i in range(0,len(test_data)):
    y=test_data['raw_text'][i]

#replace special characters with space
    x_raw = re.sub(r'[^a-zA-Z0-9\s]', ' ', y)
#just remove \ symbol because it has no meaning (i have left the other spec
#they have some meaning in char ngrams)
    x_raw_char = re.sub(r'\+','',y)
    x_raw_dev_char.append(x_raw_char)
#replace mulitple spaces with single space
    x_raw_t = re.sub(r' +',' ',x_raw)
    x_raw_test.append(x_raw_t)
```

N-gram extraction from a document

You first need to implement the `extract_ngrams` function. It takes as input:

- `x_raw` : a string corresponding to the raw text of a document
- `ngram_range` : a tuple of two integers denoting the type of ngrams you want to extract, e.g. (1,2) denotes extracting unigrams and bigrams.
- `token_pattern` : a string to be used within a regular expression to extract all tokens. Note that data is already tokenised so you could opt for a simple white space tokenisation.
- `stop_words` : a list of stop words
- `vocab` : a given vocabulary. It should be used to extract specific features.
- `char_ngrams` : boolean. If true the function extracts character n-grams

and returns:

- `` `x' ``: a list of all extracted features.

See the examples below to see how this function should work.

In [16]:
```python
def extract_ngrams(x_raw, ngram_range=(1,3), token_pattern=r' ',
                   stop_words=[], vocab=set(), char_ngrams=False):
    #convert to lowercase
    x_raw = x_raw.lower()
    tokens=[]
    tokens_new=[]
    tuple_list=[]
    new_token_list=[]
    sep=' '


    #Extract character ngrams
    if char_ngrams==True:

        x_raw =re.sub(r' +','',x_raw)
        for i in range(ngram_range[0],ngram_range[1]+1):
            tokens.extend(x_raw[z:z+i] for z in range(len(x_raw)-i+1))
        extracted_ngrams=tokens

    #Extract word ngrams
    else:
        tokens = [token for token in x_raw.split(token_pattern) if token !

        x_raw_new = [word for word in tokens if word not in stop_words]

        for i in range(ngram_range[0],ngram_range[1]+1):
            tokens_new.extend(x_raw_new[z:z+i] for z in range(len(x_raw_new

        for i in tokens_new:
            tuple_list.append(tuple(i))
        extracted_ngrams=tuple_list

    #return extracted ngrams from given vocabulary or return the full list
    return [ngram for ngram in extracted_ngrams if ngram in vocab] if voca
```

Note that it is OK to represent n-grams using lists instead of tuples: e.g. `['great', ['great', 'movie']]`

For extracting character n-grams the function should work as follows:

In [ ]:
```python
z=extract_ngrams(x_raw_test[0],
                 ngram_range=(1,3),
                 stop_words=stop_words,
                  vocab=train_vocab,
                 char_ngrams=False)
```

In [12]:
```python
t=extract_ngrams("-- movie",
                 ngram_range=(2,4),
                 stop_words=[],
                 vocab=set(),
                 char_ngrams=True)
```

In [13]:
```python
t
```

Out[13]:
```
['--',
 '- ',
 ' m',
 'mo',
 'ov',
 'vi',
 'ie',
 '-- ',
 '- m',
 ' mo',
 'mov',
 'ovi',
 'vie',
 '-- m',
 '- mo',
 ' mov',
 'movi',
 'ovie']
```

Create a vocabulary

The `get_vocab` function will be used to (1) create a vocabulary of ngrams; (2) count the document frequencies of ngrams; (3) their raw frequency. It takes as input:

- `X_raw` : a list of strings each corresponding to the raw text of a document
- `ngram_range` : a tuple of two integers denoting the type of ngrams you want to extract, e.g. (1,2) denotes extracting unigrams and bigrams.
- `token_pattern` : a string to be used within a regular expression to extract all tokens. Note that data is already tokenised so you could opt for a simple white space tokenisation.
- `stop_words` : a list of stop words
- `min_df` : keep ngrams with a minimum document frequency.
- `keep_topN` : keep top-N more frequent ngrams.

and returns:

- `vocab` : a set of the n-grams that will be used as features.
- `df` : a Counter (or dict) that contains ngrams as keys and their corresponding document frequency as values.
- `ngram_counts` : counts of each ngram in vocab

Hint: it should make use of the `extract_ngrams` function.

```
In [128…
def get_vocab(X_raw, ngram_range=(1,3), token_pattern=r' ',
              min_df=0, keep_topN=0,
              stop_words=[],char_ngrams=False):

    df = Counter()
    ngram_counter = Counter()
    #iterate over the whole list of documents
    for doc in X_raw:
        vocab_list = extract_ngrams(doc,ngram_range=ngram_range,stop_words
        #vocab=vocab_list


        #calculate document frequency of ngram using counter
        df.update(vocab_list)

        #calculate count of each ngram in vocab
        ngram_counter.update(ngram for ngram in vocab_list if df[ngram]>=m

        #Get topN ngrams
        vocab_temp=ngrams_count.most_common(keep_topN)

        #create a set of vocabulary of all top N ngrams
        vocab = {i[0] for i in vocab_temp}


    #return vocabulary, document frequency, ngram count
    return vocab, df, ngram_counter
```

Now you should use `get_vocab` to create your vocabulary and get document and raw frequencies of n-grams:

```
In [18]:
train_vocab,train_df,train_ngram_counts = get_vocab(x_raw_train,ngram_range
_,dev_df, _ = get_vocab(x_raw_dev, keep_topN=10000)
_,test_df, _ = get_vocab(x_raw_test, keep_topN=10000)
```

create vocab and get document frequencies for char n-grams

```
In [19]:
train_char_vocab,train_char_df,train_char_counts = get_vocab(x_raw_train_ch
_,dev_char_df, _ = get_vocab(x_raw_dev_char, keep_topN=10000,char_ngrams=Tr
_,test_char_df, _ = get_vocab(x_raw_test_char, keep_topN=10000,char_ngrams=
```

Then, you need to create 2 dictionaries: (1) vocabulary id -> word; and (2) word -> vocabulary id so you can use them for reference:

i have created another 2 dictionaries that have vocabulary id->chars; and chars-> vocabulary id

In [20]:
```python
#function returns 2 dictionaries with vocab_id -> word and word -> vocab_id
def vocab2word(vocab):
    v2w={}
    w2v={}
    for idx,word in enumerate(vocab):
        v2w[idx]=word
        w2v[word]=idx
    #print(v2w)

    return v2w,w2v
```

In [21]:
```python
vocab_word = dict()
word_vocab = dict()
vocab_char={}
char_vocab={}

vocab_word,word_vocab =vocab2word(train_vocab)
vocab_char,char_vocab =vocab2word(train_char_vocab)
```

Now you should be able to extract n-grams for each text in the training, development and test sets:

In [22]:
```python
train_ngrams_list=[]
train_char_list=[]
test_ngrams_list=[]
test_char_list=[]
dev_ngrams_list=[]
dev_char_list=[]
for doc in x_raw_train:
    train_ngrams_list.append(extract_ngrams(doc,ngram_range=(1,3),token_pat
    train_char_list.append(extract_ngrams(doc,ngram_range=(2,6),token_patte
for doc in x_raw_test:
    test_ngrams_list.append(extract_ngrams(doc,ngram_range=(1,3),token_patt
    test_char_list.append(extract_ngrams(doc,ngram_range=(2,6),token_patte
for doc in x_raw_dev:
    dev_ngrams_list.append(extract_ngrams(doc,ngram_range=(1,3),token_patte
    dev_char_list.append(extract_ngrams(doc,ngram_range=(2,6),token_pattern
```

Vectorise documents

Next, write a function `vectoriser` to obtain Bag-of-ngram representations for a list of documents. The function should take as input:

- `X_ngram` : a list of texts (documents), where each text is represented as list of n-grams in the `vocab`
- `vocab` : a set of n-grams to be used for representing the documents

and return:

- `X_vec` : an array with dimensionality Nx|vocab| where N is the number of documents and |vocab| is the size of the vocabulary. Each element of the array should represent the frequency of a given n-gram in a document.

In [23]:
```python
def vectorise(X_ngram, vocab ):
    final_vector=[]
    print('number of documents',len(X_ngram))

    #iterate through the list of ngrams_list
    for doc_ngram in X_ngram:
        #use counter to get count of vocab word if present in document
        count = Counter(doc_ngram)
        temp_vector=[]
        for ngram in vocab:
            temp_vector.extend([count[ngram]])
        final_vector.append(temp_vector)
    X_vec = np.array(final_vector)
    return X_vec
```

Finally, use `vectorise` to obtain document vectors for each document in the train, development and test set. You should extract both count and tf.idf vectors respectively:

Count vectors

In [24]:
```python
#create
train_count_vector = vectorise(train_ngrams_list,train_vocab)
train_char_count_vector = vectorise(train_char_list,train_char_vocab)
test_count_vector = vectorise(test_ngrams_list,train_vocab)
test_char_count_vector = vectorise(test_char_list,train_char_vocab)
dev_count_vector = vectorise(dev_ngrams_list,train_vocab)
dev_char_count_vector = vectorise(dev_char_list,train_char_vocab)
```

```
number of documents 1400
number of documents 1400
number of documents 400
number of documents 400
number of documents 200
number of documents 200
```

```
In [25]:   print("shape of train data vector -",train_count_vector.shape," shape of te
```

```
 shape of train data vector - (1400, 10000)  shape of test data vector - (40
 0, 10000)
 shape of validation data vector - (200, 10000)
```

TF.IDF vectors

First compute `idfs` an array containing inverted document frequencies (Note: its elements should correspond to your `vocab`)

```
In [26]:   #compute the IDF of training,test and validation set of BOW

           temp_arr=[]
           temp_arr2=[]
           temp_arr3=[]
           for v in train_vocab:
               temp_arr.append(np.log10(len(x_raw_train)/(train_df[v]+1)))
               temp_arr2.append(np.log10(len(x_raw_test)/(test_df[v]+1)))
               temp_arr3.append(np.log10(len(x_raw_dev)/(dev_df[v]+1)))



           train_idf=np.array(temp_arr)
           test_idf = np.array(temp_arr2)
           dev_idf = np.array(temp_arr3)

           #compute the IDF of training,test and validation set of BOCN
           temp_arr=[]
           temp_arr2=[]
           temp_arr3=[]
           for v in train_char_vocab:
               temp_arr.append(np.log10(len(x_raw_train)/(train_char_df[v]+1)))
               temp_arr2.append(np.log10(len(x_raw_test)/(test_char_df[v]+1)))
               temp_arr3.append(np.log10(len(x_raw_dev)/(dev_char_df[v]+1)))

           train_char_idf=np.array(temp_arr)
           test_char_idf = np.array(temp_arr2)
           dev_char_idf = np.array(temp_arr3)
```

i have decided to do use smoothing to avoid division by zero in cases

Then transform your count vectors to tf.idf vectors:

```
In [27]:   train_tf_idf = np.log10(1+train_count_vector) * train_idf
           test_tf_idf = np.log10(1+test_count_vector) * test_idf
           dev_tf_idf = np.log10(1+dev_count_vector) * dev_idf

           train_char_tf_idf = np.log10(1+train_char_count_vector) * train_char_idf
           test_char_tf_idf = np.log10(1+test_char_count_vector) * test_char_idf
           dev_char_tf_idf = np.log10(1+dev_char_count_vector) * dev_char_idf
```

In [28]:
```python
train_char_tf_idf.shape
```

Out[28]: (1400, 10000)

Binary Logistic Regression

After obtaining vector representations of the data, now you are ready to implement Binary Logistic Regression for classifying sentiment.

First, you need to implement the `sigmoid` function. It takes as input:

- `z` : a real number or an array of real numbers

and returns:

- `sig` : the sigmoid of `z`

In [29]:
```python
import math
def sigmoid(z):
    sig = 1 / (1 + np.exp(-z))

    return sig
```

Then, implement the `predict_proba` function to obtain prediction probabilities. It takes as input:

- `X` : an array of inputs, i.e. documents represented by bag-of-ngram vectors ($N \times |vocab|$)
- `weights` : a 1-D array of the model's weights $(1, |vocab|)$

and returns:

- `preds_proba` : the prediction probabilities of X given the weights

In [30]:
```python
def predict_proba(X, weights):

    z = np.dot(X,weights)

    preds_proba=sigmoid(z)

    return preds_proba
```

Then, implement the `predict_class` function to obtain the most probable class for each vector in an array of input vectors. It takes as input:

- X : an array of documents represented by bag-of-ngram vectors ($N \times |vocab|$)
- weights : a 1-D array of the model's weights ($1, |vocab|$)

and returns:

- preds_class : the predicted class for each x in X given the weights

In [31]:
```python
def predict_class(X, weights):

    preds_class = predict_proba(X,weights)

    return [0 if prob<0.5 else 1 for prob in preds_class]
```

To learn the weights from data, we need to minimise the binary cross-entropy loss. Implement `binary_loss` that takes as input:

- X : input vectors
- Y : labels
- weights : model weights
- alpha : regularisation strength

and return:

- l : the loss score

In [32]:
```python
epsilon = 1e-5
def binary_loss(X, Y, weights, alpha=0.00001):
    '''
    Binary Cross-entropy Loss

    X:(len(X),len(vocab))
    Y: array len(Y)
    weights: array len(X)
    '''
    predicted_prob = predict_proba(X, weights)

    l = -Y * np.log(predicted_prob) - (1 - Y) * np.log(1 - predicted_prob

    l += alpha * weights.dot(weights)

    return np.mean(l)
```

Now, you can implement Stochastic Gradient Descent to learn the weights of your sentiment classifier. The `SGD` function takes as input:

- `X_tr` : array of training data (vectors)
- `Y_tr` : labels of `X_tr`
- `X_dev` : array of development (i.e. validation) data (vectors)
- `Y_dev` : labels of `X_dev`
- `lr` : learning rate
- `alpha` : regularisation strength
- `epochs` : number of full passes over the training data
- `tolerance` : stop training if the difference between the current and previous validation loss is smaller than a threshold
- `print_progress` : flag for printing the training progress (train/validation loss)

and returns:

- `weights` : the weights learned
- `training_loss_history` : an array with the average losses of the whole training set after each epoch
- `validation_loss_history` : an array with the average losses of the whole development set after each epoch

- The Stochastic Gradient Descent (SGD) algorithm to estimate the parameters of your Logistic Regression models. Your SGD algorithm should:
  - Minimise the Binary Cross-entropy loss function (**1 mark**)
  - Use L2 regularisation (**1 mark**)
  - Perform multiple passes (epochs) over the training data (**1 mark**)
  - Randomise the order of training data after each pass (**1 mark**)
  - Stop training if the difference between the current and previous development loss is smaller than a threshold (**1 mark**)
  - After each epoch print the training and development loss (**1 mark**)

In [33]:
```python
#function to compute gradient with respect to weights
def gradient_dw(x,y,w,alpha,N):

    dw = x * (y - (predict_proba(x,w)) - (alpha / N) * w)
    return dw
```

In [34]:

```python
def SGD(X_tr, Y_tr, X_dev=[], Y_dev=[], lr=0.1,
        alpha=0.00001, epochs=5,
        tolerance=0.0001, print_progress=True):
    np.random.seed(123)

    n=X_tr.shape[0] #Samples
    m=X_tr.shape[1] #Features
    training_loss_history = []
    validation_loss_history = []


    #initialize weights randomly from standard normal distribution
    #weights = np.random.randn(X_tr.shape[1])
    weights = np.zeros(X_tr.shape[1])
    #print(weights)
    train_docs = list(zip(X_tr, Y_tr))

    #print(train_docs[0][1])
    for current_iteration in np.arange(epochs):

        temp=[]
        np.random.shuffle(train_docs)


        for x,y in train_docs:
            #calculate gradient for x and y
            dw=gradient_dw(x,y,weights,alpha,n)
            weights = weights + (lr * dw)


        cur_loss_tr = binary_loss(X_tr, Y_tr, weights, alpha)
        cur_loss_dev = binary_loss(X_dev, Y_dev, weights, alpha)

        #stop SGD if the difference in validation loss is lower than toler
        if current_iteration > 0 and validation_loss_history[-1] - cur_loss
            break
        else:
            training_loss_history.append(cur_loss_tr)
            validation_loss_history.append(cur_loss_dev)

        if print_progress:
            print(f'Epoch: {current_iteration:{10}} | Training loss: {cur_


    return weights, training_loss_history, validation_loss_history
```

Train and Evaluate Logistic Regression with Count vectors

First train the model using SGD:

In [35]:
```python
#generate hyperparameters using logspace
lr = np.linspace(0.00001, 0.01, num = 5,endpoint=False)
alpha = np.logspace(-5, -1, num = 5,endpoint=False)
```

In [36]:
```python
lr
```

Out[36]: `array([1.000e-05, 2.008e-03, 4.006e-03, 6.004e-03, 8.002e-03])`

In [37]:
```python
alpha
```

Out[37]: `array([1.00000000e-05, 6.30957344e-05, 3.98107171e-04, 2.51188643e-03,`
`         1.58489319e-02])`

In [38]:
```python
#hyper paramater tuning for BOW-Count
train_loss_history =[]
validation_loss_history=[]
hyperparam_history=[]
#
for lr_i in lr:
    for alpha_i in alpha:
        print('\nHyper Parameters -- Learning Rate -',lr_i,' Regularization
        weight, train_loss_count, dev_loss_count = SGD(X_tr=train_count_ve
                                        Y_tr=train_labels,
                                        X_dev=dev_count_vector,
                                        Y_dev=dev_labels,
                                        lr=lr_i,
                                        alpha=alpha_i,
                                        tolerance=0.0001,
                                        epochs=400,
                                        print_progress=True)
        if len(train_loss_count) > 40:
            train_loss_history.append(train_loss_count[-1])
            validation_loss_history.append(dev_loss_count[-1])
            hyperparam_history.append([lr_i,alpha_i])
```

```
Hyper Parameters -- Learning Rate - 1e-05  Regularization Parameter- 1e-05
Epoch:          0 | Training loss: 0.6837664802935786 | Validation loss: 0.
6860666266246024
Epoch:          1 | Training loss: 0.6751537941301965 | Validation loss: 0.
6800242919507538
Epoch:          2 | Training loss: 0.6670410843190909 | Validation loss: 0.
6741665937070213
Epoch:          3 | Training loss: 0.6593693831021286 | Validation loss: 0.
6688284403248014
Epoch:          4 | Training loss: 0.6520789507389164 | Validation loss: 0.
6642044718900759
Epoch:          5 | Training loss: 0.6451418867290613 | Validation loss: 0.
6592676317437978
Epoch:          6 | Training loss: 0.6385578999155843 | Validation loss: 0.
```

6546807321249714
Epoch: 7 | Training loss: 0.6322596420878759 | Validation loss: 0.
6507759296929874
Epoch: 8 | Training loss: 0.6262314087264625 | Validation loss: 0.
646674831896937
Epoch: 9 | Training loss: 0.620460854628425 | Validation loss: 0.6
4272630178654
Epoch: 10 | Training loss: 0.6149881618632875 | Validation loss: 0.
6394738548143387
Epoch: 11 | Training loss: 0.6096263303307669 | Validation loss: 0.
6356584498778969
Epoch: 12 | Training loss: 0.6045043018078649 | Validation loss: 0.
6322572826186653
Epoch: 13 | Training loss: 0.5996144292432117 | Validation loss: 0.
6293492459800534
Epoch: 14 | Training loss: 0.5948162723563388 | Validation loss: 0.
6258787119313933
Epoch: 15 | Training loss: 0.5902174540550508 | Validation loss: 0.
6229724126694056
Epoch: 16 | Training loss: 0.5858409993538789 | Validation loss: 0.
6205727203610901
Epoch: 17 | Training loss: 0.5814696132641515 | Validation loss: 0.
6175430515652522
Epoch: 18 | Training loss: 0.5772660634103965 | Validation loss: 0.
6146913686402145
Epoch: 19 | Training loss: 0.573203239868719 | Validation loss: 0.6
120757106076501
Epoch: 20 | Training loss: 0.5692533401304347 | Validation loss: 0.
609465451686768
Epoch: 21 | Training loss: 0.565418961747484 | Validation loss: 0.6
071622629742548
Epoch: 22 | Training loss: 0.5616801579878159 | Validation loss: 0.
6046943304173754
Epoch: 23 | Training loss: 0.5580456726258316 | Validation loss: 0.
6022680736754554
Epoch: 24 | Training loss: 0.5545520121760678 | Validation loss: 0.
6006037103567777
Epoch: 25 | Training loss: 0.5510367585348915 | Validation loss: 0.
5979420185980028
Epoch: 26 | Training loss: 0.5476865083427509 | Validation loss: 0.
596128864112069
Epoch: 27 | Training loss: 0.5443924556120864 | Validation loss: 0.
5940815370083644
Epoch: 28 | Training loss: 0.5411402012734088 | Validation loss: 0.
5918049348792468
Epoch: 29 | Training loss: 0.5380223918391238 | Validation loss: 0.
5901352532689339
Epoch: 30 | Training loss: 0.5349035346458563 | Validation loss: 0.
5879064173990801
Epoch: 31 | Training loss: 0.5318869420725559 | Validation loss: 0.
5860325171763313
Epoch: 32 | Training loss: 0.5289719737508198 | Validation loss: 0.
5845000056060266
Epoch: 33 | Training loss: 0.5260395933891074 | Validation loss: 0.
5822160556529584
Epoch: 34 | Training loss: 0.5232012126512148 | Validation loss: 0.
5805510208618871
Epoch: 35 | Training loss: 0.5204200399022954 | Validation loss: 0.
5787348355126516
Epoch: 36 | Training loss: 0.5176919364011832 | Validation loss: 0.
5770930718379378

```
Epoch:          37 | Training loss: 0.5150336240849595 | Validation loss: 0.
5756605902730182
Epoch:          38 | Training loss: 0.5123937823554481 | Validation loss: 0.
5739013257967216
Epoch:          39 | Training loss: 0.509812115063446 | Validation loss: 0.5
721273367399778
Epoch:          40 | Training loss: 0.50728973068448 | Validation loss: 0.57
04208804294065
Epoch:          41 | Training loss: 0.5048061870437035 | Validation loss: 0.
56883818895547951
Epoch:          42 | Training loss: 0.5023526571599741 | Validation loss: 0.
5673625681109469
Epoch:          43 | Training loss: 0.4999495815903 | Validation loss: 0.565
8515724516266
Epoch:          44 | Training loss: 0.49756792858969884 | Validation loss: 0
.5646093091599969
Epoch:          45 | Training loss: 0.4952405210849046 | Validation loss: 0.
5631584819637063
Epoch:          46 | Training loss: 0.4929495823818077 | Validation loss: 0.
5617385648972377
Epoch:          47 | Training loss: 0.4907052406130593 | Validation loss: 0.
5605148072784047
Epoch:          48 | Training loss: 0.48847718354110614 | Validation loss: 0
.5589147833835034
Epoch:          49 | Training loss: 0.48631595490055785 | Validation loss: 0
.5573487114953168
Epoch:          50 | Training loss: 0.48415099012918256 | Validation loss: 0
.5560928143646193
Epoch:          51 | Training loss: 0.4820267580317835 | Validation loss: 0.
5548089734127464
Epoch:          52 | Training loss: 0.4799531560891506 | Validation loss: 0.
5534212394390322
Epoch:          53 | Training loss: 0.4778715239330672 | Validation loss: 0.
5523197650202973
Epoch:          54 | Training loss: 0.4758583903519518 | Validation loss: 0.
550923406670577
Epoch:          55 | Training loss: 0.47385802271210575 | Validation loss: 0
.5496875054123193
Epoch:          56 | Training loss: 0.4718681295381277 | Validation loss: 0.
548613084374457
Epoch:          57 | Training loss: 0.46991966274925095 | Validation loss: 0
.5474829695359023
Epoch:          58 | Training loss: 0.4680049722151188 | Validation loss: 0.
5464390469432487
Epoch:          59 | Training loss: 0.4661056300765147 | Validation loss: 0.
5450870805694685
Epoch:          60 | Training loss: 0.4642353057270652 | Validation loss: 0.
5439437184317902
Epoch:          61 | Training loss: 0.46238963126834726 | Validation loss: 0
.5427980778893151
Epoch:          62 | Training loss: 0.4605677091500393 | Validation loss: 0.
5417392248113186
Epoch:          63 | Training loss: 0.45876931457710496 | Validation loss: 0
.5405703181534346
Epoch:          64 | Training loss: 0.4569957814670056 | Validation loss: 0.
5394118632507483
Epoch:          65 | Training loss: 0.45525567083657764 | Validation loss: 0
.5382181738733991
Epoch:          66 | Training loss: 0.45350693965796374 | Validation loss: 0
.537449221244526
Epoch:          67 | Training loss: 0.4517972310911083 | Validation loss: 0.
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5363856244619263
Epoch:             68 | Training loss: 0.45010537742194817 | Validation loss: 0
.5352418058418439
Epoch:             69 | Training loss: 0.44843390998528515 | Validation loss: 0
.5342143588566688
Epoch:             70 | Training loss: 0.4467864345514428 | Validation loss: 0.
5333387689769278
Epoch:             71 | Training loss: 0.4451541229710335 | Validation loss: 0.
53208973855215
Epoch:             72 | Training loss: 0.44353724671552713 | Validation loss: 0
.5311363596198899
Epoch:             73 | Training loss: 0.4419436689976153 | Validation loss: 0.
53035115293074777
Epoch:             74 | Training loss: 0.44036265764022897 | Validation loss: 0
.5292788789961118
Epoch:             75 | Training loss: 0.43880524132660653 | Validation loss: 0
.5283948624752359
Epoch:             76 | Training loss: 0.4372603678646285 | Validation loss: 0.
5274045270345552
Epoch:             77 | Training loss: 0.4357380559904594 | Validation loss: 0.
5265435372786134
Epoch:             78 | Training loss: 0.4342271454320785 | Validation loss: 0.
5255983716061824
Epoch:             79 | Training loss: 0.4327375884245382 | Validation loss: 0.
5247380006049372
Epoch:             80 | Training loss: 0.43125832339600356 | Validation loss: 0
.5238182689310932
Epoch:             81 | Training loss: 0.4297900551815661 | Validation loss: 0.
5228247023817667
Epoch:             82 | Training loss: 0.4283518810233583 | Validation loss: 0.
5220613935123488
Epoch:             83 | Training loss: 0.4269265876611975 | Validation loss: 0.
5212362568522544
Epoch:             84 | Training loss: 0.42550311120505496 | Validation loss: 0
.5199889692115025
Epoch:             85 | Training loss: 0.42410125587166264 | Validation loss: 0
.5191150987011416
Epoch:             86 | Training loss: 0.42270846707060045 | Validation loss: 0
.5185971321153982
Epoch:             87 | Training loss: 0.42132776064686667 | Validation loss: 0
.5177003748719688
Epoch:             88 | Training loss: 0.41996120999150743 | Validation loss: 0
.516747525008293
Epoch:             89 | Training loss: 0.4186275736309935 | Validation loss: 0.
5157430577343197
Epoch:             90 | Training loss: 0.4172757794162526 | Validation loss: 0.
5151131850544521
Epoch:             91 | Training loss: 0.4159762832232861 | Validation loss: 0.
5140810545242347
Epoch:             92 | Training loss: 0.41464340331998195 | Validation loss: 0
.5134520424238438
Epoch:             93 | Training loss: 0.4133468123738284 | Validation loss: 0.
5128286890702466
Epoch:             94 | Training loss: 0.4120585401784717 | Validation loss: 0.
5118623067546063
Epoch:             95 | Training loss: 0.4107899160380053 | Validation loss: 0.
5110190277209037
Epoch:             96 | Training loss: 0.4095229318181874 | Validation loss: 0.
5105047904426872
Epoch:             97 | Training loss: 0.40826756001931724 | Validation loss: 0
.5095879179310288
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Epoch:          98 | Training loss: 0.4070266603437674 | Validation loss: 0.
5088495815583657
Epoch:          99 | Training loss: 0.40580129879378796 | Validation loss: 0
.5082373370727296
Epoch:          100 | Training loss: 0.4045811907223099 | Validation loss: 0.
5073068644241903
Epoch:          101 | Training loss: 0.4033708860588333 | Validation loss: 0.
5066510957252813
Epoch:          102 | Training loss: 0.4021737142323049 | Validation loss: 0.
5058962069390738
Epoch:          103 | Training loss: 0.4009868699255227 | Validation loss: 0.
5052480378871065
Epoch:          104 | Training loss: 0.3998105320332447 | Validation loss: 0.
5044421897435346
Epoch:          105 | Training loss: 0.39864337152841883 | Validation loss: 0
.5038227036901928
Epoch:          106 | Training loss: 0.39749217950254906 | Validation loss: 0
.5032219159790792
Epoch:          107 | Training loss: 0.39633839108272556 | Validation loss: 0
.502394469121143
Epoch:          108 | Training loss: 0.3952003948948108 | Validation loss: 0.
5017042072427088
Epoch:          109 | Training loss: 0.39408021017633094 | Validation loss: 0
.50088691692697
Epoch:          110 | Training loss: 0.3929551844944264 | Validation loss: 0.
5002717780832359
Epoch:          111 | Training loss: 0.3918424925389611 | Validation loss: 0.
4996949738951304
Epoch:          112 | Training loss: 0.39074235881939934 | Validation loss: 0
.4989667625670596
Epoch:          113 | Training loss: 0.3896507254594083 | Validation loss: 0.
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Epoch:          114 | Training loss: 0.38856577839811474 | Validation loss: 0
.4977236576057825
Epoch:          115 | Training loss: 0.3874912587487948 | Validation loss: 0.
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Epoch:          116 | Training loss: 0.3864245058441865 | Validation loss: 0.
49639514844708915
Epoch:          117 | Training loss: 0.38536621832108536 | Validation loss: 0
.49579208574398304
Epoch:          118 | Training loss: 0.3843175961350903 | Validation loss: 0.
49509806489595914
Epoch:          119 | Training loss: 0.3832761101869947 | Validation loss: 0.
4945980545743065
Epoch:          120 | Training loss: 0.3822431351101441 | Validation loss: 0.
49399528013576244
Epoch:          121 | Training loss: 0.3812198618511562 | Validation loss: 0.
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Epoch:          122 | Training loss: 0.38019700909799203 | Validation loss: 0
.49265280746861395
Epoch:          123 | Training loss: 0.37918637405184313 | Validation loss: 0
.4921199129806377
Epoch:          124 | Training loss: 0.3781830213035372 | Validation loss: 0.
4914571494940989
Epoch:          125 | Training loss: 0.37718782077397384 | Validation loss: 0
.4909382254841343
Epoch:          126 | Training loss: 0.3762010919228765 | Validation loss: 0.
49038305322243275
Epoch:          127 | Training loss: 0.37521745495581926 | Validation loss: 0
.48971506875948606
Epoch:          128 | Training loss: 0.37424387402819387 | Validation loss: 0
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                .48910710029759175
Epoch:          129 | Training loss: 0.3732769285856317 | Validation loss: 0.
4885392655074986
Epoch:          130 | Training loss: 0.3723166583632724 | Validation loss: 0.
4879730632345186
Epoch:          131 | Training loss: 0.3713641008337482 | Validation loss: 0.
487378681738184
Epoch:          132 | Training loss: 0.3704165479403739 | Validation loss: 0.
48685780270798495
Epoch:          133 | Training loss: 0.3694787611742333 | Validation loss: 0.
48624909090034096
Epoch:          134 | Training loss: 0.36854427604964013 | Validation loss: 0
.48571717053841934
Epoch:          135 | Training loss: 0.367617447551719 | Validation loss: 0.4
851747551705035
Epoch:          136 | Training loss: 0.3666988185612402 | Validation loss: 0.
4845954720943099
Epoch:          137 | Training loss: 0.3657823020599932 | Validation loss: 0.
4841340518317611
Epoch:          138 | Training loss: 0.36487720696773046 | Validation loss: 0
.48351948615726514
Epoch:          139 | Training loss: 0.3639770230485703 | Validation loss: 0.
48316868363794596
Epoch:          140 | Training loss: 0.3630771836196717 | Validation loss: 0.
48255331134807916
Epoch:          141 | Training loss: 0.3621879412017794 | Validation loss: 0.
4819849300908874
Epoch:          142 | Training loss: 0.3613131043358653 | Validation loss: 0.
48135875654667154
Epoch:          143 | Training loss: 0.36043164837788605 | Validation loss: 0
.4808750458407627
Epoch:          144 | Training loss: 0.3595603669371584 | Validation loss: 0.
4803566282554021
Epoch:          145 | Training loss: 0.35868919508036623 | Validation loss: 0
.4799138336732156
Epoch:          146 | Training loss: 0.35782773389332767 | Validation loss: 0
.47948397072265253
Epoch:          147 | Training loss: 0.35697236820113565 | Validation loss: 0
.4789521401224263
Epoch:          148 | Training loss: 0.3561232624581765 | Validation loss: 0.
47848903725237946
Epoch:          149 | Training loss: 0.3552789495491082 | Validation loss: 0.
4779530252895735
Epoch:          150 | Training loss: 0.3544446139721459 | Validation loss: 0.
47757635267120546
Epoch:          151 | Training loss: 0.35362023402704046 | Validation loss: 0
.47717529632732564
Epoch:          152 | Training loss: 0.3527792258499768 | Validation loss: 0.
4765087429996908
Epoch:          153 | Training loss: 0.3519567366894854 | Validation loss: 0.
47605160488496323
Epoch:          154 | Training loss: 0.35113978870596857 | Validation loss: 0
.4756038160862036
Epoch:          155 | Training loss: 0.35032605388671406 | Validation loss: 0
.47508210274007345
Epoch:          156 | Training loss: 0.34951843544699124 | Validation loss: 0
.4746071712777294
Epoch:          157 | Training loss: 0.34871603472216606 | Validation loss: 0
.47413578067771944
Epoch:          158 | Training loss: 0.34791942036625095 | Validation loss: 0
.47364102772769856
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Epoch:          159 | Training loss: 0.3471295332823663 | Validation loss: 0.
4731380770914423
Epoch:          160 | Training loss: 0.3463381998065525 | Validation loss: 0.
47273382440140005
Epoch:          161 | Training loss: 0.345554218566849 | Validation loss: 0.4
7231736813332575
Epoch:          162 | Training loss: 0.34478024841307064 | Validation loss: 0
.4719752848419785
Epoch:          163 | Training loss: 0.3440021560793176 | Validation loss: 0.
47144730377500155
Epoch:          164 | Training loss: 0.34323692981262605 | Validation loss: 0
.4708934783438385
Epoch:          165 | Training loss: 0.342468076305001 | Validation loss: 0.4
7052241099472575
Epoch:          166 | Training loss: 0.341707655134254 | Validation loss: 0.4
701120375278542
Epoch:          167 | Training loss: 0.3409592786909664 | Validation loss: 0.
4695549272699273
Epoch:          168 | Training loss: 0.3402119277923956 | Validation loss: 0.
469097496921235
Epoch:          169 | Training loss: 0.3394532304418111 | Validation loss: 0.
4688064676161413
Epoch:          170 | Training loss: 0.3387193153988854 | Validation loss: 0.
46826182222140617
Epoch:          171 | Training loss: 0.337972573017819 | Validation loss: 0.4
6793741316463544
Epoch:          172 | Training loss: 0.3372380530027844 | Validation loss: 0.
4675228925721659
Epoch:          173 | Training loss: 0.3365088972153167 | Validation loss: 0.
46718129154621324
Epoch:          174 | Training loss: 0.3357879888220526 | Validation loss: 0.
46683534931068876
Epoch:          175 | Training loss: 0.33506411731170416 | Validation loss: 0
.4664010990597667
Epoch:          176 | Training loss: 0.33434973525181466 | Validation loss: 0
.46602830178329085
Epoch:          177 | Training loss: 0.33362816376952426 | Validation loss: 0
.465508050069186
Epoch:          178 | Training loss: 0.3329206905966826 | Validation loss: 0.
4651603280407606
Epoch:          179 | Training loss: 0.33221217814564225 | Validation loss: 0
.4646831356370877
Epoch:          180 | Training loss: 0.33151099935248435 | Validation loss: 0
.4643300041296846
Epoch:          181 | Training loss: 0.33081210232163055 | Validation loss: 0
.4638747885329552
Epoch:          182 | Training loss: 0.33011805846000997 | Validation loss: 0
.4635279741292131
Epoch:          183 | Training loss: 0.3294272036932456 | Validation loss: 0.
46309147136694834
Epoch:          184 | Training loss: 0.32874422459478614 | Validation loss: 0
.4628154395085077
Epoch:          185 | Training loss: 0.32805709022503043 | Validation loss: 0
.4623556638684647
Epoch:          186 | Training loss: 0.32737747565202324 | Validation loss: 0
.461940278786045
Epoch:          187 | Training loss: 0.32670557530677463 | Validation loss: 0
.4614888647627559
Epoch:          188 | Training loss: 0.3260353060054206 | Validation loss: 0.
4610928508119131
Epoch:          189 | Training loss: 0.3253700076164875 | Validation loss: 0.
```

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46069379519061937
Epoch:           190 | Training loss: 0.32469939811023496 | Validation loss: 0
.4603619337468763
Epoch:           191 | Training loss: 0.3240404177149908 | Validation loss: 0.
46019173218447484
Epoch:           192 | Training loss: 0.323375462716851 | Validation loss: 0.4
5971808113545903
Epoch:           193 | Training loss: 0.32272050285827336 | Validation loss: 0
.4593517241599492
Epoch:           194 | Training loss: 0.32206953512295705 | Validation loss: 0
.45893612843053744
Epoch:           195 | Training loss: 0.32142179912782315 | Validation loss: 0
.45856682603386134
Epoch:           196 | Training loss: 0.3207761135070402 | Validation loss: 0.
4582643333647355
Epoch:           197 | Training loss: 0.32013539395873586 | Validation loss: 0
.45793776255217006
Epoch:           198 | Training loss: 0.3194963562881158 | Validation loss: 0.
45752488975725647
Epoch:           199 | Training loss: 0.31886139082229314 | Validation loss: 0
.4571746746889178
Epoch:           200 | Training loss: 0.31823343920021396 | Validation loss: 0
.45675616731951757
Epoch:           201 | Training loss: 0.3176026336108145 | Validation loss: 0.
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Epoch:           202 | Training loss: 0.31697586594662347 | Validation loss: 0
.4561232978672811
Epoch:           203 | Training loss: 0.31635354048571507 | Validation loss: 0
.45577870249066565
Epoch:           204 | Training loss: 0.31574323525768355 | Validation loss: 0
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Epoch:           205 | Training loss: 0.31512046253664283 | Validation loss: 0
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Epoch:           206 | Training loss: 0.314507032207403 | Validation loss: 0.4
5471252109198884
Epoch:           207 | Training loss: 0.3138960911284605 | Validation loss: 0.
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Epoch:           208 | Training loss: 0.31328873673344787 | Validation loss: 0
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Epoch:           209 | Training loss: 0.31268678845709247 | Validation loss: 0
.4536968093436164
Epoch:           210 | Training loss: 0.3120930840308591 | Validation loss: 0.
4533111586850921
Epoch:           211 | Training loss: 0.31148689020278425 | Validation loss: 0
.45304208893432785
Epoch:           212 | Training loss: 0.310889034907078 | Validation loss: 0.4
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Epoch:           213 | Training loss: 0.31029713533413217 | Validation loss: 0
.45241670563134484
Epoch:           214 | Training loss: 0.30970746344897643 | Validation loss: 0
.4521761444555202
Epoch:           215 | Training loss: 0.30912236127767795 | Validation loss: 0
.4518853734867697
Epoch:           216 | Training loss: 0.3085359673552447 | Validation loss: 0.
45146156719937863
Epoch:           217 | Training loss: 0.30796291909199697 | Validation loss: 0
.4510619013801721
Epoch:           218 | Training loss: 0.3073777333634862 | Validation loss: 0.
45079927754932464
Epoch:           219 | Training loss: 0.30680210556578225 | Validation loss: 0
.45048288247201784
```

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Epoch:        220 | Training loss: 0.30623420470349505 | Validation loss: 0
.4501263782347033
Epoch:        221 | Training loss: 0.30565780120263486 | Validation loss: 0
.44986489950137226
Epoch:        222 | Training loss: 0.30508776590640835 | Validation loss: 0
.44961406174787727
Epoch:        223 | Training loss: 0.30452496279694996 | Validation loss: 0
.44924677611805897
Epoch:        224 | Training loss: 0.303960054421738 | Validation loss: 0.4
489867042579285
Epoch:        225 | Training loss: 0.3034016628748526 | Validation loss: 0.
44875736636490006
Epoch:        226 | Training loss: 0.3028440420485588 | Validation loss: 0.
44845398432703737
Epoch:        227 | Training loss: 0.30228733474043223 | Validation loss: 0
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Epoch:        228 | Training loss: 0.30173903734859786 | Validation loss: 0
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Epoch:        229 | Training loss: 0.3011862962017453 | Validation loss: 0.
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Epoch:        230 | Training loss: 0.3006397332590611 | Validation loss: 0.
4472700133123325
Epoch:        231 | Training loss: 0.3000950948197428 | Validation loss: 0.
44685733996666455
Epoch:        232 | Training loss: 0.299557102061021 | Validation loss: 0.4
652678348187946
Epoch:        233 | Training loss: 0.29901425873087273 | Validation loss: 0
.44625592099647915
Epoch:        234 | Training loss: 0.2984747267924936 | Validation loss: 0.
4459855184504905
Epoch:        235 | Training loss: 0.2979410208992743 | Validation loss: 0.
4456818025643885
Epoch:        236 | Training loss: 0.29740391584600634 | Validation loss: 0
.44547272974400676
Epoch:        237 | Training loss: 0.2968746417776504 | Validation loss: 0.
4451444432164614
Epoch:        238 | Training loss: 0.2963451747906574 | Validation loss: 0.
44492971595338177
Epoch:        239 | Training loss: 0.29581890030085234 | Validation loss: 0
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Epoch:        240 | Training loss: 0.2952951851198195 | Validation loss: 0.
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Epoch:        241 | Training loss: 0.29477429013412126 | Validation loss: 0
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Epoch:        242 | Training loss: 0.29425580756804526 | Validation loss: 0
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Epoch:        243 | Training loss: 0.29374150183319564 | Validation loss: 0
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Epoch:        244 | Training loss: 0.2932233287798214 | Validation loss: 0.
4432254818580042
Epoch:        245 | Training loss: 0.2927128436002478 | Validation loss: 0.
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Epoch:        246 | Training loss: 0.29220030793922774 | Validation loss: 0
.44269688855023914
Epoch:        247 | Training loss: 0.2916927365680737 | Validation loss: 0.
4424667519540168
Epoch:        248 | Training loss: 0.2911873017848136 | Validation loss: 0.
44221132067406527
Epoch:        249 | Training loss: 0.29068448473297326 | Validation loss: 0
.4419617055601474
Epoch:        250 | Training loss: 0.29018592028510526 | Validation loss: 0
```

```
.44173287718063264
Epoch:          251 | Training loss: 0.28968231972626435 | Validation loss: 0
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Epoch:          252 | Training loss: 0.289185744633953 | Validation loss: 0.4
411751772137923
Epoch:          253 | Training loss: 0.28869266507690483 | Validation loss: 0
.4409417372659828
Epoch:          254 | Training loss: 0.2881966360464299 | Validation loss: 0.
4406517100173884
Epoch:          255 | Training loss: 0.28770306525312644 | Validation loss: 0
.44033999372111454
Epoch:          256 | Training loss: 0.2872170773859687 | Validation loss: 0.
440149382267932
Epoch:          257 | Training loss: 0.28672681362811775 | Validation loss: 0
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Epoch:          258 | Training loss: 0.28624117295593204 | Validation loss: 0
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Epoch:          259 | Training loss: 0.2857583528304201 | Validation loss: 0.
4393409563747055
Epoch:          260 | Training loss: 0.2852784419417516 | Validation loss: 0.
43911650572563377
Epoch:          261 | Training loss: 0.2847996582006983 | Validation loss: 0.
4388753185982695
Epoch:          262 | Training loss: 0.2843209907791069 | Validation loss: 0.
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Epoch:          263 | Training loss: 0.28384475905915485 | Validation loss: 0
.4383444806919913
Epoch:          264 | Training loss: 0.2833766150637667 | Validation loss: 0.
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Epoch:          265 | Training loss: 0.28290557747517137 | Validation loss: 0
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Epoch:          266 | Training loss: 0.28242913868999325 | Validation loss: 0
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Epoch:          267 | Training loss: 0.28196117177409274 | Validation loss: 0
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Epoch:          268 | Training loss: 0.28149609523660174 | Validation loss: 0
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Epoch:          269 | Training loss: 0.2810311151075112 | Validation loss: 0.
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Epoch:          270 | Training loss: 0.28056912719671784 | Validation loss: 0
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Epoch:          271 | Training loss: 0.28011015575631687 | Validation loss: 0
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Epoch:          272 | Training loss: 0.27964962055397224 | Validation loss: 0
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Epoch:          273 | Training loss: 0.2791927882589598 | Validation loss: 0.
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Epoch:          274 | Training loss: 0.27873755087120894 | Validation loss: 0
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Epoch:          275 | Training loss: 0.27828454033736877 | Validation loss: 0
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Epoch:          276 | Training loss: 0.27783341316269955 | Validation loss: 0
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Epoch:          277 | Training loss: 0.2773835561583845 | Validation loss: 0.
4349407220671337
Epoch:          278 | Training loss: 0.2769346053615126 | Validation loss: 0.
43473758879036245
Epoch:          279 | Training loss: 0.2764882579823728 | Validation loss: 0.
434525474678895
Epoch:          280 | Training loss: 0.2760447717837533 | Validation loss: 0.
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```

```
Epoch:        281 | Training loss: 0.27560091441758056 | Validation loss: 0
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Epoch:        282 | Training loss: 0.27515956117681817 | Validation loss: 0
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Epoch:        283 | Training loss: 0.27472013718102506 | Validation loss: 0
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Epoch:        284 | Training loss: 0.27428571088847253 | Validation loss: 0
.43332310586854517
Epoch:        285 | Training loss: 0.27384758580060165 | Validation loss: 0
.43311902519112144
Epoch:        286 | Training loss: 0.2734133657476954 | Validation loss: 0.
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Epoch:        287 | Training loss: 0.2729783734089405 | Validation loss: 0.
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Epoch:        288 | Training loss: 0.27254678730167703 | Validation loss: 0
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Epoch:        289 | Training loss: 0.27211717837124283 | Validation loss: 0
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Epoch:        290 | Training loss: 0.27168931714155814 | Validation loss: 0
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Epoch:        291 | Training loss: 0.27126310081081745 | Validation loss: 0
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Epoch:        292 | Training loss: 0.2708376148901278 | Validation loss: 0.
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Epoch:        293 | Training loss: 0.270414820995472 | Validation loss: 0.4
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Epoch:        294 | Training loss: 0.26999301535104 | Validation loss: 0.43
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Epoch:        295 | Training loss: 0.26957243729672276 | Validation loss: 0
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Epoch:        296 | Training loss: 0.26915434766055624 | Validation loss: 0
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Epoch:        297 | Training loss: 0.2687364786213496 | Validation loss: 0.
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Epoch:        298 | Training loss: 0.26832086439550756 | Validation loss: 0
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Epoch:        299 | Training loss: 0.2679070238155448 | Validation loss: 0.
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Epoch:        300 | Training loss: 0.2674945662571926 | Validation loss: 0.
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Epoch:        301 | Training loss: 0.2670830823098649 | Validation loss: 0.
4297583656108707
Epoch:        302 | Training loss: 0.26667360370222315 | Validation loss: 0
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Epoch:        303 | Training loss: 0.2662657075020615 | Validation loss: 0.
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Epoch:        304 | Training loss: 0.2658592861308371 | Validation loss: 0.
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Epoch:        305 | Training loss: 0.26545521935813887 | Validation loss: 0
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Epoch:        306 | Training loss: 0.265049791409723 | Validation loss: 0.4
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Epoch:        307 | Training loss: 0.2646483464458197 | Validation loss: 0.
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Epoch:        308 | Training loss: 0.26424660678663897 | Validation loss: 0
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Epoch:        309 | Training loss: 0.26384720165744213 | Validation loss: 0
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Epoch:        310 | Training loss: 0.26344909205352957 | Validation loss: 0
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Epoch:        311 | Training loss: 0.26305248777656515 | Validation loss: 0
```

```
.4277382895928163
Epoch:        312 | Training loss: 0.26265775242531290 | Validation loss: 0.
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Epoch:        313 | Training loss: 0.2622647304426624 | Validation loss: 0.
4273075420841991
Epoch:        314 | Training loss: 0.26187214857366264 | Validation loss: 0
.42718944341781473
Epoch:        315 | Training loss: 0.2614799744369903 | Validation loss: 0.
42695951708391744
Epoch:        316 | Training loss: 0.26109052360573054 | Validation loss: 0
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Epoch:        317 | Training loss: 0.26070332718759526 | Validation loss: 0
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Epoch:        318 | Training loss: 0.26031543096135734 | Validation loss: 0
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Epoch:        319 | Training loss: 0.2599300288797742 | Validation loss: 0.
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Epoch:        320 | Training loss: 0.2595465119998346 | Validation loss: 0.
4259622187480059
Epoch:        321 | Training loss: 0.259162021978057 | Validation loss: 0.4
2580102393707375
Epoch:        322 | Training loss: 0.25878102674300774 | Validation loss: 0
.42559489621988933
Epoch:        323 | Training loss: 0.2583998525658513 | Validation loss: 0.
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Epoch:        324 | Training loss: 0.25802064116605533 | Validation loss: 0
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Epoch:        325 | Training loss: 0.2576436257548547 | Validation loss: 0.
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Epoch:        326 | Training loss: 0.2572664441475887 | Validation loss: 0.
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Epoch:        327 | Training loss: 0.25689109994580045 | Validation loss: 0
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Epoch:        328 | Training loss: 0.25651735954087707 | Validation loss: 0
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Epoch:        329 | Training loss: 0.25614445518707385 | Validation loss: 0
.424337779222284
Epoch:        330 | Training loss: 0.25577301071238473 | Validation loss: 0
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Epoch:        331 | Training loss: 0.2554041897640804 | Validation loss: 0.
4239382583282817
Epoch:        332 | Training loss: 0.2550346811380546 | Validation loss: 0.
4237672132367234
Epoch:        333 | Training loss: 0.2546666015111085 | Validation loss: 0.
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Epoch:        334 | Training loss: 0.2543006958938394 | Validation loss: 0.
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Epoch:        335 | Training loss: 0.25393825019071115 | Validation loss: 0
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Epoch:        336 | Training loss: 0.2535780459417035 | Validation loss: 0.
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Epoch:        337 | Training loss: 0.25320951104676404 | Validation loss: 0
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Epoch:        338 | Training loss: 0.25284885840949534 | Validation loss: 0
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Epoch:        339 | Training loss: 0.252488500680643 | Validation loss: 0.
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Epoch:        340 | Training loss: 0.25213102981133173 | Validation loss: 0
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Epoch:        341 | Training loss: 0.25176883295065305 | Validation loss: 0
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```

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Epoch:        342 | Training loss: 0.25141355378719593 | Validation loss: 0
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Epoch:        343 | Training loss: 0.2510555795509604 | Validation loss: 0.
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Epoch:        344 | Training loss: 0.25070074775306656 | Validation loss: 0
.42169790361153386
Epoch:        345 | Training loss: 0.25034725115205153 | Validation loss: 0
.4215330183867472
Epoch:        346 | Training loss: 0.24999558358674123 | Validation loss: 0
.4213341384153104
Epoch:        347 | Training loss: 0.24964366585315567 | Validation loss: 0
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Epoch:        348 | Training loss: 0.24929600146133687 | Validation loss: 0
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Epoch:        349 | Training loss: 0.24894596519415768 | Validation loss: 0
.42082361100200444
Epoch:        350 | Training loss: 0.24859717938803474 | Validation loss: 0
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Epoch:        351 | Training loss: 0.24825076200241564 | Validation loss: 0
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Epoch:        352 | Training loss: 0.24790490817913785 | Validation loss: 0
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Epoch:        353 | Training loss: 0.24756100803650918 | Validation loss: 0
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Epoch:        354 | Training loss: 0.24721777297460318 | Validation loss: 0
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Epoch:        355 | Training loss: 0.24687476233718744 | Validation loss: 0
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Epoch:        356 | Training loss: 0.24653380570704053 | Validation loss: 0
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Epoch:        357 | Training loss: 0.24619357739540773 | Validation loss: 0
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Epoch:        358 | Training loss: 0.2458558698624229 | Validation loss: 0.
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Epoch:        359 | Training loss: 0.2455165804589985 | Validation loss: 0.
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Epoch:        360 | Training loss: 0.24517955844786798 | Validation loss: 0
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Epoch:        361 | Training loss: 0.24484481539464428 | Validation loss: 0
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Epoch:        362 | Training loss: 0.2445101590099968 | Validation loss: 0.
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Epoch:        363 | Training loss: 0.24417653031448425 | Validation loss: 0
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Epoch:        364 | Training loss: 0.24384283170198784 | Validation loss: 0
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Epoch:        365 | Training loss: 0.24351089762153735 | Validation loss: 0
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Epoch:        366 | Training loss: 0.24318093854283263 | Validation loss: 0
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Epoch:        367 | Training loss: 0.2428508526968094 | Validation loss: 0.
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Epoch:        368 | Training loss: 0.24252224267584455 | Validation loss: 0
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Epoch:        369 | Training loss: 0.24219550823199615 | Validation loss: 0
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Epoch:        370 | Training loss: 0.24186824928921882 | Validation loss: 0
.4174824918015028
Epoch:        371 | Training loss: 0.2415423675858444 | Validation loss: 0.
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Epoch:        372 | Training loss: 0.24121802451596416 | Validation loss: 0
```

```
.417178320048798
Epoch:          373 | Training loss: 0.2408950554438425 | Validation loss: 0.
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Epoch:          374 | Training loss: 0.24057155724182913 | Validation loss: 0
.4168924434223904
Epoch:          375 | Training loss: 0.24024995653786183 | Validation loss: 0
.416735255539405
Epoch:          376 | Training loss: 0.23992966281820097 | Validation loss: 0
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Epoch:          377 | Training loss: 0.23960980406826862 | Validation loss: 0
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Epoch:          378 | Training loss: 0.23929089959867947 | Validation loss: 0
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Epoch:          379 | Training loss: 0.23897318884460142 | Validation loss: 0
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Epoch:          380 | Training loss: 0.23865629671746028 | Validation loss: 0
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Epoch:          381 | Training loss: 0.2383408229563539 | Validation loss: 0.
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Epoch:          382 | Training loss: 0.23802557770797994 | Validation loss: 0
.41571127196663454
Epoch:          383 | Training loss: 0.23771200687868363 | Validation loss: 0
.4155789658399173
Epoch:          384 | Training loss: 0.23739913648081135 | Validation loss: 0
.4154376899314753
Epoch:          385 | Training loss: 0.2370871056514189 | Validation loss: 0.
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Epoch:          386 | Training loss: 0.23677565925504268 | Validation loss: 0
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Epoch:          387 | Training loss: 0.23646556333241955 | Validation loss: 0
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Epoch:          388 | Training loss: 0.23615587452076295 | Validation loss: 0
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Epoch:          389 | Training loss: 0.23584749244114472 | Validation loss: 0
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Epoch:          390 | Training loss: 0.2355399787006666 | Validation loss: 0.
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Epoch:          391 | Training loss: 0.23523360634533666 | Validation loss: 0
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Epoch:          392 | Training loss: 0.23492765449119876 | Validation loss: 0
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Epoch:          393 | Training loss: 0.23462344698241655 | Validation loss: 0
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Epoch:          394 | Training loss: 0.23431890846330272 | Validation loss: 0
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Epoch:          395 | Training loss: 0.23401591894025922 | Validation loss: 0
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Epoch:          396 | Training loss: 0.2337143151992898 | Validation loss: 0.
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Epoch:          397 | Training loss: 0.2334125424684175 | Validation loss: 0.
41356758861573967
Epoch:          398 | Training loss: 0.23311232233817641 | Validation loss: 0
.41342268734349574
Epoch:          399 | Training loss: 0.23281265732113487 | Validation loss: 0
.41329350790053354

Hyper Parameters -- Learning Rate - 1e-05  Regularization Parameter- 6.3095
73444801929e-05
Epoch:            0 | Training loss: 0.683766487276615 | Validation loss: 0.6
860666336073428
Epoch:            1 | Training loss: 0.6751538207581191 | Validation loss: 0.
```

```
6800243185766118
Epoch:          2 | Training loss: 0.6670411424945237 | Validation loss: 0.
6741666518771904
Epoch:          3 | Training loss: 0.6593694833634935 | Validation loss: 0.
6688285405766563
Epoch:          4 | Training loss: 0.6520791025307019 | Validation loss: 0.
6642046236667289
Epoch:          5 | Training loss: 0.6451420996157484 | Validation loss: 0.
6592678446090006
Epoch:          6 | Training loss: 0.6385581823223845 | Validation loss: 0.
6546810145036194
Epoch:          7 | Training loss: 0.6322600013954514 | Validation loss: 0.
6507762889646227
Epoch:          8 | Training loss: 0.6262318524944485 | Validation loss: 0.
6466752756201382
Epoch:          9 | Training loss: 0.6204613896303036 | Validation loss: 0.
642726836735276
Epoch:         10 | Training loss: 0.6149887939672374 | Validation loss: 0.
6394744868550964
Epoch:         11 | Training loss: 0.6096270657616897 | Validation loss: 0.
6356591852360245
Epoch:         12 | Training loss: 0.604505146190321 | Validation loss: 0.6
322581269185358
Epoch:         13 | Training loss: 0.5996153873463161 | Validation loss: 0.
6293502039891434
Epoch:         14 | Training loss: 0.594817349617264 | Validation loss: 0.6
258797890881295
Epoch:         15 | Training loss: 0.5902186547646341 | Validation loss: 0.
6229736132632169
Epoch:         16 | Training loss: 0.585842327732821 | Validation loss: 0.6
205740486111879
Epoch:         17 | Training loss: 0.5814710741207962 | Validation loss: 0.
6175445122804369
Epoch:         18 | Training loss: 0.577267660606095 | Validation loss: 0.6
146929656831408
Epoch:         19 | Training loss: 0.5732049770775982 | Validation loss: 0.
612077447651208
Epoch:         20 | Training loss: 0.5692552211239409 | Validation loss: 0.
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Epoch:         21 | Training loss: 0.565420989810684 | Validation loss: 0.6
071642908468466
Epoch:         22 | Training loss: 0.5616823365215956 | Validation loss: 0.
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Epoch:         23 | Training loss: 0.5580480049007985 | Validation loss: 0.
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Epoch:         24 | Training loss: 0.554554500907306 | Validation loss: 0.6
006061988554668
Epoch:         25 | Training loss: 0.5510394070134356 | Validation loss: 0.
5979446668311033
Epoch:         26 | Training loss: 0.5476893191498592 | Validation loss: 0.
5961316746591359
Epoch:         27 | Training loss: 0.5443954316069932 | Validation loss: 0.
5940845127295902
Epoch:         28 | Training loss: 0.5411433454315574 | Validation loss: 0.
591808078750722
Epoch:         29 | Training loss: 0.5380257065162565 | Validation loss: 0.
5901385676437
Epoch:         30 | Training loss: 0.5349070223649588 | Validation loss: 0.
5879099048041803
Epoch:         31 | Training loss: 0.531890605094699 | Validation loss: 0.5
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```

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Epoch:          32 | Training loss: 0.5289758141646979 | Validation loss: 0.
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Epoch:          33 | Training loss: 0.526043613731993 | Validation loss: 0.5
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Epoch:          34 | Training loss: 0.523205414831234 | Validation loss: 0.5
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Epoch:          35 | Training loss: 0.5204244262528218 | Validation loss: 0.
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Epoch:          36 | Training loss: 0.5176965086646423 | Validation loss: 0.
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Epoch:          37 | Training loss: 0.515038383808011 | Validation loss: 0.5
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Epoch:          38 | Training loss: 0.5123987320585345 | Validation loss: 0.
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Epoch:          39 | Training loss: 0.5098172564693354 | Validation loss: 0.
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Epoch:          40 | Training loss: 0.5072950658295349 | Validation loss: 0.
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Epoch:          41 | Training loss: 0.5048117174021199 | Validation loss: 0.
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Epoch:          42 | Training loss: 0.5023583843057696 | Validation loss: 0.
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Epoch:          43 | Training loss: 0.49995550726909155 | Validation loss: 0
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Epoch:          44 | Training loss: 0.4975740543671385 | Validation loss: 0.
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Epoch:          45 | Training loss: 0.4952468486216045 | Validation loss: 0.
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Epoch:          46 | Training loss: 0.4929561132886821 | Validation loss: 0.
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Epoch:          47 | Training loss: 0.4907119760303316 | Validation loss: 0.
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Epoch:          48 | Training loss: 0.488484125236984 | Validation loss: 0.5
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Epoch:          49 | Training loss: 0.4863231045396863 | Validation loss: 0.
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Epoch:          51 | Training loss: 0.4820343271691185 | Validation loss: 0.
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Epoch:          52 | Training loss: 0.47996093699904235 | Validation loss: 0
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Epoch:          53 | Training loss: 0.4778795178434 | Validation loss: 0.552
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Epoch:          54 | Training loss: 0.47586659851662994 | Validation loss: 0
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Epoch:          56 | Training loss: 0.4718767698158061 | Validation loss: 0.
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Epoch:          57 | Training loss: 0.46992852087886866 | Validation loss: 0
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Epoch:          59 | Training loss: 0.4661149274695632 | Validation loss: 0.
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Epoch:          60 | Training loss: 0.4642448243954127 | Validation loss: 0.
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Epoch:          61 | Training loss: 0.46239937229018907 | Validation loss: 0
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Epoch:          62 | Training loss: 0.46057767366576197 | Validation loss: 0
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                    .5417491885883333
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Epoch:              64 | Training loss: 0.45700619603929665 | Validation loss: 0
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Epoch:              65 | Training loss: 0.4552663117427688 | Validation loss: 0.
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Epoch:              66 | Training loss: 0.4535178078152845 | Validation loss: 0.
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Epoch:              67 | Training loss: 0.4518083276851507 | Validation loss: 0.
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Epoch:              68 | Training loss: 0.4501167031498226 | Validation loss: 0.
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Epoch:              69 | Training loss: 0.44844546603780305 | Validation loss: 0
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Epoch:              70 | Training loss: 0.446798221764768 | Validation loss: 0.5
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Epoch:              71 | Training loss: 0.44516614247367614 | Validation loss: 0
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Epoch:              72 | Training loss: 0.4435494990911373 | Validation loss: 0.
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Epoch:              73 | Training loss: 0.4419561551334399 | Validation loss: 0.
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Epoch:              74 | Training loss: 0.440375378211713 | Validation loss: 0.5
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Epoch:              75 | Training loss: 0.43881819719291415 | Validation loss: 0
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Epoch:              76 | Training loss: 0.43727355993900596 | Validation loss: 0
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Epoch:              77 | Training loss: 0.4357514850708755 | Validation loss: 0.
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Epoch:              81 | Training loss: 0.4298044399969598 | Validation loss: 0.
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Epoch:              82 | Training loss: 0.4283665063032093 | Validation loss: 0.
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Epoch:              83 | Training loss: 0.42694145403090705 | Validation loss: 0
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Epoch:              84 | Training loss: 0.42551821982985877 | Validation loss: 0
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Epoch:              86 | Training loss: 0.42272406192827705 | Validation loss: 0
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Epoch:              87 | Training loss: 0.4213435997002452 | Validation loss: 0.
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Epoch:              88 | Training loss: 0.4199772940073773 | Validation loss: 0.
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Epoch:              89 | Training loss: 0.418643903081405 | Validation loss: 0.5
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Epoch:              90 | Training loss: 0.41729235484897964 | Validation loss: 0
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Epoch:              91 | Training loss: 0.4159931051619669 | Validation loss: 0.
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Epoch:              92 | Training loss: 0.4146604724077407 | Validation loss: 0.
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Epoch:           93 | Training loss: 0.4133641292494933 | Validation loss: 0.
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Epoch:           94 | Training loss: 0.4120761056429663 | Validation loss: 0.
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Epoch:           95 | Training loss: 0.41080773057768233 | Validation loss: 0
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Epoch:           96 | Training loss: 0.4095409958089145 | Validation loss: 0.
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Epoch:           97 | Training loss: 0.40828587410841727 | Validation loss: 0
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Epoch:           98 | Training loss: 0.40704522502634816 | Validation loss: 0
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Epoch:           99 | Training loss: 0.40582011455244194 | Validation loss: 0
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Epoch:          100 | Training loss: 0.4046002583616949 | Validation loss: 0.
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Epoch:          101 | Training loss: 0.40339020590235886 | Validation loss: 0
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Epoch:          102 | Training loss: 0.40219328703237645 | Validation loss: 0
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Epoch:          103 | Training loss: 0.4010066961152661 | Validation loss: 0.
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Epoch:          105 | Training loss: 0.3986637058057866 | Validation loss: 0.
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Epoch:          106 | Training loss: 0.3975127685552335 | Validation loss: 0.
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Epoch:          107 | Training loss: 0.39635923575060295 | Validation loss: 0
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Epoch:          114 | Training loss: 0.3885884231496642 | Validation loss: 0.
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Epoch:          115 | Training loss: 0.38751416231505476 | Validation loss: 0
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Epoch:          116 | Training loss: 0.3864476686509665 | Validation loss: 0.
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Epoch:          117 | Training loss: 0.3853896406534318 | Validation loss: 0.
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Epoch:          118 | Training loss: 0.38434127850673505 | Validation loss: 0
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Epoch:          119 | Training loss: 0.3833000530111904 | Validation loss: 0.
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Epoch:          120 | Training loss: 0.3822673388142464 | Validation loss: 0.
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Epoch:          121 | Training loss: 0.38124432673880254 | Validation loss: 0
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Epoch:          122 | Training loss: 0.3802217356528475 | Validation loss: 0.
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Epoch:          123 | Training loss: 0.379211362569147 | Validation loss: 0.4
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921449001716685
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Epoch:          125 | Training loss: 0.3772133343108172 | Validation loss: 0.
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Epoch:          126 | Training loss: 0.3762268685654517 | Validation loss: 0.
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Epoch:          127 | Training loss: 0.3752434951306018 | Validation loss: 0.
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Epoch:          128 | Training loss: 0.3742701780615065 | Validation loss: 0.
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Epoch:          129 | Training loss: 0.37330349660642986 | Validation loss: 0
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Epoch:          130 | Training loss: 0.3723434908749402 | Validation loss: 0.
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Epoch:          133 | Training loss: 0.3695063890922921 | Validation loss: 0.
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Epoch:          145 | Training loss: 0.3587200329523614 | Validation loss: 0.
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Epoch:          150 | Training loss: 0.3544768014304026 | Validation loss: 0.
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Epoch:          151 | Training loss: 0.35365269221634316 | Validation loss: 0
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Epoch:          152 | Training loss: 0.35281195502956025 | Validation loss: 0
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Epoch:          153 | Training loss: 0.35198973698704056 | Validation loss: 0
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```

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Epoch:          155 | Training loss: 0.3503595972943497 | Validation loss: 0.
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Epoch:          164 | Training loss: 0.3432729281401823 | Validation loss: 0.
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Epoch:          183 | Training loss: 0.329468439619706 | Validation loss: 0.4
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Epoch:          184 | Training loss: 0.3287857380925082 | Validation loss: 0.
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Epoch:          212 | Training loss: 0.3109383759299318 | Validation loss: 0.
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Epoch:          213 | Training loss: 0.31034675769078357 | Validation loss: 0
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Epoch:          244 | Training loss: 0.29328172253453133 | Validation loss: 0
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Epoch:          245 | Training loss: 0.2927715216368515 | Validation loss: 0.
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Epoch:         255 | Training loss: 0.28776458961312396 | Validation loss: 0
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Epoch:         258 | Training loss: 0.28630355247415623 | Validation loss: 0
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Epoch:         259 | Training loss: 0.28582101754192857 | Validation loss: 0
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Epoch:         261 | Training loss: 0.2848628934596227 | Validation loss: 0.
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Epoch:         262 | Training loss: 0.28438451134056775 | Validation loss: 0
.43867121629294475
Epoch:         263 | Training loss: 0.28390856501061346 | Validation loss: 0
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Epoch:         264 | Training loss: 0.28344070644132313 | Validation loss: 0
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Epoch:         265 | Training loss: 0.2829699543682588 | Validation loss: 0.
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Epoch:         266 | Training loss: 0.28249380118157635 | Validation loss: 0
.43763831683536564
Epoch:         267 | Training loss: 0.28202611992379967 | Validation loss: 0
.43740948468239355
Epoch:         268 | Training loss: 0.28156132896054337 | Validation loss: 0
.437124077995205
Epoch:         269 | Training loss: 0.28109663453205397 | Validation loss: 0
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Epoch:         270 | Training loss: 0.280634932346971 | Validation loss: 0.4
36655283281077
Epoch:         271 | Training loss: 0.2801762465085139 | Validation loss: 0.
43649827960157667
Epoch:         272 | Training loss: 0.2797159971775998 | Validation loss: 0.
43621449138536184
Epoch:         273 | Training loss: 0.2792594507924152 | Validation loss: 0.
43598736194081655
Epoch:         274 | Training loss: 0.27880449937615054 | Validation loss: 0
.4357467402597834
Epoch:         275 | Training loss: 0.27835177479589657 | Validation loss: 0
.43548271519993703
```

```
Epoch:          276 | Training loss: 0.2779009335440375 | Validation loss: 0.
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Epoch:          277 | Training loss: 0.2774513627699441 | Validation loss: 0.
4350085261133363
Epoch:          278 | Training loss: 0.27700269796099464 | Validation loss: 0
.4348056788131685
Epoch:          279 | Training loss: 0.2765566366449021 | Validation loss: 0.
4345938507540701
Epoch:          280 | Training loss: 0.276113436464078 | Validation loss: 0.4
3439878135195004
Epoch:          281 | Training loss: 0.2756698652981599 | Validation loss: 0.
43411483498687686
Epoch:          282 | Training loss: 0.27522879836124314 | Validation loss: 0
.43392134754647915
Epoch:          283 | Training loss: 0.27478966070726757 | Validation loss: 0
.43366297476080023
Epoch:          284 | Training loss: 0.2743555207386612 | Validation loss: 0.
43339291309212696
Epoch:          285 | Training loss: 0.2739176820313514 | Validation loss: 0.
4331891187856386
Epoch:          286 | Training loss: 0.2734837483344331 | Validation loss: 0.
4329642223183657
Epoch:          287 | Training loss: 0.27304904239601174 | Validation loss: 0
.4328173981982809
Epoch:          288 | Training loss: 0.272617742784004 | Validation loss: 0.4
32575697502562
Epoch:          289 | Training loss: 0.27218842030166285 | Validation loss: 0
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Epoch:          290 | Training loss: 0.27176084557706376 | Validation loss: 0
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Epoch:          291 | Training loss: 0.2713349157959953 | Validation loss: 0.
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Epoch:          292 | Training loss: 0.27090971644306683 | Validation loss: 0
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Epoch:          293 | Training loss: 0.2704872091729652 | Validation loss: 0.
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Epoch:          294 | Training loss: 0.2700656901442538 | Validation loss: 0.
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Epoch:          295 | Training loss: 0.26964539869670817 | Validation loss: 0
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Epoch:          296 | Training loss: 0.26922759580242234 | Validation loss: 0
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Epoch:          297 | Training loss: 0.26881001341526983 | Validation loss: 0
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Epoch:          298 | Training loss: 0.2683946859159184 | Validation loss: 0.
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Epoch:          299 | Training loss: 0.2679811321126202 | Validation loss: 0.
430217943090184
Epoch:          300 | Training loss: 0.26756896135374414 | Validation loss: 0
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Epoch:          301 | Training loss: 0.26715776427730453 | Validation loss: 0
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Epoch:          302 | Training loss: 0.26674857247376316 | Validation loss: 0
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Epoch:          303 | Training loss: 0.26634096320043554 | Validation loss: 0
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Epoch:          304 | Training loss: 0.2659348287084388 | Validation loss: 0.
4291825991490637
Epoch:          305 | Training loss: 0.2655310488461685 | Validation loss: 0.
42896351219169715
Epoch:          306 | Training loss: 0.2651259077625625 | Validation loss: 0.
```

```
4287963665834674
Epoch:        307 | Training loss: 0.26472474978643673 | Validation loss: 0
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Epoch:        308 | Training loss: 0.2643232971055322 | Validation loss: 0.
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Epoch:        309 | Training loss: 0.2639241789444257 | Validation loss: 0.
42819575235760793
Epoch:        310 | Training loss: 0.2635263562621415 | Validation loss: 0.
4280113244816054
Epoch:        311 | Training loss: 0.2631300389933077 | Validation loss: 0.
4278158379200152
Epoch:        312 | Training loss: 0.26273559065233876 | Validation loss: 0
.4275950358265337
Epoch:        313 | Training loss: 0.26234285568471244 | Validation loss: 0
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Epoch:        314 | Training loss: 0.26195056080736073 | Validation loss: 0
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Epoch:        315 | Training loss: 0.26155867373833386 | Validation loss: 0
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Epoch:        316 | Training loss: 0.26116950999597055 | Validation loss: 0
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Epoch:        317 | Training loss: 0.26078260067985437 | Validation loss: 0
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Epoch:        318 | Training loss: 0.26039499156630497 | Validation loss: 0
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Epoch:        319 | Training loss: 0.2600098766078305 | Validation loss: 0.
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Epoch:        320 | Training loss: 0.2596266468620604 | Validation loss: 0.
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Epoch:        321 | Training loss: 0.25924244404585706 | Validation loss: 0
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Epoch:        322 | Training loss: 0.2588617360718393 | Validation loss: 0.
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Epoch:        323 | Training loss: 0.2584808491164121 | Validation loss: 0.
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Epoch:        324 | Training loss: 0.25810192489748324 | Validation loss: 0
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Epoch:        325 | Training loss: 0.2577251966820897 | Validation loss: 0.
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Epoch:        326 | Training loss: 0.2573483022807606 | Validation loss: 0.
4249801452185869
Epoch:        327 | Training loss: 0.2569732452915629 | Validation loss: 0.
4247833191348597
Epoch:        328 | Training loss: 0.25659979208853595 | Validation loss: 0
.42458596604250287
Epoch:        329 | Training loss: 0.2562271750127995 | Validation loss: 0.
42442049597686304
Epoch:        330 | Training loss: 0.2558560178780955 | Validation loss: 0.
42423366005349145
Epoch:        331 | Training loss: 0.2554874842244216 | Validation loss: 0.
424021549700843
Epoch:        332 | Training loss: 0.2551182628559905 | Validation loss: 0.
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Epoch:        333 | Training loss: 0.25475047049709465 | Validation loss: 0
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Epoch:        334 | Training loss: 0.25438485217018997 | Validation loss: 0
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Epoch:        335 | Training loss: 0.25402269374472386 | Validation loss: 0
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Epoch:        336 | Training loss: 0.25366277685937605 | Validation loss: 0
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```

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Epoch:        337 | Training loss: 0.25329452921970996 | Validation loss: 0
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Epoch:        338 | Training loss: 0.2529341638843181 | Validation loss: 0.
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Epoch:        339 | Training loss: 0.2525740935393149 | Validation loss: 0.
42259188481906024
Epoch:        340 | Training loss: 0.252216909991567 | Validation loss: 0.4
224055519529618
Epoch:        341 | Training loss: 0.2518550004789705 | Validation loss: 0.
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Epoch:        342 | Training loss: 0.2515000086555047 | Validation loss: 0.
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Epoch:        343 | Training loss: 0.25114232171860146 | Validation loss: 0
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Epoch:        344 | Training loss: 0.250787777247106 | Validation loss: 0.4
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Epoch:        345 | Training loss: 0.2504345679982807 | Validation loss: 0.
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Epoch:        346 | Training loss: 0.2500831879358796 | Validation loss: 0.
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Epoch:        347 | Training loss: 0.24973155758300777 | Validation loss: 0
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Epoch:        348 | Training loss: 0.2493841804930543 | Validation loss: 0.
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Epoch:        349 | Training loss: 0.24903443156255983 | Validation loss: 0
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Epoch:        350 | Training loss: 0.2486859330533458 | Validation loss: 0.
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Epoch:        351 | Training loss: 0.24833980291994695 | Validation loss: 0
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Epoch:        352 | Training loss: 0.2479942363910951 | Validation loss: 0.
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Epoch:        353 | Training loss: 0.24765062345900463 | Validation loss: 0
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Epoch:        354 | Training loss: 0.2473076757622072 | Validation loss: 0.
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Epoch:        355 | Training loss: 0.24696495243805153 | Validation loss: 0
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Epoch:        356 | Training loss: 0.24662428306543124 | Validation loss: 0
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Epoch:        357 | Training loss: 0.24628434210718275 | Validation loss: 0
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Epoch:        358 | Training loss: 0.24594692185621483 | Validation loss: 0
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Epoch:        359 | Training loss: 0.24560791977368687 | Validation loss: 0
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Epoch:        360 | Training loss: 0.2452711850018373 | Validation loss: 0.
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Epoch:        361 | Training loss: 0.2449367292831877 | Validation loss: 0.
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Epoch:        362 | Training loss: 0.24460236019974851 | Validation loss: 0
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Epoch:        363 | Training loss: 0.244269018659048 | Validation loss: 0.4
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Epoch:        364 | Training loss: 0.24393560727775748 | Validation loss: 0
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Epoch:        365 | Training loss: 0.24360396043433435 | Validation loss: 0
.4183708575733836
Epoch:        366 | Training loss: 0.2432742885728652 | Validation loss: 0.
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Epoch:        367 | Training loss: 0.24294449004547305 | Validation loss: 0
```

```
.4180706559175058
Epoch:        368 | Training loss: 0.24261616725701587 | Validation loss: 0
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Epoch:        369 | Training loss: 0.24228972004731783 | Validation loss: 0
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Epoch:        370 | Training loss: 0.24196274833865744 | Validation loss: 0
.4175769873438828
Epoch:        371 | Training loss: 0.2416371538772509 | Validation loss: 0.
41743591009298799
Epoch:        372 | Training loss: 0.24131309799664685 | Validation loss: 0
.41727339000052793
Epoch:        373 | Training loss: 0.2409904160884007 | Validation loss: 0.
41710946924557056
Epoch:        374 | Training loss: 0.24066720508415146 | Validation loss: 0
.41698808770990686
Epoch:        375 | Training loss: 0.2403458915845608 | Validation loss: 0.
41683118702339433
Epoch:        376 | Training loss: 0.24002588502093042 | Validation loss: 0
.41670894545174336
Epoch:        377 | Training loss: 0.23970631348282959 | Validation loss: 0
.41655559911817663
Epoch:        378 | Training loss: 0.23938769613565106 | Validation loss: 0
.41638210697972783
Epoch:        379 | Training loss: 0.2390702724472006 | Validation loss: 0.
41625308196815525
Epoch:        380 | Training loss: 0.23875366740320425 | Validation loss: 0
.41608851119368157
Epoch:        381 | Training loss: 0.2384384806578341 | Validation loss: 0.
41596761281881856
Epoch:        382 | Training loss: 0.23812352253950192 | Validation loss: 0
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Epoch:        383 | Training loss: 0.23781023874309262 | Validation loss: 0
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Epoch:        384 | Training loss: 0.23749765539905557 | Validation loss: 0
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Epoch:        385 | Training loss: 0.2371859116177652 | Validation loss: 0.
4153421117686484
Epoch:        386 | Training loss: 0.23687475225866567 | Validation loss: 0
.4152047443108082
Epoch:        387 | Training loss: 0.23656494330665023 | Validation loss: 0
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Epoch:        388 | Training loss: 0.2362555415148322 | Validation loss: 0.
4149460613468733
Epoch:        389 | Training loss: 0.2359474463937328 | Validation loss: 0.
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Epoch:        390 | Training loss: 0.23564021960990034 | Validation loss: 0
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Epoch:        391 | Training loss: 0.2353341342130028 | Validation loss: 0.
4144953560953717
Epoch:        392 | Training loss: 0.23502846931737964 | Validation loss: 0
.4143769492254154
Epoch:        393 | Training loss: 0.23472454871153717 | Validation loss: 0
.4142557213545001
Epoch:        394 | Training loss: 0.23442029717193422 | Validation loss: 0
.4140944487181021
Epoch:        395 | Training loss: 0.23411759456540998 | Validation loss: 0
.41395936607212763
Epoch:        396 | Training loss: 0.23381627767815294 | Validation loss: 0
.413838394245243
Epoch:        397 | Training loss: 0.23351479179133344 | Validation loss: 0
.41366983412559505
```

Epoch: 398 | Training loss: 0.23321485848010684 | Validation loss: 0.41352521966171835
Epoch: 399 | Training loss: 0.2329154803156663 | Validation loss: 0.4133963270592447

Hyper Parameters -- Learning Rate - 1e-05 Regularization Parameter- 0.000398810717055349735
Epoch: 0 | Training loss: 0.6837665313365968 | Validation loss: 0.6860666776654553
Epoch: 1 | Training loss: 0.6751539887689503 | Validation loss: 0.680024486574417
Epoch: 2 | Training loss: 0.6670415095566851 | Validation loss: 0.6741670189061404
Epoch: 3 | Training loss: 0.6593701159699298 | Validation loss: 0.6688291731230877
Epoch: 4 | Training loss: 0.6520800602721009 | Validation loss: 0.6642055813126495
Epoch: 5 | Training loss: 0.6451434428399055 | Validation loss: 0.6592691876975997
Epoch: 6 | Training loss: 0.638559964188784 | Validation loss: 0.6546827961923918
Epoch: 7 | Training loss: 0.6322622684729223 | Validation loss: 0.6507785558153253
Epoch: 8 | Training loss: 0.626234652481057 | Validation loss: 0.6466780753241759
Epoch: 9 | Training loss: 0.6204647652638333 | Validation loss: 0.6427302120334975
Epoch: 10 | Training loss: 0.6149927822733852 | Validation loss: 0.6394784747625291
Epoch: 11 | Training loss: 0.6096317060169268 | Validation loss: 0.6356638250319553
Epoch: 12 | Training loss: 0.604510473883221 | Validation loss: 0.6322634540903544
Epoch: 13 | Training loss: 0.5996214325679544 | Validation loss: 0.6293562486175908
Epoch: 14 | Training loss: 0.5948241466738753 | Validation loss: 0.6258865854873538
Epoch: 15 | Training loss: 0.5902262307295705 | Validation loss: 0.6229811884976817
Epoch: 16 | Training loss: 0.5858507092368972 | Validation loss: 0.6205824293023126
Epoch: 17 | Training loss: 0.5814802915026074 | Validation loss: 0.6175537287696955
Epoch: 18 | Training loss: 0.5772777382291164 | Validation loss: 0.6147030423422358
Epoch: 19 | Training loss: 0.5732159381239991 | Validation loss: 0.612088407654503
Epoch: 20 | Training loss: 0.5692670893899358 | Validation loss: 0.609479199654363
Epoch: 21 | Training loss: 0.5654337860236399 | Validation loss: 0.6071770858571462
Epoch: 22 | Training loss: 0.5616960821396463 | Validation loss: 0.604710253075816
Epoch: 23 | Training loss: 0.558062720560079 | Validation loss: 0.6022851200233375
Epoch: 24 | Training loss: 0.5545702037388357 | Validation loss: 0.6006219002197112
Epoch: 25 | Training loss: 0.5510561177822344 | Validation loss: 0.5979613760512573
Epoch: 26 | Training loss: 0.547707054142564 | Validation loss: 0.5961494080110902

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Epoch:           27 | Training loss: 0.5444142088641483 | Validation loss: 0.
5941032882599346
Epoch:           28 | Training loss: 0.5411631837269357 | Validation loss: 0.
5918279152373144
Epoch:           29 | Training loss: 0.5380466207135846 | Validation loss: 0.
5901594799332246
Epoch:           30 | Training loss: 0.534929028383198 | Validation loss: 0.5
879319088411987
Epoch:           31 | Training loss: 0.5319137172002368 | Validation loss: 0.
5860592899148978
Epoch:           32 | Training loss: 0.5290000455363009 | Validation loss: 0.
5845280748836252
Epoch:           33 | Training loss: 0.5260689803787666 | Validation loss: 0.
5822454400493389
Epoch:           34 | Training loss: 0.5232319287926347 | Validation loss: 0.
5805817343148528
Epoch:           35 | Training loss: 0.5204521022514398 | Validation loss: 0.
5787668950714603
Epoch:           36 | Training loss: 0.5177253576944354 | Validation loss: 0.
5771264902324351
Epoch:           37 | Training loss: 0.5150684156277371 | Validation loss: 0.
5756953788232971
Epoch:           38 | Training loss: 0.5124299625711088 | Validation loss: 0.
57393750291330 13
Epoch:           39 | Training loss: 0.5098496965446853 | Validation loss: 0.
5721649150116933
Epoch:           40 | Training loss: 0.507328728316236 | Validation loss: 0.5
704598747713243
Epoch:           41 | Training loss: 0.5048466116017177 | Validation loss: 0.
5688786101254241
Epoch:           42 | Training loss: 0.5023945201496395 | Validation loss: 0.
5674044276146045
Epoch:           43 | Training loss: 0.4999928957713283 | Validation loss: 0.
5658948830400152
Epoch:           44 | Training loss: 0.4976127054063346 | Validation loss: 0.
564654082266523
Epoch:           45 | Training loss: 0.4952867726755134 | Validation loss: 0.
5632047297435302
Epoch:           46 | Training loss: 0.4929973205214798 | Validation loss: 0.
5617862991371915
Epoch:           47 | Training loss: 0.4907544736363382 | Validation loss: 0.
5605640363033555
Epoch:           48 | Training loss: 0.488527924372832 | Validation loss: 0.5
589655201225202
Epoch:           49 | Training loss: 0.48636821570857347 | Validation loss: 0
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Epoch:           50 | Training loss: 0.4842047788578199 | Validation loss: 0.
5561465988244886
Epoch:           51 | Training loss: 0.48208208519239343 | Validation loss: 0
.5548642962081849
Epoch:           52 | Training loss: 0.4800100312166343 | Validation loss: 0.
5534781101109658
Epoch:           53 | Training loss: 0.47792995600273147 | Validation loss: 0
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Epoch:           54 | Training loss: 0.47591838852929885 | Validation loss: 0
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Epoch:           55 | Training loss: 0.47391959557946894 | Validation loss: 0
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Epoch:           56 | Training loss: 0.47193128627679765 | Validation loss: 0
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Epoch:           57 | Training loss: 0.46998441189247014 | Validation loss: 0
```

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.5475477137340308
Epoch:           58 | Training loss: 0.46807132224183495 | Validation loss: 0
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Epoch:           59 | Training loss: 0.4661735900476332 | Validation loss: 0.
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Epoch:           60 | Training loss: 0.46430488312602264 | Validation loss: 0
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Epoch:           61 | Training loss: 0.4624608339762873 | Validation loss: 0.
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Epoch:           62 | Training loss: 0.4606405455026993 | Validation loss: 0.
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Epoch:           63 | Training loss: 0.4588437922213574 | Validation loss: 0.
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Epoch:           64 | Training loss: 0.45707190754076243 | Validation loss: 0
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Epoch:           65 | Training loss: 0.4553334513143738 | Validation loss: 0.
538295948728287
Epoch:           66 | Training loss: 0.4535863812443514 | Validation loss: 0.
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Epoch:           67 | Training loss: 0.4518783424522577 | Validation loss: 0.
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Epoch:           68 | Training loss: 0.4501881636534334 | Validation loss: 0.
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Epoch:           69 | Training loss: 0.44851837979142845 | Validation loss: 0
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Epoch:           70 | Training loss: 0.4468725940442404 | Validation loss: 0.
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Epoch:           71 | Training loss: 0.44524198039941015 | Validation loss: 0
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Epoch:           72 | Training loss: 0.4436268063457138 | Validation loss: 0.
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Epoch:           73 | Training loss: 0.44203493731500476 | Validation loss: 0
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Epoch:           74 | Training loss: 0.4404556395820326 | Validation loss: 0.
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Epoch:           75 | Training loss: 0.4388999431729441 | Validation loss: 0.
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Epoch:           76 | Training loss: 0.4373567962909372 | Validation loss: 0.
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Epoch:           77 | Training loss: 0.435836216829548 | Validation loss: 0.5
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Epoch:           78 | Training loss: 0.43432704422486984 | Validation loss: 0
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Epoch:           79 | Training loss: 0.43283923110027184 | Validation loss: 0
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Epoch:           80 | Training loss: 0.43136171509738397 | Validation loss: 0
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Epoch:           81 | Training loss: 0.4298952020345683 | Validation loss: 0.
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Epoch:           82 | Training loss: 0.42845878556869027 | Validation loss: 0
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Epoch:           83 | Training loss: 0.4270352544702712 | Validation loss: 0.
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Epoch:           84 | Training loss: 0.4256135487952431 | Validation loss: 0.
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Epoch:           85 | Training loss: 0.42421346861670567 | Validation loss: 0
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Epoch:           86 | Training loss: 0.4228224588150936 | Validation loss: 0.
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Epoch:           87 | Training loss: 0.421443537357479 | Validation loss: 0.5
178161442073518
```

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Epoch:          88 | Training loss: 0.4200787772731384 | Validation loss: 0.
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Epoch:          89 | Training loss: 0.41874693493412596 | Validation loss: 0
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Epoch:          90 | Training loss: 0.41739693874487843 | Validation loss: 0
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Epoch:          91 | Training loss: 0.4160992444049732 | Validation loss: 0.
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Epoch:          92 | Training loss: 0.4147681710556904 | Validation loss: 0.
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Epoch:          93 | Training loss: 0.4134733913331176 | Validation loss: 0.
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Epoch:          94 | Training loss: 0.4121869362157484 | Validation loss: 0.
5119906949619695
Epoch:          95 | Training loss: 0.4109201327082957 | Validation loss: 0.
5111492365034893
Epoch:          96 | Training loss: 0.4096549718689209 | Validation loss: 0.
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Epoch:         118 | Training loss: 0.3844907041457624 | Validation loss: 0.
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Epoch: 330 | Training loss: 0.25637975751473163 | Validation loss: 0
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Epoch: 331 | Training loss: 0.25601303656665925 | Validation loss: 0
.4245470825605359

```
Epoch:          332 | Training loss: 0.25564562767014765 | Validation loss: 0
.4243781371214853
Epoch:          333 | Training loss: 0.25527964784914003 | Validation loss: 0
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Epoch:          334 | Training loss: 0.25491584220091273 | Validation loss: 0
.42402072656394557
Epoch:          335 | Training loss: 0.2545554963739763 | Validation loss: 0.
4238173390856326
Epoch:          336 | Training loss: 0.25419739262976454 | Validation loss: 0
.4236213246654952
Epoch:          337 | Training loss: 0.25383095744735923 | Validation loss: 0
.4234870760152565
Epoch:          338 | Training loss: 0.253472404863274 | Validation loss: 0.4
23304766472374
Epoch:          339 | Training loss: 0.2531141477867837 | Validation loss: 0.
42313191907174397
Epoch:          340 | Training loss: 0.25275877711455347 | Validation loss: 0
.4229473990332866
Epoch:          341 | Training loss: 0.25239868064479304 | Validation loss: 0
.42281535946278326
Epoch:          342 | Training loss: 0.2520455018131103 | Validation loss: 0.
422624704320371
Epoch:          343 | Training loss: 0.25168962761144686 | Validation loss: 0
.42248918737223223
Epoch:          344 | Training loss: 0.25133689604596493 | Validation loss: 0
.4223340283173522
Epoch:          345 | Training loss: 0.2509854998658821 | Validation loss: 0.
42217124343216383
Epoch:          346 | Training loss: 0.250635933823198 | Validation loss: 0.4
2197446492371726
Epoch:          347 | Training loss: 0.25028611671903994 | Validation loss: 0
.4218377243951171
Epoch:          348 | Training loss: 0.24994055238029672 | Validation loss: 0
.42162301923175305
Epoch:          349 | Training loss: 0.2495926164207062 | Validation loss: 0.
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Epoch:          350 | Training loss: 0.24924593063142522 | Validation loss: 0
.4213262745866659
Epoch:          351 | Training loss: 0.24890161293599078 | Validation loss: 0
.42115643898332844
Epoch:          352 | Training loss: 0.2485578591114014 | Validation loss: 0.
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Epoch:          353 | Training loss: 0.24821605835427424 | Validation loss: 0
.42087746330951104
Epoch:          354 | Training loss: 0.24787492380771164 | Validation loss: 0
.4207191731988324
Epoch:          355 | Training loss: 0.24753401330664673 | Validation loss: 0
.4205293713544877
Epoch:          356 | Training loss: 0.24719515640546044 | Validation loss: 0
.4203846927595285
Epoch:          357 | Training loss: 0.24685702852346533 | Validation loss: 0
.4201948999873744
Epoch:          358 | Training loss: 0.246521420898449 | Validation loss: 0.
4200126446775381
Epoch:          359 | Training loss: 0.24618423168718534 | Validation loss: 0
.4198802771759276
Epoch:          360 | Training loss: 0.2458493092716383 | Validation loss: 0.
41973063466656624
Epoch:          361 | Training loss: 0.24551666651054777 | Validation loss: 0
.41954379034650846
Epoch:          362 | Training loss: 0.24518411017414135 | Validation loss: 0
```

```
.41938580963091027
Epoch:          363 | Training loss: 0.2448525804567741 | Validation loss: 0.
41922978496236224
Epoch:          364 | Training loss: 0.24452098138082642 | Validation loss: 0
.4190926346876019
Epoch:          365 | Training loss: 0.2441911468794747 | Validation loss: 0.
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Epoch:          366 | Training loss: 0.2438632872351971 | Validation loss: 0.
41882760855188894
Epoch:          367 | Training loss: 0.243535301564757 | Validation loss: 0.4
1866144550442824
Epoch:          368 | Training loss: 0.24320879108984766 | Validation loss: 0
.41848289348986056
Epoch:          369 | Training loss: 0.24288415620405937 | Validation loss: 0
.418375465601365
Epoch:          370 | Training loss: 0.24255899681909576 | Validation loss: 0
.41817321369631033
Epoch:          371 | Training loss: 0.2422352147309202 | Validation loss: 0.
4180339487440615
Epoch:          372 | Training loss: 0.24191297089108282 | Validation loss: 0
.41787324062881076
Epoch:          373 | Training loss: 0.24159210086333327 | Validation loss: 0
.41771113169171387
Epoch:          374 | Training loss: 0.24127070195340053 | Validation loss: 0
.4175915621498817
Epoch:          375 | Training loss: 0.24095120058984637 | Validation loss: 0
.41743647354953567
Epoch:          376 | Training loss: 0.240633005857207 | Validation loss: 0.4
1731604372840103
Epoch:          377 | Training loss: 0.24031524650217592 | Validation loss: 0
.41716450949664363
Epoch:          378 | Training loss: 0.23999844077385676 | Validation loss: 0
.41699282893183104
Epoch:          379 | Training loss: 0.23968282834598706 | Validation loss: 0
.41686561509901393
Epoch:          380 | Training loss: 0.239368034673094  | Validation loss: 0.
41670285563485976
Epoch:          381 | Training loss: 0.2390546588735071 | Validation loss: 0.
41658376810723197
Epoch:          382 | Training loss: 0.23874151242217473 | Validation loss: 0
.4164271800389448
Epoch:          383 | Training loss: 0.23843003967975726 | Validation loss: 0
.4162969719168196
Epoch:          384 | Training loss: 0.23811926752188486 | Validation loss: 0
.4161577941686576
Epoch:          385 | Training loss: 0.237809334890582  | Validation loss: 0.
4159655118743963
Epoch:          386 | Training loss: 0.23749998661316649 | Validation loss: 0
.4158299554200325
Epoch:          387 | Training loss: 0.23719198832217883 | Validation loss: 0
.4156851882834388
Epoch:          388 | Training loss: 0.23688439750201148 | Validation loss: 0
.4155748939156348
Epoch:          389 | Training loss: 0.23657811296566017 | Validation loss: 0
.41541581178306486
Epoch:          390 | Training loss: 0.23627269675475338 | Validation loss: 0
.4152932212055711
Epoch:          391 | Training loss: 0.23596842194205278 | Validation loss: 0
.4151296202054687
Epoch:          392 | Training loss: 0.23566456763114507 | Validation loss: 0
.41501302382927724
```

```
Epoch:         393 | Training loss: 0.23536245725936109 | Validation loss: 0
.414893606114217
Epoch:         394 | Training loss: 0.23506001643694518 | Validation loss: 0
.4147341441408801
Epoch:         395 | Training loss: 0.23475912415015582 | Validation loss: 0
.41460087173939913
Epoch:         396 | Training loss: 0.23445961718634659 | Validation loss: 0
.4144817097433196
Epoch:         397 | Training loss: 0.2341599411620248 | Validation loss: 0.
41431495943753843
Epoch:         398 | Training loss: 0.233861817555313 | Validation loss: 0.4
14172154610996
Epoch:         399 | Training loss: 0.23356424930730083 | Validation loss: 0
.41404507184852596


Hyper Parameters -- Learning Rate - 1e-05  Regularization Parameter- 0.0025
11886431509582
Epoch:           0 | Training loss: 0.6837668093362786 | Validation loss: 0.
6860669556533435
Epoch:           1 | Training loss: 0.6751550488455677 | Validation loss: 0.
680025546568846
Epoch:           2 | Training loss: 0.6670438255621585 | Validation loss: 0.
674169334702064
Epoch:           3 | Training loss: 0.6593741074462803 | Validation loss: 0.
6688331642208324
Epoch:           4 | Training loss: 0.6520861032110294 | Validation loss: 0.
6642116236491503
Epoch:           5 | Training loss: 0.6451519180101276 | Validation loss: 0.
6592776620125104
Epoch:           6 | Training loss: 0.6385712070038247 | Validation loss: 0.
6546940378866805
Epoch:           7 | Training loss: 0.6322765727620788 | Validation loss: 0.
6507928586736711
Epoch:           8 | Training loss: 0.6262523191986296 | Validation loss: 0.
6466957402588456
Epoch:           9 | Training loss: 0.6204860640668425 | Validation loss: 0.
6427515087208555
Epoch:          10 | Training loss: 0.6150179467780288 | Validation loss: 0.
6395036367514504
Epoch:          11 | Training loss: 0.6096609840408245 | Validation loss: 0.
6356931001578267
Epoch:          12 | Training loss: 0.6045440893439715 | Validation loss: 0.
6322970662633068
Epoch:          13 | Training loss: 0.5996595753272517 | Validation loss: 0.
6293943876341082
Epoch:          14 | Training loss: 0.594867033189261 | Validation loss: 0.6
259294678549092
Epoch:          15 | Training loss: 0.5902740318221934 | Validation loss: 0.
623028984981341
Epoch:          16 | Training loss: 0.5859035929356773 | Validation loss: 0.
6206353078717177
Epoch:          17 | Training loss: 0.5815384492309932 | Validation loss: 0.
6176118808664579
Epoch:          18 | Training loss: 0.5773413237100826 | Validation loss: 0.
614766621741241
Epoch:          19 | Training loss: 0.5732850976269929 | Validation loss: 0.
6121575605759474
Epoch:          20 | Training loss: 0.5693419730587678 | Validation loss: 0.
609554076286988
Epoch:          21 | Training loss: 0.5655145246390041 | Validation loss: 0.
6072578168842675
```

```
Epoch:           22 | Training loss: 0.5617828110930586 | Validation loss: 0.
6047969738956653
Epoch:           23 | Training loss: 0.55815557005661 | Validation loss: 0.60
23779608799253
Epoch:           24 | Training loss: 0.5546692818677558 | Validation loss: 0.
600720969090693
Epoch:           25 | Training loss: 0.5511615555618259 | Validation loss: 0.
5980668040595696
Epoch:           26 | Training loss: 0.5478189543344069 | Validation loss: 0.
5962612978505056
Epoch:           27 | Training loss: 0.5445326852962367 | Validation loss: 0.
5942217537965946
Epoch:           28 | Training loss: 0.5412883548536302 | Validation loss: 0.
591953074951351
Epoch:           29 | Training loss: 0.5381785803185116 | Validation loss: 0.
5902914275007376
Epoch:           30 | Training loss: 0.5350678769080734 | Validation loss: 0.
5880707448654288
Epoch:           31 | Training loss: 0.532059544659744 | Validation loss: 0.5
862051043623926
Epoch:           32 | Training loss: 0.5291529350826935 | Validation loss: 0.
5846809507711508
Epoch:           33 | Training loss: 0.5262290330225338 | Validation loss: 0.
5824054785691406
Epoch:           34 | Training loss: 0.52339922049746 | Validation loss: 0.58
0749011377351
Epoch:           35 | Training loss: 0.5206267259104621 | Validation loss: 0.
5789415035332701
Epoch:           36 | Training loss: 0.5179073826746877 | Validation loss: 0.
577308499424985
Epoch:           37 | Training loss: 0.5152579035026765 | Validation loss: 0.
5758848503999721
Epoch:           38 | Training loss: 0.5126270136812248 | Validation loss: 0.
5741345371446644
Epoch:           39 | Training loss: 0.5100543794744375 | Validation loss: 0.
5723695804611806
Epoch:           40 | Training loss: 0.5075411241345227 | Validation loss: 0.
5706722526719262
Epoch:           41 | Training loss: 0.5050667789971804 | Validation loss: 0.
5690987590719224
Epoch:           42 | Training loss: 0.5026225217848739 | Validation loss: 0.
5676324102637413
Epoch:           43 | Training loss: 0.5002288011404532 | Validation loss: 0.
5661307688422865
Epoch:           44 | Training loss: 0.49785657683891194 | Validation loss: 0
.5648979334924629
Epoch:           45 | Training loss: 0.49553867628156795 | Validation loss: 0
.563456612594631
Epoch:           46 | Training loss: 0.4932573204324837 | Validation loss: 0.
5620462778088792
Epoch:           47 | Training loss: 0.4910226152452545 | Validation loss: 0.
5608321561358912
Epoch:           48 | Training loss: 0.4888042780731158 | Validation loss: 0.
5592418515323903
Epoch:           49 | Training loss: 0.4866528477707904 | Validation loss: 0.
5576855774737293
Epoch:           50 | Training loss: 0.48449773254967893 | Validation loss: 0
.5564395292670529
Epoch:           51 | Training loss: 0.4823834177625742 | Validation loss: 0.
5551656050040229
Epoch:           52 | Training loss: 0.4803197945956946 | Validation loss: 0.
```

```
553787849223449
Epoch:          53 | Training loss: 0.47824819907347293 | Validation loss: 0
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Epoch:          54 | Training loss: 0.4762451612103839 | Validation loss: 0.
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Epoch:          55 | Training loss: 0.47425494461341455 | Validation loss: 0
.550084396783965
Epoch:          56 | Training loss: 0.4722752616682689 | Validation loss: 0.
5490201853540922
Epoch:          57 | Training loss: 0.470337060116626 | Validation loss: 0.5
479003350253954
Epoch:          58 | Training loss: 0.4684326894780988 | Validation loss: 0.
5468667317643489
Epoch:          59 | Training loss: 0.466543725645018 | Validation loss: 0.5
455251431082705
Epoch:          60 | Training loss: 0.4646838278420132 | Validation loss: 0.
5443922068543607
Epoch:          61 | Training loss: 0.4628486307344461 | Validation loss: 0.
5432570433107645
Epoch:          62 | Training loss: 0.46103723970251703 | Validation loss: 0
.54220872055573
Epoch:          63 | Training loss: 0.4592494255104705 | Validation loss: 0.
5410503937790179
Epoch:          64 | Training loss: 0.4574865187948109 | Validation loss: 0.
5399025648629204
Epoch:          65 | Training loss: 0.45575707307281416 | Validation loss: 0
.5387195398622994
Epoch:          66 | Training loss: 0.45401905002259446 | Validation loss: 0
.5378569955856024
Epoch:          67 | Training loss: 0.4523201054494406 | Validation loss: 0.
53690846124873
Epoch:          68 | Training loss: 0.4506390486218351 | Validation loss: 0.
5357754388922901
Epoch:          69 | Training loss: 0.4489784341379602 | Validation loss: 0.
5347588443412553
Epoch:          70 | Training loss: 0.4473418510570317 | Validation loss: 0.
5338941463396248
Epoch:          71 | Training loss: 0.4457204850051082 | Validation loss: 0.
5326560611082258
Epoch:          72 | Training loss: 0.44411458177969376 | Validation loss: 0
.5317136545675369
Epoch:          73 | Training loss: 0.44253201889906774 | Validation loss: 0
.5309394620536361
Epoch:          74 | Training loss: 0.440962054205966 | Validation loss: 0.5
298782344020548
Epoch:          75 | Training loss: 0.43941572504053017 | Validation loss: 0
.5290053043930852
Epoch:          76 | Training loss: 0.4378819817590089 | Validation loss: 0.
5280260986648642
Epoch:          77 | Training loss: 0.43637083766566936 | Validation loss: 0
.527176276132478
Epoch:          78 | Training loss: 0.4348711306068763 | Validation loss: 0.
5262423135752197
Epoch:          79 | Training loss: 0.43339281532093765 | Validation loss: 0
.52539318366212
Epoch:          80 | Training loss: 0.43192482516569086 | Validation loss: 0
.5244847264078056
Epoch:          81 | Training loss: 0.4304678713147855 | Validation loss: 0.
5235024738107659
Epoch:          82 | Training loss: 0.4290410278983427 | Validation loss: 0.
5227504951423987
```

```
Epoch:           83 | Training loss: 0.42762709474686417 | Validation loss: 0
.5219367182288424
Epoch:           84 | Training loss: 0.42621503340749745 | Validation loss: 0
.5207008454076792
Epoch:           85 | Training loss: 0.42482462138553856 | Validation loss: 0
.519838417975953
Epoch:           86 | Training loss: 0.4234433006794993 | Validation loss: 0.
5193319187678921
Epoch:           87 | Training loss: 0.4220741008140887 | Validation loss: 0.
5184466674957767
Epoch:           88 | Training loss: 0.42071909284822856 | Validation loss: 0
.517505359963303
Epoch:           89 | Training loss: 0.4193970214201991 | Validation loss: 0.
5165124572630573
Epoch:           90 | Training loss: 0.41805681794907984 | Validation loss: 0
.5158941747519608
Epoch:           91 | Training loss: 0.4167689371735533 | Validation loss: 0.
5148736592248555
Epoch:           92 | Training loss: 0.41544770299173156 | Validation loss: 0
.5142562924446153
Epoch:           93 | Training loss: 0.41416278786869304 | Validation loss: 0
.5136446143402218
Epoch:           94 | Training loss: 0.41288622923605534 | Validation loss: 0
.5126899453377248
Epoch:           95 | Training loss: 0.4116293415752305 | Validation loss: 0.
5118584024111225
Epoch:           96 | Training loss: 0.4103741115458971 | Validation loss: 0.
5113559187468464
Epoch:           97 | Training loss: 0.409130524439399 | Validation loss: 0.5
104508304621995
Epoch:           98 | Training loss: 0.4079014327856966 | Validation loss: 0.
5097243016735484
Epoch:           99 | Training loss: 0.406687901997311 | Validation loss: 0.5
091238873431171
Epoch:          100 | Training loss: 0.405479662602979 | Validation loss: 0.5
082052831582563
Epoch:          101 | Training loss: 0.40428124185565756 | Validation loss: 0
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Epoch:          102 | Training loss: 0.40309598939870356 | Validation loss: 0
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Epoch:          103 | Training loss: 0.40192108487035894 | Validation loss: 0
.506182198361645
Epoch:          104 | Training loss: 0.40075670579192546 | Validation loss: 0
.5053883085956208
Epoch:          105 | Training loss: 0.3996015276762436 | Validation loss: 0.
5047808044894826
Epoch:          106 | Training loss: 0.39846234072035747 | Validation loss: 0
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Epoch:          107 | Training loss: 0.39732059694557215 | Validation loss: 0
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Epoch:          108 | Training loss: 0.3961946578171757 | Validation loss: 0.
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Epoch:          109 | Training loss: 0.395086553819561 | Validation loss: 0.5
018932037186404
Epoch:          110 | Training loss: 0.3939736201368097 | Validation loss: 0.
5012901564144526
Epoch:          111 | Training loss: 0.3928730477252019 | Validation loss: 0.
5007254711961443
Epoch:          112 | Training loss: 0.39178505090832466 | Validation loss: 0
.5000093965811762
Epoch:          113 | Training loss: 0.3907055754017698 | Validation loss: 0.
```

```
499348428635607
Epoch:         114 | Training loss: 0.38963280460265437 | Validation loss: 0
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Epoch:         115 | Training loss: 0.38857048035940434 | Validation loss: 0
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Epoch:         116 | Training loss: 0.38751594292498126 | Validation loss: 0
.4974865257356963
Epoch:         117 | Training loss: 0.3864698843033737 | Validation loss: 0.
49689569162347297
Epoch:         118 | Training loss: 0.38543351522591673 | Validation loss: 0
.49621392358192906
Epoch:         119 | Training loss: 0.3844043018588148 | Validation loss: 0.
4957261851950686
Epoch:         120 | Training loss: 0.3833836194999456 | Validation loss: 0.
4951357031326908
Epoch:         121 | Training loss: 0.38237265326627073 | Validation loss: 0
.49456959436970854
Epoch:         122 | Training loss: 0.38136213032870825 | Validation loss: 0
.49381786668020294
Epoch:         123 | Training loss: 0.3803638390097837 | Validation loss: 0.
49329731544446337
Epoch:         124 | Training loss: 0.3793728482147224 | Validation loss: 0.
4926469136534986
Epoch:         125 | Training loss: 0.37839002476579675 | Validation loss: 0
.4921403662907624
Epoch:         126 | Training loss: 0.3774156935133273 | Validation loss: 0.
49159759108292
Epoch:         127 | Training loss: 0.376444474240402 | Validation loss: 0.4
909420240835003
Epoch:         128 | Training loss: 0.3754833263831946 | Validation loss: 0.
49034648840115524
Epoch:         129 | Training loss: 0.3745288200873169 | Validation loss: 0.
48979109241723756
Epoch:         130 | Training loss: 0.3735810127311078 | Validation loss: 0.
48923735269149515
Epoch:         131 | Training loss: 0.37264093663517933 | Validation loss: 0
.4886554522156578
Epoch:         132 | Training loss: 0.3717058751898339 | Validation loss: 0.
4881470641953146
Epoch:         133 | Training loss: 0.3707805952600438 | Validation loss: 0.
487550858926121
Epoch:         134 | Training loss: 0.3698586397702742 | Validation loss: 0.
4870314678676393
Epoch:         135 | Training loss: 0.36894435048665025 | Validation loss: 0
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Epoch:         136 | Training loss: 0.3680382779025346 | Validation loss: 0.
48593486422718457
Epoch:         137 | Training loss: 0.3671343278351526 | Validation loss: 0.
4854860099226163
Epoch:         138 | Training loss: 0.3662418190679205 | Validation loss: 0.
4848840302365066
Epoch:         139 | Training loss: 0.3653542304842398 | Validation loss: 0.
484545822430684
Epoch:         140 | Training loss: 0.36446701010334853 | Validation loss: 0
.4839430688970387
Epoch:         141 | Training loss: 0.363590394939164 | Validation loss: 0.
48338731464997226
Epoch:         142 | Training loss: 0.3627282071425914 | Validation loss: 0.
48277378995890785
Epoch:         143 | Training loss: 0.36185940099695785 | Validation loss: 0
.48230272874378444
```

```
Epoch:          144 | Training loss: 0.36100078366661237 | Validation loss: 0
.4817969749574745
Epoch:          145 | Training loss: 0.36014228286642214 | Validation loss: 0
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Epoch:          146 | Training loss: 0.3592935192546477 | Validation loss: 0.
480949685170876
Epoch:          147 | Training loss: 0.3584508660578779 | Validation loss: 0.
4804305666343606
Epoch:          148 | Training loss: 0.3576144770247642 | Validation loss: 0.
4799801801535746
Epoch:          149 | Training loss: 0.35678289519721945 | Validation loss: 0
.4794568989121538
Epoch:          150 | Training loss: 0.3559612945399022 | Validation loss: 0.
4790929606130712
Epoch:          151 | Training loss: 0.35514967149690385 | Validation loss: 0
.47870466057023997
Epoch:          152 | Training loss: 0.3543214324370389 | Validation loss: 0.
4780508764057552
Epoch:          153 | Training loss: 0.35351171841044315 | Validation loss: 0
.47760651304655277
Epoch:          154 | Training loss: 0.35270755752866534 | Validation loss: 0
.4771715108071977
Epoch:          155 | Training loss: 0.3519066270646303 | Validation loss: 0.
47666260164006585
Epoch:          156 | Training loss: 0.3511118255062749 | Validation loss: 0.
47620048677144244
Epoch:          157 | Training loss: 0.3503222445305335 | Validation loss: 0.
47574191561989077
Epoch:          158 | Training loss: 0.34953846018827117 | Validation loss: 0
.47525999247223594
Epoch:          159 | Training loss: 0.34876142146630507 | Validation loss: 0
.47476988985357843
Epoch:          160 | Training loss: 0.34798293392599583 | Validation loss: 0
.47437848270477334
Epoch:          161 | Training loss: 0.34721181987991784 | Validation loss: 0
.47397489326177245
Epoch:          162 | Training loss: 0.3464507221038255 | Validation loss: 0.
47364568173227552
Epoch:          163 | Training loss: 0.34568551557320776 | Validation loss: 0
.47313058625987836
Epoch:          164 | Training loss: 0.3449331793083848 | Validation loss: 0.
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Epoch:          165 | Training loss: 0.34417722999719036 | Validation loss: 0
.47223148698419054
Epoch:          166 | Training loss: 0.3434297208983028 | Validation loss: 0.
4718340251746074
Epoch:          167 | Training loss: 0.3426942728508584 | Validation loss: 0.
47128984321928824
Epoch:          168 | Training loss: 0.3419598644588329 | Validation loss: 0.
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Epoch:          169 | Training loss: 0.34121410535803803 | Validation loss: 0
.47056726334946686
Epoch:          170 | Training loss: 0.34049315086026305 | Validation loss: 0
.470035578508744
Epoch:          171 | Training loss: 0.33975936491399067 | Validation loss: 0
.4697241252945135
Epoch:          172 | Training loss: 0.3390378224049232 | Validation loss: 0.
469322581817749
Epoch:          173 | Training loss: 0.3383216475499532 | Validation loss: 0.
46899396129814064
Epoch:          174 | Training loss: 0.33761373041404336 | Validation loss: 0
```

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.4686610097864755
Epoch:          175 | Training loss: 0.3369028603893589 | Validation loss: 0.
4682397606039656
Epoch:          176 | Training loss: 0.3362014899722199 | Validation loss: 0.
4678799745224412
Epoch:          177 | Training loss: 0.3354929361324533 | Validation loss: 0.
4673727402336898
Epoch:          178 | Training loss: 0.33479848927141503 | Validation loss: 0
.4670380440268079
Epoch:          179 | Training loss: 0.33410301277571064 | Validation loss: 0
.4665738874668526
Epoch:          180 | Training loss: 0.33341487695066696 | Validation loss: 0
.4662337985434886
Epoch:          181 | Training loss: 0.33272903294271505 | Validation loss: 0
.46579163582864086
Epoch:          182 | Training loss: 0.3320480422212765 | Validation loss: 0.
46545787410745215
Epoch:          183 | Training loss: 0.33137024986622104 | Validation loss: 0
.4650344334133243
Epoch:          184 | Training loss: 0.330700349978342 | Validation loss: 0.4
647714801436117
Epoch:          185 | Training loss: 0.33002630012154377 | Validation loss: 0
.46432478876881966
Epoch:          186 | Training loss: 0.3293597719915032 | Validation loss: 0.
4639224897634095
Epoch:          187 | Training loss: 0.32870096676146077 | Validation loss: 0
.4634841707274839
Epoch:          188 | Training loss: 0.32804380111428705 | Validation loss: 0
.4631012601218237
Epoch:          189 | Training loss: 0.3273916075825128 | Validation loss: 0.
46271530918573023
Epoch:          190 | Training loss: 0.3267341143186907 | Validation loss: 0.
4623965634658437
Epoch:          191 | Training loss: 0.3260882577105925 | Validation loss: 0.
46223948486747707
Epoch:          192 | Training loss: 0.3254364385671783 | Validation loss: 0.
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Epoch:          193 | Training loss: 0.32479461789483044 | Validation loss: 0
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Epoch:          194 | Training loss: 0.3241567999554289 | Validation loss: 0.
4610233050180899
Epoch:          195 | Training loss: 0.32352221684890087 | Validation loss: 0
.46066715524779134
Epoch:          196 | Training loss: 0.3228896889133122 | Validation loss: 0.
46037781983319365
Epoch:          197 | Training loss: 0.32226213641670526 | Validation loss: 0
.4600644156038236
Epoch:          198 | Training loss: 0.321636269172775 | Validation loss: 0.4
596647129892365
Epoch:          199 | Training loss: 0.3210144820143719 | Validation loss: 0.
4593276759038285
Epoch:          200 | Training loss: 0.32039971543865897 | Validation loss: 0
.4589223533592384
Epoch:          201 | Training loss: 0.31978209853689693 | Validation loss: 0
.45861502706694596
Epoch:          202 | Training loss: 0.3191685283120252 | Validation loss: 0.
45831586912494926
Epoch:          203 | Training loss: 0.31855940901378305 | Validation loss: 0
.45798447948081233
Epoch:          204 | Training loss: 0.3179623101456564 | Validation loss: 0.
45780810438987446
```

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Epoch:         205 | Training loss: 0.3173527541591133 | Validation loss: 0.
4574108772370265
Epoch:         206 | Training loss: 0.3167525532045908 | Validation loss: 0.
45695794963611114
Epoch:         207 | Training loss: 0.3161548412968747 | Validation loss: 0.
4566483111481708
Epoch:         208 | Training loss: 0.31556071430063487 | Validation loss: 0
.4563343014897734
Epoch:         209 | Training loss: 0.31497200583253254 | Validation loss: 0
.45598193331731396
Epoch:         210 | Training loss: 0.31439154712343176 | Validation loss: 0
.4556095281558275
Epoch:         211 | Training loss: 0.3137985969994341 | Validation loss: 0.
4553537015149302
Epoch:         212 | Training loss: 0.31321399471445366 | Validation loss: 0
.45508579721783887
Epoch:         213 | Training loss: 0.3126353516401041 | Validation loss: 0.
4547548269204482
Epoch:         214 | Training loss: 0.3120589433036856 | Validation loss: 0.
4545275286828068
Epoch:         215 | Training loss: 0.3114871120571282 | Validation loss: 0.
4542500281793522
Epoch:         216 | Training loss: 0.3109140010117586 | Validation loss: 0.
4538395046218552
Epoch:         217 | Training loss: 0.3103542342354053 | Validation loss: 0.
45345312009498273
Epoch:         218 | Training loss: 0.3097823323483248 | Validation loss: 0.
4532037795483558
Epoch:         219 | Training loss: 0.30921999386124316 | Validation loss: 0
.4529006734871732
Epoch:         220 | Training loss: 0.3086653885680022 | Validation loss: 0.
45255746461410096
Epoch:         221 | Training loss: 0.3081022831204625 | Validation loss: 0.
4523092833476787
Epoch:         222 | Training loss: 0.30754554940471385 | Validation loss: 0
.45207174673089495
Epoch:         223 | Training loss: 0.3069960575836843 | Validation loss: 0.
4517177721196061
Epoch:         224 | Training loss: 0.30644446289671695 | Validation loss: 0
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Epoch:         225 | Training loss: 0.305899386807537 | Validation loss: 0.4
5125499040769723
Epoch:         226 | Training loss: 0.3053550877458407 | Validation loss: 0.
4509649297450196
Epoch:         227 | Training loss: 0.3048117098077291 | Validation loss: 0.
45062831755439076
Epoch:         228 | Training loss: 0.304276740203075 | Validation loss: 0.4
5026228718759237
Epoch:         229 | Training loss: 0.3037373345313222 | Validation loss: 0.
450013337846231
Epoch:         230 | Training loss: 0.3032041078753915 | Validation loss: 0.
44983428610070986
Epoch:         231 | Training loss: 0.30267281344777325 | Validation loss: 0
.4494349566544241
Epoch:         232 | Training loss: 0.3021481728056299 | Validation loss: 0.
44911775200467063
Epoch:         233 | Training loss: 0.301618679443022 | Validation loss: 0.4
488602391073446
Epoch:         234 | Training loss: 0.3010925028095466 | Validation loss: 0.
4486031913208388
Epoch:         235 | Training loss: 0.3005721534319739 | Validation loss: 0.
```

```
4483128316719812
Epoch:         236 | Training loss: 0.30004840956743023 | Validation loss: 0
.448117119393668
Epoch:         237 | Training loss: 0.2995325032544443 | Validation loss: 0.
4478022003720813
Epoch:         238 | Training loss: 0.2990164062871581 | Validation loss: 0.
447600842536141
Epoch:         239 | Training loss: 0.29850350772676704 | Validation loss: 0
.44732019732763717
Epoch:         240 | Training loss: 0.29799317045930446 | Validation loss: 0
.44703627951530833
Epoch:         241 | Training loss: 0.29748565847111147 | Validation loss: 0
.44674979642782
Epoch:         242 | Training loss: 0.29698056106051496 | Validation loss: 0
.44656548098163384
Epoch:         243 | Training loss: 0.29647964198696075 | Validation loss: 0
.44634071627952165
Epoch:         244 | Training loss: 0.2959748548664497 | Validation loss: 0.
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Epoch:         245 | Training loss: 0.29547776509662654 | Validation loss: 0
.4456824188568552
Epoch:         246 | Training loss: 0.2949786240367791 | Validation loss: 0.
4454750966511253
Epoch:         247 | Training loss: 0.29448445604303103 | Validation loss: 0
.4452583628798071
Epoch:         248 | Training loss: 0.2939924257776553 | Validation loss: 0.
4450163356733523
Epoch:         249 | Training loss: 0.29350301470107254 | Validation loss: 0
.44478012600381517
Epoch:         250 | Training loss: 0.29301786020190684 | Validation loss: 0
.4445647070453035
Epoch:         251 | Training loss: 0.2925276767188496 | Validation loss: 0.
44426735647259447
Epoch:         252 | Training loss: 0.29204451863285724 | Validation loss: 0
.4440338403571977
Epoch:         253 | Training loss: 0.2915648599406539 | Validation loss: 0.
44381382087134924
Epoch:         254 | Training loss: 0.2910822530265704 | Validation loss: 0.
44353721542749674
Epoch:         255 | Training loss: 0.2906021059713491 | Validation loss: 0.
44323892259058906
Epoch:         256 | Training loss: 0.29012954489323844 | Validation loss: 0
.44306173731337994
Epoch:         257 | Training loss: 0.289652714548386 | Validation loss: 0.4
427693557499499
Epoch:         258 | Training loss: 0.2891805088668892 | Validation loss: 0.
4425070036864865
Epoch:         259 | Training loss: 0.2887111270944167 | Validation loss: 0.
4422936170424259
Epoch:         260 | Training loss: 0.2882446547410969 | Validation loss: 0.
44208260453991755
Epoch:         261 | Training loss: 0.28777931674962653 | Validation loss: 0
.44185486277155356
Epoch:         262 | Training loss: 0.2873140928287266 | Validation loss: 0.
44160068540026726
Epoch:         263 | Training loss: 0.28685130873053977 | Validation loss: 0
.44135091520831216
Epoch:         264 | Training loss: 0.2863966140578303 | Validation loss: 0.
44118905557611576
Epoch:         265 | Training loss: 0.28593903000593296 | Validation loss: 0
.44096324005973403
```

```
Epoch:          266 | Training loss: 0.2854760486666439 | Validation loss: 0.
44062045038416625
Epoch:          267 | Training loss: 0.2850215420062095 | Validation loss: 0.
4404047924794668
Epoch:          268 | Training loss: 0.2845699217711788 | Validation loss: 0.
4401325562535948
Epoch:          269 | Training loss: 0.2841184038988626 | Validation loss: 0.
4399254728094151
Epoch:          270 | Training loss: 0.2836698794278731 | Validation loss: 0.
4396901149472056
Epoch:          271 | Training loss: 0.2832243655952366 | Validation loss: 0.
4395462826471332
Epoch:          272 | Training loss: 0.2827773006988304 | Validation loss: 0.
4392756785247179
Epoch:          273 | Training loss: 0.2823339405189328 | Validation loss: 0.
43906173480394173
Epoch:          274 | Training loss: 0.2818921781515434 | Validation loss: 0.
43883430174072074
Epoch:          275 | Training loss: 0.28145264179447127 | Validation loss: 0
.43858346462901393
Epoch:          276 | Training loss: 0.281014987346296 | Validation loss: 0.4
384242719039487
Epoch:          277 | Training loss: 0.28057861755366464 | Validation loss: 0
.4381356625830196
Epoch:          278 | Training loss: 0.2801431425511557 | Validation loss: 0.
43794600456726435
Epoch:          279 | Training loss: 0.2797102745061595 | Validation loss: 0.
43774736928678754
Epoch:          280 | Training loss: 0.279280265509314 | Validation loss: 0.4
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Epoch:          281 | Training loss: 0.27884989394229737 | Validation loss: 0
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Epoch:          282 | Training loss: 0.2784220313818291 | Validation loss: 0.
43711445991757997
Epoch:          283 | Training loss: 0.2779960998554758 | Validation loss: 0.
43686929293743715
Epoch:          284 | Training loss: 0.27757516519010356 | Validation loss: 0
.4366124364047238
Epoch:          285 | Training loss: 0.27715053439702914 | Validation loss: 0
.43642184956853003
Epoch:          286 | Training loss: 0.2767298074809023 | Validation loss: 0.
43621015946438974
Epoch:          287 | Training loss: 0.2763083103684009 | Validation loss: 0.
43607654352195974
Epoch:          288 | Training loss: 0.27589022396001983 | Validation loss: 0
.43584805560818646
Epoch:          289 | Training loss: 0.2754741125060484 | Validation loss: 0.
4356359132701432
Epoch:          290 | Training loss: 0.2750597514381959 | Validation loss: 0.
43542107603243685
Epoch:          291 | Training loss: 0.27464703737011525 | Validation loss: 0
.435212519533549
Epoch:          292 | Training loss: 0.27423505456432923 | Validation loss: 0
.4350415180207399
Epoch:          293 | Training loss: 0.2738257664605743 | Validation loss: 0.
4348098040739021
Epoch:          294 | Training loss: 0.2734174661906731 | Validation loss: 0.
4346114228172736
Epoch:          295 | Training loss: 0.27301039308909747 | Validation loss: 0
.4344232930416031
Epoch:          296 | Training loss: 0.2726058147719301 | Validation loss: 0.
```

```
4342108340215549
Epoch:        297 | Training loss: 0.27220145281893665 | Validation loss: 0
.43403806129426953
Epoch:        298 | Training loss: 0.27179934918668264 | Validation loss: 0
.43384293062103507
Epoch:        299 | Training loss: 0.2713990215643995 | Validation loss: 0.
4336357046536523
Epoch:        300 | Training loss: 0.27100007803850923 | Validation loss: 0
.4334381149455341
Epoch:        301 | Training loss: 0.2706021114884697 | Validation loss: 0.
43327726312977916
Epoch:        302 | Training loss: 0.27020614713094976 | Validation loss: 0
.4330927279145806
Epoch:        303 | Training loss: 0.2698117709640485 | Validation loss: 0.
4328634958528552
Epoch:        304 | Training loss: 0.269418867382747 | Validation loss: 0.4
326665077394847
Epoch:        305 | Training loss: 0.26902831987000264 | Validation loss: 0
.43246065285381646
Epoch:        306 | Training loss: 0.268636409031885 | Validation loss: 0.4
323067369216323
Epoch:        307 | Training loss: 0.26824848697246173 | Validation loss: 0
.43209658565810705
Epoch:        308 | Training loss: 0.26786026976993793 | Validation loss: 0
.4319334065375524
Epoch:        309 | Training loss: 0.2674743866173089 | Validation loss: 0.
4317458277617577
Epoch:        310 | Training loss: 0.26708979680055456 | Validation loss: 0
.4315746321915446
Epoch:        311 | Training loss: 0.266706716386655 | Validation loss: 0.4
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Epoch:        312 | Training loss: 0.26632550499978164 | Validation loss: 0
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Epoch:        313 | Training loss: 0.2659460072047828 | Validation loss: 0.
43098868183129146
Epoch:        314 | Training loss: 0.2655669484218357 | Validation loss: 0.
4308841055113946
Epoch:        315 | Training loss: 0.2651883009521164 | Validation loss: 0.
43066770556841577
Epoch:        316 | Training loss: 0.2648123777890663 | Validation loss: 0.
43046998680586074
Epoch:        317 | Training loss: 0.264438709657359 | Validation loss: 0.4
302685347616002
Epoch:        318 | Training loss: 0.26406434222018255 | Validation loss: 0
.43010589888821144
Epoch:        319 | Training loss: 0.26369246941855223 | Validation loss: 0
.42992431522312635
Epoch:        320 | Training loss: 0.26332248233964584 | Validation loss: 0
.4297380487525356
Epoch:        321 | Training loss: 0.26295152548340367 | Validation loss: 0
.42959038653517234
Epoch:        322 | Training loss: 0.2625840660269357 | Validation loss: 0.
4293977942237211
Epoch:        323 | Training loss: 0.26221642577631393 | Validation loss: 0
.4292716383280553
Epoch:        324 | Training loss: 0.2618507463775032 | Validation loss: 0.
42907758347175645
Epoch:        325 | Training loss: 0.2614872636711544 | Validation loss: 0.
428883707381774
Epoch:        326 | Training loss: 0.26112361524595495 | Validation loss: 0
.4287553178780623
```

```
Epoch:          327 | Training loss: 0.26076180453964304 | Validation loss: 0
.4285717375967637
Epoch:          328 | Training loss: 0.2604015971261502 | Validation loss: 0.
4283876299659154
Epoch:          329 | Training loss: 0.26004222935285676 | Validation loss: 0
.4282354086760638
Epoch:          330 | Training loss: 0.2596843243761854 | Validation loss: 0.
4280618243918557
Epoch:          331 | Training loss: 0.2593290407886529 | Validation loss: 0.
42786296385709655
Epoch:          332 | Training loss: 0.25897306777815243 | Validation loss: 0
.4277054538846569
Epoch:          333 | Training loss: 0.25861852425929427 | Validation loss: 0
.4275477159949632
Epoch:          334 | Training loss: 0.2582661558014338 | Validation loss: 0.
42737091592927823
Epoch:          335 | Training loss: 0.2579172466590752 | Validation loss: 0.
42717896480314776
Epoch:          336 | Training loss: 0.2575705830229576 | Validation loss: 0.
42699439020278873
Epoch:          337 | Training loss: 0.2572155836335957 | Validation loss: 0.
42687157681834614
Epoch:          338 | Training loss: 0.2568684686977757 | Validation loss: 0.
4267007045413169
Epoch:          339 | Training loss: 0.25652165253280285 | Validation loss: 0
.4265392976603624
Epoch:          340 | Training loss: 0.25617772029235586 | Validation loss: 0
.4263662157516116
Epoch:          341 | Training loss: 0.25582906331000155 | Validation loss: 0
.4262456151309739
Epoch:          342 | Training loss: 0.25548732364349364 | Validation loss: 0
.42606639880296693
Epoch:          343 | Training loss: 0.2551428869882491 | Validation loss: 0.
4259423187790646
Epoch:          344 | Training loss: 0.25480159404659436 | Validation loss: 0
.4257985978549975
Epoch:          345 | Training loss: 0.25446163751699763 | Validation loss: 0
.4256472521773266
Epoch:          346 | Training loss: 0.2541235171249674 | Validation loss: 0.
42546191899473923
Epoch:          347 | Training loss: 0.2537851408066573 | Validation loss: 0.
42533661869053146
Epoch:          348 | Training loss: 0.25345101411462523 | Validation loss: 0
.42513335094174265
Epoch:          349 | Training loss: 0.25311451718782085 | Validation loss: 0
.42499200854600017
Epoch:          350 | Training loss: 0.25277926884771934 | Validation loss: 0
.4248594817908354
Epoch:          351 | Training loss: 0.25244638682228016 | Validation loss: 0
.4247010815203578
Epoch:          352 | Training loss: 0.2521140703478274 | Validation loss: 0.
4245598116862154
Epoch:          353 | Training loss: 0.25178370360107516 | Validation loss: 0
.42444497613115856
Epoch:          354 | Training loss: 0.25145400921835825 | Validation loss: 0
.4242981257141548
Epoch:          355 | Training loss: 0.25112453681690805 | Validation loss: 0
.42411976160463766
Epoch:          356 | Training loss: 0.2507971157964222 | Validation loss: 0.
4239865184990287
Epoch:          357 | Training loss: 0.25047042761120303 | Validation loss: 0
```

```
.4238081650860614
Epoch:          358 | Training loss: 0.250146256841654 | Validation loss: 0.4
2363734637079953
Epoch:          359 | Training loss: 0.24982050603358566 | Validation loss: 0
.4235164167776943
Epoch:          360 | Training loss: 0.2494970187719491 | Validation loss: 0.
42337820902729134
Epoch:          361 | Training loss: 0.24917581495835553 | Validation loss: 0
.4232028032882185
Epoch:          362 | Training loss: 0.24885469624102277 | Validation loss: 0
.4230562597485568
Epoch:          363 | Training loss: 0.24853459831449382 | Validation loss: 0
.42291166645507
Epoch:          364 | Training loss: 0.24821443407055702 | Validation loss: 0
.4227859505010396
Epoch:          365 | Training loss: 0.2478960346328671 | Validation loss: 0.
4226627725880114
Epoch:          366 | Training loss: 0.24757960926422376 | Validation loss: 0
.4225437925926594
Epoch:          367 | Training loss: 0.24726306190595826 | Validation loss: 0
.42238906746313587
Epoch:          368 | Training loss: 0.246947986314684 | Validation loss: 0.
4222219500108707

Hyper Parameters -- Learning Rate - 1e-05  Regularization Parameter- 0.0158
4893192461114
Epoch:            0 | Training loss: 0.6837685633953191 | Validation loss: 0.
6860687096379716
Epoch:            1 | Training loss: 0.675161737474372 | Validation loss: 0.6
800322346790766
Epoch:            2 | Training loss: 0.6670584385611612 | Validation loss: 0.
6741839463788982
Epoch:            3 | Training loss: 0.6593992919427292 | Validation loss: 0.
6688583463284428
Epoch:            4 | Training loss: 0.6521242315474017 | Validation loss: 0.
6642497481844629
Epoch:            5 | Training loss: 0.6452053926693287 | Validation loss: 0.
6593311312750653
Epoch:            6 | Training loss: 0.6386421442963653 | Validation loss: 0.
6547649681077621
Epoch:            7 | Training loss: 0.6323668266195384 | Validation loss: 0.
6508831035033373
Epoch:            8 | Training loss: 0.6263637885081658 | Validation loss: 0.
646807198319044
Epoch:            9 | Training loss: 0.6206204502428556 | Validation loss: 0.
6428858815480362
Epoch:           10 | Training loss: 0.6151767238327646 | Validation loss: 0.
6396623979330834
Epoch:           11 | Training loss: 0.609845715591354 | Validation loss: 0.6
358778134230869
Epoch:           12 | Training loss: 0.604756188208439 | Validation loss: 0.6
325091443832197
Epoch:           13 | Training loss: 0.5999002394456334 | Validation loss: 0.
6296350281372073
Epoch:           14 | Training loss: 0.5951376283097551 | Validation loss: 0.
6262000368044384
Epoch:           15 | Training loss: 0.5905756357472257 | Validation loss: 0.
6233305598258702
Epoch:           16 | Training loss: 0.5862372658496688 | Validation loss: 0.
6209689484216493
Epoch:           17 | Training loss: 0.581905398928384 | Validation loss: 0.6
```

```
179787950308346
Epoch:           18  |  Training loss: 0.577742520110898  |  Validation loss: 0.6
151677797676206
Epoch:           19  |  Training loss: 0.5737214636229424  |  Validation loss: 0.
6125938850452932
Epoch:           20  |  Training loss: 0.5698144559872289  |  Validation loss: 0.
6100265148201706
Epoch:           21  |  Training loss: 0.5660239496643485  |  Validation loss: 0.
6077671940312467
Epoch:           22  |  Training loss: 0.5623300324717654  |  Validation loss: 0.
6053441439552966
Epoch:           23  |  Training loss: 0.5587414093216637  |  Validation loss: 0.
6029637456308884
Epoch:           24  |  Training loss: 0.5552944210101647  |  Validation loss: 0.
6013460498197573
Epoch:           25  |  Training loss: 0.5518268212456903  |  Validation loss: 0.
5987320080911547
Epoch:           26  |  Training loss: 0.5485249949354061  |  Validation loss: 0.
5969672731324652
Epoch:           27  |  Training loss: 0.5452802190147286  |  Validation loss: 0.
5949692187699758
Epoch:           28  |  Training loss: 0.5420781290805007  |  Validation loss: 0.
5927427771696481
Epoch:           29  |  Training loss: 0.5390111867826298  |  Validation loss: 0.
5911239580143767
Epoch:           30  |  Training loss: 0.5359439493482108  |  Validation loss: 0.
5889467384323289
Epoch:           31  |  Training loss: 0.5329796510247374  |  Validation loss: 0.
5871251286276815
Epoch:           32  |  Training loss: 0.5301176000221315  |  Validation loss: 0.
5856455295295541
Epoch:           33  |  Training loss: 0.5272388938640946  |  Validation loss: 0.
5834152502951336
Epoch:           34  |  Training loss: 0.5244547565334727  |  Validation loss: 0.
5818044550272002
Epoch:           35  |  Training loss: 0.52172852325207  |  Validation loss: 0.58
00432049876707
Epoch:           36  |  Training loss: 0.5190558789923125  |  Validation loss: 0.
578456896129711
Epoch:           37  |  Training loss: 0.516453487292853  |  Validation loss: 0.5
770803313558684
Epoch:           38  |  Training loss: 0.513870318044707  |  Validation loss: 0.5
753777350112871
Epoch:           39  |  Training loss: 0.5113458371442201  |  Validation loss: 0.
5736609278388736
Epoch:           40  |  Training loss: 0.5088812466154196  |  Validation loss: 0.
5720122621008485
Epoch:           41  |  Training loss: 0.5064559365837635  |  Validation loss: 0.
5704878002544378
Epoch:           42  |  Training loss: 0.5040611098456501  |  Validation loss: 0.
5690708785314242
Epoch:           43  |  Training loss: 0.5017172581487721  |  Validation loss: 0.
5676191023932475
Epoch:           44  |  Training loss: 0.49939529606206307  |  Validation loss: 0
.5664365252215591
Epoch:           45  |  Training loss: 0.497128074840416  |  Validation loss: 0.5
650458801998457
Epoch:           46  |  Training loss: 0.49489780296357805  |  Validation loss: 0
.563686626330277
Epoch:           47  |  Training loss: 0.4927144681537183  |  Validation loss: 0.
5625238716460754
```

```
Epoch:           48 | Training loss: 0.49054794550616765 | Validation loss: 0
.5609853783238933
Epoch:           49 | Training loss: 0.48844874786217424 | Validation loss: 0
.5594813342118663
Epoch:           50 | Training loss: 0.48634613829460394 | Validation loss: 0
.5582877883204269
Epoch:           51 | Training loss: 0.4842846903705197 | Validation loss: 0.
5570667276076547
Epoch:           52 | Training loss: 0.4822742617208387 | Validation loss: 0.
5557421632385584
Epoch:           53 | Training loss: 0.48025616914023217 | Validation loss: 0
.5547042242005429
Epoch:           54 | Training loss: 0.4783069491785102 | Validation loss: 0.
5533717760345802
Epoch:           55 | Training loss: 0.47637084540296337 | Validation loss: 0
.5522001348280919
Epoch:           56 | Training loss: 0.4744455907820437 | Validation loss: 0.
5511903484129346
Epoch:           57 | Training loss: 0.4725621107882126 | Validation loss: 0.
550125215764641
Epoch:           58 | Training loss: 0.470712753074095 | Validation loss: 0.5
491466224215243
Epoch:           59 | Training loss: 0.46887911353178635 | Validation loss: 0
.5478603549227371
Epoch:           60 | Training loss: 0.4670747971758169 | Validation loss: 0.
546782996583354
Epoch:           61 | Training loss: 0.46529545233905223 | Validation loss: 0
.5457036834327387
Epoch:           62 | Training loss: 0.46354020002521207 | Validation loss: 0
.5447114953262654
Epoch:           63 | Training loss: 0.46180878732468905 | Validation loss: 0
.5436095673772724
Epoch:           64 | Training loss: 0.46010252738365764 | Validation loss: 0
.5425183830617022
Epoch:           65 | Training loss: 0.4584299337411981 | Validation loss: 0.
5413922073062979
Epoch:           66 | Training loss: 0.45674899316206846 | Validation loss: 0
.5405867420030074
Epoch:           67 | Training loss: 0.45510742886167294 | Validation loss: 0
.5396955843777661
Epoch:           68 | Training loss: 0.45348392740588944 | Validation loss: 0
.5386201143125006
Epoch:           69 | Training loss: 0.45188116740576756 | Validation loss: 0
.5376613714804986
Epoch:           70 | Training loss: 0.4503026488375919 | Validation loss: 0.
5368547354606295
Epoch:           71 | Training loss: 0.44873963076113715 | Validation loss: 0
.5356749964183811
Epoch:           72 | Training loss: 0.4471922221110514 | Validation loss: 0.
5347910810492931
Epoch:           73 | Training loss: 0.4456683766667241 | Validation loss: 0.
534075602442569
Epoch:           74 | Training loss: 0.44415729906744056 | Validation loss: 0
.5330732598526281
Epoch:           75 | Training loss: 0.44267007280168935 | Validation loss: 0
.532594293515628
Epoch:           76 | Training loss: 0.4411956618106526 | Validation loss: 0.
5313395534191189
Epoch:           77 | Training loss: 0.4397440504424411 | Validation loss: 0.
5305492606412416
Epoch:           78 | Training loss: 0.4383040665127144 | Validation loss: 0.
```

```
5296750191638945
Epoch:          79 | Training loss: 0.4368856781047964 | Validation loss: 0.
5288858127520981
Epoch:          80 | Training loss: 0.43547779154670196 | Validation loss: 0
.528037456676135
Epoch:          81 | Training loss: 0.4340811518026034 | Validation loss: 0.
5271155159937243
Epoch:          82 | Training loss: 0.43271470979649 | Validation loss: 0.52
64239358533529
Epoch:          83 | Training loss: 0.4313613351424055 | Validation loss: 0.
5256707149630229
Epoch:          84 | Training loss: 0.43001012498839536 | Validation loss: 0
.5244956917430461
Epoch:          85 | Training loss: 0.4286807144462921 | Validation loss: 0.
5236942645502541
Epoch:          86 | Training loss: 0.42736052733104934 | Validation loss: 0
.5232488951091172
Epoch:          87 | Training loss: 0.42605266609169373 | Validation loss: 0
.5224249793339374
Epoch:          88 | Training loss: 0.42475918935432216 | Validation loss: 0
.5215452011200294
Epoch:          89 | Training loss: 0.4234987677220478 | Validation loss: 0.
5206139463031617
Epoch:          90 | Training loss: 0.4222203516358699 | Validation loss: 0.
5200574481127126
Epoch:          91 | Training loss: 0.4209943897707911 | Validation loss: 0.
5190988492874482
Epoch:          92 | Training loss: 0.4197352360386647 | Validation loss: 0.
5185435608175893
Epoch:          93 | Training loss: 0.41851256182607505 | Validation loss: 0
.5179941205643547
Epoch:          94 | Training loss: 0.4172984452808729 | Validation loss: 0.
5171018923189314
Epoch:          95 | Training loss: 0.4161041218678112 | Validation loss: 0.
5163329116542446
Epoch:          96 | Training loss: 0.4149115504938181 | Validation loss: 0.
5158930835719984
Epoch:          97 | Training loss: 0.4137307846367059 | Validation loss: 0.
5150508140561005
Epoch:          98 | Training loss: 0.41256463859181347 | Validation loss: 0
.5143872285423555
Epoch:          99 | Training loss: 0.4114141746281255 | Validation loss: 0.
513849877804208
Epoch:          100 | Training loss: 0.41026920417318674 | Validation loss: 0
.5129945414208679
Epoch:          101 | Training loss: 0.4091341335961638 | Validation loss: 0.
5124140035592559
Epoch:          102 | Training loss: 0.4080124202995435 | Validation loss: 0.
5117345707137345
Epoch:          103 | Training loss: 0.4069011637216388 | Validation loss: 0.
5111619868493045
Epoch:          104 | Training loss: 0.40580053406251687 | Validation loss: 0
.510431844176886
Epoch:          105 | Training loss: 0.404709231036198 | Validation loss: 0.5
09888212804336
Epoch:          106 | Training loss: 0.4036340400715333 | Validation loss: 0.
5093634229694946
Epoch:          107 | Training loss: 0.40255650324923115 | Validation loss: 0
.5086122260498738
Epoch:          108 | Training loss: 0.4014948372474508 | Validation loss: 0.
507998291503608
```

```
Epoch:          109 | Training loss: 0.40045113250525105 | Validation loss: 0
.5072574793473223
Epoch:          110 | Training loss: 0.3994026581944833 | Validation loss: 0.
5067188889651709
Epoch:          111 | Training loss: 0.398366691985684 | Validation loss: 0.5
062188068896009
Epoch:          112 | Training loss: 0.39734339390219386 | Validation loss: 0
.5055674299974872
Epoch:          113 | Training loss: 0.3963287288085639 | Validation loss: 0.
5049712701574218
Epoch:          114 | Training loss: 0.3953208665506723 | Validation loss: 0.
5044783720232037
Epoch:          115 | Training loss: 0.3943235528957187 | Validation loss: 0.
5039241281271938
Epoch:          116 | Training loss: 0.3933341330022623 | Validation loss: 0.
5033043970808911
Epoch:          117 | Training loss: 0.3923532635154811 | Validation loss: 0.
5027787504477884
Epoch:          118 | Training loss: 0.3913822126106426 | Validation loss: 0.
5021622989687501
Epoch:          119 | Training loss: 0.39041842121512005 | Validation loss: 0
.5017399791088522
Epoch:          120 | Training loss: 0.3894632681692919 | Validation loss: 0.
5012150245374769
Epoch:          121 | Training loss: 0.38851790751309295 | Validation loss: 0
.5007145193045582
Epoch:          122 | Training loss: 0.3875731116383252 | Validation loss: 0.
5000285173870387
Epoch:          123 | Training loss: 0.3866406215371825 | Validation loss: 0.
4995737648371532
Epoch:          124 | Training loss: 0.3857155291135991 | Validation loss: 0.
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Epoch:          125 | Training loss: 0.3847986846728013 | Validation loss: 0.
4985486893792735
Epoch:          126 | Training loss: 0.383890441800551 | Validation loss: 0.4
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Epoch:          127 | Training loss: 0.3829854180277261 | Validation loss: 0.
4974826269192006
Epoch:          128 | Training loss: 0.3820905476336964 | Validation loss: 0.
49695336714958366
Epoch:          129 | Training loss: 0.3812023511869097 | Validation loss: 0.
4964642791996936
Epoch:          130 | Training loss: 0.3803209801187777 | Validation loss: 0.
4959769740620793
Epoch:          131 | Training loss: 0.37944743928540026 | Validation loss: 0
.49546160664677713
Epoch:          132 | Training loss: 0.378578966482501 | Validation loss: 0.4
950198049331997
Epoch:          133 | Training loss: 0.37772035722221664 | Validation loss: 0
.4944902687455752
Epoch:          134 | Training loss: 0.37686519393095524 | Validation loss: 0
.4940376681191796
Epoch:          135 | Training loss: 0.3760177479077774 | Validation loss: 0.
49357463208614094
Epoch:          136 | Training loss: 0.3751786102263893 | Validation loss: 0.
4930748382868596
Epoch:          137 | Training loss: 0.3743416485110855 | Validation loss: 0.
4926929697976638
Epoch:          138 | Training loss: 0.37351623412655327 | Validation loss: 0
.4921580826997875
Epoch:          139 | Training loss: 0.37269578795373237 | Validation loss: 0
```

```
                 .4918870139891737
Epoch:           140 | Training loss: 0.3718758363855222 | Validation loss: 0.
4913515277130312
Epoch:           141 | Training loss: 0.3710665338020973 | Validation loss: 0.
4908630847182542
Epoch:           142 | Training loss: 0.3702717748162309 | Validation loss: 0.
4903169877156136
Epoch:           143 | Training loss: 0.3694704014669354 | Validation loss: 0.
4899133575827769
Epoch:           144 | Training loss: 0.3686792931479502 | Validation loss: 0.
48947511114830405
Epoch:           145 | Training loss: 0.3678883383830997 | Validation loss: 0.
48911253052881337
Epoch:           146 | Training loss: 0.36710726216744743 | Validation loss: 0
.488763050071894
Epoch:           147 | Training loss: 0.36633237589906115 | Validation loss: 0
.48831169616252895
Epoch:           148 | Training loss: 0.365563776255563 | Validation loss: 0.4
8792909736250484
Epoch:           149 | Training loss: 0.36480006042512514 | Validation loss: 0
.4874736801984968
Epoch:           150 | Training loss: 0.3640463462202897 | Validation loss: 0.
48717762515167934
Epoch:           151 | Training loss: 0.363302726809004 | Validation loss: 0.4
8685732553660926
Epoch:           152 | Training loss: 0.36254255649233047 | Validation loss: 0
.486271610360398
Epoch:           153 | Training loss: 0.3618009432779578 | Validation loss: 0.
48589534579646526
Epoch:           154 | Training loss: 0.36106494700224534 | Validation loss: 0
.48552850527226865
Epoch:           155 | Training loss: 0.36033227311336335 | Validation loss: 0
.4850878517409929
Epoch:           156 | Training loss: 0.3596057949000563 | Validation loss: 0.
48469405868414045
Epoch:           157 | Training loss: 0.3588845525516581 | Validation loss: 0.
48430382455748655
Epoch:           158 | Training loss: 0.3581691615506319 | Validation loss: 0.
483890293624856
Epoch:           159 | Training loss: 0.3574606139756218 | Validation loss: 0.
4834686803177793
Epoch:           160 | Training loss: 0.35675060464271113 | Validation loss: 0
.4831457492747593
Epoch:           161 | Training loss: 0.35604808212249234 | Validation loss: 0
.48281074939307833
Epoch:           162 | Training loss: 0.35535560350259304 | Validation loss: 0
.4825501537370661
Epoch:           163 | Training loss: 0.3546590876914427 | Validation loss: 0.
4821037478724831
Epoch:           164 | Training loss: 0.3539754645242062 | Validation loss: 0.
4816315247048225
Epoch:           165 | Training loss: 0.3532883039742285 | Validation loss: 0.
481342146757827
Epoch:           166 | Training loss: 0.35260962561435283 | Validation loss: 0
.4810135134774113
Epoch:           167 | Training loss: 0.3519430953207756 | Validation loss: 0.
4805382487790271
Epoch:           168 | Training loss: 0.35127767989930864 | Validation loss: 0
.4801627518469711
Epoch:           169 | Training loss: 0.3506008910725868 | Validation loss: 0.
4799536269706589
```

Epoch: 170 | Training loss: 0.34994902569550035 | Validation loss: 0
.4794910312979274
Epoch: 171 | Training loss: 0.34928430695456336 | Validation loss: 0
.4792486421320421
Epoch: 172 | Training loss: 0.3486319439722797 | Validation loss: 0.
47891627610180143
Epoch: 173 | Training loss: 0.34798496690532754 | Validation loss: 0
.4786568510986364
Epoch: 174 | Training loss: 0.34734630259286836 | Validation loss: 0
.47839314956664014
Epoch: 175 | Training loss: 0.34670473991216627 | Validation loss: 0
.4780412055039829
Epoch: 176 | Training loss: 0.3460727309790266 | Validation loss: 0.
47775077851948694
Epoch: 177 | Training loss: 0.34543357060268143 | Validation loss: 0
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Epoch: 178 | Training loss: 0.34480856341469557 | Validation loss: 0
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Epoch: 179 | Training loss: 0.3441825779950296 | Validation loss: 0.
4766530113106092
Epoch: 180 | Training loss: 0.34356397062517285 | Validation loss: 0
.4763824487951586
Epoch: 181 | Training loss: 0.34294770866766194 | Validation loss: 0
.4760098673791008
Epoch: 182 | Training loss: 0.3423363006170064 | Validation loss: 0.
47574568588934923
Epoch: 183 | Training loss: 0.3417281403530329 | Validation loss: 0.
4753918754549259
Epoch: 184 | Training loss: 0.34112796210289525 | Validation loss: 0
.4751986405081995
Epoch: 185 | Training loss: 0.3405236621453022 | Validation loss: 0.
47482169771225363
Epoch: 186 | Training loss: 0.3399268941984912 | Validation loss: 0.
47448915693938176
Epoch: 187 | Training loss: 0.3393378953768982 | Validation loss: 0.
47412064363050577
Epoch: 188 | Training loss: 0.33875058165312744 | Validation loss: 0
.473807583301183
Epoch: 189 | Training loss: 0.3381682464535065 | Validation loss: 0.
4734914897806795
Epoch: 190 | Training loss: 0.3375806722099586 | Validation loss: 0.
4732426603168354

Hyper Parameters -- Learning Rate - 0.0020080000000000002 Regularization P
arameter- 1e-05
Epoch: 0 | Training loss: 0.3012320633888825 | Validation loss: 0.
45033230765463883
Epoch: 1 | Training loss: 0.21865796311223237 | Validation loss: 0
.4127966475232387
Epoch: 2 | Training loss: 0.183508174595189 | Validation loss: 0.4
023351188471051
Epoch: 3 | Training loss: 0.1489309107671668 | Validation loss: 0.
38789650566006173
Epoch: 4 | Training loss: 0.1251774537949242 | Validation loss: 0.
38300443423134495
Epoch: 5 | Training loss: 0.11015549555848307 | Validation loss: 0
.37592915761858664
Epoch: 6 | Training loss: 0.09754061816934748 | Validation loss: 0
.3708475847517112

Hyper Parameters -- Learning Rate - 0.0020080000000000002 Regularization P

```
arameter- 6.309573444801929e-05
Epoch:          0 | Training loss: 0.3012969639331216 | Validation loss: 0.
4503972061373513
Epoch:          1 | Training loss: 0.21878958429816475 | Validation loss: 0
.4129282649904498
Epoch:          2 | Training loss: 0.1837014304984044 | Validation loss: 0.
4025283677461245
Epoch:          3 | Training loss: 0.14918381491262078 | Validation loss: 0
.38814939999372455
Epoch:          4 | Training loss: 0.12548654662238973 | Validation loss: 0
.3833135121303798
Epoch:          5 | Training loss: 0.11051765281522488 | Validation loss: 0
.37629129483515816
Epoch:          6 | Training loss: 0.0979527958130758 | Validation loss: 0.
37125973927091893


Hyper Parameters -- Learning Rate - 0.0020080000000000002  Regularization P
arameter- 0.00039810717055349735
Epoch:          0 | Training loss: 0.30170645859319156 | Validation loss: 0
.45080668779007715
Epoch:          1 | Training loss: 0.21962005751692715 | Validation loss: 0
.413758714745707
Epoch:          2 | Training loss: 0.18492079216683602 | Validation loss: 0
.4037476852211503
Epoch:          3 | Training loss: 0.15077953114222645 | Validation loss: 0
.38974505431526396
Epoch:          4 | Training loss: 0.1274367889962387 | Validation loss: 0.
3852636603124951
Epoch:          5 | Training loss: 0.11280270856323366 | Validation loss: 0
.3785762241386978
Epoch:          6 | Training loss: 0.10055345827126218 | Validation loss: 0
.37386025582386495


Hyper Parameters -- Learning Rate - 0.0020080000000000002   Regularization P
arameter- 0.002511886431509582
Epoch:          0 | Training loss: 0.3042901916267073 | Validation loss: 0.
4533903387532032
Epoch:          1 | Training loss: 0.2248599765146347 | Validation loss: 0.
41899848570026393
Epoch:          2 | Training loss: 0.1926144184302677 | Validation loss: 0.
4114410326463425
Epoch:          3 | Training loss: 0.16084777806406217 | Validation loss: 0
.3998129106295888
Epoch:          4 | Training loss: 0.13974192588589707 | Validation loss: 0
.3975682029043389
Epoch:          5 | Training loss: 0.12722035354347208 | Validation loss: 0
.39299307132641587
Epoch:          6 | Training loss: 0.11696242327227858 | Validation loss: 0
.390268300249744


Hyper Parameters -- Learning Rate - 0.0020080000000000002  Regularization P
arameter- 0.01584893192461114
Epoch:          0 | Training loss: 0.3205923016697353 | Validation loss: 0.
46969193098311834
Epoch:          1 | Training loss: 0.25792112191084204 | Validation loss: 0
.45205869706940177


Hyper Parameters -- Learning Rate - 0.004006  Regularization Parameter- 1e-
05
Epoch:          0 | Training loss: 0.21098844070905118 | Validation loss: 0
.4084597381486796
```

```
Epoch:          1 | Training loss: 0.13838955131019415 | Validation loss: 0
.39781390353484847
Epoch:          2 | Training loss: 0.11109829868495244 | Validation loss: 0
.39180226793916717
Epoch:          3 | Training loss: 0.08268631717154996 | Validation loss: 0
.37425408183274855


Hyper Parameters -- Learning Rate - 0.004006  Regularization Parameter- 6.3
09573444801929e-05
Epoch:          0 | Training loss: 0.2111867369764866 | Validation loss: 0.
40865802850800054
Epoch:          1 | Training loss: 0.13872418525175997 | Validation loss: 0
.3981485256180467
Epoch:          2 | Training loss: 0.11154481216617529 | Validation loss: 0
.3922487575030329
Epoch:          3 | Training loss: 0.08323293024006155 | Validation loss: 0
.3748006661191878


Hyper Parameters -- Learning Rate - 0.004006  Regularization Parameter- 0.0
0039810717055349735
Epoch:          0 | Training loss: 0.2124379013635932 | Validation loss: 0.
40990915561747276
Epoch:          1 | Training loss: 0.14083558122230988 | Validation loss: 0
.40025984676757204
Epoch:          2 | Training loss: 0.11436211903084265 | Validation loss: 0
.3950659134598576
Epoch:          3 | Training loss: 0.08668182130474456 | Validation loss: 0
.3782493755820356


Hyper Parameters -- Learning Rate - 0.004006  Regularization Parameter- 0.0
02511886431509582
Epoch:          0 | Training loss: 0.22033219600150647 | Validation loss: 0
.41780321505133655
Epoch:          1 | Training loss: 0.15415753101137214 | Validation loss: 0
.41358132447654555
Epoch:          2 | Training loss: 0.13213801456210242 | Validation loss: 0
.4128408568460466
Epoch:          3 | Training loss: 0.10844268410675126 | Validation loss: 0
.40000909258432044


Hyper Parameters -- Learning Rate - 0.004006  Regularization Parameter- 0.0
1584893192461114
Epoch:          0 | Training loss: 0.27014107326685194 | Validation loss: 0
.4676106083559728


Hyper Parameters -- Learning Rate - 0.006004000000000001  Regularization Pa
rameter- 1e-05
Epoch:          0 | Training loss: 0.172098095079241 | Validation loss: 0.4
0398359676132517


Hyper Parameters -- Learning Rate - 0.006004000000000001  Regularization Pa
rameter- 6.309573444801929e-05
Epoch:          0 | Training loss: 0.17250918683391267 | Validation loss: 0
.4043946751343455


Hyper Parameters -- Learning Rate - 0.006004000000000001  Regularization Pa
rameter- 0.00039810717055349735
Epoch:          0 | Training loss: 0.17510299900239124 | Validation loss: 0
.40698840287048854


Hyper Parameters -- Learning Rate - 0.006004000000000001  Regularization Pa
```

rameter- 0.002511886431509582
Epoch: 0 | Training loss: 0.1914687896494019 | Validation loss: 0.
4233536607924469

Hyper Parameters -- Learning Rate - 0.006004000000000001 Regularization Pa
rameter- 0.01584893192461114
Epoch: 0 | Training loss: 0.2947276494846339 | Validation loss: 0.
5266091596372889

Hyper Parameters -- Learning Rate - 0.008002 Regularization Parameter- 1e-
05
Epoch: 0 | Training loss: 0.16084385618121183 | Validation loss: 0
.4416418183337902
Epoch: 1 | Training loss: 0.08071210335820123 | Validation loss: 0
.43453885207148824
Epoch: 2 | Training loss: 0.054384175860235584 | Validation loss:
0.41544289144715707
Epoch: 3 | Training loss: 0.03611133282619482 | Validation loss: 0
.38009552025470283

Hyper Parameters -- Learning Rate - 0.008002 Regularization Parameter- 6.3
09573444801929e-05
Epoch: 0 | Training loss: 0.1615725603049002 | Validation loss: 0.
4423704999530994
Epoch: 1 | Training loss: 0.08172282109814254 | Validation loss: 0
.43554953659190426
Epoch: 2 | Training loss: 0.05556260529133738 | Validation loss: 0
.41662122045257843
Epoch: 3 | Training loss: 0.037420185262045984 | Validation loss:
0.3814042741276259

Hyper Parameters -- Learning Rate - 0.008002 Regularization Parameter- 0.0
0039810717055349735
Epoch: 0 | Training loss: 0.16617036901206908 | Validation loss: 0
.44696816666754763
Epoch: 1 | Training loss: 0.08810000996181006 | Validation loss: 0
.44192651585548076
Epoch: 2 | Training loss: 0.06299797692631297 | Validation loss: 0
.42405595844877503
Epoch: 3 | Training loss: 0.0456784630479232 | Validation loss: 0.
38966193002894295

Hyper Parameters -- Learning Rate - 0.008002 Regularization Parameter- 0.0
02511886431509582
Epoch: 0 | Training loss: 0.19518044216456068 | Validation loss: 0
.47597734391893604

Hyper Parameters -- Learning Rate - 0.008002 Regularization Parameter- 0.0
1584893192461114
Epoch: 0 | Training loss: 0.3782161131489366 | Validation loss: 0.
659007362642958

In [39]:
```python
#get the best hyper parameters
temp = np.array(train_loss_history)
train_loss_history_sortidx = np.argsort(temp)

best_train_loss = temp[train_loss_history_sortidx[0]]
best_validation_loss = validation_loss_history[train_loss_history_sortidx[0]]
best_hyperparams=hyperparam_history[train_loss_history_sortidx[0]]

print(f'Best Training loss - {best_train_loss},best_validation_loss-{best_v
```

```
Best Training loss - 0.23281265732113487,best_validation_loss-0.41329350790
053354,
best_hyperparams-[1e-05, 1e-05]
```

In [40]:
```python
weight, train_loss_count, dev_loss_count = SGD(X_tr=train_count_vector,
                                               Y_tr=train_labels,
                                               X_dev=dev_count_vector,
                                               Y_dev=dev_labels,
                                               lr=best_hyperparams[0],
                                               alpha=best_hyperparams[1],
                                               tolerance=0.00001,
                                               epochs=500,
                                               print_progress=True)
```

```
Epoch:            0 | Training loss: 0.6837664802935786 | Validation loss: 0.
6860666266246024
Epoch:            1 | Training loss: 0.6751537941301965 | Validation loss: 0.
6800242919507538
Epoch:            2 | Training loss: 0.6670410843190909 | Validation loss: 0.
6741665937070213
Epoch:            3 | Training loss: 0.6593693831021286 | Validation loss: 0.
6688284403248014
Epoch:            4 | Training loss: 0.6520789507389164 | Validation loss: 0.
6642044718900759
Epoch:            5 | Training loss: 0.6451418867290613 | Validation loss: 0.
6592676317437978
Epoch:            6 | Training loss: 0.6385578999155843 | Validation loss: 0.
6546807321249714
Epoch:            7 | Training loss: 0.6322596420878759 | Validation loss: 0.
6507759296929874
Epoch:            8 | Training loss: 0.6262314087264625 | Validation loss: 0.
646674831896937
Epoch:            9 | Training loss: 0.620460854628425 | Validation loss: 0.6
4272630178654
Epoch:           10 | Training loss: 0.6149881618632875 | Validation loss: 0.
6394738548143387
Epoch:           11 | Training loss: 0.6096263303307669 | Validation loss: 0.
6356584498778969
Epoch:           12 | Training loss: 0.6045043018078649 | Validation loss: 0.
6322572826186653
Epoch:           13 | Training loss: 0.5996144292432117 | Validation loss: 0.
6293492459800534
Epoch:           14 | Training loss: 0.5948162723563388 | Validation loss: 0.
6258787119313933
Epoch:           15 | Training loss: 0.5902174540550508 | Validation loss: 0.
6229724126694056
Epoch:           16 | Training loss: 0.5858409993538789 | Validation loss: 0.
```

```
                 6205727203610901
Epoch:        17 | Training loss: 0.5814696132641515 | Validation loss: 0.
                 6175430515652522
Epoch:        18 | Training loss: 0.5772660634103965 | Validation loss: 0.
                 6146913686402145
Epoch:        19 | Training loss: 0.573203239868719 | Validation loss: 0.6
                 120757106076501
Epoch:        20 | Training loss: 0.5692533401304347 | Validation loss: 0.
                 6094654516686768
Epoch:        21 | Training loss: 0.565418961747484 | Validation loss: 0.6
                 071622629742548
Epoch:        22 | Training loss: 0.5616801579878159 | Validation loss: 0.
                 6046943304173754
Epoch:        23 | Training loss: 0.5580456726258316 | Validation loss: 0.
                 6022680736754554
Epoch:        24 | Training loss: 0.5545520121760678 | Validation loss: 0.
                 6006037103567777
Epoch:        25 | Training loss: 0.5510367585348915 | Validation loss: 0.
                 5979420185980028
Epoch:        26 | Training loss: 0.5476865083427509 | Validation loss: 0.
                 596128864112069
Epoch:        27 | Training loss: 0.5443924556120864 | Validation loss: 0.
                 59408153700836
Epoch:        28 | Training loss: 0.5411402012734088 | Validation loss: 0.
                 5918049348792468
Epoch:        29 | Training loss: 0.5380223918391238 | Validation loss: 0.
                 59013525326893
Epoch:        30 | Training loss: 0.5349035346458563 | Validation loss: 0.
                 5879064173990801
Epoch:        31 | Training loss: 0.5318869420725559 | Validation loss: 0.
                 5860325171763313
Epoch:        32 | Training loss: 0.5289719737508198 | Validation loss: 0.
                 5845000056060266
Epoch:        33 | Training loss: 0.5260395933891074 | Validation loss: 0.
                 5822160556529584
Epoch:        34 | Training loss: 0.5232012126512148 | Validation loss: 0.
                 5805510208618871
Epoch:        35 | Training loss: 0.5204200399022954 | Validation loss: 0.
                 5787348355126516
Epoch:        36 | Training loss: 0.5176919364011832 | Validation loss: 0.
                 5770930718379378
Epoch:        37 | Training loss: 0.5150336240849595 | Validation loss: 0.
                 5756605902730182
Epoch:        38 | Training loss: 0.5123937823554481 | Validation loss: 0.
                 5739013257967216
Epoch:        39 | Training loss: 0.509812115063446 | Validation loss: 0.5
                 721273367399778
Epoch:        40 | Training loss: 0.50728973068448 | Validation loss: 0.57
                 04208804294065
Epoch:        41 | Training loss: 0.5048061870437035 | Validation loss: 0.
                 5688381889547951
Epoch:        42 | Training loss: 0.5023526571599741 | Validation loss: 0.
                 5673625681109469
Epoch:        43 | Training loss: 0.4999495815903 | Validation loss: 0.565
                 8515724516266
Epoch:        44 | Training loss: 0.49756792858969884 | Validation loss: 0
                 .5646093091599969
Epoch:        45 | Training loss: 0.4952405210849046 | Validation loss: 0.
                 5631584819637063
Epoch:        46 | Training loss: 0.4929495823818077 | Validation loss: 0.
                 5617385648972377
```

```
Epoch:              47 | Training loss: 0.4907052406130593 | Validation loss: 0.
5605148072784047
Epoch:              48 | Training loss: 0.48847718354110614 | Validation loss: 0
.5589147833835034
Epoch:              49 | Training loss: 0.48631595490055785 | Validation loss: 0
.5573487114953168
Epoch:              50 | Training loss: 0.48415099012918256 | Validation loss: 0
.5560928143646193
Epoch:              51 | Training loss: 0.4820267580317835 | Validation loss: 0.
5548089734127464
Epoch:              52 | Training loss: 0.4799531560891506 | Validation loss: 0.
5534212394390322
Epoch:              53 | Training loss: 0.4778715239330672 | Validation loss: 0.
5523197650202973
Epoch:              54 | Training loss: 0.4758583903519518 | Validation loss: 0.
5509223406670577
Epoch:              55 | Training loss: 0.47385802271210575 | Validation loss: 0
.5496875054123193
Epoch:              56 | Training loss: 0.4718681295381277 | Validation loss: 0.
548613084374457
Epoch:              57 | Training loss: 0.46991966274925095 | Validation loss: 0
.5474829695359023
Epoch:              58 | Training loss: 0.4680049722151188 | Validation loss: 0.
5464390469432487
Epoch:              59 | Training loss: 0.4661056300765147 | Validation loss: 0.
5450870805694685
Epoch:              60 | Training loss: 0.4642353057270652 | Validation loss: 0.
5439437184317902
Epoch:              61 | Training loss: 0.46238963126834726 | Validation loss: 0
.5427980778893151
Epoch:              62 | Training loss: 0.4605677091500393 | Validation loss: 0.
5417392248113186
Epoch:              63 | Training loss: 0.45876931457710496 | Validation loss: 0
.5405703181534346
Epoch:              64 | Training loss: 0.4569957814670056 | Validation loss: 0.
5394118632507483
Epoch:              65 | Training loss: 0.45525567083657764 | Validation loss: 0
.5382181738733991
Epoch:              66 | Training loss: 0.45350693965796374 | Validation loss: 0
.5373449221244526
Epoch:              67 | Training loss: 0.4517972310911083 | Validation loss: 0.
5363856244619263
Epoch:              68 | Training loss: 0.45010537742194817 | Validation loss: 0
.5352418058418439
Epoch:              69 | Training loss: 0.44843390998528515 | Validation loss: 0
.5342143588566688
Epoch:              70 | Training loss: 0.4467864345514428 | Validation loss: 0.
5333387689769278
Epoch:              71 | Training loss: 0.4451541229710335 | Validation loss: 0.
53208973855215
Epoch:              72 | Training loss: 0.44353724671552713 | Validation loss: 0
.531136359 6198899
Epoch:              73 | Training loss: 0.4419436689976153 | Validation loss: 0.
5303511529307477
Epoch:              74 | Training loss: 0.44036265764022897 | Validation loss: 0
.5292788789961118
Epoch:              75 | Training loss: 0.43880524132660653 | Validation loss: 0
.5283948624752359
Epoch:              76 | Training loss: 0.4372603678646285 | Validation loss: 0.
5274045270345552
Epoch:              77 | Training loss: 0.4357380559904594 | Validation loss: 0.
```

```
5265435372786134
Epoch:           78 | Training loss: 0.4342271454320785 | Validation loss: 0.
5255983716061824
Epoch:           79 | Training loss: 0.4327375884245382 | Validation loss: 0.
5247380006049372
Epoch:           80 | Training loss: 0.43125832339600356 | Validation loss: 0
.5238182689310932
Epoch:           81 | Training loss: 0.4297900551815661 | Validation loss: 0.
5228247023817667
Epoch:           82 | Training loss: 0.4283518810233583 | Validation loss: 0.
5220613935123488
Epoch:           83 | Training loss: 0.4269265876611975 | Validation loss: 0.
5212362568522544
Epoch:           84 | Training loss: 0.42550311120505496 | Validation loss: 0
.5199889692115025
Epoch:           85 | Training loss: 0.42410125587166264 | Validation loss: 0
.5191150987011416
Epoch:           86 | Training loss: 0.42270846707060045 | Validation loss: 0
.5185971321153982
Epoch:           87 | Training loss: 0.42132776064686667 | Validation loss: 0
.5177003748719688
Epoch:           88 | Training loss: 0.41996120999150743 | Validation loss: 0
.516747525008293
Epoch:           89 | Training loss: 0.4186275736309935 | Validation loss: 0.
5157430577343197
Epoch:           90 | Training loss: 0.4172757794162526 | Validation loss: 0.
5151131850544521
Epoch:           91 | Training loss: 0.4159762832232861 | Validation loss: 0.
5140810545242347
Epoch:           92 | Training loss: 0.41464340331998195 | Validation loss: 0
.5134520424238438
Epoch:           93 | Training loss: 0.4133468123738284 | Validation loss: 0.
5128286890702466
Epoch:           94 | Training loss: 0.4120585401784717 | Validation loss: 0.
5118623067546063
Epoch:           95 | Training loss: 0.4107899160380053 | Validation loss: 0.
5110190277209037
Epoch:           96 | Training loss: 0.4095229318181874 | Validation loss: 0.
5105047904426872
Epoch:           97 | Training loss: 0.40826756001931724 | Validation loss: 0
.5095879179310288
Epoch:           98 | Training loss: 0.4070266603437674 | Validation loss: 0.
5088495815583657
Epoch:           99 | Training loss: 0.40580129879378796 | Validation loss: 0
.5082373370727296
Epoch:          100 | Training loss: 0.4045811907223099 | Validation loss: 0.
5073068644241903
Epoch:          101 | Training loss: 0.4033708860588333 | Validation loss: 0.
5066510957252813
Epoch:          102 | Training loss: 0.4021737142323049 | Validation loss: 0.
5058962069390738
Epoch:          103 | Training loss: 0.4009868699255227 | Validation loss: 0.
5052480378871065
Epoch:          104 | Training loss: 0.3998105320332447 | Validation loss: 0.
5044421897435346
Epoch:          105 | Training loss: 0.39864337152841883 | Validation loss: 0
.5038227036901928
Epoch:          106 | Training loss: 0.39749217950254906 | Validation loss: 0
.5032219159790792
Epoch:          107 | Training loss: 0.39633839108272556 | Validation loss: 0
.502394469121143
```

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Epoch:          108 | Training loss: 0.3952003948948108 | Validation loss: 0.
5017042072427088
Epoch:          109 | Training loss: 0.39408021017633094 | Validation loss: 0
.50088691692697
Epoch:          110 | Training loss: 0.3929551844944264 | Validation loss: 0.
5002717780832359
Epoch:          111 | Training loss: 0.3918424925389611 | Validation loss: 0.
4996949738951304
Epoch:          112 | Training loss: 0.39074235881939934 | Validation loss: 0
.4989667625670596
Epoch:          113 | Training loss: 0.3896507254594083 | Validation loss: 0.
4982936372009222
Epoch:          114 | Training loss: 0.38856577839811474 | Validation loss: 0
.4977236576057825
Epoch:          115 | Training loss: 0.3874912587487948 | Validation loss: 0.
497092210414007
Epoch:          116 | Training loss: 0.3864245058441865 | Validation loss: 0.
49639514844708915
Epoch:          117 | Training loss: 0.38536621832108536 | Validation loss: 0
.49579208574398304
Epoch:          118 | Training loss: 0.3843175961350903 | Validation loss: 0.
49509806489595914
Epoch:          119 | Training loss: 0.3832761101869947 | Validation loss: 0.
4945980545743065
Epoch:          120 | Training loss: 0.3822431351101441 | Validation loss: 0.
49399528013576244
Epoch:          121 | Training loss: 0.3812198618511562 | Validation loss: 0.
49341686473156166
Epoch:          122 | Training loss: 0.38019700909799203 | Validation loss: 0
.49265280746861395
Epoch:          123 | Training loss: 0.37918637405184313 | Validation loss: 0
.4921199129806377
Epoch:          124 | Training loss: 0.3781830213035372 | Validation loss: 0.
4914571494940989
Epoch:          125 | Training loss: 0.37718782077397384 | Validation loss: 0
.4909382254841343
Epoch:          126 | Training loss: 0.3762010919228765 | Validation loss: 0.
49038305322243275
Epoch:          127 | Training loss: 0.37521745495581926 | Validation loss: 0
.48971506875948606
Epoch:          128 | Training loss: 0.37424387402819387 | Validation loss: 0
.48910710029759175
Epoch:          129 | Training loss: 0.3732769285856317 | Validation loss: 0.
4885392655074986
Epoch:          130 | Training loss: 0.3723166583632724 | Validation loss: 0.
4879730632345186
Epoch:          131 | Training loss: 0.3713641008337482 | Validation loss: 0.
487378681738184
Epoch:          132 | Training loss: 0.3704165479403739 | Validation loss: 0.
48685780270798495
Epoch:          133 | Training loss: 0.3694787611742333 | Validation loss: 0.
48624909090034096
Epoch:          134 | Training loss: 0.36854427604964013 | Validation loss: 0
.48571717053841934
Epoch:          135 | Training loss: 0.367617447551719 | Validation loss: 0.4
851747551705035
Epoch:          136 | Training loss: 0.3666988185612402 | Validation loss: 0.
4845954720943099
Epoch:          137 | Training loss: 0.3657823020599932 | Validation loss: 0.
4841340518317611
Epoch:          138 | Training loss: 0.36487720696773046 | Validation loss: 0
```

.48351948615726514
Epoch: 139 | Training loss: 0.3639770230485703 | Validation loss: 0.
48316868363794596
Epoch: 140 | Training loss: 0.3630771836196717 | Validation loss: 0.
48255331134807916
Epoch: 141 | Training loss: 0.3621879412017794 | Validation loss: 0.
4819849300908874
Epoch: 142 | Training loss: 0.3613131043358653 | Validation loss: 0.
48135875654667154
Epoch: 143 | Training loss: 0.36043164837788605 | Validation loss: 0
.4808750458407627
Epoch: 144 | Training loss: 0.3595603669371584 | Validation loss: 0.
4803566282554021
Epoch: 145 | Training loss: 0.35868919508036623 | Validation loss: 0
.4799138336732156
Epoch: 146 | Training loss: 0.35782773389332767 | Validation loss: 0
.47948397072265253
Epoch: 147 | Training loss: 0.35697236820113565 | Validation loss: 0
.4789521401224263
Epoch: 148 | Training loss: 0.3561232624581765 | Validation loss: 0.
47848903725237946
Epoch: 149 | Training loss: 0.3552789495491082 | Validation loss: 0.
4779530252895735
Epoch: 150 | Training loss: 0.3544446139721459 | Validation loss: 0.
47757635267120546
Epoch: 151 | Training loss: 0.35362023402704046 | Validation loss: 0
.47717529632732564
Epoch: 152 | Training loss: 0.3527792258499768 | Validation loss: 0.
4765087429996908
Epoch: 153 | Training loss: 0.3519567366894854 | Validation loss: 0.
47605160488496323
Epoch: 154 | Training loss: 0.35113978870596857 | Validation loss: 0
.4756038160862036
Epoch: 155 | Training loss: 0.35032605388671406 | Validation loss: 0
.47508210274007345
Epoch: 156 | Training loss: 0.34951843544699124 | Validation loss: 0
.4746071712777294
Epoch: 157 | Training loss: 0.34871603472216606 | Validation loss: 0
.47413578067771944
Epoch: 158 | Training loss: 0.34791942036625095 | Validation loss: 0
.47364102772769856
Epoch: 159 | Training loss: 0.3471295332823663 | Validation loss: 0.
4731380770914423
Epoch: 160 | Training loss: 0.3463381998065525 | Validation loss: 0.
47273382440140005
Epoch: 161 | Training loss: 0.345554218566849 | Validation loss: 0.4
7231736813332575
Epoch: 162 | Training loss: 0.34478024841307064 | Validation loss: 0
.4719752848419785
Epoch: 163 | Training loss: 0.3440021560793176 | Validation loss: 0.
47144730377500155
Epoch: 164 | Training loss: 0.34323692981262605 | Validation loss: 0
.4708934783438385
Epoch: 165 | Training loss: 0.342468076305001 | Validation loss: 0.4
7052241099472575
Epoch: 166 | Training loss: 0.341707655134254 | Validation loss: 0.4
701120375278542
Epoch: 167 | Training loss: 0.3409592786909664 | Validation loss: 0.
4695549272699273
Epoch: 168 | Training loss: 0.3402119277923956 | Validation loss: 0.
469097496921235

```
Epoch:          169 | Training loss: 0.3394532304418111 | Validation loss: 0.
4688064676161413
Epoch:          170 | Training loss: 0.3387193153988854 | Validation loss: 0.
46826182222140617
Epoch:          171 | Training loss: 0.337972573017819 | Validation loss: 0.4
6793741316463544
Epoch:          172 | Training loss: 0.3372380530027844 | Validation loss: 0.
4675228925721659
Epoch:          173 | Training loss: 0.3365088972153167 | Validation loss: 0.
46718129154621324
Epoch:          174 | Training loss: 0.3357879888220526 | Validation loss: 0.
46683534931068876
Epoch:          175 | Training loss: 0.33506411731170416 | Validation loss: 0
.4664010990597667
Epoch:          176 | Training loss: 0.33434973525181466 | Validation loss: 0
.46602830178329085
Epoch:          177 | Training loss: 0.33362816376952426 | Validation loss: 0
.465508050069186
Epoch:          178 | Training loss: 0.3329206905966826 | Validation loss: 0.
4651603280407606
Epoch:          179 | Training loss: 0.33221217814564225 | Validation loss: 0
.4646831356370877
Epoch:          180 | Training loss: 0.33151099935248435 | Validation loss: 0
.4643300041296846
Epoch:          181 | Training loss: 0.33081210232163055 | Validation loss: 0
.4638747885329552
Epoch:          182 | Training loss: 0.33011805846000997 | Validation loss: 0
.4635279741292131
Epoch:          183 | Training loss: 0.3294272036932456 | Validation loss: 0.
463091471366948
Epoch:          184 | Training loss: 0.32874422459478614 | Validation loss: 0
.4628154395085077
Epoch:          185 | Training loss: 0.32805709022503043 | Validation loss: 0
.4623556638684647
Epoch:          186 | Training loss: 0.32737747565202324 | Validation loss: 0
.461940278786045
Epoch:          187 | Training loss: 0.32670557530677463 | Validation loss: 0
.4614888647627559
Epoch:          188 | Training loss: 0.3260353060054206 | Validation loss: 0.
4610928508119131
Epoch:          189 | Training loss: 0.3253700076164875 | Validation loss: 0.
46069379519061937
Epoch:          190 | Training loss: 0.32469939811023496 | Validation loss: 0
.4603619337468763
Epoch:          191 | Training loss: 0.3240404177149908 | Validation loss: 0.
46019173218447484
Epoch:          192 | Training loss: 0.323375462716851 | Validation loss: 0.4
5971808113545903
Epoch:          193 | Training loss: 0.32272050285827336 | Validation loss: 0
.4593517241599492
Epoch:          194 | Training loss: 0.32206953512295705 | Validation loss: 0
.45893612843053744
Epoch:          195 | Training loss: 0.32142179912782315 | Validation loss: 0
.45856682603386134
Epoch:          196 | Training loss: 0.3207761135070402 | Validation loss: 0.
458264333647355
Epoch:          197 | Training loss: 0.32013539395873586 | Validation loss: 0
.45793776255217006
Epoch:          198 | Training loss: 0.3194963562881158 | Validation loss: 0.
45752488975725647
Epoch:          199 | Training loss: 0.31886139082229314 | Validation loss: 0
```

.4571746746889178
Epoch: 200 | Training loss: 0.31823343920021396 | Validation loss: 0
.45675616731951757
Epoch: 201 | Training loss: 0.3176026336108145 | Validation loss: 0.
4564356528359507
Epoch: 202 | Training loss: 0.31697586594662347 | Validation loss: 0
.4561232978672811
Epoch: 203 | Training loss: 0.31635354048571507 | Validation loss: 0
.45577870249066565
Epoch: 204 | Training loss: 0.31574323525768355 | Validation loss: 0
.45558912172238913
Epoch: 205 | Training loss: 0.31512046253664283 | Validation loss: 0
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Epoch:          437 | Training loss: 0.22203624272313757 | Validation loss: 0
.4084469023348704
Epoch:          438 | Training loss: 0.22176904716287385 | Validation loss: 0
.4083633529987958
Epoch:          439 | Training loss: 0.22150015483384988 | Validation loss: 0
.4082282170460054
Epoch:          440 | Training loss: 0.2212328098628687 | Validation loss: 0.
408105948109107
Epoch:          441 | Training loss: 0.22096693810609863 | Validation loss: 0
.4080009156357633
Epoch:          442 | Training loss: 0.220700399708208 | Validation loss: 0.4
078651903572045
Epoch:          443 | Training loss: 0.22043521937609176 | Validation loss: 0
```

```
.4077371894985217
Epoch:          444 | Training loss: 0.22017185827724728 | Validation loss: 0
.4075950301320391
Epoch:          445 | Training loss: 0.21990728801701112 | Validation loss: 0
.40750055127956286
Epoch:          446 | Training loss: 0.21964437223668085 | Validation loss: 0
.4073974417503937
Epoch:          447 | Training loss: 0.21938233034850121 | Validation loss: 0
.40729106579573143
Epoch:          448 | Training loss: 0.21912091496029498 | Validation loss: 0
.40718057663716634
Epoch:          449 | Training loss: 0.21885999419925334 | Validation loss: 0
.40706495675263
Epoch:          450 | Training loss: 0.21859952828562224 | Validation loss: 0
.40694336945652976
Epoch:          451 | Training loss: 0.21834029345426975 | Validation loss: 0
.4068377678530383
Epoch:          452 | Training loss: 0.21808134076779062 | Validation loss: 0
.406691713827346
Epoch:          453 | Training loss: 0.21782310367567237 | Validation loss: 0
.4065816102267918
Epoch:          454 | Training loss: 0.2175656833106895 | Validation loss: 0.
40646754676537133
Epoch:          455 | Training loss: 0.217308975111601 | Validation loss: 0.4
0638406021940626
Epoch:          456 | Training loss: 0.2170546879049753 | Validation loss: 0.
4062178157201805
Epoch:          457 | Training loss: 0.21679780830955442 | Validation loss: 0
.406122533552396
Epoch:          458 | Training loss: 0.21654235153805432 | Validation loss: 0
.4060297893990572
Epoch:          459 | Training loss: 0.21628826169531626 | Validation loss: 0
.40593218150455657
Epoch:          460 | Training loss: 0.21603497903166827 | Validation loss: 0
.40582921585326526
Epoch:          461 | Training loss: 0.21578452337228538 | Validation loss: 0
.40575360167351954
Epoch:          462 | Training loss: 0.21552985925759616 | Validation loss: 0
.40560570190782785
Epoch:          463 | Training loss: 0.21527866028822612 | Validation loss: 0
.40546666893646716
Epoch:          464 | Training loss: 0.21502779997228305 | Validation loss: 0
.4053574184458678
Epoch:          465 | Training loss: 0.21477704088410238 | Validation loss: 0
.40526742571201174
Epoch:          466 | Training loss: 0.2145277155093855 | Validation loss: 0.
40514644479554823
Epoch:          467 | Training loss: 0.21427883044166085 | Validation loss: 0
.40503666812230976
Epoch:          468 | Training loss: 0.21403012713098787 | Validation loss: 0
.4049490213929041
Epoch:          469 | Training loss: 0.21378302797452328 | Validation loss: 0
.404861865928374
Epoch:          470 | Training loss: 0.2135355850945529 | Validation loss: 0.
40474668008452674
Epoch:          471 | Training loss: 0.21329115521001785 | Validation loss: 0
.40467110847791815
Epoch:          472 | Training loss: 0.21304348509055784 | Validation loss: 0
.40453909683895434
Epoch:          473 | Training loss: 0.21279797875886536 | Validation loss: 0
.4044249470927188
```

```
Epoch:          474 | Training loss: 0.21255326509891273 | Validation loss: 0
.4043112070855892
Epoch:          475 | Training loss: 0.21230945759936243 | Validation loss: 0
.4041944306728286
Epoch:          476 | Training loss: 0.21206594407610685 | Validation loss: 0
.4040990130970394
Epoch:          477 | Training loss: 0.21182334642530057 | Validation loss: 0
.40398611667733986
Epoch:          478 | Training loss: 0.21158124458590985 | Validation loss: 0
.40388059664934345
Epoch:          479 | Training loss: 0.21134230198474288 | Validation loss: 0
.4037470988091057
Epoch:          480 | Training loss: 0.21109994650584202 | Validation loss: 0
.40365635354536245
Epoch:          481 | Training loss: 0.21085920074112663 | Validation loss: 0
.40355892173743824
Epoch:          482 | Training loss: 0.21061878865550285 | Validation loss: 0
.4034691336682451
Epoch:          483 | Training loss: 0.21037991407754703 | Validation loss: 0
.4033990321574138
Epoch:          484 | Training loss: 0.21014467292762118 | Validation loss: 0
.4033349054703899
Epoch:          485 | Training loss: 0.20990482458604617 | Validation loss: 0
.40321496127267026
Epoch:          486 | Training loss: 0.20966614337327721 | Validation loss: 0
.40309413790252696
Epoch:          487 | Training loss: 0.20943071132361998 | Validation loss: 0
.4030129848616822
Epoch:          488 | Training loss: 0.20919345671230677 | Validation loss: 0
.40289792767882304
Epoch:          489 | Training loss: 0.2089574813503881 | Validation loss: 0.
4027905531892129
Epoch:          490 | Training loss: 0.20872253739508823 | Validation loss: 0
.40265675362381054
Epoch:          491 | Training loss: 0.2084877810535611 | Validation loss: 0.
402565868577866614
Epoch:          492 | Training loss: 0.20825387315981012 | Validation loss: 0
.40246925609676687
Epoch:          493 | Training loss: 0.20802115104961932 | Validation loss: 0
.4023561213256771
Epoch:          494 | Training loss: 0.2077884911416652 | Validation loss: 0.
40225708315537545
Epoch:          495 | Training loss: 0.20755592284852165 | Validation loss: 0
.4021929651274633
Epoch:          496 | Training loss: 0.2073262520493661 | Validation loss: 0.
4021247120528588
Epoch:          497 | Training loss: 0.20709420304959614 | Validation loss: 0
.40201468929635453
Epoch:          498 | Training loss: 0.2068627555530405 | Validation loss: 0.
40189749156180526
Epoch:          499 | Training loss: 0.206632745655962 | Validation loss: 0.4
0179490798290757
```

Now plot the training and validation history per epoch for the best hyperparameter combination. Does your model underfit, overfit or is it about right? Explain why.
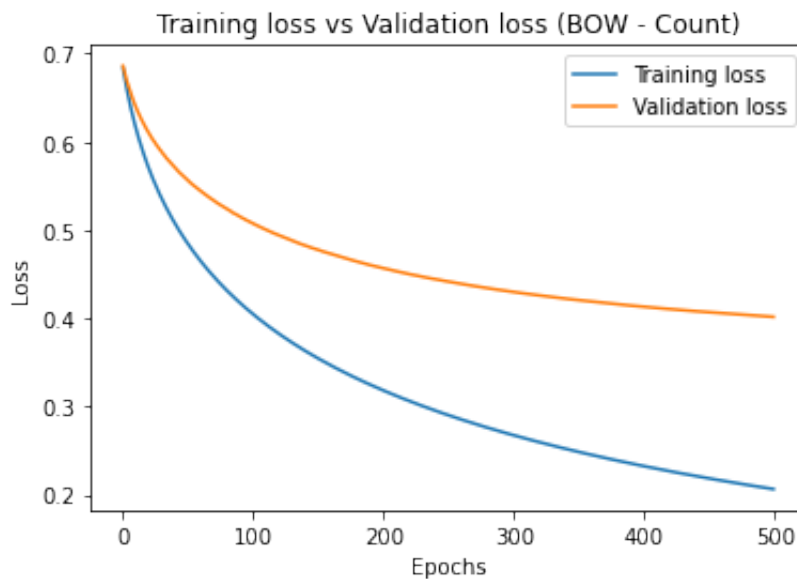
In [41]:
```python
plt.plot(train_loss_count, label='Training loss')
plt.plot(dev_loss_count, label='Validation loss')

plt.xlabel('Epochs')
plt.ylabel('Loss')

plt.title('Training loss vs Validation loss (BOW - Count)')

plt.legend()

plt.show()
```


Explain here...

Evaluation

Compute accuracy, precision, recall and F1-scores:

In [42]:
```python
preds_te_count = predict_class(test_count_vector, weight)

print('Accuracy:', accuracy_score(test_labels,preds_te_count))
print('Precision:', precision_score(test_labels,preds_te_count))
print('Recall:', recall_score(test_labels,preds_te_count))
print('F1-Score:', f1_score(test_labels,preds_te_count))
```

```
Accuracy: 0.845
Precision: 0.8349514563106796
Recall: 0.86
F1-Score: 0.8472906403940887
```

Finally, print the top-10 words for the negative and positive class respectively.

In [43]:
```python
top_negative_words = weight.argsort()[:10]
for i in top_negative_words:
    print(vocab_word[i])
```

```
('bad',)
('only',)
('plot',)
('worst',)
('unfortunately',)
('script',)
('why',)
('boring',)
('nothing',)
('any',)
```

In [44]:
```python
top_positive_words = weight.argsort()[::-1][:10]
for i in top_positive_words:
    print(vocab_word[i])
```

```
('great',)
('well',)
('also',)
('seen',)
('life',)
('world',)
('many',)
('see',)
('very',)
('fun',)
```

If we were to apply the classifier we've learned into a different domain such laptop reviews or restaurant reviews, do you think these features would generalise well? Can you propose what features the classifier could pick up as important in the new domain?

This classifier is trained on movie reviews data. Word count are the features we used to train this classfier and therefore if we were to apply this classifier in different domain such as laptop review or restaurant review, Most probably it would classify reviews correctly as reviews are either positive or negative, given that reviews are positive if the words used are among the top positive words and negative reviews contain words from top negative words of this classifier.

But, Restaurant and laptop reviews use different words to express positive and negative. In case of restaurant reviews,positive words like 'Delicious','Amazing','Welcomed','Cozy','Luxurious','Atmosphere',etc. And negative words like 'Unequipped','Snappy','mediocre',etc. And in case of Laptop reviews,positive words like 'Budget-friendly','fast','productivity','Gaming','Performance',etc. And negative words like 'Unsatisfied','Unhygenic',etc.

The above mentioned words are features that can be important in the new domain. I think that this classifier would not generalise well in different domains.

Discuss how did you choose model hyperparameters (e.g. learning rate and regularisation strength)? What is the relation between training epochs and learning rate? How the regularisation strength affects performance?

Generated 5 different values using logspace and linspace and trained the model for all 25 different variations and selected the best hyperparameter from the results. From online review i found out that learning rate range is between 0.0001 to 0.01.

If learning rate is too high then the cost function will converge very fast or in less epochs which may result in underfitting. if learning rate is too low then the cost function will converge very slow or takes higher epochs. Each epoch results in a larger weight update. Consequently, a higher learning rate will result in fewer convergence epochs.

from the above trails, it can observed that tiny changes in the regularization parameter affects the number of epochs required for convergence

Train and Evaluate Logistic Regression with TF.IDF vectors

Follow the same steps as above (i.e. evaluating count n-gram representations).

In [45]:
```python
#hyper paramater tuning for BOW-tfidf
train_loss_history =[]
validation_loss_history=[]
hyperparam_history=[]
#
for lr_i in lr:
    for alpha_i in alpha:
        print('\nHyper Parameters -- Learning Rate -',lr_i,' Regularizatior
        weight, train_loss_count, dev_loss_count = SGD(X_tr=train_tf_idf,
                                    Y_tr=train_labels,
                                    X_dev=dev_tf_idf,
                                    Y_dev=dev_labels,
                                    lr=lr_i,
                                    alpha=alpha_i,
                                    tolerance=0.00001,
                                    epochs=800,
                                    print_progress=True)
        if len(train_loss_count) > 40:
            train_loss_history.append(train_loss_count[-1])
            validation_loss_history.append(dev_loss_count[-1])
            hyperparam_history.append([lr_i,alpha_i])
```

```
Hyper Parameters -- Learning Rate - 1e-05  Regularization Parameter- 1e-05
Epoch:          0 | Training loss: 0.692800567939075 | Validation loss: 0.6
929612367529309
Epoch:          1 | Training loss: 0.6924645246871444 | Validation loss: 0.
6927857452679851
Epoch:          2 | Training loss: 0.6921289972266077 | Validation loss: 0.
6926106239865666
Epoch:          3 | Training loss: 0.6917940102060743 | Validation loss: 0.
6924359134949697
Epoch:          4 | Training loss: 0.6914596151049924 | Validation loss: 0.
```

```
6922617139230058
Epoch:          5 | Training loss: 0.6911256856816516 | Validation loss: 0.
6920878043710136
Epoch:          6 | Training loss: 0.6907922745230222 | Validation loss: 0.
6919142807633173
Epoch:          7 | Training loss: 0.6904594194224082 | Validation loss: 0.
6917412155235771
Epoch:          8 | Training loss: 0.6901270647922811 | Validation loss: 0.
6915685123754411
Epoch:          9 | Training loss: 0.6897951969477328 | Validation loss: 0.
691396150182651
Epoch:         10 | Training loss: 0.6894638851421462 | Validation loss: 0.
6912242577454198
Epoch:         11 | Training loss: 0.6891330140258485 | Validation loss: 0.
6910526305696232
Epoch:         12 | Training loss: 0.6888026418186329 | Validation loss: 0.
6908813831118628
Epoch:         13 | Training loss: 0.6884727898324601 | Validation loss: 0.
6907105483911548
Epoch:         14 | Training loss: 0.6881433669462337 | Validation loss: 0.
6905399698950612
Epoch:         15 | Training loss: 0.6878144453240634 | Validation loss: 0.
69036977936985
Epoch:         16 | Training loss: 0.6874860440655188 | Validation loss: 0.
6902000204523278
Epoch:         17 | Training loss: 0.6871580664763042 | Validation loss: 0.
6900305143626656
Epoch:         18 | Training loss: 0.6868305492277922 | Validation loss: 0.
6898613348676486
Epoch:         19 | Training loss: 0.6865034954013911 | Validation loss: 0.
6896924867683548
Epoch:         20 | Training loss: 0.686176901147569 | Validation loss: 0.6
895239713547265
Epoch:         21 | Training loss: 0.6858507583792727 | Validation loss: 0.
6893557715419854
Epoch:         22 | Training loss: 0.6855250533388121 | Validation loss: 0.
6891878594710401
Epoch:         23 | Training loss: 0.6851997888492011 | Validation loss: 0.
689020252878054
Epoch:         24 | Training loss: 0.6848750337064395 | Validation loss: 0.
6888530907466551
Epoch:         25 | Training loss: 0.6845506478067618 | Validation loss: 0.
6886860902355825
Epoch:         26 | Training loss: 0.6842267575834493 | Validation loss: 0.
6885195140174067
Epoch:         27 | Training loss: 0.6839032858950445 | Validation loss: 0.
6883532120930809
Epoch:         28 | Training loss: 0.6835802167162462 | Validation loss: 0.
6881871544565155
Epoch:         29 | Training loss: 0.6832576074183787 | Validation loss: 0.
688021452836907
Epoch:         30 | Training loss: 0.682935389748153 | Validation loss: 0.6
878559748865111
Epoch:         31 | Training loss: 0.6826136148306082 | Validation loss: 0.
6876908299680962
Epoch:         32 | Training loss: 0.6822922751907821 | Validation loss: 0.
6875260049885948
Epoch:         33 | Training loss: 0.6819712947284523 | Validation loss: 0.
6873613462878878
Epoch:         34 | Training loss: 0.6816507628913423 | Validation loss: 0.
6871970415639265
```

```
Epoch:           35 | Training loss: 0.6813306292200167 | Validation loss: 0.
6870329903876103
Epoch:           36 | Training loss: 0.6810109089689214 | Validation loss: 0.
6868692220551254
Epoch:           37 | Training loss: 0.6806916307291744 | Validation loss: 0.
6867058049080452
Epoch:           38 | Training loss: 0.6803727241319865 | Validation loss: 0.
686542589733213
Epoch:           39 | Training loss: 0.6800541936801452 | Validation loss: 0.
6863795899885752
Epoch:           40 | Training loss: 0.679736056949027 | Validation loss: 0.6
862168456164816
Epoch:           41 | Training loss: 0.6794183064025695 | Validation loss: 0.
6860543376291056
Epoch:           42 | Training loss: 0.6791009660933165 | Validation loss: 0.
6858921300331715
Epoch:           43 | Training loss: 0.6787840014415206 | Validation loss: 0.
6857301412171688
Epoch:           44 | Training loss: 0.6784674527138913 | Validation loss: 0.
6855684701457604
Epoch:           45 | Training loss: 0.6781512925525423 | Validation loss: 0.
6854070583614253
Epoch:           46 | Training loss: 0.6778355168554328 | Validation loss: 0.
6852458972275457
Epoch:           47 | Training loss: 0.677520143717432 | Validation loss: 0.6
850850294524722
Epoch:           48 | Training loss: 0.6772051117243725 | Validation loss: 0.
6849243151255568
Epoch:           49 | Training loss: 0.6768904490298635 | Validation loss: 0.
6847638226354056
Epoch:           50 | Training loss: 0.6765761771633134 | Validation loss: 0.
684603606942597
Epoch:           51 | Training loss: 0.6762622805269796 | Validation loss: 0.
6844436324093063
Epoch:           52 | Training loss: 0.6759487415438972 | Validation loss: 0.
6842838599729204
Epoch:           53 | Training loss: 0.6756356005342836 | Validation loss: 0.
6841243900098926
Epoch:           54 | Training loss: 0.6753228023582545 | Validation loss: 0.
6839650843559351
Epoch:           55 | Training loss: 0.6750103810899802 | Validation loss: 0.
6838060397860108
Epoch:           56 | Training loss: 0.6746983391644108 | Validation loss: 0.
6836472603724192
Epoch:           57 | Training loss: 0.6743866505901573 | Validation loss: 0.
6834886841473914
Epoch:           58 | Training loss: 0.6740753448204242 | Validation loss: 0.
6833303909117291
Epoch:           59 | Training loss: 0.6737643788790149 | Validation loss: 0.
6831722658671626
Epoch:           60 | Training loss: 0.6734537703485578 | Validation loss: 0.
6830143581853213
Epoch:           61 | Training loss: 0.6731435374316779 | Validation loss: 0.
6828567245150174
Epoch:           62 | Training loss: 0.6728336388647603 | Validation loss: 0.
6826992576060087
Epoch:           63 | Training loss: 0.672524104598194 | Validation loss: 0.6
8254203510953
Epoch:           64 | Training loss: 0.6722149213536749 | Validation loss: 0.
6823850246262382
Epoch:           65 | Training loss: 0.6719060750612919 | Validation loss: 0.
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```
6822281862375599
Epoch:            66 | Training loss: 0.6715975928420242 | Validation loss: 0.
6820716068197987
Epoch:            67 | Training loss: 0.6712894643429211 | Validation loss: 0.
6819152547871188
Epoch:            68 | Training loss: 0.6709816596609254 | Validation loss: 0.
6817590452622241
Epoch:            69 | Training loss: 0.6706742103534433 | Validation loss: 0.
6816030775832718
Epoch:            70 | Training loss: 0.6703671181382608 | Validation loss: 0.
6814473572958661
Epoch:            71 | Training loss: 0.6700603487091171 | Validation loss: 0.
681291787498692
Epoch:            72 | Training loss: 0.6697539252468182 | Validation loss: 0.
6811364279246732
Epoch:            73 | Training loss: 0.6694478468661129 | Validation loss: 0.
680981292375343
Epoch:            74 | Training loss: 0.6691421122887807 | Validation loss: 0.
6808263670246321
Epoch:            75 | Training loss: 0.6688367130651744 | Validation loss: 0.
6806716383098845
Epoch:            76 | Training loss: 0.6685316532796075 | Validation loss: 0.
6805171227357757
Epoch:            77 | Training loss: 0.6682269333783901 | Validation loss: 0.
6803628148697846
Epoch:            78 | Training loss: 0.6679225456077287 | Validation loss: 0.
6802087065886684
Epoch:            79 | Training loss: 0.6676184877148605 | Validation loss: 0.
680054784436978
Epoch:            80 | Training loss: 0.6673147677689449 | Validation loss: 0.
6799010754946707
Epoch:            81 | Training loss: 0.6670113612358961 | Validation loss: 0.
6797475114396216
Epoch:            82 | Training loss: 0.6667082950294083 | Validation loss: 0.
6795941599202662
Epoch:            83 | Training loss: 0.6664055614335234 | Validation loss: 0.
6794410228966363
Epoch:            84 | Training loss: 0.6661031245675162 | Validation loss: 0.
6792879760053756
Epoch:            85 | Training loss: 0.665801034535914 | Validation loss: 0.6
791351861869024
Epoch:            86 | Training loss: 0.6654992872749306 | Validation loss: 0.
6789826500284238
Epoch:            87 | Training loss: 0.6651978461863991 | Validation loss: 0.
6788302374253661
Epoch:            88 | Training loss: 0.6648967191432789 | Validation loss: 0.
6786779733315665
Epoch:            89 | Training loss: 0.6645958994831338 | Validation loss: 0.
6785258386542818
Epoch:            90 | Training loss: 0.6642954253760514 | Validation loss: 0.
6783739766510328
Epoch:            91 | Training loss: 0.663995243098021 | Validation loss: 0.6
782221846601486
Epoch:            92 | Training loss: 0.6636954082365566 | Validation loss: 0.
6780706855515956
Epoch:            93 | Training loss: 0.6633958957594278 | Validation loss: 0.
6779193829454906
Epoch:            94 | Training loss: 0.6630966880400112 | Validation loss: 0.
6777682115850182
Epoch:            95 | Training loss: 0.6627977977989086 | Validation loss: 0.
6776172236180668
```

```
Epoch:          96 | Training loss: 0.6624992433462207 | Validation loss: 0.
6774664888022767
Epoch:          97 | Training loss: 0.662200984367971 | Validation loss: 0.6
773158491882738
Epoch:          98 | Training loss: 0.6619030537296247 | Validation loss: 0.
6771654449825875
Epoch:          99 | Training loss: 0.6616054324706488 | Validation loss: 0.
677015205389964
Epoch:         100 | Training loss: 0.6613081133509421 | Validation loss: 0.
6768650966485668
Epoch:         101 | Training loss: 0.6610111101593095 | Validation loss: 0.
6767151760020531
Epoch:         102 | Training loss: 0.6607144145489127 | Validation loss: 0.
6765654190679788
Epoch:         103 | Training loss: 0.6604180347703628 | Validation loss: 0.
6764158544941499
Epoch:         104 | Training loss: 0.6601219540514127 | Validation loss: 0.
6762664223176676
Epoch:         105 | Training loss: 0.659826200566249 | Validation loss: 0.6
761172318006722
Epoch:         106 | Training loss: 0.6595307533572135 | Validation loss: 0.
6759682086688915
Epoch:         107 | Training loss: 0.659235602789792 | Validation loss: 0.6
758193186648043
Epoch:         108 | Training loss: 0.6589407562411161 | Validation loss: 0.
6756705956507321
Epoch:         109 | Training loss: 0.6586462017956569 | Validation loss: 0.
675521972129794
Epoch:         110 | Training loss: 0.6583519686264908 | Validation loss: 0.
6753735848307799
Epoch:         111 | Training loss: 0.6580580353589341 | Validation loss: 0.
67522534283359
Epoch:         112 | Training loss: 0.6577644090176792 | Validation loss: 0.
6750772823119757
Epoch:         113 | Training loss: 0.6574710779172253 | Validation loss: 0.
6749293589530513
Epoch:         114 | Training loss: 0.657178060604061 | Validation loss: 0.6
747816411286922
Epoch:         115 | Training loss: 0.6568853374047693 | Validation loss: 0.
6746340630553042
Epoch:         116 | Training loss: 0.6565929201311967 | Validation loss: 0.
674486661986355
Epoch:         117 | Training loss: 0.6563008055066791 | Validation loss: 0.
6743394387216323
Epoch:         118 | Training loss: 0.6560089853693535 | Validation loss: 0.
6741923552081142
Epoch:         119 | Training loss: 0.6557174670147218 | Validation loss: 0.
6740454505030037
Epoch:         120 | Training loss: 0.655426249127771 | Validation loss: 0.6
738987169993118
Epoch:         121 | Training loss: 0.655135331488778 | Validation loss: 0.6
737521580027345
Epoch:         122 | Training loss: 0.6548447046948332 | Validation loss: 0.
6736057263999942
Epoch:         123 | Training loss: 0.6545543809221767 | Validation loss: 0.
67345948338054
Epoch:         124 | Training loss: 0.6542643449337537 | Validation loss: 0.
6733133583131777
Epoch:         125 | Training loss: 0.6539746045006526 | Validation loss: 0.
6731674041785961
Epoch:         126 | Training loss: 0.6536851555546134 | Validation loss: 0.
```

```
6730215873655832
Epoch:          127 | Training loss: 0.6533959970231519 | Validation loss: 0.
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Epoch:        370 | Training loss: 0.5908047455683864 | Validation loss: 0.
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Epoch:         598 | Training loss: 0.5433096031272064 | Validation loss: 0.
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Epoch:         613 | Training loss: 0.5404909638633858 | Validation loss: 0.
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Epoch:         614 | Training loss: 0.5403042615222707 | Validation loss: 0.
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Epoch: 616 | Training loss: 0.5399313058353423 | Validation loss: 0.
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Epoch: 617 | Training loss: 0.5397450535851304 | Validation loss: 0.
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Epoch: 621 | Training loss: 0.5390015320489981 | Validation loss: 0.
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Epoch: 637 | Training loss: 0.5360511051319622 | Validation loss: 0.
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Epoch: 641 | Training loss: 0.5353193521433351 | Validation loss: 0.
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6128852330258334
Epoch: 644 | Training loss: 0.5347720597123885 | Validation loss: 0.
612791909994357

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Epoch:        645 | Training loss: 0.5345899171145577 | Validation loss: 0.
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Epoch:        646 | Training loss: 0.5344079195302056 | Validation loss: 0.
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Epoch:        647 | Training loss: 0.5342260659610159 | Validation loss: 0.
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Epoch:        674 | Training loss: 0.529369798917012 | Validation loss: 0.6
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Epoch:        675 | Training loss: 0.5291919051712036 | Validation loss: 0.
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Epoch:        680 | Training loss: 0.52830451936613 | Validation loss: 0.60
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Epoch:        682 | Training loss: 0.5279505321392101 | Validation loss: 0.
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Epoch:        683 | Training loss: 0.5277737458527963 | Validation loss: 0.
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Epoch:        684 | Training loss: 0.5275970961062004 | Validation loss: 0.
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Epoch:        685 | Training loss: 0.5274205844469526 | Validation loss: 0.
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Epoch:        692 | Training loss: 0.5261888360522551 | Validation loss: 0.
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Epoch:        699 | Training loss: 0.5249637513360207 | Validation loss: 0.
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Epoch:        703 | Training loss: 0.5242666756961119 | Validation loss: 0.
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Epoch:          707 | Training loss: 0.5235717463543215 | Validation loss: 0.
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Epoch:          708 | Training loss: 0.523398348445492 | Validation loss: 0.6
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Epoch:          709 | Training loss: 0.523225083892533 | Validation loss: 0.6
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Epoch:          710 | Training loss: 0.5230519521526503 | Validation loss: 0.
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Epoch:          712 | Training loss: 0.5227060886952829 | Validation loss: 0.
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Epoch:          713 | Training loss: 0.5225333572548598 | Validation loss: 0.
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Epoch:          714 | Training loss: 0.522360757503386 | Validation loss: 0.6
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Epoch:          715 | Training loss: 0.5221882913611825 | Validation loss: 0.
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Epoch:          716 | Training loss: 0.5220159563438492 | Validation loss: 0.
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Epoch:          730 | Training loss: 0.5196170712189809 | Validation loss: 0.
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Epoch:          733 | Training loss: 0.5191063525567232 | Validation loss: 0.
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Epoch:          735 | Training loss: 0.5187665218130056 | Validation loss: 0.
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Epoch:          736 | Training loss: 0.5185968000957009 | Validation loss: 0.
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Epoch:        745 | Training loss: 0.5170750864161291 | Validation loss: 0.
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Epoch:        750 | Training loss: 0.5162341619195804 | Validation loss: 0.
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Epoch:          776 | Training loss: 0.5119120388833899 | Validation loss: 0.
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Epoch:          781 | Training loss: 0.5110904703824123 | Validation loss: 0.
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Epoch:          782 | Training loss: 0.5109265233702079 | Validation loss: 0.
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Epoch:          787 | Training loss: 0.5101086199976002 | Validation loss: 0.
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Epoch:          788 | Training loss: 0.5099454033647414 | Validation loss: 0.
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Epoch:          792 | Training loss: 0.5092937497619932 | Validation loss: 0.
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Epoch:          793 | Training loss: 0.5091311387216559 | Validation loss: 0.
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Epoch:          794 | Training loss: 0.5089686476051756 | Validation loss: 0.
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Epoch:          795 | Training loss: 0.5088062763495708 | Validation loss: 0.
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Epoch:          796 | Training loss: 0.5086440258925053 | Validation loss: 0.
5993777223968629
Epoch:          797 | Training loss: 0.508481895223534 | Validation loss: 0.5
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992942685868634
Epoch: 798 | Training loss: 0.5083198843584814 | Validation loss: 0.
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Epoch: 799 | Training loss: 0.5081579933534266 | Validation loss: 0.
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Hyper Parameters -- Learning Rate - 1e-05 Regularization Parameter- 6.3095
73444801929e-05
Epoch: 0 | Training loss: 0.692800568189326 | Validation loss: 0.6
92961237003181
Epoch: 1 | Training loss: 0.6924645256872685 | Validation loss: 0.
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Epoch: 2 | Training loss: 0.6921289994751355 | Validation loss: 0.
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Epoch: 3 | Training loss: 0.6917940142002783 | Validation loss: 0.
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Epoch: 4 | Training loss: 0.6914596213405053 | Validation loss: 0.
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Epoch: 7 | Training loss: 0.6904594353474706 | Validation loss: 0.
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Epoch: 8 | Training loss: 0.6901270849313998 | Validation loss: 0.
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Epoch: 10 | Training loss: 0.6894639151788389 | Validation loss: 0.
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Epoch: 23 | Training loss: 0.6851999304413916 | Validation loss: 0.
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Epoch: 24 | Training loss: 0.684875187229955 | Validation loss: 0.6
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Epoch: 26 | Training loss: 0.6842269363941366 | Validation loss: 0.

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6885196928276541
Epoch:          27 | Training loss: 0.6839034780572074 | Validation loss: 0.
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Epoch:          28 | Training loss: 0.6835804227024505 | Validation loss: 0.
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Epoch:          29 | Training loss: 0.6832578276972076 | Validation loss: 0.
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Epoch:          514 | Training loss: 0.5597995623712008 | Validation loss: 0.
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Epoch:         735  | Training loss: 0.5188607298587062 | Validation loss: 0.
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Epoch:         736  | Training loss: 0.5186912255806455 | Validation loss: 0.
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Epoch:         737  | Training loss: 0.5185218506776843 | Validation loss: 0.
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Epoch:         738  | Training loss: 0.5183526040035187 | Validation loss: 0.
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Epoch:         739  | Training loss: 0.5181834861822686 | Validation loss: 0.
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Epoch:         740  | Training loss: 0.5180144972075086 | Validation loss: 0.
6042427591486598
Epoch:         741  | Training loss: 0.5178456368220129 | Validation loss: 0.
6041561221990975
Epoch:         742  | Training loss: 0.5176769046363286 | Validation loss: 0.
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Epoch:         743  | Training loss: 0.5175083004450133 | Validation loss: 0.
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Epoch:         744  | Training loss: 0.517339824439989 | Validation loss: 0.6
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Epoch:         745  | Training loss: 0.5171714763180109 | Validation loss: 0.
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Epoch:         746  | Training loss: 0.5170032564055382 | Validation loss: 0.
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Epoch:         747  | Training loss: 0.5168351643975462 | Validation loss: 0.
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Epoch:         748  | Training loss: 0.5166671985010969 | Validation loss: 0.
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Epoch:         749  | Training loss: 0.5164993601905312 | Validation loss: 0.
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Epoch:         750  | Training loss: 0.5163316489263896 | Validation loss: 0.
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Epoch:         751  | Training loss: 0.5161640648051725 | Validation loss: 0.
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Epoch:         752  | Training loss: 0.5159966082248423 | Validation loss: 0.
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Epoch:         753  | Training loss: 0.5158292777759508 | Validation loss: 0.
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Epoch:         754  | Training loss: 0.5156620739000672 | Validation loss: 0.
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Epoch:         755  | Training loss: 0.5154949965533897 | Validation loss: 0.
6029495335484263
Epoch:         756  | Training loss: 0.5153280447646068 | Validation loss: 0.
6028638507567533
Epoch:         757  | Training loss: 0.5151612196019486 | Validation loss: 0.
6027782064646656
Epoch:         758  | Training loss: 0.5149945199006827 | Validation loss: 0.
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6026926039812602
Epoch: 759 | Training loss: 0.5148279460942982 | Validation loss: 0.
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Epoch: 760 | Training loss: 0.5146614978314772 | Validation loss: 0.
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Epoch: 761 | Training loss: 0.5144951745534271 | Validation loss: 0.
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Epoch: 762 | Training loss: 0.5143289774135431 | Validation loss: 0.
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Epoch: 763 | Training loss: 0.5141629059180645 | Validation loss: 0.
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Epoch: 764 | Training loss: 0.513996959376971 | Validation loss: 0.6
021803595972294
Epoch: 765 | Training loss: 0.5138311369354388 | Validation loss: 0.
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Epoch: 766 | Training loss: 0.5136654398093452 | Validation loss: 0.
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Epoch: 767 | Training loss: 0.5134998669035045 | Validation loss: 0.
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Epoch: 769 | Training loss: 0.5131690953901686 | Validation loss: 0.
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Epoch: 770 | Training loss: 0.5130038954377859 | Validation loss: 0.
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Epoch: 771 | Training loss: 0.5128388193120488 | Validation loss: 0.
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Epoch: 772 | Training loss: 0.5126738673644596 | Validation loss: 0.
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Epoch: 773 | Training loss: 0.5125090395305444 | Validation loss: 0.
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Epoch: 774 | Training loss: 0.5123443353758993 | Validation loss: 0.
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Epoch: 775 | Training loss: 0.512179754655857 | Validation loss: 0.6
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Epoch: 776 | Training loss: 0.5120152960397151 | Validation loss: 0.
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Epoch: 777 | Training loss: 0.5118509605524564 | Validation loss: 0.
6010780934270032
Epoch: 778 | Training loss: 0.5116867495650052 | Validation loss: 0.
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Epoch: 779 | Training loss: 0.5115226601940862 | Validation loss: 0.
6009094071519564
Epoch: 780 | Training loss: 0.5113586932693674 | Validation loss: 0.
600825156064446
Epoch: 781 | Training loss: 0.51119484951659 | Validation loss: 0.60
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Epoch: 782 | Training loss: 0.5110311273736469 | Validation loss: 0.
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Epoch: 783 | Training loss: 0.5108675277391312 | Validation loss: 0.
6005728332241915
Epoch: 784 | Training loss: 0.5107040509659837 | Validation loss: 0.
6004888154073335
Epoch: 785 | Training loss: 0.510540695511235 | Validation loss: 0.6
004048703240641
Epoch: 786 | Training loss: 0.5103774622511974 | Validation loss: 0.
6003209602513376
Epoch: 787 | Training loss: 0.5102143506810192 | Validation loss: 0.
60023715690761
Epoch: 788 | Training loss: 0.5100513598514289 | Validation loss: 0.
6001533983394786

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Epoch:          789 | Training loss: 0.5098884904214738 | Validation loss: 0.
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Epoch:          790 | Training loss: 0.5097257431849612 | Validation loss: 0.
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Epoch:          791 | Training loss: 0.5095631166052641 | Validation loss: 0.
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Epoch:          792 | Training loss: 0.5094006110087715 | Validation loss: 0.
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Epoch:          793 | Training loss: 0.5092382265459678 | Validation loss: 0.
599735488465502
Epoch:          794 | Training loss: 0.5090759621603915 | Validation loss: 0.
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Epoch:          795 | Training loss: 0.5089138177875435 | Validation loss: 0.
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Epoch:          796 | Training loss: 0.5087517943691222 | Validation loss: 0.
5994854907456044
Epoch:          797 | Training loss: 0.5085898908934517 | Validation loss: 0.
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Epoch:          798 | Training loss: 0.5084281073736098 | Validation loss: 0.
5993191104522689
Epoch:          799 | Training loss: 0.50826644386756 | Validation loss: 0.59
92360102901795

Hyper Parameters -- Learning Rate - 1e-05  Regularization Parameter- 0.0003
9810717055349735
Epoch:            0 | Training loss: 0.6928005697683023 | Validation loss: 0.
6929612385821536
Epoch:            1 | Training loss: 0.6924645319976247 | Validation loss: 0.
6927857525784468
Epoch:            2 | Training loss: 0.6921290136623879 | Validation loss: 0.
6926106404223052
Epoch:            3 | Training loss: 0.6917940394020018 | Validation loss: 0.
6924359426908236
Epoch:            4 | Training loss: 0.6914596606839316 | Validation loss: 0.
6922617595018262
Epoch:            5 | Training loss: 0.6911257512640153 | Validation loss: 0.
6920878699532085
Epoch:            6 | Training loss: 0.6907923637182771 | Validation loss: 0.
6919143699583435
Epoch:            7 | Training loss: 0.6904595358278207 | Validation loss: 0.
6917413319286904
Epoch:            8 | Training loss: 0.6901272120006485 | Validation loss: 0.
6915686595834297
Epoch:            9 | Training loss: 0.6897953785450675 | Validation loss: 0.
6913963317795195
Epoch:           10 | Training loss: 0.689464104697558 | Validation loss: 0.6
91224477300266
Epoch:           11 | Training loss: 0.6891332751140147 | Validation loss: 0.
6910528916571209
Epoch:           12 | Training loss: 0.6888029479987144 | Validation loss: 0.
6908816892911631
Epoch:           13 | Training loss: 0.6884731446512823 | Validation loss: 0.
6907109032090716
Epoch:           14 | Training loss: 0.6881437739571384 | Validation loss: 0.
6905403769049318
Epoch:           15 | Training loss: 0.6878149080601265 | Validation loss: 0.
6903702421047413
Epoch:           16 | Training loss: 0.6874865660465109 | Validation loss: 0.
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Epoch:           17 | Training loss: 0.687158651232982 | Validation loss: 0.6
90031099117867
```

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Epoch:          18 | Training loss: 0.6868312002758548 | Validation loss: 0.
6898619859140734
Epoch:          19 | Training loss: 0.6865042162477869 | Validation loss: 0.
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Epoch:          20 | Training loss: 0.6861776952917732 | Validation loss: 0.
6895247654969449
Epoch:          21 | Training loss: 0.6858516293148598 | Validation loss: 0.
6893566424754013
Epoch:          22 | Training loss: 0.6855260045553905 | Validation loss: 0.
6891888106852554
Epoch:          23 | Training loss: 0.685200823827716 | Validation loss: 0.6
890212878540057
Epoch:          24 | Training loss: 0.6848761558978496 | Validation loss: 0.
6888542129352899
Epoch:          25 | Training loss: 0.684551860698506 | Validation loss: 0.6
886873031243382
Epoch:          26 | Training loss: 0.6842280646132982 | Validation loss: 0.
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Epoch:          27 | Training loss: 0.6839046905184867 | Validation loss: 0.
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Epoch:          28 | Training loss: 0.6835817223875337 | Validation loss: 0.
6881886601241226
Epoch:          29 | Training loss: 0.6832592175626548 | Validation loss: 0.
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Epoch:          30 | Training loss: 0.682937107809107 | Validation loss: 0.6
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Epoch:          31 | Training loss: 0.682615444223611 | Validation loss: 0.6
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Epoch:          32 | Training loss: 0.682294219325746 | Validation loss: 0.6
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Epoch:          33 | Training loss: 0.681973357041929 | Validation loss: 0.6
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Epoch:          34 | Training loss: 0.6816529467718865 | Validation loss: 0.
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Epoch:          35 | Training loss: 0.6813329380716855 | Validation loss: 0.
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Epoch:          36 | Training loss: 0.6810133461811202 | Validation loss: 0.
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Epoch:          37 | Training loss: 0.6806941996679537 | Validation loss: 0.
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Epoch:          38 | Training loss: 0.6803754281924204 | Validation loss: 0.
6865452937872221
Epoch:          39 | Training loss: 0.6800570362487858 | Validation loss: 0.
6863824325504827
Epoch:          40 | Training loss: 0.6797390413957924 | Validation loss: 0.
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Epoch:          41 | Training loss: 0.6794214360949399 | Validation loss: 0.
68605746731411
Epoch:          42 | Training loss: 0.6791042443762489 | Validation loss: 0.
6858954083084118
Epoch:          43 | Training loss: 0.678787431674258 | Validation loss: 0.6
85733571441883
Epoch:          44 | Training loss: 0.678471038221835 | Validation loss: 0.6
855720556453407
Epoch:          45 | Training loss: 0.678155036670727 | Validation loss: 0.6
854108024709007
Epoch:          46 | Training loss: 0.6778394229143995 | Validation loss: 0.
6852498032774507
Epoch:          47 | Training loss: 0.6775242150273308 | Validation loss: 0.
6850891007529483
Epoch:          48 | Training loss: 0.677209351632386 | Validation loss: 0.6
```

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849285550237856
Epoch:          49 | Training loss: 0.6768948608565003 | Validation loss: 0.
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Epoch:          50 | Training loss: 0.6765807642054465 | Validation loss: 0.
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Epoch:          51 | Training loss: 0.6762670460856582 | Validation loss: 0.
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Epoch:          52 | Training loss: 0.6759536889274177 | Validation loss: 0.
6842888073451552
Epoch:          53 | Training loss: 0.6756407330104568 | Validation loss: 0.
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Epoch:          54 | Training loss: 0.675328123234597 | Validation loss: 0.6
839704052202055
Epoch:          55 | Training loss: 0.6750158936366607 | Validation loss: 0.
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Epoch:          56 | Training loss: 0.6747040466420997 | Validation loss: 0.
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Epoch:          57 | Training loss: 0.6743925562757086 | Validation loss: 0.
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Epoch:          58 | Training loss: 0.6740814519553154 | Validation loss: 0.
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Epoch:          59 | Training loss: 0.6737706907401412 | Validation loss: 0.
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Epoch:          60 | Training loss: 0.6734602901886693 | Validation loss: 0.
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Epoch:          61 | Training loss: 0.673150268476475 | Validation loss: 0.6
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Epoch:          62 | Training loss: 0.6728405843757016 | Validation loss: 0.
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Epoch:          63 | Training loss: 0.6725312677993162 | Validation loss: 0.
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Epoch:          64 | Training loss: 0.6722223054757006 | Validation loss: 0.
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Epoch:          66 | Training loss: 0.6716054284886823 | Validation loss: 0.
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Epoch:          67 | Training loss: 0.6712975305589391 | Validation loss: 0.
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Epoch:          68 | Training loss: 0.6709899596823683 | Validation loss: 0.
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Epoch:          69 | Training loss: 0.6706827473702868 | Validation loss: 0.
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Epoch:          70 | Training loss: 0.6703758953309236 | Validation loss: 0.
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Epoch:          71 | Training loss: 0.6700693692949673 | Validation loss: 0.
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Epoch:          72 | Training loss: 0.6697631924089988 | Validation loss: 0.
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Epoch:          73 | Training loss: 0.6694573637788043 | Validation loss: 0.
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Epoch:          74 | Training loss: 0.6691518821228236 | Validation loss: 0.
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Epoch:          75 | Training loss: 0.6688467389947582 | Validation loss: 0.
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Epoch:          76 | Training loss: 0.6685419384657301 | Validation loss: 0.
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Epoch:          77 | Training loss: 0.6682374809763323 | Validation loss: 0.
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Epoch:          78 | Training loss: 0.6679333587742354 | Validation loss: 0.
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```

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Epoch:            79 | Training loss: 0.6676295696052956 | Validation loss: 0.
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Epoch:            89 | Training loss: 0.6646098409453222 | Validation loss: 0.
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Epoch:            91 | Training loss: 0.6640097938471884 | Validation loss: 0.
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Epoch:            93 | Training loss: 0.6634110680803954 | Validation loss: 0.
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Epoch:           107 | Training loss: 0.6592554687665393 | Validation loss: 0.
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Epoch:           108 | Training loss: 0.6589609802243939 | Validation loss: 0.
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Epoch:           109 | Training loss: 0.6586667868316264 | Validation loss: 0.
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Epoch: 110 | Training loss: 0.658372917674233 | Validation loss: 0.6
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Epoch: 139 | Training loss: 0.6499816465966517 | Validation loss: 0.
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Epoch:          140 | Training loss: 0.6496967110299315 | Validation loss: 0.
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Epoch:          169 | Training loss: 0.6415572389815608 | Validation loss: 0.
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Epoch:          170 | Training loss: 0.6412807532241559 | Validation loss: 0.
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Epoch:          638 | Training loss: 0.5364084436144524 | Validation loss: 0.
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Epoch:          639 | Training loss: 0.536226896299417 | Validation loss: 0.6
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Epoch:          640 | Training loss: 0.5360454950178972 | Validation loss: 0.
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Epoch:          641 | Training loss: 0.5358642413270152 | Validation loss: 0.
6136170311800134
Epoch:          642 | Training loss: 0.5356831329599255 | Validation loss: 0.
6135250224032123
Epoch:          643 | Training loss: 0.5355021719085323 | Validation loss: 0.
6134330577691253
Epoch:          644 | Training loss: 0.5353213553269315 | Validation loss: 0.
6133412049141718
Epoch:          645 | Training loss: 0.5351406843024568 | Validation loss: 0.
6132494073893375
Epoch:          646 | Training loss: 0.5349601597079389 | Validation loss: 0.
6131576301427437
Epoch:          647 | Training loss: 0.5347797804597179 | Validation loss: 0.
6130659701281692
Epoch:          648 | Training loss: 0.534599546146424 | Validation loss: 0.6
129743818067535
Epoch:          649 | Training loss: 0.5344194568585513 | Validation loss: 0.
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Epoch:          650 | Training loss: 0.5342395121379342 | Validation loss: 0.
6127913893767776
Epoch:          651 | Training loss: 0.5340597143907503 | Validation loss: 0.
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Epoch:          652 | Training loss: 0.5338800591432191 | Validation loss: 0.
6126087060121352
Epoch:          653 | Training loss: 0.5337005486904167 | Validation loss: 0.
6125174907426352
Epoch:          654 | Training loss: 0.5335211820817721 | Validation loss: 0.
6124263762487316
Epoch:          655 | Training loss: 0.5333419588925569 | Validation loss: 0.
612335288846082
Epoch:          656 | Training loss: 0.5331628793613853 | Validation loss: 0.
6122442625506536
Epoch:          657 | Training loss: 0.532983943274593 | Validation loss: 0.6
121533182697467
Epoch:          658 | Training loss: 0.5328051510941225 | Validation loss: 0.
```

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6120624340726033
Epoch:        659 | Training loss: 0.5326265030322687 | Validation loss: 0.
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Epoch:        660 | Training loss: 0.5324479972863638 | Validation loss: 0.
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Epoch:        661 | Training loss: 0.5322696343499813 | Validation loss: 0.
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Epoch:        662 | Training loss: 0.532091413373541 | Validation loss: 0.6
116996245340167
Epoch:        663 | Training loss: 0.5319133348090561 | Validation loss: 0.
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Epoch:        664 | Training loss: 0.5317353992603369 | Validation loss: 0.
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Epoch:        665 | Training loss: 0.5315576064151937 | Validation loss: 0.
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Epoch:        666 | Training loss: 0.5313799551931678 | Validation loss: 0.
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Epoch:        667 | Training loss: 0.5312024441754107 | Validation loss: 0.
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Epoch:        668 | Training loss: 0.5310250762558644 | Validation loss: 0.
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Epoch:        669 | Training loss: 0.5308478497854764 | Validation loss: 0.
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Epoch:        670 | Training loss: 0.530670764694895 | Validation loss: 0.6
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Epoch:        671 | Training loss: 0.5304938204931557 | Validation loss: 0.
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Epoch:        672 | Training loss: 0.5303170169756491 | Validation loss: 0.
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Epoch:        673 | Training loss: 0.5301403548104355 | Validation loss: 0.
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Epoch:        674 | Training loss: 0.5299638325869209 | Validation loss: 0.
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Epoch:        675 | Training loss: 0.5297874508726367 | Validation loss: 0.
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Epoch:        676 | Training loss: 0.5296112104502886 | Validation loss: 0.
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Epoch:        677 | Training loss: 0.5294351093363604 | Validation loss: 0.
6103491174973938
Epoch:        678 | Training loss: 0.5292591479833733 | Validation loss: 0.
610259644289746
Epoch:        679 | Training loss: 0.5290833264230436 | Validation loss: 0.
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Epoch:        680 | Training loss: 0.5289076449567495 | Validation loss: 0.
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Epoch:        681 | Training loss: 0.5287321023260312 | Validation loss: 0.
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Epoch:        682 | Training loss: 0.5285566989044697 | Validation loss: 0.
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Epoch:        683 | Training loss: 0.528381435159286 | Validation loss: 0.6
09813305053505
Epoch:        684 | Training loss: 0.528206309294538 | Validation loss: 0.6
097242136492799
Epoch:        685 | Training loss: 0.5280313227904417 | Validation loss: 0.
6096352169275199
Epoch:        686 | Training loss: 0.5278564752117418 | Validation loss: 0.
6095462899789369
Epoch:        687 | Training loss: 0.5276817650709599 | Validation loss: 0.
6094574273854776
Epoch:        688 | Training loss: 0.5275071932000217 | Validation loss: 0.
6093686337616557
```

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Epoch:          689 | Training loss: 0.5273327604120607 | Validation loss: 0.
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Epoch:          690 | Training loss: 0.5271584646958588 | Validation loss: 0.
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Epoch:          691 | Training loss: 0.5269843068526755 | Validation loss: 0.
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Epoch:          692 | Training loss: 0.5268102867829269 | Validation loss: 0.
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Epoch:          693 | Training loss: 0.5266364037769993 | Validation loss: 0.
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Epoch:          694 | Training loss: 0.5264626578614133 | Validation loss: 0.
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Epoch:          695 | Training loss: 0.5262890483983937 | Validation loss: 0.
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Epoch:          696 | Training loss: 0.5261155756677626 | Validation loss: 0.
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Epoch:          697 | Training loss: 0.5259422402732229 | Validation loss: 0.
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Epoch:          698 | Training loss: 0.5257690404744515 | Validation loss: 0.
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Epoch:          699 | Training loss: 0.5255959776661825 | Validation loss: 0.
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Epoch:          700 | Training loss: 0.5254230511153378 | Validation loss: 0.
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Epoch:          701 | Training loss: 0.5252502609588418 | Validation loss: 0.
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Epoch:          702 | Training loss: 0.5250776066645467 | Validation loss: 0.
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Epoch:          703 | Training loss: 0.5249050877097371 | Validation loss: 0.
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Epoch:          704 | Training loss: 0.5247327036466249 | Validation loss: 0.
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Epoch:          705 | Training loss: 0.5245604552803383 | Validation loss: 0.
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Epoch:          706 | Training loss: 0.5243883426103647 | Validation loss: 0.
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Epoch:          707 | Training loss: 0.5242163644686986 | Validation loss: 0.
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Epoch:          708 | Training loss: 0.5240445212690285 | Validation loss: 0.
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Epoch:          709 | Training loss: 0.5238728126393363 | Validation loss: 0.
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Epoch:          710 | Training loss: 0.5237012381391462 | Validation loss: 0.
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Epoch:          711 | Training loss: 0.5235297981501486 | Validation loss: 0.
607345242916589
Epoch:          712 | Training loss: 0.5233584928324149 | Validation loss: 0.
6072580762536127
Epoch:          713 | Training loss: 0.5231873223026493 | Validation loss: 0.
6071710266216757
Epoch:          714 | Training loss: 0.5230162847863554 | Validation loss: 0.
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Epoch:          715 | Training loss: 0.5228453821339272 | Validation loss: 0.
606996976804499
Epoch:          716 | Training loss: 0.5226746118675445 | Validation loss: 0.
6069100451389917
Epoch:          717 | Training loss: 0.5225039750965363 | Validation loss: 0.
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Epoch:          718 | Training loss: 0.5223334717299081 | Validation loss: 0.
6067364692477868
Epoch:          719 | Training loss: 0.5221631012647827 | Validation loss: 0.
```

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6066497489927819
Epoch:        720 | Training loss: 0.5219928639380818 | Validation loss: 0.
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Epoch:        721 | Training loss: 0.521822759226203 | Validation loss: 0.6
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Epoch:        722 | Training loss: 0.5216527864168753 | Validation loss: 0.
606390047035513
Epoch:        723 | Training loss: 0.52148294611553 | Validation loss: 0.60
63036098178648
Epoch:        724 | Training loss: 0.5213132393979009 | Validation loss: 0.
6062172225734608
Epoch:        725 | Training loss: 0.5211436646067895 | Validation loss: 0.
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Epoch:        726 | Training loss: 0.5209742205235224 | Validation loss: 0.
6060446821843327
Epoch:        727 | Training loss: 0.5208049085058349 | Validation loss: 0.
6059584945864747
Epoch:        728 | Training loss: 0.5206357282111618 | Validation loss: 0.
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Epoch:        729 | Training loss: 0.5204666805493908 | Validation loss: 0.
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Epoch:        730 | Training loss: 0.5202977631961627 | Validation loss: 0.
6057003666824379
Epoch:        731 | Training loss: 0.5201289770740329 | Validation loss: 0.
60561443106326
Epoch:        732 | Training loss: 0.5199603218694119 | Validation loss: 0.
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Epoch:        733 | Training loss: 0.5197917980646921 | Validation loss: 0.
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Epoch:        734 | Training loss: 0.519623404407013 | Validation loss: 0.6
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Epoch:        735 | Training loss: 0.5194551424231912 | Validation loss: 0.
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Epoch:        736 | Training loss: 0.5192870100939393 | Validation loss: 0.
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Epoch:        737 | Training loss: 0.5191190081767038 | Validation loss: 0.
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Epoch:        738 | Training loss: 0.5189511355512282 | Validation loss: 0.
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Epoch:        739 | Training loss: 0.5187833928327977 | Validation loss: 0.
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Epoch:        740 | Training loss: 0.5186157800170232 | Validation loss: 0.
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Epoch:        741 | Training loss: 0.5184482968016565 | Validation loss: 0.
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Epoch:        742 | Training loss: 0.5182809428355036 | Validation loss: 0.
6046735795373909
Epoch:        743 | Training loss: 0.518113717912999 | Validation loss: 0.6
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Epoch:        744 | Training loss: 0.5179466222210303 | Validation loss: 0.
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Epoch:        745 | Training loss: 0.5177796554636159 | Validation loss: 0.
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Epoch:        746 | Training loss: 0.5176128179530726 | Validation loss: 0.
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Epoch:        747 | Training loss: 0.517446109333440 | Validation loss: 0.
604248465860773
Epoch:        748 | Training loss: 0.5172795279053424 | Validation loss: 0.
6041636283296745
Epoch:        749 | Training loss: 0.5171130750676147 | Validation loss: 0.
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```

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Epoch:         750 | Training loss: 0.5169467503357555 | Validation loss: 0.
6039941739262834
Epoch:         751 | Training loss: 0.5167805537614553 | Validation loss: 0.
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Epoch:         752 | Training loss: 0.5166144857794298 | Validation loss: 0.
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Epoch:         753 | Training loss: 0.5164485449359787 | Validation loss: 0.
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Epoch:         754 | Training loss: 0.5162827316950831 | Validation loss: 0.
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Epoch:         755 | Training loss: 0.5161170460158411 | Validation loss: 0.
6035715822601102
Epoch:         756 | Training loss: 0.5159514868884417 | Validation loss: 0.
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Epoch:         757 | Training loss: 0.5157860554236486 | Validation loss: 0.
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Epoch:         758 | Training loss: 0.5156207504606782 | Validation loss: 0.
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Epoch:         759 | Training loss: 0.5154555723842841 | Validation loss: 0.
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Epoch:         760 | Training loss: 0.5152905208887542 | Validation loss: 0.
603150650209335
Epoch:         761 | Training loss: 0.5151255953994788 | Validation loss: 0.
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Epoch:         762 | Training loss: 0.5149607970435498 | Validation loss: 0.
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Epoch:         763 | Training loss: 0.514796125367966 | Validation loss: 0.6
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Epoch:         764 | Training loss: 0.5146315796515616 | Validation loss: 0.
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Epoch:         765 | Training loss: 0.5144671590573235 | Validation loss: 0.
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Epoch:         766 | Training loss: 0.5143028647675691 | Validation loss: 0.
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Epoch:         767 | Training loss: 0.5141386957008953 | Validation loss: 0.
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Epoch:         768 | Training loss: 0.5139746522954319 | Validation loss: 0.
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Epoch:         769 | Training loss: 0.5138107349301957 | Validation loss: 0.
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Epoch:         770 | Training loss: 0.5136469418354785 | Validation loss: 0.
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Epoch:         771 | Training loss: 0.513483273565362 | Validation loss: 0.6
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Epoch:         772 | Training loss: 0.5133197305042144 | Validation loss: 0.
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Epoch:         773 | Training loss: 0.5131563125242374 | Validation loss: 0.
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Epoch:         774 | Training loss: 0.5129930192276893 | Validation loss: 0.
6019802250837268
Epoch:         775 | Training loss: 0.5128298503552405 | Validation loss: 0.
6018971098302466
Epoch:         776 | Training loss: 0.5126668046293229 | Validation loss: 0.
6018140115837524
Epoch:         777 | Training loss: 0.5125038829960623 | Validation loss: 0.
6017310150897458
Epoch:         778 | Training loss: 0.5123410868702506 | Validation loss: 0.
6016480442792109
Epoch:         779 | Training loss: 0.5121784133448123 | Validation loss: 0.
6015651595190834
Epoch:         780 | Training loss: 0.5120158632679842 | Validation loss: 0.
```

6014823252780963
Epoch: 781 | Training loss: 0.5118534373074829 | Validation loss: 0.
6013996022779322
Epoch: 782 | Training loss: 0.5116911339935826 | Validation loss: 0.
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Epoch: 783 | Training loss: 0.5115289541556266 | Validation loss: 0.
6012342588516169
Epoch: 784 | Training loss: 0.5113668981791502 | Validation loss: 0.
6011516618300625
Epoch: 785 | Training loss: 0.5112049645023228 | Validation loss: 0.
6010691385233474
Epoch: 786 | Training loss: 0.5110431540191371 | Validation loss: 0.
6009866512261062
Epoch: 787 | Training loss: 0.5108814661706523 | Validation loss: 0.
6009042716027045
Epoch: 788 | Training loss: 0.5107199000632915 | Validation loss: 0.
6008219377554357
Epoch: 789 | Training loss: 0.5105584563251321 | Validation loss: 0.
6007396767293416
Epoch: 790 | Training loss: 0.5103971357686121 | Validation loss: 0.
60006574511419461
Epoch: 791 | Training loss: 0.5102359368266716 | Validation loss: 0.
6005753175705696
Epoch: 792 | Training loss: 0.510074859870566 | Validation loss: 0.6
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Epoch: 793 | Training loss: 0.509913905015273 | Validation loss: 0.6
004111661320672
Epoch: 794 | Training loss: 0.5097530712049092 | Validation loss: 0.
6003291977360533
Epoch: 795 | Training loss: 0.5095923583654001 | Validation loss: 0.
6002473126486509
Epoch: 796 | Training loss: 0.5094317674639002 | Validation loss: 0.
6001654630335425
Epoch: 797 | Training loss: 0.5092712974809688 | Validation loss: 0.
6000836699079999
Epoch: 798 | Training loss: 0.5091109484123517 | Validation loss: 0.
6000019506814381
Epoch: 799 | Training loss: 0.5089507203279033 | Validation loss: 0.
5999202859395838

Hyper Parameters -- Learning Rate - 1e-05 Regularization Parameter- 0.0025
11886431509582
Epoch: 0 | Training loss: 0.6928005797309699 | Validation loss: 0.
6929612485447971
Epoch: 1 | Training loss: 0.6924645718132811 | Validation loss: 0.
6927857923940011
Epoch: 2 | Training loss: 0.6921291031778982 | Validation loss: 0.
6926107299375898
Epoch: 3 | Training loss: 0.6917941984141271 | Validation loss: 0.
6924361017025485
Epoch: 4 | Training loss: 0.6914599089241698 | Validation loss: 0.
692262007741416
Epoch: 5 | Training loss: 0.6911261084505111 | Validation loss: 0.
6920882271387856
Epoch: 6 | Training loss: 0.690792849509558 | Validation loss: 0.6
9191485574838
Epoch: 7 | Training loss: 0.6904601698159687 | Validation loss: 0.
6917419659152076
Epoch: 8 | Training loss: 0.6901280137534036 | Validation loss: 0.
691569461334121
Epoch: 9 | Training loss: 0.6897963675932178 | Validation loss: 0.

```
6913973208251304
Epoch:          10 | Training loss: 0.689465300479832 | Validation loss: 0.6
912256730794601
Epoch:          11 | Training loss: 0.6891346970994638 | Validation loss: 0.
6910543136389288
Epoch:          12 | Training loss: 0.6888046155718832 | Validation loss: 0.
6908833568600768
Epoch:          13 | Training loss: 0.6884750771295312 | Validation loss: 0.
6907128356823904
Epoch:          14 | Training loss: 0.6881459906933162 | Validation loss: 0.
6905425936354781
Epoch:          15 | Training loss: 0.6878174282967101 | Validation loss: 0.
6903727623349434
Epoch:          16 | Training loss: 0.6874894089535084 | Validation loss: 0.
6902033853317959
Epoch:          17 | Training loss: 0.6871618360402377 | Validation loss: 0.
6900342839170807
Epoch:          18 | Training loss: 0.6868347461312029 | Validation loss: 0.
6898655317605004
Epoch:          19 | Training loss: 0.6865081422514016 | Validation loss: 0.
6896971336067099
Epoch:          20 | Training loss: 0.6861820205031252 | Validation loss: 0.
689529090697481
Epoch:          21 | Training loss: 0.6858563727612865 | Validation loss: 0.
6893613859100032
Epoch:          22 | Training loss: 0.6855311852426264 | Validation loss: 0.
689193991359619
Epoch:          23 | Training loss: 0.6852064607143105 | Validation loss: 0.
689026924726642
Epoch:          24 | Training loss: 0.6848822677790368 | Validation loss: 0.
6888603248013618
Epoch:          25 | Training loss: 0.6845584665682043 | Validation loss: 0.
6886939089777608
Epoch:          26 | Training loss: 0.6842351831949137 | Validation loss: 0.
6885279396081532
Epoch:          27 | Training loss: 0.6839123406319231 | Validation loss: 0.
6883622668077541
Epoch:          28 | Training loss: 0.6835899228459607 | Validation loss: 0.
6881968605625053
Epoch:          29 | Training loss: 0.6832679870207066 | Validation loss: 0.
6880318324139293
Epoch:          30 | Training loss: 0.6829464650224231 | Validation loss: 0.
6878670501338678
Epoch:          31 | Training loss: 0.6826254077936003 | Validation loss: 0.
6877026229025034
Epoch:          32 | Training loss: 0.6823048078240875 | Validation loss: 0.
6875385375915988
Epoch:          33 | Training loss: 0.6819845891853903 | Validation loss: 0.
6873746407127957
Epoch:          34 | Training loss: 0.6816648410158245 | Validation loss: 0.
6872111196545834
Epoch:          35 | Training loss: 0.6813455129558883 | Validation loss: 0.
6870478740878332
Epoch:          36 | Training loss: 0.6810266201655789 | Validation loss: 0.
6868849332142601
Epoch:          37 | Training loss: 0.6807081910854594 | Validation loss: 0.
6867223652248708
Epoch:          38 | Training loss: 0.6803901555338362 | Validation loss: 0.
6865600210936458
Epoch:          39 | Training loss: 0.680072517958562 | Validation loss: 0.6
863979142235883
```

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Epoch:           40 | Training loss: 0.6797552958277855 | Validation loss: 0.
686236084449813
Epoch:           41 | Training loss: 0.679438481589724 | Validation loss: 0.6
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Epoch:           42 | Training loss: 0.6791220991517344 | Validation loss: 0.
6859132630420013
Epoch:           43 | Training loss: 0.6788061140261584 | Validation loss: 0.
6857522537500855
Epoch:           44 | Training loss: 0.678490566261548 | Validation loss: 0.6
855915836395045
Epoch:           45 | Training loss: 0.6781754285621221 | Validation loss: 0.
6854311943148614
Epoch:           46 | Training loss: 0.6778606967968686 | Validation loss: 0.
6852710771105659
Epoch:           47 | Training loss: 0.6775463889292078 | Validation loss: 0.
6851112746035055
Epoch:           48 | Training loss: 0.6772324437837017 | Validation loss: 0.
6849516471218083
Epoch:           49 | Training loss: 0.676918889342004 | Validation loss: 0.6
847922628821144
Epoch:           50 | Training loss: 0.676605746981163 | Validation loss: 0.6
846331766925563
Epoch:           51 | Training loss: 0.6762930011303565 | Validation loss: 0.
6844743529423961
Epoch:           52 | Training loss: 0.6759806342593365 | Validation loss: 0.
684315752615608
Epoch:           53 | Training loss: 0.6756686864273367 | Validation loss: 0.
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Epoch:           54 | Training loss: 0.6753571027504297 | Validation loss: 0.
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Epoch:           55 | Training loss: 0.6750459170620277 | Validation loss: 0.
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Epoch:           56 | Training loss: 0.6747351317358528 | Validation loss: 0.
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Epoch:           57 | Training loss: 0.6744247208848378 | Validation loss: 0.
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Epoch:           58 | Training loss: 0.6741147137341406 | Validation loss: 0.
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Epoch:           59 | Training loss: 0.6738050675358784 | Validation loss: 0.
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Epoch:           60 | Training loss: 0.673495799717032 | Validation loss: 0.6
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Epoch:           61 | Training loss: 0.673186928305854 | Validation loss: 0.6
829001152925105
Epoch:           62 | Training loss: 0.672878412269238 | Validation loss: 0.6
827440309109821
Epoch:           63 | Training loss: 0.6725702813163407 | Validation loss: 0.
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Epoch:           64 | Training loss: 0.6722625222119559 | Validation loss: 0.
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Epoch:           65 | Training loss: 0.6719551209502511 | Validation loss: 0.
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Epoch:           66 | Training loss: 0.6716481043997458 | Validation loss: 0.
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Epoch:           67 | Training loss: 0.6713414622383933 | Validation loss: 0.
6819672525684894
Epoch:           68 | Training loss: 0.6710351647550535 | Validation loss: 0.
6818125502392545
Epoch:           69 | Training loss: 0.6707292432100206 | Validation loss: 0.
6816581103197152
Epoch:           70 | Training loss: 0.6704236992594759 | Validation loss: 0.
```

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681503938293865
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Epoch:          77 | Training loss: 0.6682949272050678 | Validation loss: 0.
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Epoch:          98 | Training loss: 0.662011224351356 | Validation loss: 0.6
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Epoch:          99 | Training loss: 0.661715735021417 | Validation loss: 0.6
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Epoch:         558 | Training loss: 0.5537556843688425 | Validation loss: 0.
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Epoch:        770 | Training loss: 0.5177042894551918 | Validation loss: 0.
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Epoch:        771 | Training loss: 0.5175495041505356 | Validation loss: 0.
6062962213444221
```

Epoch: 772 | Training loss: 0.5173948505588817 | Validation loss: 0.6062217700199191
Epoch: 773 | Training loss: 0.5172403281528848 | Validation loss: 0.606147423609767
Epoch: 774 | Training loss: 0.517085936766123 | Validation loss: 0.6060731377211479
Epoch: 775 | Training loss: 0.5169316760467567 | Validation loss: 0.6059989306121183
Epoch: 776 | Training loss: 0.5167775450524706 | Validation loss: 0.6059247470886293
Epoch: 777 | Training loss: 0.5166235442318347 | Validation loss: 0.6058506713986124
Epoch: 778 | Training loss: 0.5164696752764306 | Validation loss: 0.6057766277498534
Epoch: 779 | Training loss: 0.5163159351290119 | Validation loss: 0.6057026763591135
Epoch: 780 | Training loss: 0.5161623247549767 | Validation loss: 0.6056287818122922
Epoch: 781 | Training loss: 0.5160088444559311 | Validation loss: 0.6055550044649513
Epoch: 782 | Training loss: 0.5158554933450359 | Validation loss: 0.6054812430901829
Epoch: 783 | Training loss: 0.5157022718146965 | Validation loss: 0.6054075715319982
Epoch: 784 | Training loss: 0.5155491804561081 | Validation loss: 0.6053339391197037
Epoch: 785 | Training loss: 0.5153962175884316 | Validation loss: 0.6052603866135147
Epoch: 786 | Training loss: 0.5152433842172178 | Validation loss: 0.605186876419622
Epoch: 787 | Training loss: 0.5150906794422452 | Validation loss: 0.6051134798611042
Epoch: 788 | Training loss: 0.5149381027213449 | Validation loss: 0.6050401353916709
Epoch: 789 | Training loss: 0.5147856544871898 | Validation loss: 0.6049668698609572
Epoch: 790 | Training loss: 0.514633335669769 | Validation loss: 0.6048936460040377
Epoch: 791 | Training loss: 0.514481144510002 | Validation loss: 0.604820520206204
Epoch: 792 | Training loss: 0.5143290816622349 | Validation loss: 0.6047474256555243
Epoch: 793 | Training loss: 0.5141771470174129 | Validation loss: 0.6046744030692676
Epoch: 794 | Training loss: 0.5140253395232987 | Validation loss: 0.6046014609808809
Epoch: 795 | Training loss: 0.513873659045402 | Validation loss: 0.6045286082464655
Epoch: 796 | Training loss: 0.5137221067114933 | Validation loss: 0.604455797190327
Epoch: 797 | Training loss: 0.513570681453141 | Validation loss: 0.6043830487807419
Epoch: 798 | Training loss: 0.513419383156733 | Validation loss: 0.6043103803177671
Epoch: 799 | Training loss: 0.5132682119671487 | Validation loss: 0.6042377724621575

Hyper Parameters -- Learning Rate – 1e-05 Regularization Parameter- 0.01584893192461114
Epoch: 0 | Training loss: 0.6928006425911526 | Validation loss: 0.6929613114048272

```
Epoch:            1 | Training loss: 0.692464823033089 | Validation loss: 0.6
927860436131642
Epoch:            2 | Training loss: 0.6921296679825824 | Validation loss: 0.
6926112947408487
Epoch:            3 | Training loss: 0.6917952017128038 | Validation loss: 0.
6924371049986985
Epoch:            4 | Training loss: 0.6914614752141729 | Validation loss: 0.
6922635740273292
Epoch:            5 | Training loss: 0.6911283621449203 | Validation loss: 0.
6920904808273982
Epoch:            6 | Training loss: 0.6907959146452924 | Validation loss: 0.
6919179208762614
Epoch:            7 | Training loss: 0.6904641700107036 | Validation loss: 0.
6917459660996553
Epoch:            8 | Training loss: 0.6901330724712289 | Validation loss: 0.
6915745200389251
Epoch:            9 | Training loss: 0.6898026080650703 | Validation loss: 0.
6914035612809599
Epoch:           10 | Training loss: 0.6894728453557911 | Validation loss: 0.
691233217935985
Epoch:           11 | Training loss: 0.6891436692209328 | Validation loss: 0.
6910632857374226
Epoch:           12 | Training loss: 0.6888151372470616 | Validation loss: 0.
6908938785084079
Epoch:           13 | Training loss: 0.688487270242716 | Validation loss: 0.6
907250287644675
Epoch:           14 | Training loss: 0.6881599773527209 | Validation loss: 0.
6905565802593511
Epoch:           15 | Training loss: 0.6878333299141464 | Validation loss: 0.
6903886639121152
Epoch:           16 | Training loss: 0.687507346483542 | Validation loss: 0.6
902213228164047
Epoch:           17 | Training loss: 0.6871819308149724 | Validation loss: 0.
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Epoch:           18 | Training loss: 0.6868571189652939 | Validation loss: 0.
6898879045383033
Epoch:           19 | Training loss: 0.6865329136587884 | Validation loss: 0.
6897219049519652
Epoch:           20 | Training loss: 0.6862093107409281 | Validation loss: 0.
6895563808670414
Epoch:           21 | Training loss: 0.6858863018838761 | Validation loss: 0.
6893913149579828
Epoch:           22 | Training loss: 0.6855638731680636 | Validation loss: 0.
6892266792038391
Epoch:           23 | Training loss: 0.6852420270629427 | Validation loss: 0.
6890624909872034
Epoch:           24 | Training loss: 0.6849208311407605 | Validation loss: 0.
6888988880677138
Epoch:           25 | Training loss: 0.6846001467865253 | Validation loss: 0.
6887355890933893
Epoch:           26 | Training loss: 0.6842800984065237 | Validation loss: 0.
6885728547093205
Epoch:           27 | Training loss: 0.6839606095823699 | Validation loss: 0.
6884105356398283
Epoch:           28 | Training loss: 0.6836416642383015 | Validation loss: 0.
6882486018283749
Epoch:           29 | Training loss: 0.683323318557709 | Validation loss: 0.6
880871638160332
Epoch:           30 | Training loss: 0.6830055050441524 | Validation loss: 0.
6879260900121277
Epoch:           31 | Training loss: 0.6826882736669931 | Validation loss: 0.
```

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687765488623516
Epoch:          32 | Training loss: 0.6823716167284982 | Validation loss: 0.
6876053463344785
Epoch:          33 | Training loss: 0.6820554592156158 | Validation loss: 0.
6874455105722751
Epoch:          34 | Training loss: 0.681739888617273 | Validation loss: 0.6
872861670757154
Epoch:          35 | Training loss: 0.6814248551066928 | Validation loss: 0.
6871272160486024
Epoch:          36 | Training loss: 0.6811103733403882 | Validation loss: 0.
6869686861890417
Epoch:          37 | Training loss: 0.6807964709563401 | Validation loss: 0.
6868106448854013
Epoch:          38 | Training loss: 0.6804830787702252 | Validation loss: 0.
6866529441092477
Epoch:          39 | Training loss: 0.6801702009370462 | Validation loss: 0.
6864955969706957
Epoch:          40 | Training loss: 0.6798578543533443 | Validation loss: 0.
68633864273321
Epoch:          41 | Training loss: 0.6795460313835333 | Validation loss: 0.
6861820623094641
Epoch:          42 | Training loss: 0.6792347551610087 | Validation loss: 0.
6860259187869304
Epoch:          43 | Training loss: 0.6789239916890196 | Validation loss: 0.
6858701311372322
Epoch:          44 | Training loss: 0.6786137798531636 | Validation loss: 0.
685714796943723
Epoch:          45 | Training loss: 0.6783040926887316 | Validation loss: 0.
6855598581421799
Epoch:          46 | Training loss: 0.6779949259102669 | Validation loss: 0.
68540530591256 21
Epoch:          47 | Training loss: 0.6776862967804659 | Validation loss: 0.
6852511821309577
Epoch:          48 | Training loss: 0.6773781453965034 | Validation loss: 0.
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Epoch:          49 | Training loss: 0.677070498823373 | Validation loss: 0.6
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Epoch:          50 | Training loss: 0.6767633776259249 | Validation loss: 0.
6847908069756593
Epoch:          51 | Training loss: 0.6764567663768417 | Validation loss: 0.
6846381178141948
Epoch:          52 | Training loss: 0.6761506477949151 | Validation loss: 0.
6844857657633605
Epoch:          53 | Training loss: 0.6758450605481234 | Validation loss: 0.
6843338495471586
Epoch:          54 | Training loss: 0.6755399511169952 | Validation loss: 0.
6841822326220042
Epoch:          55 | Training loss: 0.675235352051508 | Validation loss: 0.6
840310102385062
Epoch:          56 | Training loss: 0.6749312653989937 | Validation loss: 0.
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Epoch:          57 | Training loss: 0.6746276658284986 | Validation loss: 0.
6837296988432322
Epoch:          58 | Training loss: 0.6743245813495107 | Validation loss: 0.
683579626881155
Epoch:          59 | Training loss: 0.674021970431242 | Validation loss: 0.6
834298568425049
Epoch:          60 | Training loss: 0.6737198496709452 | Validation loss: 0.
6832804369133831
Epoch:          61 | Training loss: 0.6734182361673303 | Validation loss: 0.
6831314226385894
```

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Epoch:           62 | Training loss: 0.6731170901160817 | Validation loss: 0.
6829827082273883
Epoch:           63 | Training loss: 0.6728164399403979 | Validation loss: 0.
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Epoch:           64 | Training loss: 0.6725162726348174 | Validation loss: 0.
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Epoch:           65 | Training loss: 0.6722165745350983 | Validation loss: 0.
6825386850266157
Epoch:           66 | Training loss: 0.6719173711639448 | Validation loss: 0.
6823913844382455
Epoch:           67 | Training loss: 0.6716186523640565 | Validation loss: 0.
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Epoch:           68 | Training loss: 0.6713203894473609 | Validation loss: 0.
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Epoch:           69 | Training loss: 0.6710226120903079 | Validation loss: 0.
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Epoch:           70 | Training loss: 0.6707253216206789 | Validation loss: 0.
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Epoch:           71 | Training loss: 0.6704284852401396 | Validation loss: 0.
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Epoch:           72 | Training loss: 0.6701321247327441 | Validation loss: 0.
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Epoch:           73 | Training loss: 0.6698362388474464 | Validation loss: 0.
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Epoch:           74 | Training loss: 0.6695408261697668 | Validation loss: 0.
6812250800460012
Epoch:           75 | Training loss: 0.6692458783866935 | Validation loss: 0.
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Epoch:           76 | Training loss: 0.6689513990442008 | Validation loss: 0.
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Epoch:           77 | Training loss: 0.6686573883552668 | Validation loss: 0.
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Epoch:           78 | Training loss: 0.6683638386258672 | Validation loss: 0.
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Epoch:           79 | Training loss: 0.6680707475468484 | Validation loss: 0.
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Epoch:           80 | Training loss: 0.6677781224045246 | Validation loss: 0.
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Epoch:           81 | Training loss: 0.6674859398949796 | Validation loss: 0.
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Epoch:           82 | Training loss: 0.6671942251391191 | Validation loss: 0.
680080089002237
Epoch:           83 | Training loss: 0.6669029703935653 | Validation loss: 0.
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Epoch:           84 | Training loss: 0.6666121420393306 | Validation loss: 0.
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Epoch:           85 | Training loss: 0.6663217865000498 | Validation loss: 0.
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Epoch:           86 | Training loss: 0.666031899578918 | Validation loss: 0.6
795152612164845
Epoch:           87 | Training loss: 0.6657424471081046 | Validation loss: 0.
6793748372086875
Epoch:           88 | Training loss: 0.6654534362009243 | Validation loss: 0.
6792346892282857
Epoch:           89 | Training loss: 0.6651648604619582 | Validation loss: 0.
6790947984496074
Epoch:           90 | Training loss: 0.6648767547831813 | Validation loss: 0.
6789553048517569
Epoch:           91 | Training loss: 0.6645890695091973 | Validation loss: 0.
6788160098420858
Epoch:           92 | Training loss: 0.6643018553201664 | Validation loss: 0.
```

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6786771313827118
Epoch:            93 | Training loss: 0.6640150889550636 | Validation loss: 0.
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Epoch:            94 | Training loss: 0.6637287540302738 | Validation loss: 0.
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Epoch:            95 | Training loss: 0.6634428619106685 | Validation loss: 0.
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Epoch:            96 | Training loss: 0.6631574290504092 | Validation loss: 0.
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Epoch:            97 | Training loss: 0.6628724184804062 | Validation loss: 0.
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Epoch:            98 | Training loss: 0.6625878597359227 | Validation loss: 0.
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Epoch:            99 | Training loss: 0.6623037352810212 | Validation loss: 0.
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Epoch:           100 | Training loss: 0.6620200384022041 | Validation loss: 0.
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Epoch:           101 | Training loss: 0.6617367813105485 | Validation loss: 0.
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Epoch:           102 | Training loss: 0.6614539560938519 | Validation loss: 0.
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Epoch:           103 | Training loss: 0.6611715700653643 | Validation loss: 0.
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Epoch:           104 | Training loss: 0.6608896077343912 | Validation loss: 0.
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Epoch:           105 | Training loss: 0.6606080943066402 | Validation loss: 0.
6768991239723496
Epoch:           106 | Training loss: 0.6603270105060416 | Validation loss: 0.
6767644642235728
Epoch:           107 | Training loss: 0.660046347390583 | Validation loss: 0.6
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Epoch:           108 | Training loss: 0.659766111340791 | Validation loss: 0.6
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Epoch:           109 | Training loss: 0.6594862917101741 | Validation loss: 0.
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Epoch:           110 | Training loss: 0.659206914117984 | Validation loss: 0.6
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Epoch:           111 | Training loss: 0.6589279592968743 | Validation loss: 0.
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Epoch:           112 | Training loss: 0.6586494331538827 | Validation loss: 0.
6759623046991123
Epoch:           113 | Training loss: 0.6583713249696376 | Validation loss: 0.
67582960423013
Epoch:           114 | Training loss: 0.6580936511755802 | Validation loss: 0.
6756972298983669
Epoch:           115 | Training loss: 0.6578163937585928 | Validation loss: 0.
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Epoch:           116 | Training loss: 0.6575395632308509 | Validation loss: 0.
6754333032307727
Epoch:           117 | Training loss: 0.6572631561634461 | Validation loss: 0.
6753017874962159
Epoch:           118 | Training loss: 0.6569871652164749 | Validation loss: 0.
6751705331460304
Epoch:           119 | Training loss: 0.6567115964519854 | Validation loss: 0.
6750395780038181
Epoch:           120 | Training loss: 0.6564364484909856 | Validation loss: 0.
6749089143987237
Epoch:           121 | Training loss: 0.6561617208519341 | Validation loss: 0.
6747785453745607
Epoch:           122 | Training loss: 0.6558874051958701 | Validation loss: 0.
6746484248821386
```

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Epoch:         123 | Training loss: 0.6556135117722677 | Validation loss: 0.
6745186121839403
Epoch:         124 | Training loss: 0.6553400271486697 | Validation loss: 0.
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Epoch:         125 | Training loss: 0.6550669575448818 | Validation loss: 0.
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Epoch:         126 | Training loss: 0.6547942994870386 | Validation loss: 0.
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Epoch:         127 | Training loss: 0.654522051791636 | Validation loss: 0.6
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Epoch:         128 | Training loss: 0.6542502199071738 | Validation loss: 0.
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Epoch:         129 | Training loss: 0.6539788059546724 | Validation loss: 0.
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Epoch:         130 | Training loss: 0.6537077992715814 | Validation loss: 0.
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32352379086792
Epoch:         134 | Training loss: 0.6526278483117829 | Validation loss: 0.
673108413889104
Epoch:         135 | Training loss: 0.6523588797377646 | Validation loss: 0.
672981830252967
Epoch:         136 | Training loss: 0.6520903191665736 | Validation loss: 0.
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Epoch:         137 | Training loss: 0.6518221664991318 | Validation loss: 0.
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Epoch:         138 | Training loss: 0.651554415553907 | Validation loss: 0.6
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Epoch:         139 | Training loss: 0.6512870775683465 | Validation loss: 0.
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Epoch:         140 | Training loss: 0.6510201357777771 | Validation loss: 0.
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Epoch:         141 | Training loss: 0.6507535975345063 | Validation loss: 0.
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Epoch:         142 | Training loss: 0.6504874540675661 | Validation loss: 0.
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Epoch:         143 | Training loss: 0.6502217189101371 | Validation loss: 0.
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Epoch:         144 | Training loss: 0.6499563845268094 | Validation loss: 0.
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Epoch:         145 | Training loss: 0.6496914524864633 | Validation loss: 0.
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Epoch:         146 | Training loss: 0.6494269200768916 | Validation loss: 0.
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Epoch:         147 | Training loss: 0.6491627813523271 | Validation loss: 0.
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Epoch:         148 | Training loss: 0.6488990459726599 | Validation loss: 0.
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Epoch:         149 | Training loss: 0.6486357051372112 | Validation loss: 0.
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Epoch:         150 | Training loss: 0.6483727682199255 | Validation loss: 0.
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Epoch:         151 | Training loss: 0.6481102232290394 | Validation loss: 0.
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Epoch:         152 | Training loss: 0.6478480700001531 | Validation loss: 0.
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Epoch:         153 | Training loss: 0.6475863150753635 | Validation loss: 0.
```

6707491364445376
Epoch: 154 | Training loss: 0.6473249514785254 | Validation loss: 0.
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Epoch: 155 | Training loss: 0.6470639826940617 | Validation loss: 0.
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Epoch: 156 | Training loss: 0.6468034049768673 | Validation loss: 0.
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Epoch: 157 | Training loss: 0.646543223149199 | Validation loss: 0.6
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Epoch: 159 | Training loss: 0.6460240295867266 | Validation loss: 0.
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Epoch: 160 | Training loss: 0.6457650204728456 | Validation loss: 0.
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Epoch: 161 | Training loss: 0.645506400351346 | Validation loss: 0.6
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Epoch: 162 | Training loss: 0.6452481726999085 | Validation loss: 0.
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Epoch: 163 | Training loss: 0.6449903292442349 | Validation loss: 0.
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Epoch: 166 | Training loss: 0.6442191230096554 | Validation loss: 0.
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Epoch: 167 | Training loss: 0.6439628213921493 | Validation loss: 0.
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Epoch: 174 | Training loss: 0.642179502078777 | Validation loss: 0.6
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Epoch: 179 | Training loss: 0.6409171534220689 | Validation loss: 0.
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Epoch: 180 | Training loss: 0.6406658212317767 | Validation loss: 0.
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Epoch: 181 | Training loss: 0.6404148658784768 | Validation loss: 0.
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Epoch: 182 | Training loss: 0.6401642899927593 | Validation loss: 0.
6673268917556624
Epoch: 183 | Training loss: 0.6399140883477904 | Validation loss: 0.
667212581999993

```
Epoch:          184 | Training loss: 0.6396642652597397 | Validation loss: 0.
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Epoch:          185 | Training loss: 0.6394148133208717 | Validation loss: 0.
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Epoch:          186 | Training loss: 0.6391657379333535 | Validation loss: 0.
6668711690541089
Epoch:          187 | Training loss: 0.6389170377100075 | Validation loss: 0.
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Epoch:          188 | Training loss: 0.6386687095665127 | Validation loss: 0.
6666447274168306
Epoch:          189 | Training loss: 0.6384207536624833 | Validation loss: 0.
6665318706004502
Epoch:          190 | Training loss: 0.6381731709680671 | Validation loss: 0.
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Epoch:          191 | Training loss: 0.6379259639819632 | Validation loss: 0.
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Epoch:          192 | Training loss: 0.6376791238604703 | Validation loss: 0.
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Epoch:          193 | Training loss: 0.6374326575263304 | Validation loss: 0.
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Epoch:          194 | Training loss: 0.6371865586959125 | Validation loss: 0.
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Epoch:          195 | Training loss: 0.6369408319750568 | Validation loss: 0.
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Epoch:          197 | Training loss: 0.6364504881226877 | Validation loss: 0.
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Epoch:          199 | Training loss: 0.6359616174674718 | Validation loss: 0.
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Epoch:          201 | Training loss: 0.6354742125690339 | Validation loss: 0.
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Epoch:          202 | Training loss: 0.6352310604634117 | Validation loss: 0.
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Epoch:          204 | Training loss: 0.6347458524352018 | Validation loss: 0.
6648676949583284
Epoch:          205 | Training loss: 0.6345037961244064 | Validation loss: 0.
6647586675993784
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Epoch:          214 | Training loss: 0.6323415905049634 | Validation loss: 0.
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Epoch:          675 | Training loss: 0.553496523921076 | Validation loss: 0.6
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Epoch:          676 | Training loss: 0.553380530971564 | Validation loss: 0.6
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Epoch:          677 | Training loss: 0.553264729176955 | Validation loss: 0.6
341787076210222
Epoch:          678 | Training loss: 0.5531491201981659 | Validation loss: 0.
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Epoch:          679 | Training loss: 0.5530337031999968 | Validation loss: 0.
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Epoch:          680 | Training loss: 0.5529184782580725 | Validation loss: 0.
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Epoch:          681 | Training loss: 0.5528034448778066 | Validation loss: 0.
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Epoch:          682 | Training loss: 0.5526886033186321 | Validation loss: 0.
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Epoch:          683 | Training loss: 0.5525739529160155 | Validation loss: 0.
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Epoch:          684 | Training loss: 0.5524594937645074 | Validation loss: 0.
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Epoch:          685 | Training loss: 0.5523452246645109 | Validation loss: 0.
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Epoch:          686 | Training loss: 0.5522311461643425 | Validation loss: 0.
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Epoch:          687 | Training loss: 0.5521172573858195 | Validation loss: 0.
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Epoch:          688 | Training loss: 0.5520035585582783 | Validation loss: 0.
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Epoch:          690 | Training loss: 0.5517767279728407 | Validation loss: 0.
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Epoch:          692 | Training loss: 0.5515506556515485 | Validation loss: 0.
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Epoch:          693 | Training loss: 0.5514379022704398 | Validation loss: 0.
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Epoch:          694 | Training loss: 0.5513253372551776 | Validation loss: 0.
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Epoch:          695 | Training loss: 0.5512129603503403 | Validation loss: 0.
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Epoch:          696 | Training loss: 0.5511007711472781 | Validation loss: 0.
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Epoch:          698 | Training loss: 0.5508769561459361 | Validation loss: 0.
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Epoch:          699 | Training loss: 0.5507653300429332 | Validation loss: 0.
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Epoch:          700 | Training loss: 0.5506538915641807 | Validation loss: 0.
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Epoch:          701 | Training loss: 0.5505426407239793 | Validation loss: 0.
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Epoch:          702 | Training loss: 0.5504315760772684 | Validation loss: 0.
```

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Epoch:          704 | Training loss: 0.5502100036642683 | Validation loss: 0.
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Epoch:          705 | Training loss: 0.5500994978536909 | Validation loss: 0.
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Epoch:          706 | Training loss: 0.5499891775289805 | Validation loss: 0.
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Epoch:          707 | Training loss: 0.5498790416903431 | Validation loss: 0.
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Epoch:          708 | Training loss: 0.5497690924545598 | Validation loss: 0.
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Epoch:          709 | Training loss: 0.5496593261229572 | Validation loss: 0.
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Epoch:          710 | Training loss: 0.5495497463284363 | Validation loss: 0.
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Epoch:          713 | Training loss: 0.5492221069060942 | Validation loss: 0.
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Epoch:          714 | Training loss: 0.5491132629682667 | Validation loss: 0.
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Epoch:          715 | Training loss: 0.5490046038403539 | Validation loss: 0.
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Epoch:          716 | Training loss: 0.5488961273064982 | Validation loss: 0.
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Epoch:          717 | Training loss: 0.5487878321429537 | Validation loss: 0.
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Epoch:          722 | Training loss: 0.5482490982667328 | Validation loss: 0.
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Epoch:          723 | Training loss: 0.5481418972926276 | Validation loss: 0.
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Epoch:          724 | Training loss: 0.5480348792238839 | Validation loss: 0.
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Epoch:          725 | Training loss: 0.5479280423354357 | Validation loss: 0.
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Epoch:          726 | Training loss: 0.5478213843803802 | Validation loss: 0.
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Epoch:          727 | Training loss: 0.5477149087115739 | Validation loss: 0.
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Epoch:          728 | Training loss: 0.5476086134212738 | Validation loss: 0.
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Epoch:          729 | Training loss: 0.5475024980868645 | Validation loss: 0.
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Epoch:          730 | Training loss: 0.5473965638721874 | Validation loss: 0.
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Epoch:          731 | Training loss: 0.5472908098732852 | Validation loss: 0.
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Epoch:          732 | Training loss: 0.547185234887952 | Validation loss: 0.6
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Epoch:          733 | Training loss: 0.5470798398216753 | Validation loss: 0.
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Epoch:          734 | Training loss: 0.5469746229432638 | Validation loss: 0.
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Epoch:          735 | Training loss: 0.5468695870159006 | Validation loss: 0.
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Epoch:          736 | Training loss: 0.5467647292341431 | Validation loss: 0.
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Epoch:          737 | Training loss: 0.5466600496870211 | Validation loss: 0.
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Epoch:          738 | Training loss: 0.5465555484555944 | Validation loss: 0.
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Epoch:          739 | Training loss: 0.546451225747684 | Validation loss: 0.6
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Epoch:          741 | Training loss: 0.5462431137923097 | Validation loss: 0.
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Epoch:          742 | Training loss: 0.5461393235794555 | Validation loss: 0.
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Epoch:          743 | Training loss: 0.5460357108030525 | Validation loss: 0.
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Epoch:          744 | Training loss: 0.5459322754177564 | Validation loss: 0.
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Epoch:          745 | Training loss: 0.5458290174626009 | Validation loss: 0.
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Epoch:          746 | Training loss: 0.5457259365976262 | Validation loss: 0.
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Epoch:          747 | Training loss: 0.5456230301177213 | Validation loss: 0.
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Epoch:          748 | Training loss: 0.5455203006385947 | Validation loss: 0.
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Epoch:          749 | Training loss: 0.545417746076749 | Validation loss: 0.6
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Epoch:          751 | Training loss: 0.5452131658405139 | Validation loss: 0.
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Epoch:          753 | Training loss: 0.5450092883090557 | Validation loss: 0.
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Epoch:          754 | Training loss: 0.5449076114224649 | Validation loss: 0.
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Epoch:          755 | Training loss: 0.5448061097140124 | Validation loss: 0.
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Epoch:          756 | Training loss: 0.5447047803982777 | Validation loss: 0.
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Epoch:          757 | Training loss: 0.5446036265477009 | Validation loss: 0.
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Epoch:          758 | Training loss: 0.5445026471836 | Validation loss: 0.632
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Epoch:          759 | Training loss: 0.5444018404430345 | Validation loss: 0.
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Epoch:          760 | Training loss: 0.5443012081236509 | Validation loss: 0.
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Epoch:          761 | Training loss: 0.5442007489213541 | Validation loss: 0.
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Epoch:          762 | Training loss: 0.5441004627501147 | Validation loss: 0.
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Epoch:          763 | Training loss: 0.544000351036783 | Validation loss: 0.6
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32102997562246
Epoch:          764 | Training loss: 0.5439004116237405 | Validation loss: 0.
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Epoch:          765 | Training loss: 0.5438006444954054 | Validation loss: 0.
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Epoch:          766 | Training loss: 0.5437010492863058 | Validation loss: 0.
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Epoch:          767 | Training loss: 0.5436016255507035 | Validation loss: 0.
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Epoch:          768 | Training loss: 0.543502376002191 | Validation loss: 0.6
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Epoch:          769 | Training loss: 0.543403296767783 | Validation loss: 0.6
319893131746614
Epoch:          770 | Training loss: 0.5433043882172912 | Validation loss: 0.
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Epoch:          771 | Training loss: 0.5432056505170757 | Validation loss: 0.
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Epoch:          772 | Training loss: 0.5431070855672965 | Validation loss: 0.
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Epoch:          773 | Training loss: 0.5430086903196273 | Validation loss: 0.
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Epoch:          774 | Training loss: 0.5429104660671802 | Validation loss: 0.
6318976360991558
Epoch:          775 | Training loss: 0.542812411874415 | Validation loss: 0.6
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Epoch:          776 | Training loss: 0.5427145289143237 | Validation loss: 0.
6318616999185438
Epoch:          777 | Training loss: 0.5426168144961002 | Validation loss: 0.
6318439105764564
Epoch:          778 | Training loss: 0.5425192720577591 | Validation loss: 0.
6318261933902982
Epoch:          779 | Training loss: 0.5424218975945354 | Validation loss: 0.
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Epoch:          780 | Training loss: 0.5423246928110742 | Validation loss: 0.
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Epoch:          781 | Training loss: 0.5422276556989662 | Validation loss: 0.
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Epoch:          782 | Training loss: 0.5421307890491514 | Validation loss: 0.
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Epoch:          783 | Training loss: 0.5420340904971306 | Validation loss: 0.
631739358801289
Epoch:          784 | Training loss: 0.5419375619317334 | Validation loss: 0.
6317222891277473
Epoch:          785 | Training loss: 0.5418412009212278 | Validation loss: 0.
6317053384243111
Epoch:          786 | Training loss: 0.5417450091750482 | Validation loss: 0.
6316884698010423
Epoch:          787 | Training loss: 0.5416489836396293 | Validation loss: 0.
6316717524276395
Epoch:          788 | Training loss: 0.5415531259900433 | Validation loss: 0.
6316551269751031
Epoch:          789 | Training loss: 0.541457435426047 | Validation loss: 0.6
316386190601337
Epoch:          790 | Training loss: 0.5413619136193227 | Validation loss: 0.
6316221921595052
Epoch:          791 | Training loss: 0.5412665575992212 | Validation loss: 0.
6316059014468801
Epoch:          792 | Training loss: 0.5411713698062703 | Validation loss: 0.
631589681896619
Epoch:          793 | Training loss: 0.5410763487178682 | Validation loss: 0.
6315735728123836
```

```
Epoch:          794 | Training loss: 0.5409814933047812 | Validation loss: 0.
6315575827506205
Epoch:          795 | Training loss: 0.5408868030513151 | Validation loss: 0.
6315417201862144
Epoch:          796 | Training loss: 0.5407922800986652 | Validation loss: 0.
6315259384569383
Epoch:          797 | Training loss: 0.5406979230692868 | Validation loss: 0.
6315102582219307
Epoch:          798 | Training loss: 0.5406037311595662 | Validation loss: 0.
6314946960912424
Epoch:          799 | Training loss: 0.5405097049877615 | Validation loss: 0.
6314792331990273


Hyper Parameters -- Learning Rate - 0.0020080000000000002  Regularization P
arameter- 1e-05
Epoch:            0 | Training loss: 0.6322157760030671 | Validation loss: 0.
6620715516593583
Epoch:            1 | Training loss: 0.5824560708641378 | Validation loss: 0.
6371893094874866
Epoch:            2 | Training loss: 0.5409338888512373 | Validation loss: 0.
6157850638271697
Epoch:            3 | Training loss: 0.5057426264785053 | Validation loss: 0.
5977147075509621
Epoch:            4 | Training loss: 0.47547696444484616 | Validation loss: 0
.5825353144777179
Epoch:            5 | Training loss: 0.44902412451220425 | Validation loss: 0
.5683770163312565
Epoch:            6 | Training loss: 0.4257601648376538 | Validation loss: 0.
556261945998232
Epoch:            7 | Training loss: 0.4050734465795574 | Validation loss: 0.
545708812174579
Epoch:            8 | Training loss: 0.3865097290164647 | Validation loss: 0.
5359193597946633
Epoch:            9 | Training loss: 0.36976790727993847 | Validation loss: 0
.5271410555398846
Epoch:           10 | Training loss: 0.35466726004442 | Validation loss: 0.51
94018634027951
Epoch:           11 | Training loss: 0.34062497375377987 | Validation loss: 0
.5116253511130803
Epoch:           12 | Training loss: 0.3278504627330174 | Validation loss: 0.
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Epoch:           13 | Training loss: 0.31612375467359566 | Validation loss: 0
.49881562526696627
Epoch:           14 | Training loss: 0.3051712677310905 | Validation loss: 0.
4927551640777614
Epoch:           15 | Training loss: 0.29503808798951187 | Validation loss: 0
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Epoch:           16 | Training loss: 0.28562840217334734 | Validation loss: 0
.48246707963854507
Epoch:           17 | Training loss: 0.276787244391714 | Validation loss: 0.4
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Epoch:           18 | Training loss: 0.2684909562800462 | Validation loss: 0.
4730647191093192
Epoch:           19 | Training loss: 0.2607100657494986 | Validation loss: 0.
4689233263464407
Epoch:           20 | Training loss: 0.2533890525922464 | Validation loss: 0.
4649320398372329
Epoch:           21 | Training loss: 0.24648170038773384 | Validation loss: 0
.46120240009367014
Epoch:           22 | Training loss: 0.23997091832299386 | Validation loss: 0
.4577345884593706
```

```
Epoch:              23 | Training loss: 0.23377368679784244 | Validation loss: 0
.454280420424994
Epoch:              24 | Training loss: 0.22794517956325613 | Validation loss: 0
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Epoch:              25 | Training loss: 0.22234576642096793 | Validation loss: 0
.44805219680277781
Epoch:              26 | Training loss: 0.21706372358595286 | Validation loss: 0
.44520354202697104
Epoch:              27 | Training loss: 0.21200544889476702 | Validation loss: 0
.4423819828058076
Epoch:              28 | Training loss: 0.20718849374874992 | Validation loss: 0
.4397017776403594
Epoch:              29 | Training loss: 0.20261009026044177 | Validation loss: 0
.4372424878440721
Epoch:              30 | Training loss: 0.19820061558931507 | Validation loss: 0
.4347425812278811
Epoch:              31 | Training loss: 0.1939983714570131 | Validation loss: 0.
4324182215155241
Epoch:              32 | Training loss: 0.18997566152505804 | Validation loss: 0
.43020166664383225
Epoch:              33 | Training loss: 0.1861070008670935 | Validation loss: 0.
42800064540123883
Epoch:              34 | Training loss: 0.18239919082843067 | Validation loss: 0
.42594356624672
Epoch:              35 | Training loss: 0.178837421907323 | Validation loss: 0.4
23950446665840914
Epoch:              36 | Training loss: 0.17541338429082065 | Validation loss: 0
.4220276839054403
Epoch:              37 | Training loss: 0.17211947268801492 | Validation loss: 0
.4201946979704282
Epoch:              38 | Training loss: 0.16894578434537413 | Validation loss: 0
.41840180228803064
Epoch:              39 | Training loss: 0.1658904279391498 | Validation loss: 0.
41665435743040646
Epoch:              40 | Training loss: 0.16294201970241956 | Validation loss: 0
.41498934781092767
Epoch:              41 | Training loss: 0.1600982689576983 | Validation loss: 0.
413374397980733355
Epoch:              42 | Training loss: 0.157348277230425 | Validation loss: 0.4
118232580579877
Epoch:              43 | Training loss: 0.15469669581808676 | Validation loss: 0
.41031163028014594
Epoch:              44 | Training loss: 0.15212457246876748 | Validation loss: 0
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Epoch:              45 | Training loss: 0.14964149168860463 | Validation loss: 0
.4074528049432064
Epoch:              46 | Training loss: 0.14724038563368957 | Validation loss: 0
.40610545550465477
Epoch:              47 | Training loss: 0.14491679273948402 | Validation loss: 0
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Epoch:              48 | Training loss: 0.1426561043783783 | Validation loss: 0.
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Epoch:              49 | Training loss: 0.14047225611749647 | Validation loss: 0
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Epoch:              50 | Training loss: 0.13835186558171506 | Validation loss: 0
.4009810509892456
Epoch:              51 | Training loss: 0.13629473067191314 | Validation loss: 0
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Epoch:              52 | Training loss: 0.13429973347723123 | Validation loss: 0
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Epoch:              53 | Training loss: 0.13235569159070248 | Validation loss: 0
```

```
.397539805684096
Epoch:          54 | Training loss: 0.13047131797748998 | Validation loss: 0
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Epoch:          55 | Training loss: 0.1286415373763113 | Validation loss: 0.
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Epoch:          56 | Training loss: 0.12685840821553274 | Validation loss: 0
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Epoch:          57 | Training loss: 0.125125657727054 | Validation loss: 0.3
933599196770065
Epoch:          58 | Training loss: 0.12344096468458117 | Validation loss: 0
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Epoch:          59 | Training loss: 0.12179824544886196 | Validation loss: 0
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Epoch:          60 | Training loss: 0.12019984637793361 | Validation loss: 0
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Epoch:          61 | Training loss: 0.11864289081348207 | Validation loss: 0
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Epoch:          62 | Training loss: 0.11712552765537149 | Validation loss: 0
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Epoch:          63 | Training loss: 0.11564645517525146 | Validation loss: 0
.3878479779522019
Epoch:          64 | Training loss: 0.11420436818085343 | Validation loss: 0
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Epoch:          65 | Training loss: 0.11279811268523537 | Validation loss: 0
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Epoch:          66 | Training loss: 0.11142441795924628 | Validation loss: 0
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Epoch:          67 | Training loss: 0.11008628905621042 | Validation loss: 0
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Epoch:          69 | Training loss: 0.10749922559902071 | Validation loss: 0
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Epoch:          70 | Training loss: 0.10625195917854163 | Validation loss: 0
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Epoch:          71 | Training loss: 0.10503345033866915 | Validation loss: 0
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Epoch:          72 | Training loss: 0.10384160554147386 | Validation loss: 0
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Epoch:          73 | Training loss: 0.10267641552392252 | Validation loss: 0
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Epoch:          74 | Training loss: 0.10153748681148017 | Validation loss: 0
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Epoch:          75 | Training loss: 0.10042363153730244 | Validation loss: 0
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Epoch:          76 | Training loss: 0.09933417006553458 | Validation loss: 0
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Epoch:          77 | Training loss: 0.09826782738567863 | Validation loss: 0
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Epoch:          78 | Training loss: 0.0972241530755214 | Validation loss: 0.
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Epoch:          79 | Training loss: 0.09620241312932426 | Validation loss: 0
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Epoch:          80 | Training loss: 0.09520226435925613 | Validation loss: 0
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Epoch:          81 | Training loss: 0.09422238551395783 | Validation loss: 0
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Epoch:          82 | Training loss: 0.09326307062447182 | Validation loss: 0
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Epoch:          83 | Training loss: 0.09232373447862054 | Validation loss: 0
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```

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Epoch:         84 | Training loss: 0.091401339211501 | Validation loss: 0.3
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Epoch:         85 | Training loss: 0.09049924085880036 | Validation loss: 0
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Epoch:         86 | Training loss: 0.08961264489019133 | Validation loss: 0
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Epoch:         87 | Training loss: 0.08874445034893047 | Validation loss: 0
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Epoch:         88 | Training loss: 0.08789320715316301 | Validation loss: 0
.3714421458011971
Epoch:         89 | Training loss: 0.08705892662555292 | Validation loss: 0
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Epoch:         90 | Training loss: 0.08623902547287576 | Validation loss: 0
.37045029632938836
Epoch:         91 | Training loss: 0.08543595894380303 | Validation loss: 0
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Epoch:         92 | Training loss: 0.08464592788783959 | Validation loss: 0
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Epoch:         93 | Training loss: 0.08387145934970283 | Validation loss: 0
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Epoch:         94 | Training loss: 0.08311121788585492 | Validation loss: 0
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Epoch:         95 | Training loss: 0.08236491770352164 | Validation loss: 0
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Epoch:         96 | Training loss: 0.08163163190825153 | Validation loss: 0
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Epoch:         98 | Training loss: 0.08020431120193511 | Validation loss: 0
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Epoch:        100 | Training loss: 0.07882655948501432 | Validation loss: 0
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Epoch:        102 | Training loss: 0.077495924537793 | Validation loss: 0.3
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Epoch:        103 | Training loss: 0.0768476528170751 | Validation loss: 0.
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Epoch:        104 | Training loss: 0.07621006467046024 | Validation loss: 0
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Epoch:        105 | Training loss: 0.07558330294729945 | Validation loss: 0
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Epoch:        106 | Training loss: 0.07496693933728113 | Validation loss: 0
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Epoch:        107 | Training loss: 0.07436042711826821 | Validation loss: 0
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Epoch:        108 | Training loss: 0.07376401216220148 | Validation loss: 0
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Epoch:        109 | Training loss: 0.0731773435893989 | Validation loss: 0.
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Epoch:        110 | Training loss: 0.07259991045776668 | Validation loss: 0
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Epoch:        111 | Training loss: 0.07203165616586941 | Validation loss: 0
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Epoch:        112 | Training loss: 0.07147249166970171 | Validation loss: 0
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Epoch:        113 | Training loss: 0.07092213911921524 | Validation loss: 0
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Epoch:        114 | Training loss: 0.07038025608372216 | Validation loss: 0
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.36091600151670067
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Epoch:         116 | Training loss: 0.06932156377793125 | Validation loss: 0
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Epoch:         117 | Training loss: 0.06880436850145677 | Validation loss: 0
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Epoch:         118 | Training loss: 0.0682949397091079 | Validation loss: 0.
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Epoch:         119 | Training loss: 0.06779322738058487 | Validation loss: 0
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Epoch:         120 | Training loss: 0.06729906153445868 | Validation loss: 0
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Epoch:         121 | Training loss: 0.06681220741210217 | Validation loss: 0
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Epoch:         122 | Training loss: 0.06633227464239207 | Validation loss: 0
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Epoch:         123 | Training loss: 0.06585957551594637 | Validation loss: 0
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Epoch:         124 | Training loss: 0.06539362211159262 | Validation loss: 0
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Epoch:         125 | Training loss: 0.06493445017374103 | Validation loss: 0
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Epoch:         126 | Training loss: 0.06448187827803664 | Validation loss: 0
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Epoch:         127 | Training loss: 0.06403572338741248 | Validation loss: 0
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Epoch:         128 | Training loss: 0.06359589702164119 | Validation loss: 0
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Epoch:         129 | Training loss: 0.06316224265618756 | Validation loss: 0
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Epoch:         130 | Training loss: 0.06273463865342843 | Validation loss: 0
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Epoch:         131 | Training loss: 0.0623129721440332 | Validation loss: 0.
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Epoch:         135 | Training loss: 0.060683277505748846 | Validation loss:
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Epoch:         136 | Training loss: 0.060289546585844636 | Validation loss:
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Epoch:         137 | Training loss: 0.05990099394251239 | Validation loss: 0
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Epoch:         138 | Training loss: 0.0595177294283726 | Validation loss: 0.
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Epoch:         139 | Training loss: 0.05913930157979217 | Validation loss: 0
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Epoch:         140 | Training loss: 0.05876597324164702 | Validation loss: 0
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Epoch:         141 | Training loss: 0.05839759620708976 | Validation loss: 0
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Epoch:         142 | Training loss: 0.058034127490068754 | Validation loss:
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Epoch:         143 | Training loss: 0.05767490898144211 | Validation loss: 0
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Epoch:         144 | Training loss: 0.057320430421366836 | Validation loss:
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Epoch:        145 | Training loss: 0.05697045405707793 | Validation loss: 0
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Epoch:        150 | Training loss: 0.0552854367982723 | Validation loss: 0.
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Epoch:        151 | Training loss: 0.054960929622736666 | Validation loss:
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Epoch:        152 | Training loss: 0.05464025507238497 | Validation loss: 0
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Epoch:        153 | Training loss: 0.054323521016448044 | Validation loss:
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Epoch:        154 | Training loss: 0.054010631943040226 | Validation loss:
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Epoch:        155 | Training loss: 0.05370148700520243 | Validation loss: 0
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Epoch:        156 | Training loss: 0.053396025232537454 | Validation loss:
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Epoch:        157 | Training loss: 0.05309420206685867 | Validation loss: 0
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Epoch:        159 | Training loss: 0.05250118926042505 | Validation loss: 0
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Epoch:        163 | Training loss: 0.05135602120791225 | Validation loss: 0
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Epoch:        164 | Training loss: 0.05107788175695924 | Validation loss: 0
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Epoch:        165 | Training loss: 0.050802933762886936 | Validation loss:
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Epoch:        166 | Training loss: 0.05053110793093528 | Validation loss: 0
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Epoch:        167 | Training loss: 0.050262313436670494 | Validation loss:
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Epoch:        169 | Training loss: 0.04973373027828637 | Validation loss: 0
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Epoch:        170 | Training loss: 0.04947386500581448 | Validation loss: 0
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Epoch:        171 | Training loss: 0.04921680812542123 | Validation loss: 0
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Epoch:        172 | Training loss: 0.04896260172051319 | Validation loss: 0
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Epoch:        173 | Training loss: 0.04871116465963023 | Validation loss: 0
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Epoch:        174 | Training loss: 0.048462462591038126 | Validation loss:
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Epoch:        175 | Training loss: 0.048216476498641914 | Validation loss:
```

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0.34748365714772206
Epoch:        176 | Training loss: 0.047973130085229486 | Validation loss:
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Epoch:        177 | Training loss: 0.04773229589108695 | Validation loss: 0
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Epoch:        178 | Training loss: 0.04749409745388298 | Validation loss: 0
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Epoch:        180 | Training loss: 0.04702522161510845 | Validation loss: 0
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Epoch:        184 | Training loss: 0.04611659496281283 | Validation loss: 0
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Epoch:        185 | Training loss: 0.045895222234757574 | Validation loss:
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Epoch:        186 | Training loss: 0.04567616343159561 | Validation loss: 0
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Epoch:        187 | Training loss: 0.04545931690526399 | Validation loss: 0
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Epoch:        188 | Training loss: 0.045244738886834404 | Validation loss:
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Epoch:        189 | Training loss: 0.04503232157372536 | Validation loss: 0
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Epoch:        190 | Training loss: 0.04482199320786509 | Validation loss: 0
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Epoch:        194 | Training loss: 0.044001405835314526 | Validation loss:
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Epoch:        199 | Training loss: 0.04302023738201531 | Validation loss: 0
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Epoch:        200 | Training loss: 0.04282968057602799 | Validation loss: 0
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Epoch:        201 | Training loss: 0.04264093072558035 | Validation loss: 0
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Epoch:        202 | Training loss: 0.04245397739238164 | Validation loss: 0
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Epoch:        203 | Training loss: 0.04226879199459342 | Validation loss: 0
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Epoch:        204 | Training loss: 0.04208533382470589 | Validation loss: 0
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Epoch:        205 | Training loss: 0.04190363161631846 | Validation loss: 0
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Epoch:         206 | Training loss: 0.041723624479678464 | Validation loss:
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Epoch:         207 | Training loss: 0.04154529688125434 | Validation loss: 0
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Epoch:         208 | Training loss: 0.04136862809870714 | Validation loss: 0
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Epoch:         209 | Training loss: 0.041193609094459835 | Validation loss:
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Epoch:         215 | Training loss: 0.040176470909747075 | Validation loss:
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Epoch:         216 | Training loss: 0.04001227934071279 | Validation loss: 0
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Epoch:         217 | Training loss: 0.039849598465702865 | Validation loss:
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Epoch:         220 | Training loss: 0.0393700830136009 | Validation loss: 0
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Epoch:         225 | Training loss: 0.03859839722552127 | Validation loss: 0
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Epoch:         226 | Training loss: 0.03844807533423544 | Validation loss:
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Epoch:         227 | Training loss: 0.03829904045864853 | Validation loss: 0
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Epoch:         229 | Training loss: 0.03800477279396916 | Validation loss: 0
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Epoch:         230 | Training loss: 0.03785952598654599 | Validation loss: 0
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Epoch:         231 | Training loss: 0.03771549230812486 | Validation loss: 0
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Epoch:         232 | Training loss: 0.03757268246580459 | Validation loss: 0
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Epoch:         233 | Training loss: 0.03743106586345274 | Validation loss: 0
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Epoch:         235 | Training loss: 0.037151391046825376 | Validation loss:
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Epoch:         236 | Training loss: 0.0370132823016599 | Validation loss: 0.
```

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Epoch:        238 | Training loss: 0.0367404828065079 | Validation loss: 0.
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Epoch:        239 | Training loss: 0.03660576192559479 | Validation loss: 0
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Epoch:        240 | Training loss: 0.03647214227426335 | Validation loss: 0
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Epoch:        241 | Training loss: 0.03633962291167028 | Validation loss: 0
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Epoch:        242 | Training loss: 0.036208162990774846 | Validation loss:
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Epoch:        244 | Training loss: 0.03594843844566256 | Validation loss: 0
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Epoch:        245 | Training loss: 0.03582013726435047 | Validation loss: 0
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Epoch:        247 | Training loss: 0.035566613977818594 | Validation loss:
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Epoch:        248 | Training loss: 0.035441356715953734 | Validation loss:
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Epoch:        249 | Training loss: 0.03531709074238752 | Validation loss: 0
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Epoch:        250 | Training loss: 0.03519381426839941 | Validation loss: 0
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Epoch:        252 | Training loss: 0.03495013588229191 | Validation loss: 0
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Epoch:        253 | Training loss: 0.034829738250286936 | Validation loss:
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Epoch:        255 | Training loss: 0.034591703074914666 | Validation loss:
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Epoch:        256 | Training loss: 0.03447407813473621 | Validation loss: 0
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Epoch:        257 | Training loss: 0.034357345522499014 | Validation loss:
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Epoch:        259 | Training loss: 0.03412656088094741 | Validation loss: 0
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Epoch:        262 | Training loss: 0.033786932835499196 | Validation loss:
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Epoch:        263 | Training loss: 0.03367541171982369 | Validation loss: 0
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Epoch:        264 | Training loss: 0.03356475151367861 | Validation loss: 0
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Epoch:        265 | Training loss: 0.03345492739237423 | Validation loss: 0
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Epoch:          267 | Training loss: 0.03323766668820485 | Validation loss: 0
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Epoch:          270 | Training loss: 0.03291781475152472 | Validation loss: 0
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Epoch:          271 | Training loss: 0.03281276279341 6446 | Validation loss:
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Epoch:          273 | Training loss: 0.032604953169451334 | Validation loss:
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Epoch:          276 | Training loss: 0.03229885930227272 | Validation loss: 0
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Epoch:          277 | Training loss: 0.03219829107937104 | Validation loss: 0
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Epoch:          294 | Training loss: 0.030593239501949632 | Validation loss:
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Epoch:          297 | Training loss: 0.03032907972375349 | Validation loss: 0
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Epoch:        317 | Training loss: 0.028696533857132264 | Validation loss:
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Epoch:        319 | Training loss: 0.028544630261813555 | Validation loss:
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Epoch:        325 | Training loss: 0.028100266869760186 | Validation loss:
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Epoch:          328 | Training loss: 0.02788425661685922 | Validation loss: 0
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Epoch:          331 | Training loss: 0.027672216568733685 | Validation loss:
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Epoch:          332 | Training loss: 0.027602400433703767 | Validation loss:
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Epoch:          335 | Training loss: 0.027395495210811395 | Validation loss:
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Epoch:          336 | Training loss: 0.027327364388075658 | Validation loss:
0.335417120866192
Epoch:          337 | Training loss: 0.02725963731661457 | Validation loss: 0
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Epoch:          338 | Training loss: 0.02719232272722621 | Validation loss: 0
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Epoch:          339 | Training loss: 0.02712541058311315 | Validation loss: 0
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Epoch:          340 | Training loss: 0.02705890520567811 | Validation loss: 0
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Epoch:          341 | Training loss: 0.02699278436381514 | Validation loss: 0
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Epoch:          342 | Training loss: 0.0269270655644432 | Validation loss: 0.
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Epoch:          343 | Training loss: 0.026861732299232957 | Validation loss:
0.3351764477871885
Epoch:          344 | Training loss: 0.026796784807748917 | Validation loss:
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Epoch:          345 | Training loss: 0.02673221980476514 | Validation loss: 0
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Epoch:          346 | Training loss: 0.026668039719883293 | Validation loss:
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Epoch:          347 | Training loss: 0.026604228980938203 | Validation loss:
0.3350478246797316
Epoch:          348 | Training loss: 0.026540806928835505 | Validation loss:
0.33501393827909026
Epoch:          349 | Training loss: 0.026477746515503862 | Validation loss:
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Epoch:          350 | Training loss: 0.026415054875172667 | Validation loss:
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Epoch:          351 | Training loss: 0.026352722067230445 | Validation loss:
0.3349199920096771
Epoch:          352 | Training loss: 0.026290753172119433 | Validation loss:
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Epoch:          353 | Training loss: 0.026229141376363174 | Validation loss:
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Epoch:          354 | Training loss: 0.026167886313812838 | Validation loss:
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Epoch:          355 | Training loss: 0.026106990614061302 | Validation loss:
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Epoch:          356 | Training loss: 0.02604643782215931 | Validation loss: 0
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Epoch:          357 | Training loss: 0.02598623499293201 | Validation loss: 0
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Epoch:          358 | Training loss: 0.025926376957937276 | Validation loss:
```

```
0.3347083343782714
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Epoch:        360 | Training loss: 0.02580767385899852 | Validation loss: 0
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Epoch:        361 | Training loss: 0.02574882957055345 | Validation loss: 0
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Epoch:        362 | Training loss: 0.025690317804766803 | Validation loss:
0.33459305458085015
Epoch:        363 | Training loss: 0.025632137290066 | Validation loss: 0.3
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Epoch:        364 | Training loss: 0.02557428117429126 | Validation loss: 0
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Epoch:        365 | Training loss: 0.02551675023083816 | Validation loss: 0
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Epoch:        366 | Training loss: 0.02545954281960257 | Validation loss: 0
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Epoch:        367 | Training loss: 0.02540265446864347 | Validation loss: 0
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Epoch:        368 | Training loss: 0.025346083749361023 | Validation loss:
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Epoch:        369 | Training loss: 0.025289828354394604 | Validation loss:
0.3344004798811765
Epoch:        370 | Training loss: 0.025233882784884965 | Validation loss:
0.3343713170229849
Epoch:        371 | Training loss: 0.02517824767207481 | Validation loss: 0
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Epoch:        372 | Training loss: 0.025122920064895082 | Validation loss:
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Epoch:        373 | Training loss: 0.02506789851611683 | Validation loss: 0
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Epoch:        374 | Training loss: 0.025013175625497857 | Validation loss:
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Epoch:        375 | Training loss: 0.02495875357941884 | Validation loss: 0
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Epoch:        376 | Training loss: 0.02490462989246648 | Validation loss: 0
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Epoch:        379 | Training loss: 0.024744019017901898 | Validation loss:
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Epoch:        380 | Training loss: 0.024691061578978192 | Validation loss:
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Epoch:        381 | Training loss: 0.02463839196750386 | Validation loss: 0
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Epoch:        382 | Training loss: 0.02458600370561463 | Validation loss: 0
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Epoch:        383 | Training loss: 0.02453389813239677 | Validation loss:
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Epoch:        384 | Training loss: 0.02448207269713411 | Validation loss: 0
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Epoch:        385 | Training loss: 0.02443052194393488 | Validation loss: 0
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Epoch:        386 | Training loss: 0.024379248005354518 | Validation loss:
0.333962986758676
Epoch:        387 | Training loss: 0.024328247525115438 | Validation loss:
0.33393824330511923
Epoch:        388 | Training loss: 0.024277517495121137 | Validation loss:
0.3339153883807905
```

```
Epoch:          389 | Training loss: 0.024227057153917833 | Validation loss:
0.33389056655637817
Epoch:          390 | Training loss: 0.024176862955546222 | Validation loss:
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Epoch:          391 | Training loss: 0.024126935621625642 | Validation loss:
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Epoch:          392 | Training loss: 0.024077268395306776 | Validation loss:
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Epoch:          393 | Training loss: 0.02402786233908452 | Validation loss: 0
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Epoch:          394 | Training loss: 0.023978715770924662 | Validation loss:
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Epoch:          395 | Training loss: 0.023929826299475324 | Validation loss:
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Epoch:          396 | Training loss: 0.023881191891059025 | Validation loss:
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Epoch:          397 | Training loss: 0.023832810408100785 | Validation loss:
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Epoch:          398 | Training loss: 0.02378468044152182 | Validation loss: 0
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Epoch:          399 | Training loss: 0.023736799799096937 | Validation loss:
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Epoch:          400 | Training loss: 0.023689166728388854 | Validation loss:
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Epoch:          401 | Training loss: 0.023641779728264884 | Validation loss:
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Epoch:          402 | Training loss: 0.023594636129429476 | Validation loss:
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Epoch:          403 | Training loss: 0.02354773502973417 | Validation loss: 0
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Epoch:          404 | Training loss: 0.02350107428439842 | Validation loss: 0
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Epoch:          405 | Training loss: 0.02345465286857773 | Validation loss: 0
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Epoch:          406 | Training loss: 0.023408466333279455 | Validation loss:
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Epoch:          407 | Training loss: 0.023362515753216764 | Validation loss:
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Epoch:          408 | Training loss: 0.0233167991400821 | Validation loss: 0.
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Epoch:          409 | Training loss: 0.023271314815290555 | Validation loss:
0.33345667228125647
Epoch:          410 | Training loss: 0.023226060684970733 | Validation loss:
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Epoch:          411 | Training loss: 0.023181031344667206 | Validation loss:
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Epoch:          412 | Training loss: 0.02313623087514585 | Validation loss: 0
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Epoch:          413 | Training loss: 0.023091655707691186 | Validation loss:
0.33337578354496583
Epoch:          414 | Training loss: 0.023047304562533046 | Validation loss:
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Epoch:          415 | Training loss: 0.023003174035211384 | Validation loss:
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Epoch:          416 | Training loss: 0.022959264240811288 | Validation loss:
0.3333175465412756
Epoch:          417 | Training loss: 0.02291557270088291 | Validation loss: 0
.33329782015982445
Epoch:          418 | Training loss: 0.02287209864278445 | Validation loss: 0
.3332786186073649
Epoch:          419 | Training loss: 0.022828841371648832 | Validation loss:
```

```
                    0.3332604919278944
Epoch:          420 | Training loss: 0.022785796450928816 | Validation loss:
0.33324092390167687
Epoch:          421 | Training loss: 0.022742965028764186 | Validation loss:
0.33322284651781525
Epoch:          422 | Training loss: 0.022700343813467673 | Validation loss:
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Epoch:          423 | Training loss: 0.022657933695540998 | Validation loss:
0.3331861429963076
Epoch:          424 | Training loss: 0.022615731403598273 | Validation loss:
0.3331683607560615
Epoch:          425 | Training loss: 0.022573735117908618 | Validation loss:
0.33315023631175306
Epoch:          426 | Training loss: 0.022531944424728334 | Validation loss:
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Epoch:          427 | Training loss: 0.022490356163264703 | Validation loss:
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Epoch:          428 | Training loss: 0.0224489711297343 | Validation loss: 0.
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Epoch:          429 | Training loss: 0.02240778695781335 | Validation loss: 0
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Epoch:          430 | Training loss: 0.022366802703583825 | Validation loss:
0.33305960720080013
Epoch:          431 | Training loss: 0.022326016392878525 | Validation loss:
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Epoch:          432 | Training loss: 0.022285427073943938 | Validation loss:
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Epoch:          433 | Training loss: 0.022245033146418933 | Validation loss:
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Epoch:          434 | Training loss: 0.022204833413098674 | Validation loss:
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Epoch:          435 | Training loss: 0.0221648263341117 | Validation loss: 0.
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Epoch:          436 | Training loss: 0.02212501099442323 | Validation loss: 0
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Epoch:          437 | Training loss: 0.022085385218973075 | Validation loss:
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Epoch:          438 | Training loss: 0.022045949809485203 | Validation loss:
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Epoch:          439 | Training loss: 0.02200670059198855 | Validation loss: 0
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Epoch:          440 | Training loss: 0.02196763766556774 | Validation loss: 0
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Epoch:          441 | Training loss: 0.021928760518013346 | Validation loss:
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Epoch:          442 | Training loss: 0.021890066156104337 | Validation loss:
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Epoch:          443 | Training loss: 0.021851554901346368 | Validation loss:
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Epoch:          444 | Training loss: 0.02181322490766704 | Validation loss: 0
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Epoch:          445 | Training loss: 0.021775075190471605 | Validation loss:
0.33281383501135264
Epoch:          446 | Training loss: 0.02173710467152026 | Validation loss: 0
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Epoch:          447 | Training loss: 0.021699311721416335 | Validation loss:
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Epoch:          448 | Training loss: 0.0216616951410653 | Validation loss: 0.
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Epoch:          449 | Training loss: 0.021624254034307327 | Validation loss:
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```

```
Epoch:          450 | Training loss: 0.02158698734017098 | Validation loss: 0
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Epoch:          451 | Training loss: 0.021549893857999877 | Validation loss:
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Epoch:          452 | Training loss: 0.02151297110507315 | Validation loss:
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Epoch:          453 | Training loss: 0.02147622000867706 | Validation loss: 0
.3326944569190352
Epoch:          454 | Training loss: 0.02143963821339118 | Validation loss: 0
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Epoch:          455 | Training loss: 0.021403225333131642 | Validation loss:
0.33266569797887996
Epoch:          456 | Training loss: 0.021366979711655267 | Validation loss:
0.33264896832664803
Epoch:          457 | Training loss: 0.021330900126166792 | Validation loss:
0.33263545211943507
Epoch:          458 | Training loss: 0.02129498610694857 | Validation loss: 0
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Epoch:          459 | Training loss: 0.021259236140854627 | Validation loss:
0.332607277377903
Epoch:          460 | Training loss: 0.021223649704587823 | Validation loss:
0.33259269079706705
Epoch:          461 | Training loss: 0.0211882247154103 | Validation loss: 0.
33257997456069427
Epoch:          462 | Training loss: 0.021152961093024395 | Validation loss:
0.33256580646152306
Epoch:          463 | Training loss: 0.021117858781088954 | Validation loss:
0.3325502959781917
Epoch:          464 | Training loss: 0.02108291437285406 | Validation loss: 0
.3325365270526679
Epoch:          465 | Training loss: 0.021048126435928485 | Validation loss:
0.3325238882520003
Epoch:          466 | Training loss: 0.02101349640761408 | Validation loss: 0
.332510480647069
Epoch:          467 | Training loss: 0.0209790220524639 | Validation loss: 0.
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Epoch:          468 | Training loss: 0.020944702106850666 | Validation loss:
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Epoch:          469 | Training loss: 0.0209105361757736 | Validation loss: 0.
33247259691545056
Epoch:          470 | Training loss: 0.020876523560879514 | Validation loss:
0.3324599794127401
Epoch:          471 | Training loss: 0.02084266292875888 | Validation loss: 0
.3324481222702449
Epoch:          472 | Training loss: 0.02080895322909561 | Validation loss: 0
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Epoch:          473 | Training loss: 0.020775393730062992 | Validation loss:
0.33242189856247917
Epoch:          474 | Training loss: 0.020741983275045926 | Validation loss:
0.3324090259706311
Epoch:          475 | Training loss: 0.020708721433297245 | Validation loss:
0.33239589207457754
Epoch:          476 | Training loss: 0.020675606035177502 | Validation loss:
0.3323837132201436
Epoch:          477 | Training loss: 0.020642637970758885 | Validation loss:
0.3323705579829874
Epoch:          478 | Training loss: 0.020609814226565857 | Validation loss:
0.3323586268915362
Epoch:          479 | Training loss: 0.020577136294014586 | Validation loss:
0.33234579857385915
Epoch:          480 | Training loss: 0.02054460013278031 | Validation loss: 0
```

```
.33233429499470013
Epoch:          481 | Training loss: 0.02051220688530535 | Validation loss: 0
.3323226077089751
Epoch:          482 | Training loss: 0.02047995500485722 | Validation loss: 0
.33231156241500215
Epoch:          483 | Training loss: 0.02044784422597637 | Validation loss: 0
.3323007090522956


Hyper Parameters -- Learning Rate - 0.0020080000000000002  Regularization P
arameter- 6.309573444801929e-05
Epoch:            0 | Training loss: 0.6322250199773958 | Validation loss: 0.
6620807956176307
Epoch:            1 | Training loss: 0.5824894588114936 | Validation loss: 0.
6372226973889807
Epoch:            2 | Training loss: 0.5410024965702094 | Validation loss: 0.
61158536714592304
Epoch:            3 | Training loss: 0.5058546187408584 | Validation loss: 0.
5978266996839597
Epoch:            4 | Training loss: 0.4756385690360885 | Validation loss: 0.
5826969189009628
Epoch:            5 | Training loss: 0.4492401763575117 | Validation loss: 0.
5685930679636665
Epoch:            6 | Training loss: 0.42603433972426086 | Validation loss: 0
.5565361206345162
Epoch:            7 | Training loss: 0.4054086332305636 | Validation loss: 0.
5460439985573897
Epoch:            8 | Training loss: 0.3869082387878942 | Validation loss: 0.
536317869275874
Epoch:            9 | Training loss: 0.37023156188061423 | Validation loss: 0
.5276047098341444
Epoch:           10 | Training loss: 0.3551974411426412 | Validation loss: 0.
5199320442042704
Epoch:           11 | Training loss: 0.3412228533244028 | Validation loss: 0.
5122232303637035
Epoch:           12 | Training loss: 0.32851694933382164 | Validation loss: 0
.5055314253391586
Epoch:           13 | Training loss: 0.31685949833390836 | Validation loss: 0
.4995513686436112
Epoch:           14 | Training loss: 0.3059768320773745 | Validation loss: 0.
49356072812724805
Epoch:           15 | Training loss: 0.2959138305987873 | Validation loss: 0.
4882144908276378
Epoch:           16 | Training loss: 0.28657460321658645 | Validation loss: 0
.48341328046486043
Epoch:           17 | Training loss: 0.27780414887559224 | Validation loss: 0
.4787057805538003
Epoch:           18 | Training loss: 0.26957868837094295 | Validation loss: 0
.4741524510208632
Epoch:           19 | Training loss: 0.2618686351585562 | Validation loss: 0.
47008189563386177
Epoch:           20 | Training loss: 0.2546184734826855 | Validation loss: 0.
4661614606450422
Epoch:           21 | Training loss: 0.24778191032179572 | Validation loss: 0
.46250261000287457
Epoch:           22 | Training loss: 0.24134177899265674 | Validation loss: 0
.45910544918233653
Epoch:           23 | Training loss: 0.235215055361637 | Validation loss: 0.4
557217890751206
Epoch:           24 | Training loss: 0.229456878341143 | Validation loss: 0.4
527161103013014
Epoch:           25 | Training loss: 0.22392758514354752 | Validation loss: 0
```

```
.4496340157536266
Epoch:          26 | Training loss: 0.21871542991656234 | Validation loss: 0
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Epoch:          27 | Training loss: 0.21372680540950903 | Validation loss: 0
.4441033396983419
Epoch:          28 | Training loss: 0.20897924612808028 | Validation loss: 0
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Epoch:          29 | Training loss: 0.20446993287250748 | Validation loss: 0
.4391023310146339
Epoch:          30 | Training loss: 0.2001292611369046 | Validation loss: 0.
4366712273836096
Epoch:          31 | Training loss: 0.1959954875177732 | Validation loss: 0.
4344153382748448
Epoch:          32 | Training loss: 0.19204094548426018 | Validation loss: 0
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Epoch:          33 | Training loss: 0.18824013486391622 | Validation loss: 0
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Epoch:          34 | Training loss: 0.18459986205268347 | Validation loss: 0
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Epoch:          35 | Training loss: 0.1811052867287398 | Validation loss: 0.
42621831252981224
Epoch:          36 | Training loss: 0.17774809073115616 | Validation loss: 0
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Epoch:          37 | Training loss: 0.1745206614578822 | Validation loss: 0.
4225958879954827
Epoch:          38 | Training loss: 0.17141314001548785 | Validation loss: 0
.42086915930801605
Epoch:          39 | Training loss: 0.16842358494486426 | Validation loss: 0
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Epoch:          40 | Training loss: 0.16554064168321325 | Validation loss: 0
.41758797131651787
Epoch:          41 | Training loss: 0.1627620023879935 | Validation loss: 0.
41603813303299353
Epoch:          42 | Training loss: 0.16007676435266627 | Validation loss: 0
.41455174691957175
Epoch:          43 | Training loss: 0.15748957899283786 | Validation loss: 0
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Epoch:          44 | Training loss: 0.15498151656741932 | Validation loss: 0
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Epoch:          45 | Training loss: 0.15256214311225633 | Validation loss: 0
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Epoch:          46 | Training loss: 0.15022439615620786 | Validation loss: 0
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Epoch:          47 | Training loss: 0.14796380138761417 | Validation loss: 0
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Epoch:          48 | Training loss: 0.1457657704870609 | Validation loss: 0.
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Epoch:          49 | Training loss: 0.14364423700167533 | Validation loss: 0
.40536755973918287
Epoch:          50 | Training loss: 0.1415858016738142 | Validation loss: 0.
4042149897276164
Epoch:          51 | Training loss: 0.13959029117268115 | Validation loss: 0
.4030928885251693
Epoch:          52 | Training loss: 0.13765656199231183 | Validation loss: 0
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Epoch:          53 | Training loss: 0.135773465542749 | Validation loss: 0.4
00957582676425
Epoch:          54 | Training loss: 0.13394968480280678 | Validation loss: 0
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Epoch:          55 | Training loss: 0.13218016588192838 | Validation loss: 0
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```

```
Epoch:            56 | Training loss: 0.1304569704972652 | Validation loss: 0.
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Epoch:            57 | Training loss: 0.12878382571677446 | Validation loss: 0
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Epoch:            58 | Training loss: 0.12715841111564158 | Validation loss: 0
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Epoch:            59 | Training loss: 0.12557464876958777 | Validation loss: 0
.3952085443296336
Epoch:            60 | Training loss: 0.1240348805139825 | Validation loss: 0.
39433647358118057
Epoch:            61 | Training loss: 0.12253623462176239 | Validation loss: 0
.39349055193913124
Epoch:            62 | Training loss: 0.12107687745980152 | Validation loss: 0
.3926636089342373
Epoch:            63 | Training loss: 0.11965548989866939 | Validation loss: 0
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Epoch:            64 | Training loss: 0.11827077627531866 | Validation loss: 0
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Epoch:            65 | Training loss: 0.11692158889441212 | Validation loss: 0
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Epoch:            66 | Training loss: 0.11560465348411966 | Validation loss: 0
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Epoch:            67 | Training loss: 0.11432298724720734 | Validation loss: 0
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Epoch:            68 | Training loss: 0.11306975015745678 | Validation loss: 0
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Epoch:            69 | Training loss: 0.111847932328439 3 | Validation loss: 0.
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Epoch:            70 | Training loss: 0.1106562398549574 | Validation loss: 0.
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Epoch:            71 | Training loss: 0.10949299798946949 | Validation loss: 0
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Epoch:            72 | Training loss: 0.10835613927091893 | Validation loss: 0
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Epoch:            73 | Training loss: 0.10724564661722642 | Validation loss: 0
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Epoch:            74 | Training loss: 0.10616112623621494 | Validation loss: 0
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Epoch:            75 | Training loss: 0.10510139874784069 | Validation loss: 0
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Epoch:            76 | Training loss: 0.10406579530590 66 | Validation loss: 0.
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Epoch:            77 | Training loss: 0.10305303456276158 | Validation loss: 0
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Epoch:            78 | Training loss: 0.10206267109291785 | Validation loss: 0
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Epoch:            79 | Training loss: 0.10109396885155976 | Validation loss: 0
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Epoch:            80 | Training loss: 0.10014659618274717 | Validation loss: 0
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Epoch:            84 | Training loss: 0.09655410697460687 | Validation loss: 0
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Epoch:            86 | Training loss: 0.09486810827243117 | Validation loss: 0
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Epoch:          309 | Training loss: 0.04234180317025195 | Validation loss: 0
.34948975687474615
Epoch:          310 | Training loss: 0.04228662572137527 | Validation loss: 0
.34947299314824337
Epoch:          311 | Training loss: 0.04223191809746264 | Validation loss: 0
.34945410710949587
Epoch:          312 | Training loss: 0.04217767089749468 | Validation loss: 0
.34943642817820403
Epoch:          313 | Training loss: 0.04212388088467214 | Validation loss: 0
.3494192168372406
Epoch:          314 | Training loss: 0.0420705407700531 | Validation loss: 0.
34940414750184834
Epoch:          315 | Training loss: 0.042017650839397465 | Validation loss:
0.34938795212313606
Epoch:          316 | Training loss: 0.04196520608760059 | Validation loss: 0
.34937014901105357
Epoch:          317 | Training loss: 0.04191320103506609 | Validation loss: 0
.34935309411949933
Epoch:          318 | Training loss: 0.04186163245987325 | Validation loss: 0
.3493364569106109
Epoch:          319 | Training loss: 0.04181048924786385 | Validation loss: 0
.34932222468498336
Epoch:          320 | Training loss: 0.0417597812112607 | Validation loss: 0.
3493050792854341
Epoch:          321 | Training loss: 0.04170949195214765 | Validation loss: 0
.3492898164560652
Epoch:          322 | Training loss: 0.04165962067491867 | Validation loss: 0
.3492749958891073
Epoch:          323 | Training loss: 0.041610157181900836 | Validation loss:
0.34926302874645926
Epoch:          324 | Training loss: 0.041561110343725685 | Validation loss:
0.3492488187548066
Epoch:          325 | Training loss: 0.041512472196510275 | Validation loss:
0.3492337658287808
Epoch:          326 | Training loss: 0.041464232568604834 | Validation loss:
0.34922183461406353
Epoch:          327 | Training loss: 0.041416396488913064 | Validation loss:
0.34920693393712454
Epoch:          328 | Training loss: 0.04136895351367602 | Validation loss: 0
.34919364291009664
Epoch:          329 | Training loss: 0.041321901417196834 | Validation loss:
0.3491815718181389
Epoch:          330 | Training loss: 0.041275237974542224 | Validation loss:
```

0.34916898529743035
Epoch: 331 | Training loss: 0.041228959719902106 | Validation loss:
0.3491558056657663
Epoch: 332 | Training loss: 0.04118306113679402 | Validation loss: 0
.34914347918533795
Epoch: 333 | Training loss: 0.041137540934074034 | Validation loss:
0.3491305311263821
Epoch: 334 | Training loss: 0.041092392531582186 | Validation loss:
0.3491185892553642
Epoch: 335 | Training loss: 0.041047617240444284 | Validation loss:
0.3491056528206417
Epoch: 336 | Training loss: 0.04100321071498017 | Validation loss: 0
.34909301870139103
Epoch: 337 | Training loss: 0.040959159928958745 | Validation loss:
0.3490823813821213
Epoch: 338 | Training loss: 0.040915474366090956 | Validation loss:
0.3490705773437145
Epoch: 339 | Training loss: 0.04087214400463596 | Validation loss: 0
.34905947216798494
Epoch: 340 | Training loss: 0.0408291728364433 | Validation loss: 0.
3490474087277336

Hyper Parameters -- Learning Rate - 0.0020080000000000002 Regularization P
arameter- 0.00039810717055349735
Epoch: 0 | Training loss: 0.6322833455118273 | Validation loss: 0.
6621391210507541
Epoch: 1 | Training loss: 0.5827001225138192 | Validation loss: 0.
637433360801938
Epoch: 2 | Training loss: 0.5414353820007083 | Validation loss: 0.
6162865563413564
Epoch: 3 | Training loss: 0.5065612421209523 | Validation loss: 0.
5985333222478757
Epoch: 4 | Training loss: 0.4766582250292777 | Validation loss: 0.
5837165738341601
Epoch: 5 | Training loss: 0.45060337127235195 | Validation loss: 0
.5699562615352153
Epoch: 6 | Training loss: 0.4277642662024283 | Validation loss: 0.
5582660455332538
Epoch: 7 | Training loss: 0.407523517874515 | Validation loss: 0.5
481588815091438
Epoch: 8 | Training loss: 0.3894226652600356 | Validation loss: 0.
53883229391686
Epoch: 9 | Training loss: 0.3731570243781011 | Validation loss: 0.
5305301703982793
Epoch: 10 | Training loss: 0.35854265739456415 | Validation loss: 0
.5232772585838559
Epoch: 11 | Training loss: 0.3449952179839652 | Validation loss: 0.
5159955930042077
Epoch: 12 | Training loss: 0.3327221950041466 | Validation loss: 0.
5097366690192962
Epoch: 13 | Training loss: 0.3215017264138218 | Validation loss: 0.
5041935949337073
Epoch: 14 | Training loss: 0.31105959880109 | Validation loss: 0.49
8643492978304
Epoch: 15 | Training loss: 0.30143939211617254 | Validation loss: 0
.49374005062846466
Epoch: 16 | Training loss: 0.29254472727814873 | Validation loss: 0
.48938340315773504
Epoch: 17 | Training loss: 0.28422038136050876 | Validation loss: 0
.4851220118764935
Epoch: 18 | Training loss: 0.2764418127078585 | Validation loss: 0.

```
4810155742261498
Epoch:          19 | Training loss: 0.26917871261191 | Validation loss: 0.47
73919723197529
Epoch:          20 | Training loss: 0.2623755934083301 | Validation loss: 0.
4739185800493428
Epoch:          21 | Training loss: 0.25598567875572836 | Validation loss: 0
.47070637827998313
Epoch:          22 | Training loss: 0.24999132326210344 | Validation loss: 0
.46775499378812135
Epoch:          23 | Training loss: 0.24430947418974586 | Validation loss: 0
.46481620844796817
Epoch:          24 | Training loss: 0.2389950506343966 | Validation loss: 0.
4622542838238662
Epoch:          25 | Training loss: 0.233908184184121 | Validation loss: 0.4
5961461623450467
Epoch:          26 | Training loss: 0.22913698975095007 | Validation loss: 0
.4572768105368161
Epoch:          27 | Training loss: 0.22458782798674032 | Validation loss: 0
.4549643646593121
Epoch:          28 | Training loss: 0.22027812679259826 | Validation loss: 0
.45279141390176614
Epoch:          29 | Training loss: 0.2162047432099584 | Validation loss: 0.
4508371448759946
Epoch:          30 | Training loss: 0.21229818841704742 | Validation loss: 0
.4488401585008895
Epoch:          31 | Training loss: 0.2085964342894331 | Validation loss: 0.
447016289454167
Epoch:          32 | Training loss: 0.20507200237046097 | Validation loss: 0
.4452980133515576
Epoch:          33 | Training loss: 0.20169929629115063 | Validation loss: 0
.44359294706178815
Epoch:          34 | Training loss: 0.19848515431478267 | Validation loss: 0
.44202953672472134
Epoch:          35 | Training loss: 0.1954145416582673 | Validation loss: 0.
4405275740843635
Epoch:          36 | Training loss: 0.19247908748833514 | Validation loss: 0
.4390933954500022
Epoch:          37 | Training loss: 0.18967113307286038 | Validation loss: 0
.4377463675302233
Epoch:          38 | Training loss: 0.18698109625701054 | Validation loss: 0
.4364371240667237
Epoch:          39 | Training loss: 0.18440671924924582 | Validation loss: 0
.43517065914089137
Epoch:          40 | Training loss: 0.1819368317520095 | Validation loss: 0.
4339841710062094
Epoch:          41 | Training loss: 0.17956901761882282 | Validation loss: 0
.43284515849781285
Epoch:          42 | Training loss: 0.1772923474414309 | Validation loss: 0.
431767340982937
Epoch:          43 | Training loss: 0.17511147338065805 | Validation loss: 0
.4307264212386243
Epoch:          44 | Training loss: 0.17300760772901214 | Validation loss: 0
.4297475485883501
Epoch:          45 | Training loss: 0.17099019998287465 | Validation loss: 0
.4288015285451323
Epoch:          46 | Training loss: 0.16905222157099678 | Validation loss: 0
.4279173078122133
Epoch:          47 | Training loss: 0.16718911775276757 | Validation loss: 0
.42706484134300043
Epoch:          48 | Training loss: 0.16538642834526818 | Validation loss: 0
.42620326820502674
```

```
Epoch:           49 | Training loss: 0.16365807415035183 | Validation loss: 0
.42538141282506475
Epoch:           50 | Training loss: 0.1619905493882749 | Validation loss: 0.
4246197541390586
Epoch:           51 | Training loss: 0.16038386224473444 | Validation loss: 0
.4238864770401274
Epoch:           52 | Training loss: 0.15883670771970101 | Validation loss: 0
.42318231608716134
Epoch:           53 | Training loss: 0.15733815059349704 | Validation loss: 0
.42252228691021626
Epoch:           54 | Training loss: 0.15589668464446635 | Validation loss: 0
.42187515166718
Epoch:           55 | Training loss: 0.1545073908225 | Validation loss: 0.421
2487414517024
Epoch:           56 | Training loss: 0.15316235159483388 | Validation loss: 0
.4206664491062145
Epoch:           57 | Training loss: 0.15186529299574347 | Validation loss: 0
.42009958087809385
Epoch:           58 | Training loss: 0.15061389965726601 | Validation loss: 0
.4195734382473074
Epoch:           59 | Training loss: 0.1494021297142482 | Validation loss: 0.
4190360493248421
Epoch:           60 | Training loss: 0.1482322964659583 | Validation loss: 0.
41853391440773174
Epoch:           61 | Training loss: 0.14710155929955984 | Validation loss: 0
.41805590237652984
Epoch:           62 | Training loss: 0.14600819479110771 | Validation loss: 0
.4175949528513325
Epoch:           63 | Training loss: 0.1449507740178212 | Validation loss: 0.
4171523285825344
Epoch:           64 | Training loss: 0.14392806144241863 | Validation loss: 0
.4167139733908995
Epoch:           65 | Training loss: 0.14293894906669222 | Validation loss: 0
.41630505214411156
Epoch:           66 | Training loss: 0.1419801402656429 | Validation loss: 0.
4159334574777966
Epoch:           67 | Training loss: 0.1410547289003613 | Validation loss: 0.
4155767566814972
Epoch:           68 | Training loss: 0.14015578188627406 | Validation loss: 0
.4152068186917355
Epoch:           69 | Training loss: 0.139286399131438 | Validation loss: 0.4
1485564414516285
Epoch:           70 | Training loss: 0.1384453540749709 | Validation loss: 0.
4145367022735807
Epoch:           71 | Training loss: 0.13763082275562386 | Validation loss: 0
.41420336845845596
Epoch:           72 | Training loss: 0.13684090224494952 | Validation loss: 0
.41390418017703795
Epoch:           73 | Training loss: 0.13607552612665524 | Validation loss: 0
.41362900985903683
Epoch:           74 | Training loss: 0.1353342986048838 | Validation loss: 0.
4133506990808793
Epoch:           75 | Training loss: 0.13461609384748072 | Validation loss: 0
.4130881511045571
Epoch:           76 | Training loss: 0.13392031108646485 | Validation loss: 0
.412843211945298
Epoch:           77 | Training loss: 0.1332456289892568 | Validation loss: 0.
41260330331771583
Epoch:           78 | Training loss: 0.13259163365778165 | Validation loss: 0
.4123736794900541
Epoch:           79 | Training loss: 0.1319575761813895 | Validation loss: 0.
```

```
41215297814717156
Epoch:          80 | Training loss: 0.13134319766546498 | Validation loss: 0
.41194799530117365
Epoch:          81 | Training loss: 0.13074712753751425 | Validation loss: 0
.4117460663823456
Epoch:          82 | Training loss: 0.1301696120490528 | Validation loss: 0.
4115632412779874
Epoch:          83 | Training loss: 0.12961020737667028 | Validation loss: 0
.41139309156018866
Epoch:          84 | Training loss: 0.1290658481422729 | Validation loss: 0.
4111998862743721
Epoch:          85 | Training loss: 0.12853999787919235 | Validation loss: 0
.4110302077669061
Epoch:          86 | Training loss: 0.12802781387036677 | Validation loss: 0
.4108898124793998
Epoch:          87 | Training loss: 0.12753219908553298 | Validation loss: 0
.410742838988625
Epoch:          88 | Training loss: 0.1270516950646558 | Validation loss: 0.
4106006913489061
Epoch:          89 | Training loss: 0.12658636390268344 | Validation loss: 0
.41046389417778384
Epoch:          90 | Training loss: 0.1261336330638868 | Validation loss: 0.
41034496368152096
Epoch:          91 | Training loss: 0.12569594010039173 | Validation loss: 0
.41022401425986255
Epoch:          92 | Training loss: 0.12526958341212402 | Validation loss: 0
.41012369328866977
Epoch:          93 | Training loss: 0.124857049763719 | Validation loss: 0.4
100318075840403
Epoch:          94 | Training loss: 0.12445707955122497 | Validation loss: 0
.40992582214265383
Epoch:          95 | Training loss: 0.12406933679145074 | Validation loss: 0
.409833719500826
Epoch:          96 | Training loss: 0.12369291000217462 | Validation loss: 0
.40976049121150665
Epoch:          97 | Training loss: 0.12332820091950453 | Validation loss: 0
.4096757036253833
Epoch:          98 | Training loss: 0.12297436628048984 | Validation loss: 0
.4096069985635259
Epoch:          99 | Training loss: 0.1226314487408377 | Validation loss: 0.
4095478430588458
Epoch:         100 | Training loss: 0.12229886813402581 | Validation loss: 0
.4094834613663887
Epoch:         101 | Training loss: 0.12197652753599321 | Validation loss: 0
.409429414798268
Epoch:         102 | Training loss: 0.12166412270906006 | Validation loss: 0
.40938108515729044
Epoch:         103 | Training loss: 0.12136144852938571 | Validation loss: 0
.409340120192546
Epoch:         104 | Training loss: 0.12106786091807976 | Validation loss: 0
.4092946427544817
Epoch:         105 | Training loss: 0.12078356442688004 | Validation loss: 0
.40926323169010154
Epoch:         106 | Training loss: 0.12050814634326193 | Validation loss: 0
.4092348332159277
Epoch:         107 | Training loss: 0.12024112040232189 | Validation loss: 0
.40920202144368756
Epoch:         108 | Training loss: 0.11998268018580406 | Validation loss: 0
.40917546338049715
Epoch:         109 | Training loss: 0.11973247681671625 | Validation loss: 0
.40915419059972225
```

Epoch: 110 | Training loss: 0.11949004389648353 | Validation loss: 0.4091418753277868

Hyper Parameters -- Learning Rate - 0.0020080000000000002 Regularization Parameter- 0.002511886431509582
Epoch: 0 | Training loss: 0.6326513547344836 | Validation loss: 0.662507129634199
Epoch: 1 | Training loss: 0.5840293204690051 | Validation loss: 0.638762556931334
Epoch: 2 | Training loss: 0.5441667039703284 | Validation loss: 0.6190178748509795
Epoch: 3 | Training loss: 0.5110197332612287 | Validation loss: 0.6029918082384238
Epoch: 4 | Training loss: 0.48309181764426773 | Validation loss: 0.59015015976106511
Epoch: 5 | Training loss: 0.45920454688007095 | Validation loss: 0.5785574286673586
Epoch: 6 | Training loss: 0.43867936016653647 | Validation loss: 0.5691811295318626
Epoch: 7 | Training loss: 0.42086753195933657 | Validation loss: 0.5615028849169645
Epoch: 8 | Training loss: 0.40528761582870904 | Validation loss: 0.5546972329317827
Epoch: 9 | Training loss: 0.39161543457509435 | Validation loss: 0.5489885683967227
Epoch: 10 | Training loss: 0.37964953203264745 | Validation loss: 0.5443841214083917
Epoch: 11 | Training loss: 0.36879721384309894 | Validation loss: 0.5397975761240681
Epoch: 12 | Training loss: 0.359255482009817 | Validation loss: 0.5362699434678858
Epoch: 13 | Training loss: 0.35079218228665754 | Validation loss: 0.5334840395137532
Epoch: 14 | Training loss: 0.3431296615296015 | Validation loss: 0.5307135438913549
Epoch: 15 | Training loss: 0.3363032967012461 | Validation loss: 0.5286039443830526
Epoch: 16 | Training loss: 0.33021362712029617 | Validation loss: 0.5270522943643706
Epoch: 17 | Training loss: 0.32470402996210723 | Validation loss: 0.5256056531453375
Epoch: 18 | Training loss: 0.3197451528412391 | Validation loss: 0.5243189072198574
Epoch: 19 | Training loss: 0.31530213048213024 | Validation loss: 0.5235153853481027
Epoch: 20 | Training loss: 0.3113196524931135 | Validation loss: 0.5228626358452242
Epoch: 21 | Training loss: 0.30774789297671973 | Validation loss: 0.5224685915121152
Epoch: 22 | Training loss: 0.3045661861017552 | Validation loss: 0.5223298587506505
Epoch: 23 | Training loss: 0.30169129865271715 | Validation loss: 0.5221980363488066

Hyper Parameters -- Learning Rate - 0.0020080000000000002 Regularization Parameter- 0.01584893192461114
Epoch: 0 | Training loss: 0.6349733351351995 | Validation loss: 0.6648291060017616
Epoch: 1 | Training loss: 0.5924159867460904 | Validation loss: 0.6471492116884943
Epoch: 2 | Training loss: 0.5614001627319484 | Validation loss: 0.

```
6362513117816149
Epoch:           3 | Training loss: 0.5391508717789819 | Validation loss: 0.
6311229142638594
Epoch:           4 | Training loss: 0.5236849725981949 | Validation loss: 0.
6307432725165212


Hyper Parameters -- Learning Rate - 0.004006  Regularization Parameter- 1e-
05
Epoch:           0 | Training loss: 0.5812361433749502 | Validation loss: 0.
6361836863248399
Epoch:           1 | Training loss: 0.5040917800858423 | Validation loss: 0.
5973001253473954
Epoch:           2 | Training loss: 0.4472330776284936 | Validation loss: 0.
5673987200788001
Epoch:           3 | Training loss: 0.4033607936019798 | Validation loss: 0.
5445036098114949
Epoch:           4 | Training loss: 0.36818917777037624 | Validation loss: 0
.5265340957214277
Epoch:           5 | Training loss: 0.33908593964657135 | Validation loss: 0
.5106494544172329
Epoch:           6 | Training loss: 0.3145455448959675 | Validation loss: 0.
49766049255316447
Epoch:           7 | Training loss: 0.29360306416603343 | Validation loss: 0
.48675966607724797
Epoch:           8 | Training loss: 0.2753565006184584 | Validation loss: 0.
4768802108022494
Epoch:           9 | Training loss: 0.25944603478203787 | Validation loss: 0
.46842606233953693
Epoch:          10 | Training loss: 0.24547250876525026 | Validation loss: 0
.4610941651960132
Epoch:          11 | Training loss: 0.23259057134694947 | Validation loss: 0
.45361206559086825
Epoch:          12 | Training loss: 0.22121514662976413 | Validation loss: 0
.44743813301276014
Epoch:          13 | Training loss: 0.21100458874590705 | Validation loss: 0
.4420179479130572
Epoch:          14 | Training loss: 0.20158786128062453 | Validation loss: 0
.43661542616356797
Epoch:          15 | Training loss: 0.1930452473931412 | Validation loss: 0.
43185824574817305
Epoch:          16 | Training loss: 0.18523509414538872 | Validation loss: 0
.4276516336762042
Epoch:          17 | Training loss: 0.17800793832542347 | Validation loss: 0
.42360676012991805
Epoch:          18 | Training loss: 0.17131068487878268 | Validation loss: 0
.4196897354911435
Epoch:          19 | Training loss: 0.16509803143369858 | Validation loss: 0
.416243306292456
Epoch:          20 | Training loss: 0.15933621748635993 | Validation loss: 0
.41294548868175196
Epoch:          21 | Training loss: 0.15396403713014267 | Validation loss: 0
.40990919681614274
Epoch:          22 | Training loss: 0.14897765062217266 | Validation loss: 0
.40717574631291226
Epoch:          23 | Training loss: 0.1442446921539215 | Validation loss: 0.
4043646919342701
Epoch:          24 | Training loss: 0.13987334563062412 | Validation loss: 0
.4019831242367555
Epoch:          25 | Training loss: 0.13568006137715166 | Validation loss: 0
.39947041741624084
Epoch:          26 | Training loss: 0.13178665131204165 | Validation loss: 0
```

```
.3972927762018388
Epoch:          27 | Training loss: 0.12807528840956317 | Validation loss: 0
.39509149120551285
Epoch:          28 | Training loss: 0.12458041012977383 | Validation loss: 0
.39304822514150944
Epoch:          29 | Training loss: 0.12129283715785545 | Validation loss: 0
.39122125162077914
Epoch:          30 | Training loss: 0.11813787438670945 | Validation loss: 0
.3893124336982025
Epoch:          31 | Training loss: 0.11516135426082334 | Validation loss: 0
.3875821242419512
Epoch:          32 | Training loss: 0.11233353798615851 | Validation loss: 0
.38594658381434827
Epoch:          33 | Training loss: 0.10963321113710031 | Validation loss: 0
.384318355197903
Epoch:          34 | Training loss: 0.10706290459624852 | Validation loss: 0
.3828266405849404
Epoch:          35 | Training loss: 0.10461096838269611 | Validation loss: 0
.38138535250984346
Epoch:          36 | Training loss: 0.1022689377275661 | Validation loss: 0.
3799928757765754
Epoch:          37 | Training loss: 0.10002995899327324 | Validation loss: 0
.37868712511113195
Epoch:          38 | Training loss: 0.09788646347628131 | Validation loss: 0
.3774081243214542
Epoch:          39 | Training loss: 0.0958359240640975 | Validation loss: 0.
37616671239583405
Epoch:          40 | Training loss: 0.09386752822131363 | Validation loss: 0
.3749984444654849
Epoch:          41 | Training loss: 0.09198010275313846 | Validation loss: 0
.37386819176161423
Epoch:          42 | Training loss: 0.09016370694927099 | Validation loss: 0
.372795143457109
Epoch:          43 | Training loss: 0.0884233032045404 | Validation loss: 0.
37174624477753304
Epoch:          44 | Training loss: 0.08674297479638295 | Validation loss: 0
.37075870429610347
Epoch:          45 | Training loss: 0.08512921944326808 | Validation loss: 0
.369797022141981
Epoch:          46 | Training loss: 0.08357816856930052 | Validation loss: 0
.3689004576037438
Epoch:          47 | Training loss: 0.08208356830468835 | Validation loss: 0
.36802261421677407
Epoch:          48 | Training loss: 0.08063290349255973 | Validation loss: 0
.36711441488731383
Epoch:          49 | Training loss: 0.07924117250484183 | Validation loss: 0
.3662406144699765
Epoch:          50 | Training loss: 0.07789426269264618 | Validation loss: 0
.3654342158659014
Epoch:          51 | Training loss: 0.07659403094871131 | Validation loss: 0
.36464906631413774
Epoch:          52 | Training loss: 0.0753387610913155 | Validation loss: 0.
3638875369875842
Epoch:          53 | Training loss: 0.07411887434793166 | Validation loss: 0
.3631748485809188
Epoch:          54 | Training loss: 0.07294225165478663 | Validation loss: 0
.3624645064574035
Epoch:          55 | Training loss: 0.07180468787692162 | Validation loss: 0
.36175965843108027
Epoch:          56 | Training loss: 0.07069978914594313 | Validation loss: 0
.3611099930409397
```

```
Epoch:             57 | Training loss: 0.06963046542839754 | Validation loss: 0
.36046378529032425
Epoch:             58 | Training loss: 0.06859512306279399 | Validation loss: 0
.3598642691270444
Epoch:             59 | Training loss: 0.06758823959617377 | Validation loss: 0
.35923429986176486
Epoch:             60 | Training loss: 0.06661239024500928 | Validation loss: 0
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Epoch:             61 | Training loss: 0.06566521430520186 | Validation loss: 0
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Epoch:             62 | Training loss: 0.06474521000369665 | Validation loss: 0
.3575138799509174
Epoch:             63 | Training loss: 0.06385140708511443 | Validation loss: 0
.3569711227905232
Epoch:             64 | Training loss: 0.06298279260805789 | Validation loss: 0
.35642242388211415
Epoch:             65 | Training loss: 0.062138556829861274 | Validation loss:
0.35590507011852823
Epoch:             66 | Training loss: 0.06131634713193636 | Validation loss: 0
.35543651002917287
Epoch:             67 | Training loss: 0.06051839430929527 | Validation loss: 0
.3549749506600588
Epoch:             68 | Training loss: 0.059738867228150756 | Validation loss:
0.3544827215572346
Epoch:             69 | Training loss: 0.05898077996282746 | Validation loss: 0
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Epoch:             70 | Training loss: 0.05824314587754661 | Validation loss: 0
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Epoch:             71 | Training loss: 0.05752470650672169 | Validation loss: 0
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Epoch:             72 | Training loss: 0.05682343378797328 | Validation loss: 0
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Epoch:             73 | Training loss: 0.05614001072719601 | Validation loss: 0
.3522898833591473
Epoch:             74 | Training loss: 0.05547369919352347 | Validation loss: 0
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Epoch:             75 | Training loss: 0.054823805098966706 | Validation loss:
0.3514836074243503
Epoch:             76 | Training loss: 0.05418995997824711 | Validation loss: 0
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Epoch:             77 | Training loss: 0.0535708709529392 | Validation loss: 0.
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Epoch:             78 | Training loss: 0.05296655704291707 | Validation loss: 0
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Epoch:             79 | Training loss: 0.05237638574329799 | Validation loss: 0
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Epoch:             80 | Training loss: 0.051800117380436245 | Validation loss:
0.3496578478793009
Epoch:             81 | Training loss: 0.051236825442966635 | Validation loss:
0.3493109553471815
Epoch:             82 | Training loss: 0.050686628546720035 | Validation loss:
0.3489858019282174
Epoch:             83 | Training loss: 0.05014926160913034 | Validation loss: 0
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Epoch:             84 | Training loss: 0.04962258652670689 | Validation loss: 0
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Epoch:             85 | Training loss: 0.049108979785803815 | Validation loss:
0.3479991467475735
Epoch:             86 | Training loss: 0.04860477939069635 | Validation loss: 0
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Epoch:             87 | Training loss: 0.04811238555214722 | Validation loss: 0
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.3474169436810598
Epoch:            88 | Training loss: 0.047630634039903946 | Validation loss:
0.34711968769300994
Epoch:            89 | Training loss: 0.04715953794065744 | Validation loss: 0
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Epoch:            90 | Training loss: 0.04669732958823494 | Validation loss: 0
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Epoch:            91 | Training loss: 0.04624563526231569 | Validation loss: 0
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Epoch:            92 | Training loss: 0.04580199377252764 | Validation loss: 0
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Epoch:            93 | Training loss: 0.04536809309732812 | Validation loss: 0
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Epoch:            94 | Training loss: 0.04494295029034876 | Validation loss: 0
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Epoch:            95 | Training loss: 0.044526431130842495 | Validation loss:
0.3452477949026247
Epoch:            96 | Training loss: 0.044117850259927115 | Validation loss:
0.3450186464077203
Epoch:            97 | Training loss: 0.04371754319173601 | Validation loss: 0
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Epoch:            98 | Training loss: 0.04332486220240333 | Validation loss: 0
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Epoch:            99 | Training loss: 0.042939865468389286 | Validation loss:
0.3443166262119463
Epoch:           100 | Training loss: 0.042562136937791026 | Validation loss:
0.34408472385098265
Epoch:           101 | Training loss: 0.04219161268310672 | Validation loss: 0
.34386524194338536
Epoch:           102 | Training loss: 0.04182806875494012 | Validation loss: 0
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Epoch:           103 | Training loss: 0.04147136928848416 | Validation loss: 0
.34344533685298345
Epoch:           104 | Training loss: 0.041121070451963185 | Validation loss:
0.3432279472805954
Epoch:           105 | Training loss: 0.04077733636007886 | Validation loss: 0
.34303051749676633
Epoch:           106 | Training loss: 0.04043985178432197 | Validation loss: 0
.34283376531364496
Epoch:           107 | Training loss: 0.040108256610718894 | Validation loss:
0.342626808180881
Epoch:           108 | Training loss: 0.03978274081622869 | Validation loss: 0
.34242659800548836
Epoch:           109 | Training loss: 0.03946301966710874 | Validation loss: 0
.3422337029476892
Epoch:           110 | Training loss: 0.03914880595545657 | Validation loss: 0
.34205104051226454
Epoch:           111 | Training loss: 0.038840070724516784 | Validation loss:
0.3418778014337906
Epoch:           112 | Training loss: 0.03853673464962793 | Validation loss: 0
.34169388073673573
Epoch:           113 | Training loss: 0.038238622516243104 | Validation loss:
0.3415156494800846
Epoch:           114 | Training loss: 0.03794550595354148 | Validation loss: 0
.34135243731858095
Epoch:           115 | Training loss: 0.03765738513034383 | Validation loss: 0
.3411852786041925
Epoch:           116 | Training loss: 0.03737408941689909 | Validation loss: 0
.34101824765340216
Epoch:           117 | Training loss: 0.03709554654906041 | Validation loss: 0
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```

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Epoch:          118 | Training loss: 0.03682156200634309 | Validation loss: 0
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Epoch:          119 | Training loss: 0.03655209377753245 | Validation loss: 0
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Epoch:          120 | Training loss: 0.03628703682835392 | Validation loss: 0
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Epoch:          121 | Training loss: 0.03602624845237931 | Validation loss: 0
.34024697712217233
Epoch:          122 | Training loss: 0.035769506991683526 | Validation loss:
0.34009108054270015
Epoch:          123 | Training loss: 0.035516986682716904 | Validation loss:
0.3399481315664296
Epoch:          124 | Training loss: 0.035268374907585893 | Validation loss:
0.33980062459238086
Epoch:          125 | Training loss: 0.03502369488728699 | Validation loss: 0
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Epoch:          126 | Training loss: 0.034782844009668724 | Validation loss:
0.33952091182161553
Epoch:          127 | Training loss: 0.03454570553890239 | Validation loss: 0
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Epoch:          128 | Training loss: 0.034312223062940246 | Validation loss:
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Epoch:          129 | Training loss: 0.03408229188545786 | Validation loss: 0
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Epoch:          130 | Training loss: 0.033855850654029934 | Validation loss:
0.33898282917505557
Epoch:          131 | Training loss: 0.033632820707139126 | Validation loss:
0.338855213989234
Epoch:          132 | Training loss: 0.033413144459686364 | Validation loss:
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Epoch:          133 | Training loss: 0.03319671545521699 | Validation loss: 0
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Epoch:          134 | Training loss: 0.03298344952422758 | Validation loss: 0
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Epoch:          136 | Training loss: 0.03256628840868894 | Validation loss: 0
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Epoch:          137 | Training loss: 0.03236218363317975 | Validation loss: 0
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Epoch:          138 | Training loss: 0.03216109649687887 | Validation loss: 0
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Epoch:          139 | Training loss: 0.031962751525451014 | Validation loss:
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Epoch:          140 | Training loss: 0.03176730422049064 | Validation loss: 0
.337803144505468 6
Epoch:          141 | Training loss: 0.031574668579418506 | Validation loss:
0.33769008953504726
Epoch:          142 | Training loss: 0.031384814985000946 | Validation loss:
0.3375771117549677
Epoch:          143 | Training loss: 0.031197320387999793 | Validation loss:
0.3374789493920307
Epoch:          144 | Training loss: 0.031012522878824167 | Validation loss:
0.33737792046659415
Epoch:          145 | Training loss: 0.030830261771701062 | Validation loss:
0.3372793986045368
Epoch:          146 | Training loss: 0.03065048816680246 | Validation loss: 0
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Epoch:          147 | Training loss: 0.03047316261255117 | Validation loss: 0
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Epoch:          148 | Training loss: 0.030298250589842268 | Validation loss:
```

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0.3369935233383488
Epoch:        149 | Training loss: 0.03012568930032598 | Validation loss: 0
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Epoch:        150 | Training loss: 0.02995540952550752 | Validation loss: 0
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Epoch:        151 | Training loss: 0.02978744011212343 | Validation loss: 0
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Epoch:        152 | Training loss: 0.029621611805289022 | Validation loss:
0.33663396164509846
Epoch:        153 | Training loss: 0.02945797687842597 | Validation loss: 0
.3365409385718267
Epoch:        154 | Training loss: 0.029296490101731527 | Validation loss:
0.33644992407757995
Epoch:        155 | Training loss: 0.029137081885839942 | Validation loss:
0.3363645458296536
Epoch:        156 | Training loss: 0.028979721226865058 | Validation loss:
0.3362824246251271
Epoch:        157 | Training loss: 0.028824382201288867 | Validation loss:
0.336199136446295
Epoch:        158 | Training loss: 0.028671020109824325 | Validation loss:
0.33612141103154775
Epoch:        159 | Training loss: 0.02851959720226589 | Validation loss: 0
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Epoch:        160 | Training loss: 0.028370078052422275 | Validation loss:
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Epoch:        161 | Training loss: 0.028222427903649257 | Validation loss:
0.3358837373750366
Epoch:        162 | Training loss: 0.02807664208657644 | Validation loss: 0
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Epoch:        163 | Training loss: 0.027932624753276583 | Validation loss:
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Epoch:        164 | Training loss: 0.027790375613652378 | Validation loss:
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Epoch:        165 | Training loss: 0.027649884340750504 | Validation loss:
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Epoch:        166 | Training loss: 0.027511110950923866 | Validation loss:
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Epoch:        167 | Training loss: 0.02737399906829436 | Validation loss: 0
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Epoch:        168 | Training loss: 0.027238568851213018 | Validation loss:
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Epoch:        169 | Training loss: 0.027104717850260716 | Validation loss:
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Epoch:        170 | Training loss: 0.0269725012118742 | Validation loss: 0.
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Epoch:        171 | Training loss: 0.026841819564675237 | Validation loss:
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Epoch:        172 | Training loss: 0.026712695997100053 | Validation loss:
0.33509580599731590
Epoch:        173 | Training loss: 0.026585085632389118 | Validation loss:
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Epoch:        174 | Training loss: 0.02645896544572056 | Validation loss: 0
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Epoch:        175 | Training loss: 0.02633432779681872 | Validation loss: 0
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Epoch:        176 | Training loss: 0.026211125810566917 | Validation loss:
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Epoch:        177 | Training loss: 0.026089283070923546 | Validation loss:
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Epoch:        178 | Training loss: 0.025968878097806628 | Validation loss:
0.334727710022089
```

```
Epoch:          179 | Training loss: 0.025849833275931742 | Validation loss:
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Epoch:          180 | Training loss: 0.025732146749417702 | Validation loss:
0.33461049813535676
Epoch:          181 | Training loss: 0.025615776040911645 | Validation loss:
0.3345510703375267
Epoch:          182 | Training loss: 0.025500716668390894 | Validation loss:
0.334495882535187
Epoch:          183 | Training loss: 0.02538693622906665 | Validation loss: 0
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Epoch:          184 | Training loss: 0.025274458745793784 | Validation loss:
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Epoch:          185 | Training loss: 0.025163158785807355 | Validation loss:
0.33433338340399665
Epoch:          186 | Training loss: 0.025053111152309425 | Validation loss:
0.3342809452108999
Epoch:          187 | Training loss: 0.02494425191769043 | Validation loss: 0
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Epoch:          188 | Training loss: 0.024836619465321733 | Validation loss:
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Epoch:          189 | Training loss: 0.02473014782876067 | Validation loss:
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Epoch:          190 | Training loss: 0.024624795746647173 | Validation loss:
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Epoch:          191 | Training loss: 0.024520541495082898 | Validation loss:
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Epoch:          192 | Training loss: 0.024417452377281615 | Validation loss:
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Epoch:          193 | Training loss: 0.02431543943078922 | Validation loss: 0
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Epoch:          194 | Training loss: 0.024214511651282265 | Validation loss:
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Epoch:          195 | Training loss: 0.024114653805578864 | Validation loss:
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Epoch:          197 | Training loss: 0.023918046031872656 | Validation loss:
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Epoch:          198 | Training loss: 0.02382128463058481 | Validation loss: 0
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Epoch:          199 | Training loss: 0.023725516992134 | Validation loss: 0.3
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Epoch:          200 | Training loss: 0.0236307495474982 | Validation loss: 0.
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Epoch:          201 | Training loss: 0.02353694389624193 | Validation loss: 0
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Epoch:          202 | Training loss: 0.023444094349465955 | Validation loss:
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Epoch:          203 | Training loss: 0.02335218535363414 | Validation loss: 0
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Epoch:          204 | Training loss: 0.023261193368966763 | Validation loss:
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Epoch:          205 | Training loss: 0.023171135535374015 | Validation loss:
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Epoch:          206 | Training loss: 0.023081978628424364 | Validation loss:
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Epoch:          207 | Training loss: 0.022993711525634487 | Validation loss:
0.3333180213148087
Epoch:          208 | Training loss: 0.022906324022579517 | Validation loss:
0.33327892770845835
Epoch:          209 | Training loss: 0.02281981091636705 | Validation loss: 0
```

```
.3332373451905771
Epoch:        210 | Training loss: 0.02273415237970294 | Validation loss: 0
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Epoch:        211 | Training loss: 0.02264933396838549 | Validation loss: 0
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Epoch:        212 | Training loss: 0.022565324960404795 | Validation loss:
0.3331240752784066
Epoch:        213 | Training loss: 0.02248212817538184 | Validation loss: 0
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Epoch:        214 | Training loss: 0.022399748051407816 | Validation loss:
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Epoch:        215 | Training loss: 0.022318166249529096 | Validation loss:
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Epoch:        216 | Training loss: 0.02223737293008165 | Validation loss: 0
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Epoch:        217 | Training loss: 0.02215737680308164 | Validation loss: 0
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Epoch:        218 | Training loss: 0.02207812408366052 | Validation loss: 0
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Epoch:        219 | Training loss: 0.021999612046340117 | Validation loss:
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Epoch:        220 | Training loss: 0.021921872599716237 | Validation loss:
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Epoch:        221 | Training loss: 0.021844812923125845 | Validation loss:
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Epoch:        222 | Training loss: 0.021768491834101702 | Validation loss:
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Epoch:        223 | Training loss: 0.02169289469762117 | Validation loss: 0
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Epoch:        224 | Training loss: 0.021618002809594493 | Validation loss:
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Epoch:        225 | Training loss: 0.021543805528087854 | Validation loss:
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Epoch:        226 | Training loss: 0.02147029840323937 | Validation loss: 0
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Epoch:        227 | Training loss: 0.021397464423758568 | Validation loss:
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Epoch:        228 | Training loss: 0.021325294882848945 | Validation loss:
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Epoch:        229 | Training loss: 0.02125378361865493 | Validation loss: 0
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Epoch:        230 | Training loss: 0.021182929481862862 | Validation loss:
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Epoch:        231 | Training loss: 0.021112709723434184 | Validation loss:
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Epoch:        234 | Training loss: 0.020905836108554173 | Validation loss:
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Epoch:        235 | Training loss: 0.020838105421334057 | Validation loss:
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Epoch:        236 | Training loss: 0.02077097329704386 | Validation loss: 0
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Epoch:        237 | Training loss: 0.02070445214743394 | Validation loss: 0
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Epoch:        238 | Training loss: 0.020638488090597658 | Validation loss:
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Epoch:        239 | Training loss: 0.02057311766238376 | Validation loss: 0
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```

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Epoch:        240 | Training loss: 0.020508319507824533 | Validation loss:
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Epoch:        241 | Training loss: 0.02044409368629367 | Validation loss: 0
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Epoch:        242 | Training loss: 0.020380415725619164 | Validation loss:
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Epoch:        243 | Training loss: 0.020317296344254568 | Validation loss:
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Epoch:        244 | Training loss: 0.020254718220562344 | Validation loss:
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Epoch:        245 | Training loss: 0.02019267826814989 | Validation loss: 0
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Epoch:        246 | Training loss: 0.02013117208903717 | Validation loss: 0
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Epoch:        247 | Training loss: 0.020070192719163594 | Validation loss:
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Epoch:        248 | Training loss: 0.020009727688967253 | Validation loss:
0.3321370650045952
Epoch:        249 | Training loss: 0.019949774852132205 | Validation loss:
0.3321159834712482
Epoch:        250 | Training loss: 0.019890333578592042 | Validation loss:
0.33209785314739754
Epoch:        251 | Training loss: 0.019831384182917994 | Validation loss:
0.3320758887041315
Epoch:        252 | Training loss: 0.019772935230900998 | Validation loss:
0.3320573379604906
Epoch:        253 | Training loss: 0.019714979880310887 | Validation loss:
0.33204063481470514
Epoch:        254 | Training loss: 0.019657502376556207 | Validation loss:
0.33202232487193667
Epoch:        255 | Training loss: 0.019600491243922307 | Validation loss:
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Epoch:        256 | Training loss: 0.019543964303762918 | Validation loss:
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Epoch:        257 | Training loss: 0.01948789660938964 | Validation loss: 0
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Epoch:        258 | Training loss: 0.019432287170154303 | Validation loss:
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Epoch:        259 | Training loss: 0.01937714025207656 | Validation loss: 0
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Epoch:        260 | Training loss: 0.01932244353808961 | Validation loss: 0
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Epoch:        261 | Training loss: 0.019268191159410728 | Validation loss:
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Epoch:        262 | Training loss: 0.01921437154311716 | Validation loss: 0
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Epoch:        263 | Training loss: 0.019160981839134873 | Validation loss:
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Epoch:        264 | Training loss: 0.01910803400338843 | Validation loss: 0
.33184639963003737
Epoch:        265 | Training loss: 0.019055515336958928 | Validation loss:
0.3318333808087142
Epoch:        266 | Training loss: 0.019003394982929727 | Validation loss:
0.331812697793711
Epoch:        267 | Training loss: 0.018951700109821192 | Validation loss:
0.3317947841826829
Epoch:        268 | Training loss: 0.01890041868394344 | Validation loss: 0
.33177645706999814
Epoch:        269 | Training loss: 0.018849543028579885 | Validation loss:
0.33176167953410046
Epoch:        270 | Training loss: 0.018799069538554616 | Validation loss:
```

0.33174641645228187

Hyper Parameters -- Learning Rate - 0.004006 Regularization Parameter- 6.3
09573444801929e-05
Epoch: 0 | Training loss: 0.5812704974794202 | Validation loss: 0.
636218040382353
Epoch: 1 | Training loss: 0.5042063398445658 | Validation loss: 0.
5974146849828793
Epoch: 2 | Training loss: 0.447453371140667 | Validation loss: 0.5
676190133752261
Epoch: 3 | Training loss: 0.4037017415827759 | Validation loss: 0.
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Epoch: 4 | Training loss: 0.3686601299402931 | Validation loss: 0.
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Epoch: 5 | Training loss: 0.339692514417916 | Validation loss: 0.5
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Epoch: 6 | Training loss: 0.31529120765019353 | Validation loss: 0
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Epoch: 7 | Training loss: 0.2944899241885057 | Validation loss: 0.
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Epoch: 8 | Training loss: 0.2763855630602824 | Validation loss: 0.
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Epoch: 9 | Training loss: 0.26061764952783656 | Validation loss: 0
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Epoch: 10 | Training loss: 0.2467864032701683 | Validation loss: 0.
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Epoch: 11 | Training loss: 0.2340463030845897 | Validation loss: 0.
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Epoch: 12 | Training loss: 0.22281196876316017 | Validation loss: 0
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Epoch: 13 | Training loss: 0.2127414326678307 | Validation loss: 0.
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Epoch: 14 | Training loss: 0.2034636283728031 | Validation loss: 0.
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Epoch: 15 | Training loss: 0.195058636761384 | Validation loss: 0.4
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Epoch: 16 | Training loss: 0.18738481454216932 | Validation loss: 0
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Epoch: 17 | Training loss: 0.18029272277162475 | Validation loss: 0
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Epoch: 18 | Training loss: 0.17372917202815985 | Validation loss: 0
.4221082238347602
Epoch: 19 | Training loss: 0.16764877719918556 | Validation loss: 0
.41879405354331517
Epoch: 20 | Training loss: 0.16201782391760142 | Validation loss: 0
.41562709676509796
Epoch: 21 | Training loss: 0.1567751014749273 | Validation loss: 0.
41272026305015913
Epoch: 22 | Training loss: 0.15191667354669308 | Validation loss: 0
.4101147714511906
Epoch: 23 | Training loss: 0.1473102525855631 | Validation loss: 0.
4074302546892855
Epoch: 24 | Training loss: 0.14306403033695103 | Validation loss: 0
.4051738116610595
Epoch: 25 | Training loss: 0.1389944686971597 | Validation loss: 0.
40278482757037987
Epoch: 26 | Training loss: 0.13522338429526207 | Validation loss: 0
.40072951234812704
Epoch: 27 | Training loss: 0.13163302357433707 | Validation loss: 0
.39864929709859
Epoch: 28 | Training loss: 0.1282578193754718 | Validation loss: 0.

```
39672563794845345
Epoch:         29 | Training loss: 0.1250885497501554 | Validation loss: 0.
3950169681580348
Epoch:         30 | Training loss: 0.12205060680871786 | Validation loss: 0
.3932251702137083
Epoch:         31 | Training loss: 0.11918978445421223 | Validation loss: 0
.39161055881507223
Epoch:         32 | Training loss: 0.11647643758776728 | Validation loss: 0
.39008948810746474
Epoch:         33 | Training loss: 0.1138893482294195 | Validation loss: 0.
3885744971456269
Epoch:         34 | Training loss: 0.11143110028603363 | Validation loss: 0
.3871948414505462
Epoch:         35 | Training loss: 0.10909002724510425 | Validation loss: 0
.3858644168325
Epoch:         36 | Training loss: 0.10685767435467873 | Validation loss: 0
.3845816181101098
Epoch:         37 | Training loss: 0.10472720945369454 | Validation loss: 0
.3833843816040058
Epoch:         38 | Training loss: 0.10269115885516779 | Validation loss: 0
.38221282599857703
Epoch:         39 | Training loss: 0.10074692917173735 | Validation loss: 0
.3810777240213601
Epoch:         40 | Training loss: 0.09888379262098893 | Validation loss: 0
.3800147156740657
Epoch:         41 | Training loss: 0.09710057278580446 | Validation loss: 0
.3789886688764165
Epoch:         42 | Training loss: 0.09538733826825087 | Validation loss: 0
.37801878219488344
Epoch:         43 | Training loss: 0.09374906765916326 | Validation loss: 0
.3770720168994181
Epoch:         44 | Training loss: 0.09216990384786784 | Validation loss: 0
.37618564140578675
Epoch:         45 | Training loss: 0.0906563329732333 | Validation loss: 0.
37532414404088543
Epoch:         46 | Training loss: 0.08920450836234933 | Validation loss: 0
.37452680616409323
Epoch:         47 | Training loss: 0.08780818104536937 | Validation loss: 0
.37374723608212224
Epoch:         48 | Training loss: 0.08645488135622514 | Validation loss: 0
.3729364020825039
Epoch:         49 | Training loss: 0.08515961306052186 | Validation loss: 0
.3721590645149389
Epoch:         50 | Training loss: 0.08390826222448755 | Validation loss: 0
.37144822521328197
Epoch:         51 | Training loss: 0.08270273468821705 | Validation loss: 0
.3707577801727498
Epoch:         52 | Training loss: 0.08154129313115237 | Validation loss: 0
.3700900794295322
Epoch:         53 | Training loss: 0.08041441968135221 | Validation loss: 0
.3694704047577643
Epoch:         54 | Training loss: 0.07932996956949505 | Validation loss: 0
.3688522355319748
Epoch:         55 | Training loss: 0.07828377516084481 | Validation loss: 0
.36823875711033344
Epoch:         56 | Training loss: 0.0772694543991466 8 | Validation loss: 0
.3676796700975824
Epoch:         57 | Training loss: 0.07628993315511287 | Validation loss: 0
.3671232651442895
Epoch:         58 | Training loss: 0.07534362658550733 | Validation loss: 0
.3666127851928337
```

```
Epoch:              59 | Training loss: 0.07442503668493593 | Validation loss: 0
.36607110973990586
Epoch:              60 | Training loss: 0.07353673565741806 | Validation loss: 0
.3655647348554841
Epoch:              61 | Training loss: 0.07267638009265369 | Validation loss: 0
.3650818763022612
Epoch:              62 | Training loss: 0.07184249775722315 | Validation loss: 0
.36461118148989224
Epoch:              63 | Training loss: 0.07103410736226237 | Validation loss: 0
.3641538371872714
Epoch:              64 | Training loss: 0.07025021691158177 | Validation loss: 0
.3636898625438015
Epoch:              65 | Training loss: 0.0694900376926079 | Validation loss: 0.
36325656563615966
Epoch:              66 | Training loss: 0.06875121178325155 | Validation loss: 0
.36287138980253303
Epoch:              67 | Training loss: 0.06803599523479562 | Validation loss: 0
.362492567125653
Epoch:              68 | Training loss: 0.06733855394783267 | Validation loss: 0
.3620824240810322
Epoch:              69 | Training loss: 0.06666192100750214 | Validation loss: 0
.3616882421800399
Epoch:              70 | Training loss: 0.06600513175675082 | Validation loss: 0
.36133527630878104
Epoch:              71 | Training loss: 0.06536690616480147 | Validation loss: 0
.3609473789697155
Epoch:              72 | Training loss: 0.06474525761016536 | Validation loss: 0
.3606060659352979
Epoch:              73 | Training loss: 0.06414086172597759 | Validation loss: 0
.3602907518184141
Epoch:              74 | Training loss: 0.06355298827687882 | Validation loss: 0
.3599584244278629
Epoch:              75 | Training loss: 0.06298096014432907 | Validation loss: 0
.3596407805851426
Epoch:              76 | Training loss: 0.06242442520743942 | Validation loss: 0
.3593450965468077
Epoch:              77 | Training loss: 0.061882091154062624 | Validation loss:
0.35904317637712985
Epoch:              78 | Training loss: 0.0613539880843076 | Validation loss: 0.
3587513478047345
Epoch:              79 | Training loss: 0.06083948451362151 | Validation loss: 0
.3584653930055024
Epoch:              80 | Training loss: 0.06033835983994367 | Validation loss: 0
.3581961102059742
Epoch:              81 | Training loss: 0.059849685433407275 | Validation loss:
0.35792383551899853
Epoch:              82 | Training loss: 0.059373576893845224 | Validation loss:
0.35767277084040183
Epoch:              83 | Training loss: 0.058909794267552454 | Validation loss:
0.35743555965442453
Epoch:              84 | Training loss: 0.05845620173460829 | Validation loss: 0
.3571574811699378
Epoch:              85 | Training loss: 0.058015198735379435 | Validation loss:
0.35690538709837943
Epoch:              86 | Training loss: 0.057583117314740966 | Validation loss:
0.35669553749527183
Epoch:              87 | Training loss: 0.057162365348141904 | Validation loss:
0.35646694569897697
Epoch:              88 | Training loss: 0.05675177905762543 | Validation loss: 0
.3562408552423652
Epoch:              89 | Training loss: 0.056351384140589204 | Validation loss:
```

```
0.3560165553086302
Epoch:          90 | Training loss: 0.05595941724294854 | Validation loss: 0
.3558147544699771
Epoch:          91 | Training loss: 0.05557750948701265 | Validation loss: 0
.35560408037416363
Epoch:          92 | Training loss: 0.055203214498757466 | Validation loss:
0.35542127335741225
Epoch:          93 | Training loss: 0.05483821715558071 | Validation loss: 0
.35524566413448333
Epoch:          94 | Training loss: 0.05448155373623806 | Validation loss: 0
.3550414195688625
Epoch:          95 | Training loss: 0.05413308302210254 | Validation loss: 0
.35485447176088203
Epoch:          96 | Training loss: 0.053792124325179394 | Validation loss:
0.3546929458897063
Epoch:          97 | Training loss: 0.05345903054745585 | Validation loss: 0
.3545079175558535
Epoch:          98 | Training loss: 0.05313314744414663 | Validation loss: 0
.3543445783501668
Epoch:          99 | Training loss: 0.05281454470053543 | Validation loss: 0
.3541913319448396
Epoch:          100 | Training loss: 0.052502810893615685 | Validation loss:
0.35402542461752573
Epoch:          101 | Training loss: 0.05219788881937875 | Validation loss: 0
.3538715452574235
Epoch:          102 | Training loss: 0.051899560869882545 | Validation loss:
0.3537233860079813
Epoch:          103 | Training loss: 0.05160769354441969 | Validation loss: 0
.35358168905216353
Epoch:          104 | Training loss: 0.05132184148423438 | Validation loss: 0
.3534287465644489
Epoch:          105 | Training loss: 0.05104218017070048 | Validation loss: 0
.3532953899532301
Epoch:          106 | Training loss: 0.05076840034246166 | Validation loss: 0
.35316234290021115
Epoch:          107 | Training loss: 0.050500152654647266 | Validation loss:
0.35301873354416907
Epoch:          108 | Training loss: 0.050237621947038104 | Validation loss:
0.3528815087635973
Epoch:          109 | Training loss: 0.04998052622802282 | Validation loss: 0
.352751239467845
Epoch:          110 | Training loss: 0.04972858678778188 | Validation loss: 0
.35263085168438096
Epoch:          111 | Training loss: 0.049481775875452744 | Validation loss:
0.35251953734384756
Epoch:          112 | Training loss: 0.04924002245720753 | Validation loss: 0
.35239719962183735
Epoch:          113 | Training loss: 0.0490031575069378 | Validation loss: 0.
3522802158859078
Epoch:          114 | Training loss: 0.04877095105334734 | Validation loss: 0
.3521779142478939
Epoch:          115 | Training loss: 0.04854340711302198 | Validation loss: 0
.3520713327891304
Epoch:          116 | Training loss: 0.04832036163642909 | Validation loss: 0
.35196455243065666
Epoch:          117 | Training loss: 0.04810174461036417 | Validation loss: 0
.3518669640083671
Epoch:          118 | Training loss: 0.04788736976574439 | Validation loss: 0
.35176670814354677
Epoch:          119 | Training loss: 0.04767719740198227 | Validation loss: 0
.35167071937685357
```

```
Epoch:        120 | Training loss: 0.047471119714294005 | Validation loss:
0.3515796617199666
Epoch:        121 | Training loss: 0.04726900398302685 | Validation loss: 0
.3514897671053013
Epoch:        122 | Training loss: 0.047070631819762385 | Validation loss:
0.35139224013850645
Epoch:        123 | Training loss: 0.0468761803116858 | Validation loss: 0.
3513073603504571
Epoch:        124 | Training loss: 0.04668533685172329 | Validation loss: 0
.3512176220252894
Epoch:        125 | Training loss: 0.046498133216714796 | Validation loss:
0.35113298901244433
Epoch:        126 | Training loss: 0.046314465295338086 | Validation loss:
0.3510525693203694
Epoch:        127 | Training loss: 0.04613422595159933 | Validation loss: 0
.3509714524233117
Epoch:        128 | Training loss: 0.045957355072580496 | Validation loss:
0.3508874380244285
Epoch:        129 | Training loss: 0.0457837484134339 | Validation loss: 0.
350814215370817
Epoch:        130 | Training loss: 0.04561336003949477 | Validation loss: 0
.35074037617596593
Epoch:        131 | Training loss: 0.04544610842607112 | Validation loss: 0
.3506685396772928
Epoch:        132 | Training loss: 0.045281934027042246 | Validation loss:
0.3505959736813237
Epoch:        133 | Training loss: 0.04512073527612175 | Validation loss: 0
.3505284515290461
Epoch:        134 | Training loss: 0.044962435963526996 | Validation loss:
0.35046465104345026
Epoch:        135 | Training loss: 0.04480701685105115 | Validation loss: 0
.35040010996124343
Epoch:        136 | Training loss: 0.04465442075291889 | Validation loss: 0
.3503350975671395
Epoch:        137 | Training loss: 0.044504497827751587 | Validation loss:
0.3502778078035693
Epoch:        138 | Training loss: 0.04435733565708046 | Validation loss: 0
.3502140592085214
Epoch:        139 | Training loss: 0.044212664034604665 | Validation loss:
0.35016587708215297
Epoch:        140 | Training loss: 0.044070640979294425 | Validation loss:
0.3501065225192772
Epoch:        141 | Training loss: 0.04393117594991891 | Validation loss: 0
.35004663847675005
Epoch:        142 | Training loss: 0.04379425258666921 | Validation loss: 0
.34998659122799597
Epoch:        143 | Training loss: 0.04365944584535323 | Validation loss: 0
.3499411171384906
Epoch:        144 | Training loss: 0.04352709341409193 | Validation loss: 0
.3498925336705859
Epoch:        145 | Training loss: 0.04339703848354276 | Validation loss: 0
.3498462183677474
Epoch:        146 | Training loss: 0.043269236692961226 | Validation loss:
0.3498018939380245
Epoch:        147 | Training loss: 0.043143652022316535 | Validation loss:
0.3497600013229875
Epoch:        148 | Training loss: 0.04302024429316203 | Validation loss: 0
.34971556124820674
Epoch:        149 | Training loss: 0.04289895970790143 | Validation loss: 0
.34967114588893866
Epoch:        150 | Training loss: 0.04277972741980584 | Validation loss: 0
```

.34963593735813175
Epoch: 151 | Training loss: 0.042662583492309565 | Validation loss:
0.34960371628377973
Epoch: 152 | Training loss: 0.04254736134624533 | Validation loss: 0
.349559756934447383
Epoch: 153 | Training loss: 0.04243410836720876 | Validation loss: 0
.3495171161414187
Epoch: 154 | Training loss: 0.04232278872937578 | Validation loss: 0
.3494762691218365
Epoch: 155 | Training loss: 0.042213330370553984 | Validation loss:
0.349440841103934
Epoch: 156 | Training loss: 0.0421057052441442 | Validation loss: 0.
34940845582149604
Epoch: 157 | Training loss: 0.04199989050282633 | Validation loss: 0
.3493746922937687
Epoch: 158 | Training loss: 0.04189584390440325 | Validation loss: 0
.3493462827784576
Epoch: 159 | Training loss: 0.04179352664698409 | Validation loss: 0
.34931032917503024
Epoch: 160 | Training loss: 0.041692908048217805 | Validation loss:
0.34928505187792735
Epoch: 161 | Training loss: 0.04159395438832176 | Validation loss: 0
.3492553129213762
Epoch: 162 | Training loss: 0.04149666062743514 | Validation loss: 0
.3492325959405047
Epoch: 163 | Training loss: 0.041400936367543294 | Validation loss:
0.3492036514079524
Epoch: 164 | Training loss: 0.041306779021036015 | Validation loss:
0.34917104079345485
Epoch: 165 | Training loss: 0.04121418611189969 | Validation loss: 0
.34914765262621444
Epoch: 166 | Training loss: 0.04112311593216433 | Validation loss: 0
.3491258111608927
Epoch: 167 | Training loss: 0.04103351252057925 | Validation loss: 0
.3490948970565854
Epoch: 168 | Training loss: 0.04094540275358969 | Validation loss: 0
.3490676925414191
Epoch: 169 | Training loss: 0.04085867583074701 | Validation loss: 0
.34905367213389227
Epoch: 170 | Training loss: 0.0407733989671613 | Validation loss: 0.
3490259346912657
Epoch: 171 | Training loss: 0.040689469166618114 | Validation loss:
0.3490116462632381
Epoch: 172 | Training loss: 0.04060691470346701 | Validation loss: 0
.34899007780092794
Epoch: 173 | Training loss: 0.0405256882386252 | Validation loss: 0.
348977800462025
Epoch: 174 | Training loss: 0.040445771465308165 | Validation loss:
0.34896087660137776
Epoch: 175 | Training loss: 0.04036715440449447 | Validation loss: 0
.3489480618107927
Epoch: 176 | Training loss: 0.040289796563210654 | Validation loss:
0.34893475134265517
Epoch: 177 | Training loss: 0.04021362057705823 | Validation loss: 0
.3489099682595097
Epoch: 178 | Training loss: 0.040138707972233484 | Validation loss:
0.3488975952976052
Epoch: 179 | Training loss: 0.04006498061148551 | Validation loss: 0
.34888046466750255

Hyper Parameters -- Learning Rate - 0.004006 Regularization Parameter- 0.0

```
0039810717055349735
Epoch:           0 | Training loss: 0.5814872572208878 | Validation loss: 0.
636434799827543
Epoch:           1 | Training loss: 0.5049291630311853 | Validation loss: 0.
5981375073919094
Epoch:           2 | Training loss: 0.44884332916290287 | Validation loss: 0
.5690089700361888
Epoch:           3 | Training loss: 0.4058529777578992 | Validation loss: 0.
546995791947912
Epoch:           4 | Training loss: 0.37163163698335716 | Validation loss: 0
.5299765528015563
Epoch:           5 | Training loss: 0.34351974208085045 | Validation loss: 0
.5150832543431602
Epoch:           6 | Training loss: 0.3199960209760585 | Validation loss: 0.
503110966278625
Epoch:           7 | Training loss: 0.30008563183334463 | Validation loss: 0
.49324223203637124
Epoch:           8 | Training loss: 0.28287850706475937 | Validation loss: 0
.4844022159061747
Epoch:           9 | Training loss: 0.26801003748045826 | Validation loss: 0
.476990064450318
Epoch:          10 | Training loss: 0.25507651549613924 | Validation loss: 0
.4706981725493003
Epoch:          11 | Training loss: 0.2432313473998034 | Validation loss: 0.
46425284223822927
Epoch:          12 | Training loss: 0.23288723291146093 | Validation loss: 0
.4591102209713514
Epoch:          13 | Training loss: 0.223700174160895 | Validation loss: 0.4
547135366660517
Epoch:          14 | Training loss: 0.21529891536833215 | Validation loss: 0
.45032648393829544
Epoch:          15 | Training loss: 0.207762261141674 | Validation loss: 0.4
4657526437444517
Epoch:          16 | Training loss: 0.20094862905590713 | Validation loss: 0
.4433651755096459
Epoch:          17 | Training loss: 0.1947087332923339 | Validation loss: 0.
4403075634505552
Epoch:          18 | Training loss: 0.18898878901442384 | Validation loss: 0
.4373678483562306
Epoch:          19 | Training loss: 0.18374288904801053 | Validation loss: 0
.4348881747642808
Epoch:          20 | Training loss: 0.17893761013277634 | Validation loss: 0
.4325468934044322
Epoch:          21 | Training loss: 0.17451171126117168 | Validation loss: 0
.43045688475674504
Epoch:          22 | Training loss: 0.17046064672103375 | Validation loss: 0
.42865875859350794
Epoch:          23 | Training loss: 0.16665262276036039 | Validation loss: 0
.42677263952369726
Epoch:          24 | Training loss: 0.16319588059169987 | Validation loss: 0
.4253056790652193
Epoch:          25 | Training loss: 0.15990695512563888 | Validation loss: 0
.4236973318811606
Epoch:          26 | Training loss: 0.15690769270969704 | Validation loss: 0
.4224138407203307
Epoch:          27 | Training loss: 0.15408080334746296 | Validation loss: 0
.4210970305544335
Epoch:          28 | Training loss: 0.15146069073531568 | Validation loss: 0
.4199285317784281
Epoch:          29 | Training loss: 0.1490378639238704 | Validation loss: 0.
4189663072229452
```

```
Epoch:          30 | Training loss: 0.1467382653302219 | Validation loss: 0.
41791285456365473
Epoch:          31 | Training loss: 0.14460744567525413 | Validation loss: 0
.417028247670594
Epoch:          32 | Training loss: 0.1426163510396912 | Validation loss: 0.
4162294311610589
Epoch:          33 | Training loss: 0.14074374101645953 | Validation loss: 0
.41542892056847
Epoch:          34 | Training loss: 0.13899253407301676 | Validation loss: 0
.4147563078950428
Epoch:          35 | Training loss: 0.1373509593906883 | Validation loss: 0.
41412538343023586
Epoch:          36 | Training loss: 0.13581062541946667 | Validation loss: 0
.41353460518031737
Epoch:          37 | Training loss: 0.13436483550630487 | Validation loss: 0
.41302204571917467
Epoch:          38 | Training loss: 0.13300671547845472 | Validation loss: 0
.41252842236142667
Epoch:          39 | Training loss: 0.13173325378347137 | Validation loss: 0
.41206408975857245
Epoch:          40 | Training loss: 0.13053425739319055 | Validation loss: 0
.4116652234079768
Epoch:          41 | Training loss: 0.12940852955991192 | Validation loss: 0
.411296670336227
Epoch:          42 | Training loss: 0.12834619764354996 | Validation loss: 0
.41097768838008464
Epoch:          43 | Training loss: 0.12735234242484145 | Validation loss: 0
.4106753400427454
Epoch:          44 | Training loss: 0.1264114829178587 | Validation loss: 0.
4104272713200996
Epoch:          45 | Training loss: 0.12553003220043343 | Validation loss: 0
.41019789607307755
Epoch:          46 | Training loss: 0.12470428179796751 | Validation loss: 0
.41002663491822816
Epoch:          47 | Training loss: 0.12392801365694853 | Validation loss: 0
.40986712626708127
Epoch:          48 | Training loss: 0.12318904514064465 | Validation loss: 0
.4096706247455098
Epoch:          49 | Training loss: 0.12250241404666248 | Validation loss: 0
.40950192537506974
Epoch:          50 | Training loss: 0.12185399833163517 | Validation loss: 0
.40939402325299384
Epoch:          51 | Training loss: 0.12124601267512838 | Validation loss: 0
.40930112200763596
Epoch:          52 | Training loss: 0.12067658638009111 | Validation loss: 0
.4092254383121174
Epoch:          53 | Training loss: 0.12013658582858651 | Validation loss: 0
.4091926393231911
Epoch:          54 | Training loss: 0.11963370406318162 | Validation loss: 0
.4091560404404751
Epoch:          55 | Training loss: 0.11916401006021216 | Validation loss: 0
.4091190639102416


Hyper Parameters -- Learning Rate - 0.004006  Regularization Parameter- 0.0
02511886431509582
Epoch:           0 | Training loss: 0.5828549185776327 | Validation loss: 0.
6378024593149029
Epoch:           1 | Training loss: 0.5094898680248788 | Validation loss: 0.
602698207479353
Epoch:           2 | Training loss: 0.4576133685136455 | Validation loss: 0.
5777790007978963
```

```
Epoch:            3 | Training loss: 0.41942635440783077 | Validation loss: 0
.5605691575989069
Epoch:            4 | Training loss: 0.39038056848231284 | Validation loss: 0
.5487254726842655
Epoch:            5 | Training loss: 0.3676678999220135 | Validation loss: 0.
5392313985230021
Epoch:            6 | Training loss: 0.34968136283179496 | Validation loss: 0
.5327962953103299
Epoch:            7 | Training loss: 0.3353921282577494 | Validation loss: 0.
5285487191576195
Epoch:            8 | Training loss: 0.32384617227331086 | Validation loss: 0
.5253698738040218
Epoch:            9 | Training loss: 0.31465279905267673 | Validation loss: 0
.5236328228225464
Epoch:           10 | Training loss: 0.30738352170334327 | Validation loss: 0
.5230051821470297
Epoch:           11 | Training loss: 0.3011849795051291 | Validation loss: 0.
5222064775822727

Hyper Parameters -- Learning Rate - 0.004006  Regularization Parameter- 0.0
15848931924461114
Epoch:            0 | Training loss: 0.5914842723075941 | Validation loss: 0.
6464318012498529
Epoch:            1 | Training loss: 0.53826593173492 | Validation loss: 0.63
14742402333111

Hyper Parameters -- Learning Rate - 0.006004000000000001  Regularization Pa
rameter- 1e-05
Epoch:            0 | Training loss: 0.5376859470947345 | Validation loss: 0.
6138329695577703
Epoch:            1 | Training loss: 0.4452696299179622 | Validation loss: 0.
5669274962913282
Epoch:            2 | Training loss: 0.3827035244874081 | Validation loss: 0.
5336995566724084
Epoch:            3 | Training loss: 0.33712599748854555 | Validation loss: 0
.509635573161238
Epoch:            4 | Training loss: 0.3019980802828556 | Validation loss: 0.
491413476665162316
Epoch:            5 | Training loss: 0.2738033606643748 | Validation loss: 0.
47586892272057
Epoch:            6 | Training loss: 0.25056932277335825 | Validation loss: 0
.463344127790829
Epoch:            7 | Training loss: 0.23120753939518038 | Validation loss: 0
.4530575429848082
Epoch:            8 | Training loss: 0.21461061926318295 | Validation loss: 0
.4438824781847204
Epoch:            9 | Training loss: 0.2004294619764381 | Validation loss: 0.
4362277370818414
Epoch:           10 | Training loss: 0.18813693061122694 | Validation loss: 0
.42964413639429
Epoch:           11 | Training loss: 0.17687687372587516 | Validation loss: 0
.4228413255758099
Epoch:           12 | Training loss: 0.16709675576038174 | Validation loss: 0
.4173943470934669
Epoch:           13 | Training loss: 0.15842815076881903 | Validation loss: 0
.4126742135503461
Epoch:           14 | Training loss: 0.1505051908719266 | Validation loss: 0.
4079866247350157
Epoch:           15 | Training loss: 0.14339829685654829 | Validation loss: 0
.4038982681863858
Epoch:           16 | Training loss: 0.13694555917885382 | Validation loss: 0
```

```
.40031132519846857
Epoch:           17 | Training loss: 0.13104187762118225 | Validation loss: 0
.3969311085068253
Epoch:           18 | Training loss: 0.12560112213150554 | Validation loss: 0
.3936150923164446
Epoch:           19 | Training loss: 0.12058816355762242 | Validation loss: 0
.3907504598504177
Epoch:           20 | Training loss: 0.11597397660672638 | Validation loss: 0
.3880103355838102
Epoch:           21 | Training loss: 0.11170123294062147 | Validation loss: 0
.3855201442446446
Epoch:           22 | Training loss: 0.1077684163233761 | Validation loss: 0.
38334150458342026
Epoch:           23 | Training loss: 0.10404274126741192 | Validation loss: 0
.3810134831470833
Epoch:           24 | Training loss: 0.10063261942842172 | Validation loss: 0
.37914378268115556
Epoch:           25 | Training loss: 0.09736747850020014 | Validation loss: 0
.3770896778358987
Epoch:           26 | Training loss: 0.09436108314075468 | Validation loss: 0
.37539149934020294
Epoch:           27 | Training loss: 0.09150145661022108 | Validation loss: 0
.3736167600470104
Epoch:           28 | Training loss: 0.08882523763750455 | Validation loss: 0
.37200292064831486
Epoch:           29 | Training loss: 0.08632039445058576 | Validation loss: 0
.3706016882163211
Epoch:           30 | Training loss: 0.08392346917330486 | Validation loss: 0
.369081743548762
Epoch:           31 | Training loss: 0.08167300271530648 | Validation loss: 0
.3677411975965504
Epoch:           32 | Training loss: 0.07954335875354986 | Validation loss: 0
.3664826280739718
Epoch:           33 | Training loss: 0.07751784646384946 | Validation loss: 0
.3652124158915717
Epoch:           34 | Training loss: 0.07559646118330117 | Validation loss: 0
.3640809984819665
Epoch:           35 | Training loss: 0.07377019375093449 | Validation loss: 0
.362982243893924
Epoch:           36 | Training loss: 0.07203155626516138 | Validation loss: 0
.3619145030149858
Epoch:           37 | Training loss: 0.07037472376685404 | Validation loss: 0
.36093421256478825
Epoch:           38 | Training loss: 0.06879384226965489 | Validation loss: 0
.359964449373267
Epoch:           39 | Training loss: 0.06728617085574887 | Validation loss: 0
.3590234661339302
Epoch:           40 | Training loss: 0.06584301711798572 | Validation loss: 0
.3581502527741582
Epoch:           41 | Training loss: 0.06446315468725368 | Validation loss: 0
.3573051500327596
Epoch:           42 | Training loss: 0.06313861153035717 | Validation loss: 0
.3565152839798298
Epoch:           43 | Training loss: 0.061873234439853264 | Validation loss:
0.3557320301853189
Epoch:           44 | Training loss: 0.06065480124038865 | Validation loss: 0
.35501460270426494
Epoch:           45 | Training loss: 0.05948745418897091 | Validation loss: 0
.35431120779896824
Epoch:           46 | Training loss: 0.05836880930746237 | Validation loss: 0
.35367384191402335
```

```
Epoch:          47 | Training loss: 0.057293201339228585 | Validation loss:
0.353043940841463
Epoch:          48 | Training loss: 0.0562503718472778 | Validation loss: 0.
3523634876065364
Epoch:          49 | Training loss: 0.05525325579007547 | Validation loss: 0
.3517072598959703
Epoch:          50 | Training loss: 0.05428974059922485 | Validation loss: 0
.35112847312704504
Epoch:          51 | Training loss: 0.053361999572338996 | Validation loss:
0.35056245118316537
Epoch:          52 | Training loss: 0.05246830211824384 | Validation loss: 0
.3500130596288979
Epoch:          53 | Training loss: 0.05160088390833478 | Validation loss: 0
.3495203869728873
Epoch:          54 | Training loss: 0.050766260589639955 | Validation loss:
0.34901727017186696
Epoch:          55 | Training loss: 0.0499609115563533 | Validation loss: 0.
3485039777931624
Epoch:          56 | Training loss: 0.049180051905933046 | Validation loss:
0.34805609366410784
Epoch:          57 | Training loss: 0.0484257391378249 | Validation loss: 0.
34760010059761365
Epoch:          58 | Training loss: 0.04769681932781613 | Validation loss: 0
.34719457273200155
Epoch:          59 | Training loss: 0.046988877326969825 | Validation loss:
0.34674254565738083
Epoch:          60 | Training loss: 0.0463040022200662 | Validation loss: 0.
3463251602708643
Epoch:          61 | Training loss: 0.0456403599510017 | Validation loss: 0.
345931637236843
Epoch:          62 | Training loss: 0.044996792667773934 | Validation loss:
0.34554708348396895
Epoch:          63 | Training loss: 0.04437250362127907 | Validation loss: 0
.3451717145964497
Epoch:          64 | Training loss: 0.04376672696887121 | Validation loss: 0
.34478177346229777
Epoch:          65 | Training loss: 0.04317888880405636 | Validation loss: 0
.3444227532160396
Epoch:          66 | Training loss: 0.042607198492321446 | Validation loss:
0.3441212079831766
Epoch:          67 | Training loss: 0.042053297888692276 | Validation loss:
0.3438189972849935
Epoch:          68 | Training loss: 0.04151260439151035 | Validation loss: 0
.3434724941769528
Epoch:          69 | Training loss: 0.04098762266703852 | Validation loss: 0
.34313989514262316
Epoch:          70 | Training loss: 0.0404775504937298 | Validation loss: 0.
34285575646194366
Epoch:          71 | Training loss: 0.03998144657504624 | Validation loss: 0
.3425207123254023
Epoch:          72 | Training loss: 0.03949766686942213 | Validation loss: 0
.3422426275530603
Epoch:          73 | Training loss: 0.03902691378253998 | Validation loss: 0
.3419916010186249
Epoch:          74 | Training loss: 0.038568448945711944 | Validation loss:
0.34171310047591313
Epoch:          75 | Training loss: 0.03812183824505113 | Validation loss: 0
.34144893512962965
Epoch:          76 | Training loss: 0.037686829758735524 | Validation loss:
0.34120954119866254
Epoch:          77 | Training loss: 0.03726235409829819 | Validation loss: 0
```

```
                      .3409562165600284
Epoch:           78 | Training loss: 0.03684851295150023 | Validation loss: 0
.3407125332948848
Epoch:           79 | Training loss: 0.03644481376979387 | Validation loss: 0
.34047294500254166
Epoch:           80 | Training loss: 0.03605106057211947 | Validation loss: 0
.3402502713606683
Epoch:           81 | Training loss: 0.03566658808393195 | Validation loss: 0
.34002035724344737
Epoch:           82 | Training loss: 0.035291442172125785 | Validation loss:
0.33981337873441136
Epoch:           83 | Training loss: 0.034925468245337446 | Validation loss:
0.33962097216897236
Epoch:           84 | Training loss: 0.034567097724206464 | Validation loss:
0.33937560067441697
Epoch:           85 | Training loss: 0.03421805571796947 | Validation loss: 0
.33915736932230894
Epoch:           86 | Training loss: 0.033875619435434934 | Validation loss:
0.3389908402642686
Epoch:           87 | Training loss: 0.03354159816128501 | Validation loss: 0
.3387970230753337
Epoch:           88 | Training loss: 0.03321511139420533 | Validation loss: 0
.3386037843962296
Epoch:           89 | Training loss: 0.032896159985898295 | Validation loss:
0.3384099925575832
Epoch:           90 | Training loss: 0.03258348551601552 | Validation loss: 0
.3382418848768711
Epoch:           91 | Training loss: 0.03227823152008876 | Validation loss: 0
.3380599236694208
Epoch:           92 | Training loss: 0.03197864845470221 | Validation loss: 0
.33791095216274014
Epoch:           93 | Training loss: 0.03168594495400005 | Validation loss: 0
.3377680638587078
Epoch:           94 | Training loss: 0.03139938864370486 | Validation loss: 0
.33758709924201724
Epoch:           95 | Training loss: 0.031118901874308387 | Validation loss:
0.3374252992191982
Epoch:           96 | Training loss: 0.03084397120286073 | Validation loss: 0
.337293119021909
Epoch:           97 | Training loss: 0.03057486194137322 | Validation loss: 0
.33712980961462735
Epoch:           98 | Training loss: 0.030311083840667954 | Validation loss:
0.3369915456559498
Epoch:           99 | Training loss: 0.03005268806376165 | Validation loss: 0
.33686334494178927
Epoch:          100 | Training loss: 0.029799373019351906 | Validation loss:
0.33671796838577434
Epoch:          101 | Training loss: 0.029551090457891633 | Validation loss:
0.33658541398539116
Epoch:          102 | Training loss: 0.029307682394022833 | Validation loss:
0.3364585667548438
Epoch:          103 | Training loss: 0.029069045106869373 | Validation loss:
0.33633729748629193
Epoch:          104 | Training loss: 0.02883485343485863 | Validation loss: 0
.33620042518842225
Epoch:          105 | Training loss: 0.028605243173043138 | Validation loss:
0.33608669062027713
Epoch:          106 | Training loss: 0.028379973597165015 | Validation loss:
0.3359711287262515
Epoch:          107 | Training loss: 0.028158792634036922 | Validation loss:
0.3358414005987916
```

```
Epoch:        108 | Training loss: 0.02794183959386702 | Validation loss: 0
.3357176311874997
Epoch:        109 | Training loss: 0.027728895057823725 | Validation loss:
0.33560201477545576
Epoch:        110 | Training loss: 0.027519768004165866 | Validation loss:
0.33549667541233785
Epoch:        111 | Training loss: 0.027314439982007083 | Validation loss:
0.33540046481479846
Epoch:        112 | Training loss: 0.02711284650668882 | Validation loss: 0
.33528931392938044
Epoch:        113 | Training loss: 0.02691486294735282 | Validation loss: 0
.33518411630297557
Epoch:        114 | Training loss: 0.026720325641677544 | Validation loss:
0.3350954853917496
Epoch:        115 | Training loss: 0.02652923952572199 | Validation loss: 0
.33500039724486713
Epoch:        116 | Training loss: 0.02634148029628998 | Validation loss: 0
.33490344550988554
Epoch:        117 | Training loss: 0.026156997813111756 | Validation loss:
0.3348172761570438
Epoch:        118 | Training loss: 0.02597565690494265 | Validation loss: 0
.33472676047854066
Epoch:        119 | Training loss: 0.02579741928974473 | Validation loss: 0
.33463954628241227
Epoch:        120 | Training loss: 0.025622213266633078 | Validation loss:
0.33455708388574507
Epoch:        121 | Training loss: 0.02544994168991879 | Validation loss: 0
.3344752187123251
Epoch:        122 | Training loss: 0.025280452657729456 | Validation loss:
0.33438384838869994
Epoch:        123 | Training loss: 0.025113861784125422 | Validation loss:
0.334306716856757
Epoch:        124 | Training loss: 0.024949947402407194 | Validation loss:
0.3342226986694375
Epoch:        125 | Training loss: 0.024788726753635908 | Validation loss:
0.3341435200929418
Epoch:        126 | Training loss: 0.02463012958430061 | Validation loss: 0
.3340688171961028
Epoch:        127 | Training loss: 0.02447407253139985 | Validation loss: 0
.33399226816966293
Epoch:        128 | Training loss: 0.024320516987201037 | Validation loss:
0.33391111124604644
Epoch:        129 | Training loss: 0.024169387155843276 | Validation loss:
0.33384244377837874
Epoch:        130 | Training loss: 0.024020643245624213 | Validation loss:
0.3337720307316763
Epoch:        131 | Training loss: 0.023874228199008793 | Validation loss:
0.3337033930963634
Epoch:        132 | Training loss: 0.02373010216570618 | Validation loss: 0
.33363286733259073
Epoch:        133 | Training loss: 0.023588186071015968 | Validation loss:
0.3335679601881592
Epoch:        134 | Training loss: 0.023448424833678077 | Validation loss:
0.33350703709446367
Epoch:        135 | Training loss: 0.02331080801979443 | Validation loss: 0
.3334442116053441
Epoch:        136 | Training loss: 0.023175290025989722 | Validation loss:
0.3333799742316 4095
Epoch:        137 | Training loss: 0.023041765432544103 | Validation loss:
0.3333245498368153
Epoch:        138 | Training loss: 0.02291029475765863 | Validation loss: 0
```

```
.3332605302527661
Epoch:        139 | Training loss: 0.022780686162493277 | Validation loss:
0.3332143040774405
Epoch:        140 | Training loss: 0.022653046814562705 | Validation loss:
0.3331544040505641
Epoch:        141 | Training loss: 0.022527317153082923 | Validation loss:
0.33309296630093327
Epoch:        142 | Training loss: 0.022403477365427294 | Validation loss:
0.3330308646264173
Epoch:        143 | Training loss: 0.022281225015022214 | Validation loss:
0.33298612595458826
Epoch:        144 | Training loss: 0.02216080659519004 | Validation loss: 0
.3329367629245684
Epoch:        145 | Training loss: 0.022042105766146125 | Validation loss:
0.33288952739654276
Epoch:        146 | Training loss: 0.02192509005956019 | Validation loss: 0
.33284405412124257
Epoch:        147 | Training loss: 0.021809731540425363 | Validation loss:
0.33280073493315476
Epoch:        148 | Training loss: 0.021696004628202654 | Validation loss:
0.3327538727665804
Epoch:        149 | Training loss: 0.0215838675861582 | Validation loss: 0.
332706471340665
Epoch:        150 | Training loss: 0.02147326974826108 | Validation loss: 0
.3326695387702324
Epoch:        151 | Training loss: 0.02136423330924526 | Validation loss: 0
.3326356727900252
Epoch:        152 | Training loss: 0.02125664282510054 | Validation loss: 0
.3325878254277958
Epoch:        153 | Training loss: 0.021150531082582323 | Validation loss:
0.33254064703447306
Epoch:        154 | Training loss: 0.02104586957462877 | Validation loss: 0
.3324952287049046
Epoch:        155 | Training loss: 0.020942607349487306 | Validation loss:
0.33245608846118613
Epoch:        156 | Training loss: 0.020840724638908185 | Validation loss:
0.33241991317586556
Epoch:        157 | Training loss: 0.020740203631404018 | Validation loss:
0.3323816551620729
Epoch:        158 | Training loss: 0.020641013713680517 | Validation loss:
0.3323495903268657
Epoch:        159 | Training loss: 0.02054312745450368 | Validation loss: 0
.3323081219561654
Epoch:        160 | Training loss: 0.02044652325263782 | Validation loss: 0
.3322784933594151
Epoch:        161 | Training loss: 0.020351174062525894 | Validation loss:
0.3322430202163098
Epoch:        162 | Training loss: 0.020257077910386476 | Validation loss:
0.33221576068918396
Epoch:        163 | Training loss: 0.020164169916801304 | Validation loss:
0.3321809975142446
Epoch:        164 | Training loss: 0.020072448406890996 | Validation loss:
0.3321414669807576
Epoch:        165 | Training loss: 0.01998190677298369 | Validation loss: 0
.3321125541731948
Epoch:        166 | Training loss: 0.019892517717130197 | Validation loss:
0.33208486644033486
Epoch:        167 | Training loss: 0.019804242294817212 | Validation loss:
0.3320463435098354
Epoch:        168 | Training loss: 0.019717094577670416 | Validation loss:
0.3320118649612753
```

```
Epoch:          169 | Training loss: 0.019631004164778018 | Validation loss:
0.3319923006633183
Epoch:          170 | Training loss: 0.019546008816115748 | Validation loss:
0.33195654203123703
Epoch:          171 | Training loss: 0.019462040360949808 | Validation loss:
0.331936144237989
Epoch:          172 | Training loss: 0.019379114969957815 | Validation loss:
0.33190702462079075
Epoch:          173 | Training loss: 0.019297201955924277 | Validation loss:
0.3318881534242326
Epoch:          174 | Training loss: 0.019216285175975675 | Validation loss:
0.33186382927770375
Epoch:          175 | Training loss: 0.019136360212489927 | Validation loss:
0.33184404641771786
Epoch:          176 | Training loss: 0.019057394013800633 | Validation loss:
0.33182320164555734
Epoch:          177 | Training loss: 0.01897933399018547 | Validation loss: 0
.3317887850261277
Epoch:          178 | Training loss: 0.018902235406583694 | Validation loss:
0.33176873299811904
Epoch:          179 | Training loss: 0.01882604415347751 | Validation loss: 0
.33174281217661966
Epoch:          180 | Training loss: 0.018750759327943782 | Validation loss:
0.33172528825700426
Epoch:          181 | Training loss: 0.018676351959157993 | Validation loss:
0.33170190099940217
Epoch:          182 | Training loss: 0.018602818795226836 | Validation loss:
0.3316830278508537
Epoch:          183 | Training loss: 0.018530138166131898 | Validation loss:
0.33166284577922994
Epoch:          184 | Training loss: 0.018458326154124863 | Validation loss:
0.33165207692165244
Epoch:          185 | Training loss: 0.01838729690019072 | Validation loss: 0
.3316275411707133
Epoch:          186 | Training loss: 0.018317102554566145 | Validation loss:
0.33161033697484776
Epoch:          187 | Training loss: 0.01824769775127137 | Validation loss: 0
.3315843061078015
Epoch:          188 | Training loss: 0.018179110716384252 | Validation loss:
0.3315582294107999
Epoch:          189 | Training loss: 0.018111295501683604 | Validation loss:
0.33153826662372926
Epoch:          190 | Training loss: 0.018044223534130762 | Validation loss:
0.331522553784983


Hyper Parameters -- Learning Rate - 0.006004000000000001  Regularization Pa
rameter- 6.309573444801929e-05
Epoch:            0 | Training loss: 0.5377584351453684 | Validation loss: 0.
6139054575220299
Epoch:            1 | Training loss: 0.4454952964786625 | Validation loss: 0.
5671531626590388
Epoch:            2 | Training loss: 0.38311668710078833 | Validation loss: 0
.5341127189883069
Epoch:            3 | Training loss: 0.33774292275834417 | Validation loss: 0
.5102524981049793
Epoch:            4 | Training loss: 0.30282686675513154 | Validation loss: 0
.4922422628754586
Epoch:            5 | Training loss: 0.2748468871120589 | Validation loss: 0.
476912448921787
Epoch:            6 | Training loss: 0.2518282148231339 | Validation loss: 0.
4646030197492741
```

```
Epoch:          7 | Training loss: 0.23268103564472695 | Validation loss: 0
.45453103940365097
Epoch:          8 | Training loss: 0.21629667606048866 | Validation loss: 0
.44556853552770346
Epoch:          9 | Training loss: 0.20232551226643702 | Validation loss: 0
.43812378800744317
Epoch:         10 | Training loss: 0.19023992821975672 | Validation loss: 0
.4317471350143588
Epoch:         11 | Training loss: 0.17918384302550525 | Validation loss: 0
.4251482959031837
Epoch:         12 | Training loss: 0.16960449539571026 | Validation loss: 0
.41990208809826035
Epoch:         13 | Training loss: 0.16113322928364995 | Validation loss: 0
.41537929390257106
Epoch:         14 | Training loss: 0.1534043498629756 | Validation loss: 0.
41088578570395967
Epoch:         15 | Training loss: 0.14648814358632165 | Validation loss: 0
.40698811720755373
Epoch:         16 | Training loss: 0.14022284913611363 | Validation loss: 0
.4035886179873637
Epoch:         17 | Training loss: 0.13450357264700588 | Validation loss: 0
.4003928067681292
Epoch:         18 | Training loss: 0.1292441527939766 | Validation loss: 0.
39725812631331453
Epoch:         19 | Training loss: 0.12440948069701091 | Validation loss: 0
.3945717808898486
Epoch:         20 | Training loss: 0.11997063858142512 | Validation loss: 0
.3920070017594886
Epoch:         21 | Training loss: 0.11587041178404912 | Validation loss: 0
.3896893277231604
Epoch:         22 | Training loss: 0.11210719325188545 | Validation loss: 0
.38768028675653526
Epoch:         23 | Training loss: 0.108548427227596 | Validation loss: 0.3
8551917452970047
Epoch:         24 | Training loss: 0.10530254981002006 | Validation loss: 0
.3838137192093897
Epoch:         25 | Training loss: 0.10219910709265284 | Validation loss: 0
.381921312771552
Epoch:         26 | Training loss: 0.09935188585881467 | Validation loss: 0
.38038230900141246
Epoch:         27 | Training loss: 0.0966490812535128 | Validation loss: 0.
37876439192656364
Epoch:         28 | Training loss: 0.0941273514511356 | Validation loss: 0.
3773050420976734
Epoch:         29 | Training loss: 0.09177464771594324 | Validation loss: 0
.37605594978569423
Epoch:         30 | Training loss: 0.08952768293816503 | Validation loss: 0
.3746859658674589
Epoch:         31 | Training loss: 0.08742497463124078 | Validation loss: 0
.37349317856371
Epoch:         32 | Training loss: 0.08544104028749439 | Validation loss: 0
.372380319192669
Epoch:         33 | Training loss: 0.08355920760048431 | Validation loss: 0
.3712537868979285
Epoch:         34 | Training loss: 0.08177957011347908 | Validation loss: 0
.3702641178402558
Epoch:         35 | Training loss: 0.08009313213809878 | Validation loss: 0
.36930519319474314
Epoch:         36 | Training loss: 0.07849244001934008 | Validation loss: 0
.3683753980851725
Epoch:         37 | Training loss: 0.07697171866005131 | Validation loss: 0
```

```
.36753121932705163
Epoch:          38 | Training loss: 0.07552524858370427 | Validation loss: 0
.3666958679984697
Epoch:          39 | Training loss: 0.07415023169465401 | Validation loss: 0
.36588753966436643
Epoch:          40 | Training loss: 0.07283809901004702 | Validation loss: 0
.36514534784576086
Epoch:          41 | Training loss: 0.07158764010103928 | Validation loss: 0
.3644296490866931
Epoch:          42 | Training loss: 0.07039091093624841 | Validation loss: 0
.3637675975997064
Epoch:          43 | Training loss: 0.06925179117435853 | Validation loss: 0
.36311060154190966
Epoch:          44 | Training loss: 0.0681581462623374 | Validation loss: 0.
362517963299291766
Epoch:          45 | Training loss: 0.06711412188953095 | Validation loss: 0
.3619378912815801
Epoch:          46 | Training loss: 0.06611736962094249 | Validation loss: 0
.36142241867392744
Epoch:          47 | Training loss: 0.06516224977394185 | Validation loss: 0
.36091300631558054
Epoch:          48 | Training loss: 0.06423856993770695 | Validation loss: 0
.36035170306717207
Epoch:          49 | Training loss: 0.06335927711158336 | Validation loss: 0
.35981329882514695
Epoch:          50 | Training loss: 0.06251227628207633 | Validation loss: 0
.35935102696381366
Epoch:          51 | Training loss: 0.061699802646686196 | Validation loss:
0.35890027290342436
Epoch:          52 | Training loss: 0.06092011504911106 | Validation loss: 0
.35846489166554635
Epoch:          53 | Training loss: 0.06016552529906154 | Validation loss: 0
.35808504820362175
Epoch:          54 | Training loss: 0.059442536398325266 | Validation loss:
0.3576935663456928
Epoch:          55 | Training loss: 0.05874767521988486 | Validation loss: 0
.3572907621887633
Epoch:          56 | Training loss: 0.058076176793970244 | Validation loss:
0.3569522399539818
Epoch:          57 | Training loss: 0.0574301283033525 | Validation loss: 0.
35660451168353335
Epoch:          58 | Training loss: 0.05680839210769662 | Validation loss: 0
.35630616811226196
Epoch:          59 | Training loss: 0.056206591973864926 | Validation loss:
0.35596028329762375
Epoch:          60 | Training loss: 0.05562681860624717 | Validation loss: 0
.35564800015769266
Epoch:          61 | Training loss: 0.0550672637424706 | Validation loss: 0.
3553585650982143
Epoch:          62 | Training loss: 0.0545268089650222 | Validation loss: 0.
35507712437880834
Epoch:          63 | Training loss: 0.05400465264618448 | Validation loss: 0
.3548038887553082
Epoch:          64 | Training loss: 0.05350005958630329 | Validation loss: 0
.35451513159320713
Epoch:          65 | Training loss: 0.05301248594912983 | Validation loss: 0
.3542563763472197
Epoch:          66 | Training loss: 0.052540138348301846 | Validation loss:
0.35405417459136
Epoch:          67 | Training loss: 0.05208469274206412 | Validation loss: 0
.3538504195648522
```

```
Epoch:            68 | Training loss: 0.051641574652995695 | Validation loss:
0.35360149227473137
Epoch:            69 | Training loss: 0.0512133082109144 | Validation loss: 0.
353365608932663
Epoch:            70 | Training loss: 0.05079912037384456 | Validation loss: 0
.35317735524373634
Epoch:            71 | Training loss: 0.05039805361197334 | Validation loss: 0
.3529373485237342
Epoch:            72 | Training loss: 0.05000851395277329 | Validation loss: 0
.3527535044010614
Epoch:            73 | Training loss: 0.04963119861008879 | Validation loss: 0
.3525959163273876
Epoch:            74 | Training loss: 0.04926538395304685 | Validation loss: 0
.3524100664432918
Epoch:            75 | Training loss: 0.04891065856797217 | Validation loss: 0
.35223778696084407
Epoch:            76 | Training loss: 0.048566789484092834 | Validation loss:
0.3520895330729717
Epoch:            77 | Training loss: 0.04823271478531948 | Validation loss: 0
.35192660990128716
Epoch:            78 | Training loss: 0.0479085515398536 | Validation loss: 0.
35177260505723495
Epoch:            79 | Training loss: 0.047593811613843136 | Validation loss:
0.35162197653199356
Epoch:            80 | Training loss: 0.047288321832770014 | Validation loss:
0.3514875669008491
Epoch:            81 | Training loss: 0.0469914202847414 | Validation loss: 0.
35134522421204123
Epoch:            82 | Training loss: 0.04670315273468994 | Validation loss: 0
.3512251246721354
Epoch:            83 | Training loss: 0.04642339247686755 | Validation loss: 0
.3511189324325557
Epoch:            84 | Training loss: 0.04615057891404206 | Validation loss:
0.3509591181614791
Epoch:            85 | Training loss: 0.04588646346396771 | Validation loss: 0
.350825813750814
Epoch:            86 | Training loss: 0.045628319968870804 | Validation loss:
0.35074357826694524
Epoch:            87 | Training loss: 0.045377970077360386 | Validation loss:
0.3506334329778643
Epoch:            88 | Training loss: 0.04513453597775591 | Validation loss: 0
.3505232474490161
Epoch:            89 | Training loss: 0.04489803394675409 | Validation loss: 0
.3504119054175115
Epoch:            90 | Training loss: 0.044667213151174744 | Validation loss:
0.3503256520390968
Epoch:            91 | Training loss: 0.044443225998294755 | Validation loss:
0.35022495813144827
Epoch:            92 | Training loss: 0.04422433921596337 | Validation loss: 0
.35015668361747193
Epoch:            93 | Training loss: 0.0440117603657762 | Validation loss: 0.
3500939206833989
Epoch:            94 | Training loss: 0.04380478108751908 | Validation loss: 0
.34999253347463866
Epoch:            95 | Training loss: 0.04360331852970933 | Validation loss: 0
.34990975815683867
Epoch:            96 | Training loss: 0.04340686551062331 | Validation loss: 0
.349856056321873
Epoch:            97 | Training loss: 0.043215709018597843 | Validation loss:
0.349770700108363
Epoch:            98 | Training loss: 0.043029353367728326 | Validation loss:
```

```
0.3497098592032711
Epoch:          99 | Training loss: 0.04284786340766895 | Validation loss: 0
.3496585649729746
Epoch:         100 | Training loss: 0.042670944890566956 | Validation loss:
0.3495895854245449
Epoch:         101 | Training loss: 0.04249855892183016 | Validation loss: 0
.3495329281880759
Epoch:         102 | Training loss: 0.04233055504446395 | Validation loss: 0
.3494814857301252
Epoch:         103 | Training loss: 0.04216683428942437 | Validation loss: 0
.34943513360540757
Epoch:         104 | Training loss: 0.042007072141469814 | Validation loss:
0.3493726913025007
Epoch:         105 | Training loss: 0.041851417384063665 | Validation loss:
0.34933291285879764
Epoch:         106 | Training loss: 0.04169963761804527 | Validation loss: 0
.34929084136985666
Epoch:         107 | Training loss: 0.04155149285435782 | Validation loss: 0
.34923414988447177
Epoch:         108 | Training loss: 0.0414071194699937 | Validation loss: 0.
34918296059952586
Epoch:         109 | Training loss: 0.041266302328630565 | Validation loss:
0.3491394721006264
Epoch:         110 | Training loss: 0.041128860444708315 | Validation loss:
0.3491058185035063
Epoch:         111 | Training loss: 0.040994778259570715 | Validation loss:
0.349080854396524
Epoch:         112 | Training loss: 0.04086400184900558 | Validation loss: 0
.3490405210598682
Epoch:         113 | Training loss: 0.040736413676818406 | Validation loss:
0.34900571934071967
Epoch:         114 | Training loss: 0.0406118499699499 | Validation loss: 0.
3489870626772944
Epoch:         115 | Training loss: 0.04049032167223802 | Validation loss: 0
.34896153292775056
Epoch:         116 | Training loss: 0.040371712221748804 | Validation loss:
0.34893373151763657
Epoch:         117 | Training loss: 0.04025597451695475 | Validation loss: 0
.34891630756265213
Epoch:         118 | Training loss: 0.0401429838967196 | Validation loss: 0.
34889414273357544
Epoch:         119 | Training loss: 0.04003270501543314 | Validation loss: 0
.3488748878494042
Epoch:         120 | Training loss: 0.03992506529406872 | Validation loss: 0
.3488599923476003
Epoch:         121 | Training loss: 0.03981997836434702 | Validation loss: 0
.3488453123991841
Epoch:         122 | Training loss: 0.03971729747587238 | Validation loss: 0
.3488207507032798
Epoch:         123 | Training loss: 0.03961714173779838 | Validation loss: 0
.34881005490908096
Epoch:         124 | Training loss: 0.03951929102200077 | Validation loss: 0
.34879210089933765
Epoch:         125 | Training loss: 0.0394237718547332 | Validation loss: 0.
34877862434562706


Hyper Parameters -- Learning Rate - 0.006004000000000001  Regularization Pa
rameter- 0.0003981071705349735
Epoch:           0 | Training loss: 0.5382158038127332 | Validation loss: 0.
61436282564441
Epoch:           1 | Training loss: 0.44691915614369315 | Validation loss: 0
```

```
.5685770211063876
Epoch:           2 | Training loss: 0.3857235667487943 | Validation loss: 0.
5367195967593317
Epoch:           3 | Training loss: 0.3416354576434125 | Validation loss: 0.
5141450309327678
Epoch:           4 | Training loss: 0.30805615517012597 | Validation loss: 0
.49747154972290486
Epoch:           5 | Training loss: 0.2814310928108189 | Validation loss: 0.
48349665306545303
Epoch:           6 | Training loss: 0.2597712851637921 | Validation loss: 0.
4725460895136889
Epoch:           7 | Training loss: 0.24197816642881084 | Validation loss: 0
.4638281712559422
Epoch:           8 | Training loss: 0.22693497264381643 | Validation loss: 0
.45620683409213547
Epoch:           9 | Training loss: 0.2142887775551681 | Validation loss: 0.
45008705730659443
Epoch:          10 | Training loss: 0.20350894208720635 | Validation loss: 0
.4450161552642391
Epoch:          11 | Training loss: 0.19373983046909513 | Validation loss: 0
.4397042898314551
Epoch:          12 | Training loss: 0.18542725716123590 | Validation loss: 0.
4357248585045959
Epoch:          13 | Training loss: 0.17820111428202481 | Validation loss: 0
.4324471904942071
Epoch:          14 | Training loss: 0.17169679890173872 | Validation loss: 0
.4291782472224962
Epoch:          15 | Training loss: 0.16598374988023804 | Validation loss: 0
.4264837379593085
Epoch:          16 | Training loss: 0.16090114114506715 | Validation loss: 0
.42426692786286835
Epoch:          17 | Training loss: 0.15634538082922217 | Validation loss: 0
.42223463536500816
Epoch:          18 | Training loss: 0.15223011029208364 | Validation loss: 0
.4202441048502308
Epoch:          19 | Training loss: 0.14852034855676036 | Validation loss: 0
.4186826733574066
Epoch:          20 | Training loss: 0.14518785625118652 | Validation loss: 0
.41722424593586566
Epoch:          21 | Training loss: 0.14217613594997663 | Validation loss: 0
.4159950811347711
Epoch:          22 | Training loss: 0.13948300758512536 | Validation loss: 0
.4150561341812909
Epoch:          23 | Training loss: 0.13697736490106877 | Validation loss: 0
.41394814641672456
Epoch:          24 | Training loss: 0.13476779821894053 | Validation loss: 0
.4132790064013193
Epoch:          25 | Training loss: 0.13268460069307483 | Validation loss: 0
.4124068463952433
Epoch:          26 | Training loss: 0.130841698700357700 | Validation loss: 0.
4118721656516899
Epoch:          27 | Training loss: 0.12912837191458476 | Validation loss: 0
.41124372824581057
Epoch:          28 | Training loss: 0.1275814012005385 | Validation loss: 0.
41075914002574826
Epoch:          29 | Training loss: 0.12618863078702452 | Validation loss: 0
.41046998525211364
Epoch:          30 | Training loss: 0.12488785103253175 | Validation loss: 0
.4100461879334587
Epoch:          31 | Training loss: 0.12371743182559622 | Validation loss: 0
.40978569286805383
```

```
Epoch:          32 | Training loss: 0.12265286117411851 | Validation loss: 0
.40959220055566165
Epoch:          33 | Training loss: 0.1216775836093467 | Validation loss: 0.
40937222518122923
Epoch:          34 | Training loss: 0.1207923123136935 | Validation loss: 0.
40927692583816194
Epoch:          35 | Training loss: 0.11998813660778987 | Validation loss: 0
.4092002665257508
Epoch:          36 | Training loss: 0.11925781891676093 | Validation loss: 0
.40914084838263437

Hyper Parameters -- Learning Rate - 0.006004000000000001  Regularization Pa
rameter- 0.002511886431509582
Epoch:           0 | Training loss: 0.5411016045338805 | Validation loss: 0.
6172486229269377
Epoch:           1 | Training loss: 0.45590310033953185 | Validation loss: 0
.5775609576191928
Epoch:           2 | Training loss: 0.4021718571581016 | Validation loss: 0.
5531678753257401
Epoch:           3 | Training loss: 0.36619567587853763 | Validation loss: 0
.5387052361874524
Epoch:           4 | Training loss: 0.34105070654599223 | Validation loss: 0
.530466091208442
Epoch:           5 | Training loss: 0.3229745798646933 | Validation loss: 0.
5250401303076895
Epoch:           6 | Training loss: 0.3098886108817941 | Validation loss: 0.
5226634115963807
Epoch:           7 | Training loss: 0.30063901539758914 | Validation loss: 0
.5224890269654928

Hyper Parameters -- Learning Rate - 0.006004000000000001  Regularization Pa
rameter- 0.01584893192461114
Epoch:           0 | Training loss: 0.5593097571437595 | Validation loss: 0.
6354567538406601
Epoch:           1 | Training loss: 0.5125878391940609 | Validation loss: 0.
6342456479978615

Hyper Parameters -- Learning Rate - 0.008002  Regularization Parameter- 1e-
05
Epoch:           0 | Training loss: 0.5000687628863478 | Validation loss: 0.
5943528148320568
Epoch:           1 | Training loss: 0.39920986884994153 | Validation loss: 0
.5428902906558546
Epoch:           2 | Training loss: 0.33499138039352355 | Validation loss: 0
.508580032542277
Epoch:           3 | Training loss: 0.29000179667592907 | Validation loss: 0
.4845671543225173
Epoch:           4 | Training loss: 0.25627014471622933 | Validation loss: 0
.46684129906035027
Epoch:           5 | Training loss: 0.2297458089909241 | Validation loss: 0.
45205353662995096
Epoch:           6 | Training loss: 0.20825335037158837 | Validation loss: 0
.440253446789454
Epoch:           7 | Training loss: 0.19063950647322533 | Validation loss: 0
.4307245702563378
Epoch:           8 | Training loss: 0.17571415147854116 | Validation loss: 0
.4223184849980601
Epoch:           9 | Training loss: 0.16313514118760217 | Validation loss: 0
.4154286345989037
Epoch:          10 | Training loss: 0.15233302691037892 | Validation loss: 0
.4095581931210676
```

```
Epoch:           11 | Training loss: 0.14248769777094802 | Validation loss: 0
.4033856303816895
Epoch:           12 | Training loss: 0.13402776573644645 | Validation loss: 0
.3985700575132637
Epoch:           13 | Training loss: 0.12659288795590481 | Validation loss: 0
.3944502399601706
Epoch:           14 | Training loss: 0.11984430551756174 | Validation loss: 0
.3903455132172136
Epoch:           15 | Training loss: 0.11383599085876578 | Validation loss: 0
.3868023405782895
Epoch:           16 | Training loss: 0.10840242385149411 | Validation loss: 0
.3837186499239702
Epoch:           17 | Training loss: 0.10347369225721091 | Validation loss: 0
.3808620681655126
Epoch:           18 | Training loss: 0.09894391240847246 | Validation loss: 0
.3779948549001507
Epoch:           19 | Training loss: 0.09479263724454472 | Validation loss: 0
.37558441628371925
Epoch:           20 | Training loss: 0.09098871924656077 | Validation loss: 0
.3732604072060216
Epoch:           21 | Training loss: 0.08748261549740667 | Validation loss: 0
.3711773375441949
Epoch:           22 | Training loss: 0.08427194176593678 | Validation loss: 0
.36940727045842037
Epoch:           23 | Training loss: 0.08123619623984052 | Validation loss: 0
.36742806644112663
Epoch:           24 | Training loss: 0.0784718329233569 | Validation loss: 0.
365931564740213
Epoch:           25 | Training loss: 0.0758300103311477 | Validation loss: 0.
3642032708495659
Epoch:           26 | Training loss: 0.07340995328355328 | Validation loss: 0
.36284864239845566
Epoch:           27 | Training loss: 0.07111099828057926 | Validation loss: 0
.3613707816523887
Epoch:           28 | Training loss: 0.06896805999201652 | Validation loss: 0
.36005571733005015
Epoch:           29 | Training loss: 0.06696821305405734 | Validation loss: 0
.3589500726377199
Epoch:           30 | Training loss: 0.06505900340137155 | Validation loss: 0
.3576963856805789
Epoch:           31 | Training loss: 0.06327138240390888 | Validation loss: 0
.35662330068380554
Epoch:           32 | Training loss: 0.06158389751687704 | Validation loss: 0
.35562200620074175
Epoch:           33 | Training loss: 0.05998304066038968 | Validation loss: 0
.3545915982541497
Epoch:           34 | Training loss: 0.05846767805412077 | Validation loss: 0
.3537046399996238
Epoch:           35 | Training loss: 0.057030512281680615 | Validation loss:
0.35283445001143626
Epoch:           36 | Training loss: 0.05566514411310914 | Validation loss: 0
.3519818910589847
Epoch:           37 | Training loss: 0.05436655515442238 | Validation loss: 0
.35121852830235784
Epoch:           38 | Training loss: 0.05313005394056189 | Validation loss: 0
.35045231369952434
Epoch:           39 | Training loss: 0.05195298579768281 | Validation loss: 0
.3497083703444011
Epoch:           40 | Training loss: 0.05082831246401901 | Validation loss: 0
.3490283060562943
Epoch:           41 | Training loss: 0.04975474675976106 | Validation loss: 0
```

```
.34836949714068877
Epoch:          42 | Training loss: 0.048725894556434356 | Validation loss:
0.3477654647826584
Epoch:          43 | Training loss: 0.047744689540984465 | Validation loss:
0.3471533286132313
Epoch:          44 | Training loss: 0.04680148307650878 | Validation loss: 0
.34661173051075067
Epoch:          45 | Training loss: 0.04589910487292043 | Validation loss: 0
.3460751346028658
Epoch:          46 | Training loss: 0.04503588589591633 | Validation loss: 0
.3456048042068136
Epoch:          47 | Training loss: 0.044207019153829595 | Validation loss:
0.34513449972913707
Epoch:          48 | Training loss: 0.04340392498276445 | Validation loss: 0
.3445985532478361
Epoch:          49 | Training loss: 0.042637540722205304 | Validation loss:
0.34407803320067815
Epoch:          50 | Training loss: 0.041897683744451686 | Validation loss:
0.343644673588846
Epoch:          51 | Training loss: 0.041186406606258635 | Validation loss:
0.3432171744362746
Epoch:          52 | Training loss: 0.04050214149427618 | Validation loss: 0
.34280107332000886
Epoch:          53 | Training loss: 0.039838472686686846 | Validation loss:
0.3424492154248247
Epoch:          54 | Training loss: 0.03920083530317034 | Validation loss: 0
.34207726694126506
Epoch:          55 | Training loss: 0.038586243896331 | Validation loss: 0.3
416829828891649
Epoch:          56 | Training loss: 0.037990995766305054 | Validation loss:
0.3413623338245357
Epoch:          57 | Training loss: 0.037416608888609725 | Validation loss:
0.3410251916844907
Epoch:          58 | Training loss: 0.036862197232481526 | Validation loss:
0.34074158648316233
Epoch:          59 | Training loss: 0.03632418577979033 | Validation loss: 0
.3404001600189022
Epoch:          60 | Training loss: 0.03580426195842193 | Validation loss: 0
.3400921748685252
Epoch:          61 | Training loss: 0.03530095823851452 | Validation loss: 0
.3398081961741603
Epoch:          62 | Training loss: 0.03481335658487021 | Validation loss: 0
.3395307243473487
Epoch:          63 | Training loss: 0.03434078716764366 | Validation loss: 0
.3392590047153974
Epoch:          64 | Training loss: 0.033882648325428456 | Validation loss:
0.3389668115105515
Epoch:          65 | Training loss: 0.03343850865205626 | Validation loss: 0
.3387050553369445
Epoch:          66 | Training loss: 0.033006930826666184 | Validation loss:
0.3385074418202704
Epoch:          67 | Training loss: 0.03258920513097954 | Validation loss: 0
.338303834057439
Epoch:          68 | Training loss: 0.03218163261075827 | Validation loss: 0
.338046363280083
Epoch:          69 | Training loss: 0.03178629337640348 | Validation loss: 0
.33780109422050436
Epoch:          70 | Training loss: 0.031402514070550426 | Validation loss:
0.3376093395616946
Epoch:          71 | Training loss: 0.031029560074560487 | Validation loss:
0.33735488880841347
```

```
Epoch:          72 | Training loss: 0.03066609809750166 | Validation loss: 0
.3371646563922275
Epoch:          73 | Training loss: 0.030312745844919605 | Validation loss:
0.33700183932381633
Epoch:          74 | Training loss: 0.029968846446398203 | Validation loss:
0.33680381273570686
Epoch:          75 | Training loss: 0.0296340976847317 | Validation loss: 0.
3366198013180812
Epoch:          76 | Training loss: 0.02930830664275227 | Validation loss: 0
.3364621001448229
Epoch:          77 | Training loss: 0.028990597794295865 | Validation loss:
0.3362849941568476
Epoch:          78 | Training loss: 0.02868107974104836 | Validation loss:
0.33611683807384296
Epoch:          79 | Training loss: 0.028379361638838807 | Validation loss:
0.3359514616461552
Epoch:          80 | Training loss: 0.02808527811401247 | Validation loss: 0
.33580265218258326
Epoch:          81 | Training loss: 0.027798322924846183 | Validation loss:
0.3356434873278126
Epoch:          82 | Training loss: 0.027518510138858504 | Validation loss:
0.33550830805641896
Epoch:          83 | Training loss: 0.02724573828754203 | Validation loss: 0
.33538803309271953
Epoch:          84 | Training loss: 0.026978785788872795 | Validation loss:
0.3352062187187219
Epoch:          85 | Training loss: 0.026718982460657854 | Validation loss:
0.33505200424436715
Epoch:          86 | Training loss: 0.02646421128843187 | Validation loss: 0
.3349557961906654
Epoch:          87 | Training loss: 0.02621588230609095 | Validation loss: 0
.33482626147780936
Epoch:          88 | Training loss: 0.025973306720391248 | Validation loss:
0.334695588240145
Epoch:          89 | Training loss: 0.025736477503264833 | Validation loss:
0.3345627173753212
Epoch:          90 | Training loss: 0.025504439328551183 | Validation loss:
0.33445741962174685
Epoch:          91 | Training loss: 0.025278057005136287 | Validation loss:
0.33433456728305166
Epoch:          92 | Training loss: 0.025055991256853295 | Validation loss:
0.334248096385748
Epoch:          93 | Training loss: 0.02483917047448617 | Validation loss: 0
.3341666762470636
Epoch:          94 | Training loss: 0.024627020160449292 | Validation loss:
0.334040682245154
Epoch:          95 | Training loss: 0.024419490226773043 | Validation loss:
0.3339347650191625
Epoch:          96 | Training loss: 0.024216176467809953 | Validation loss:
0.33386107894527284
Epoch:          97 | Training loss: 0.02401729117559786 | Validation loss: 0
.3337511055608183
Epoch:          98 | Training loss: 0.023822449933726477 | Validation loss:
0.3336680807760572
Epoch:          99 | Training loss: 0.023631693085793673 | Validation loss:
0.333594789473549
Epoch:         100 | Training loss: 0.023444789830848127 | Validation loss:
0.3335013088546437
Epoch:         101 | Training loss: 0.023261700463329465 | Validation loss:
0.33342095818581724
Epoch:         102 | Training loss: 0.023082305451976218 | Validation loss:
```

```
0.33334607710168085
Epoch:          103 | Training loss: 0.022906521582143832 | Validation loss:
0.3332759015791804
Epoch:          104 | Training loss: 0.0227340970849175 | Validation loss: 0.
33318702999270644
Epoch:          105 | Training loss: 0.022565143720884504 | Validation loss:
0.33312356323495407
Epoch:          106 | Training loss: 0.022399469327307974 | Validation loss:
0.33305655261512557
Epoch:          107 | Training loss: 0.0222368847679602 | Validation loss: 0.
3329729849120309
Epoch:          108 | Training loss: 0.02207749680342985 | Validation loss: 0
.33289469335810784
Epoch:          109 | Training loss: 0.02192113061749038 | Validation loss: 0
.33282530716963094
Epoch:          110 | Training loss: 0.021767645850881773 | Validation loss:
0.3327662542743807
Epoch:          111 | Training loss: 0.02161702908963536 | Validation loss: 0
.33271608733312436
Epoch:          112 | Training loss: 0.021469228297094942 | Validation loss:
0.33264829330888546
Epoch:          113 | Training loss: 0.021324147223538807 | Validation loss:
0.33258670277555824
Epoch:          114 | Training loss: 0.02118166049449371 | Validation loss: 0
.33254272246460137
Epoch:          115 | Training loss: 0.021041774047631835 | Validation loss:
0.33249063420634306
Epoch:          116 | Training loss: 0.020904391487915893 | Validation loss:
0.3324353822707095
Epoch:          117 | Training loss: 0.02076947421132589 | Validation loss: 0
.3323918789259984
Epoch:          118 | Training loss: 0.02063692156264473 | Validation loss: 0
.33234279928875377
Epoch:          119 | Training loss: 0.020506699687832364 | Validation loss:
0.3322961673250691
Epoch:          120 | Training loss: 0.020378755118865943 | Validation loss:
0.33225394356891913
Epoch:          121 | Training loss: 0.02025301591277404 | Validation loss: 0
.33221187694082394
Epoch:          122 | Training loss: 0.020129367463060432 | Validation loss:
0.33215894402804735
Epoch:          123 | Training loss: 0.020007895082795914 | Validation loss:
0.33212110423885854
Epoch:          124 | Training loss: 0.019888429092080002 | Validation loss:
0.3320748502490112
Epoch:          125 | Training loss: 0.019770983660456536 | Validation loss:
0.33203317401255716
Epoch:          126 | Training loss: 0.0196555055539041 | Validation loss: 0.
3319959486378686
Epoch:          127 | Training loss: 0.01954193074632353 | Validation loss: 0
.33195592261116164
Epoch:          128 | Training loss: 0.019430230777789517 | Validation loss:
0.331910043437494
Epoch:          129 | Training loss: 0.01932034696614566 | Validation loss: 0
.3318776262994879
Epoch:          130 | Training loss: 0.019212250420639027 | Validation loss:
0.33184257203303985
Epoch:          131 | Training loss: 0.0191058970035085832 | Validation loss:
0.3318090286991676
Epoch:          132 | Training loss: 0.019001256499751953 | Validation loss:
0.33177267734265853
```

```
Epoch:          133 | Training loss: 0.018898267193748496 | Validation loss:
0.3317421755855795
Epoch:          134 | Training loss: 0.01879688897932875 | Validation loss: 0
.33171568541427576
Epoch:          135 | Training loss: 0.018697114552796813 | Validation loss:
0.3316863788727208
Epoch:          136 | Training loss: 0.0185989094413352 | Validation loss: 0.
33165491499624183
Epoch:          137 | Training loss: 0.01850219165944013 | Validation loss: 0
.33163282782057507
Epoch:          138 | Training loss: 0.018407008644148185 | Validation loss:
0.3316006614351423
Epoch:          139 | Training loss: 0.018313214790264962 | Validation loss:
0.3315875633466498
Epoch:          140 | Training loss: 0.018220891429279976 | Validation loss:
0.3315590507014351
Epoch:          141 | Training loss: 0.018129993139736483 | Validation loss:
0.3315282265213715
Epoch:          142 | Training loss: 0.01804050603452024 | Validation loss: 0
.3314962386870355
Epoch:          143 | Training loss: 0.017952196458610216 | Validation loss:
0.3314833432620698
Epoch:          144 | Training loss: 0.017865256602693468 | Validation loss:
0.3314647096970907
Epoch:          145 | Training loss: 0.017779596364837884 | Validation loss:
0.3314479889361393
Epoch:          146 | Training loss: 0.017695192070307474 | Validation loss:
0.3314326987869932
Epoch:          147 | Training loss: 0.017612022061507505 | Validation loss:
0.33141926216947515
Epoch:          148 | Training loss: 0.017530066464825536 | Validation loss:
0.3314015231148633
Epoch:          149 | Training loss: 0.01744929454307362 | Validation loss: 0
.3313827620476839


Hyper Parameters -- Learning Rate - 0.008002  Regularization Parameter- 6.3
09573444801929e-05
Epoch:            0 | Training loss: 0.5001902292319901 | Validation loss: 0.
5944742810473235
Epoch:            1 | Training loss: 0.39956644036863936 | Validation loss: 0
.5432468619383015
Epoch:            2 | Training loss: 0.33562006337466876 | Validation loss: 0
.5092087152152804
Epoch:            3 | Training loss: 0.29091624740133654 | Validation loss: 0
.4854816047772978
Epoch:            4 | Training loss: 0.2574744486162753 | Validation loss: 0.
46804560290838288
Epoch:            5 | Training loss: 0.23123819063607967 | Validation loss: 0
.4535459183129278
Epoch:            6 | Training loss: 0.21003023553542513 | Validation loss: 0
.4420303323196233
Epoch:            7 | Training loss: 0.19269624577780048 | Validation loss: 0
.4327813103857342
Epoch:            8 | Training loss: 0.17804490734318185 | Validation loss: 0
.4246492420165772
Epoch:            9 | Training loss: 0.1657338540088273 | Validation loss: 0.
41802734907121547
Epoch:           10 | Training loss: 0.1551935087718901 | Validation loss: 0.
4124186772459092
Epoch:           11 | Training loss: 0.14560417512000667 | Validation loss: 0
.4065021100198941
```

```
Epoch:          12 | Training loss: 0.1373943855874264 | Validation loss: 0.
4019366802074953
Epoch:          13 | Training loss: 0.130203759122777 | Validation loss: 0.3
9806111469609534
Epoch:          14 | Training loss: 0.12369397139365443 | Validation loss: 0
.3941951829098583
Epoch:          15 | Training loss: 0.11791896948650558 | Validation loss: 0
.3908853234881097
Epoch:          16 | Training loss: 0.11271353832950068 | Validation loss: 0
.38802976949297274
Epoch:          17 | Training loss: 0.1080081999924816 | Validation loss: 0.
3853965816290062
Epoch:          18 | Training loss: 0.10369711886481757 | Validation loss: 0
.3827480672320203
Epoch:          19 | Training loss: 0.09975998948189801 | Validation loss: 0
.38055177524863
Epoch:          20 | Training loss: 0.09616585210668889 | Validation loss: 0
.37843754723128437
Epoch:          21 | Training loss: 0.09286539531556932 | Validation loss: 0
.3765601251634189
Epoch:          22 | Training loss: 0.08985617236277142 | Validation loss: 0
.37499150976670265
Epoch:          23 | Training loss: 0.08701806854279343 | Validation loss: 0
.37320994769915644
Epoch:          24 | Training loss: 0.08444757299966552 | Validation loss: 0
.37190731484373063
Epoch:          25 | Training loss: 0.08199607970500077 | Validation loss: 0
.3703693505269126
Epoch:          26 | Training loss: 0.07976285068993258 | Validation loss: 0
.3692015509955883
Epoch:          27 | Training loss: 0.07764748830482286 | Validation loss: 0
.3679072832726018
Epoch:          28 | Training loss: 0.07568495490901839 | Validation loss: 0
.3667726244292739
Epoch:          29 | Training loss: 0.07386234077448375 | Validation loss: 0
.36584421349777785
Epoch:          30 | Training loss: 0.07212743570679923 | Validation loss: 0
.3647648314783314
Epoch:          31 | Training loss: 0.07051118735961862 | Validation loss: 0
.3638631198456169
Epoch:          32 | Training loss: 0.06899234866453993 | Validation loss: 0
.36303047231535035
Epoch:          33 | Training loss: 0.0675574542754182 | Validation loss: 0.
3621660272455992
Epoch:          34 | Training loss: 0.06620550740869492 | Validation loss: 0
.36144248553595026
Epoch:          35 | Training loss: 0.06492925486958662 | Validation loss: 0
.3607332094684024
Epoch:          36 | Training loss: 0.06372235541930323 | Validation loss: 0
.36003911979500247
Epoch:          37 | Training loss: 0.06257986560510884 | Validation loss: 0
.35943185696629676
Epoch:          38 | Training loss: 0.061497258496479544 | Validation loss:
0.3588195370881692
Epoch:          39 | Training loss: 0.06047183885628138 | Validation loss: 0
.3582272427811625
Epoch:          40 | Training loss: 0.05949671999032475 | Validation loss: 0
.35769673364734217
Epoch:          41 | Training loss: 0.05857064827160562 | Validation loss: 0
.3571854193700609
Epoch:          42 | Training loss: 0.057687276241901585 | Validation loss:
```

0.3567268680033914
Epoch: 43 | Training loss: 0.05684958493106334 | Validation loss: 0
.3562582461056546
Epoch: 44 | Training loss: 0.05604803483710958 | Validation loss: 0
.3558583052752799
Epoch: 45 | Training loss: 0.05528547396590124 | Validation loss: 0
.3554615274221176
Epoch: 46 | Training loss: 0.05456028038945382 | Validation loss: 0
.35512922335965763
Epoch: 47 | Training loss: 0.053867690290062778 | Validation loss: 0
.35479519636036544
Epoch: 48 | Training loss: 0.05319920654472594 | Validation loss: 0
.35439386075596374
Epoch: 49 | Training loss: 0.052565784057860665 | Validation loss:
0.3540063027910523
Epoch: 50 | Training loss: 0.05195727497022732 | Validation loss: 0
.35370429184087276
Epoch: 51 | Training loss: 0.05137580286570043 | Validation loss: 0
.3534065984014065
Epoch: 52 | Training loss: 0.050819799291124026 | Validation loss:
0.3531187594582903
Epoch: 53 | Training loss: 0.05028293536340409 | Validation loss: 0
.35289370747592486
Epoch: 54 | Training loss: 0.049770646222885934 | Validation loss:
0.3526471079720464
Epoch: 55 | Training loss: 0.04928000067840694 | Validation loss: 0
.35237677027640296
Epoch: 56 | Training loss: 0.04880732340284374 | Validation loss: 0
.3521786930006764
Epoch: 57 | Training loss: 0.04835417257657747 | Validation loss: 0
.3519627876239008
Epoch: 58 | Training loss: 0.047919684765286935 | Validation loss:
0.3517991072142236
Epoch: 59 | Training loss: 0.04750033427170653 | Validation loss: 0
.35157634224655737
Epoch: 60 | Training loss: 0.04709781531343801 | Validation loss: 0
.351385762652518
Epoch: 61 | Training loss: 0.04671069228525474 | Validation loss: 0
.351217965437826
Epoch: 62 | Training loss: 0.04633809431668727 | Validation loss: 0
.3510554980263091
Epoch: 63 | Training loss: 0.045979351933633165 | Validation loss:
0.35089760616621307
Epoch: 64 | Training loss: 0.045633901340144604 | Validation loss:
0.35071810172838747
Epoch: 65 | Training loss: 0.045301347566498576 | Validation loss:
0.3505679320998943
Epoch: 66 | Training loss: 0.04498025371392011 | Validation loss: 0
.35048080362590867
Epoch: 67 | Training loss: 0.044671950496859486 | Validation loss:
0.3503866192746831
Epoch: 68 | Training loss: 0.044372755697539845 | Validation loss:
0.35023752676783176
Epoch: 69 | Training loss: 0.0440847695068158 | Validation loss: 0.
3500996113020109
Epoch: 70 | Training loss: 0.043807352694294824 | Validation loss:
0.35001422004544663
Epoch: 71 | Training loss: 0.04353975917892501 | Validation loss: 0
.3498651301137609
Epoch: 72 | Training loss: 0.04328071171949695 | Validation loss: 0
.34977931305088217

```
Epoch:            73 | Training loss: 0.043030824762457225 | Validation loss:
0.34971996227133084
Epoch:            74 | Training loss: 0.04278946158756026 | Validation loss: 0
.34962447255114154
Epoch:            75 | Training loss: 0.04255634668299767 | Validation loss: 0
.349542095739378
Epoch:            76 | Training loss: 0.042331307808746436 | Validation loss:
0.3494851476178924
Epoch:            77 | Training loss: 0.042113482282539326 | Validation loss:
0.3494079256354891
Epoch:            78 | Training loss: 0.04190299743658431 | Validation loss: 0
.3493388034650903
Epoch:            79 | Training loss: 0.041699469476108 | Validation loss: 0.3
4927161787630273
Epoch:            80 | Training loss: 0.0415027583061644 | Validation loss: 0.
3492201815790116
Epoch:            81 | Training loss: 0.04131236542782057 | Validation loss: 0
.34915757969242045
Epoch:            82 | Training loss: 0.04112830713951412 | Validation loss: 0
.349118155748825
Epoch:            83 | Training loss: 0.040950511513807485 | Validation loss:
0.3490928579156769
Epoch:            84 | Training loss: 0.04077776951614942 | Validation loss: 0
.34900525439195074
Epoch:            85 | Training loss: 0.04061143907274418 | Validation loss: 0
.3489445133174284


Hyper Parameters -- Learning Rate - 0.008002  Regularization Parameter- 0.0
0039810717055349735
Epoch:             0 | Training loss: 0.5009566300341718 | Validation loss: 0.
5952406810268918
Epoch:             1 | Training loss: 0.4018162543975639 | Validation loss: 0.
54549667444765856
Epoch:             2 | Training loss: 0.3395867843954055 | Validation loss: 0.
5131754342917771
Epoch:             3 | Training loss: 0.2966860405861439 | Validation loss: 0.
4912513962545714
Epoch:             4 | Training loss: 0.26507309115000877 | Validation loss: 0
.4756442451139475
Epoch:             5 | Training loss: 0.24065448018637003 | Validation loss: 0
.4629622081018734
Epoch:             6 | Training loss: 0.22124162012336093 | Validation loss: 0
.45324171921899115
Epoch:             7 | Training loss: 0.2056733896887203 | Validation loss: 0.
44575845950096915
Epoch:             8 | Training loss: 0.19275097781565245 | Validation loss: 0
.439355319769576
Epoch:             9 | Training loss: 0.18213061741293518 | Validation loss: 0
.434424122830551
Epoch:            10 | Training loss: 0.1732419218878012 | Validation loss: 0.
43046710464257515
Epoch:            11 | Training loss: 0.16526780919326062 | Validation loss: 0
.4261657585367976
Epoch:            12 | Training loss: 0.15863631066805442 | Validation loss: 0
.4231786232279714
Epoch:            13 | Training loss: 0.1529868042386514 | Validation loss: 0.
42084418233134907
Epoch:            14 | Training loss: 0.14798370759433432 | Validation loss: 0
.41848494319155377
Epoch:            15 | Training loss: 0.14368080786610016 | Validation loss: 0
.41664718888603713
```

```
Epoch:          16 | Training loss: 0.13991481475782921 | Validation loss: 0
.41523107804359244
Epoch:          17 | Training loss: 0.1366189906457142 | Validation loss: 0.
4140074084252055
Epoch:          18 | Training loss: 0.1336878031439646 | Validation loss: 0.
4127387885835653
Epoch:          19 | Training loss: 0.13110184018845442 | Validation loss: 0
.41189366840360947
Epoch:          20 | Training loss: 0.12883132688163612 | Validation loss: 0
.41110306721562095
Epoch:          21 | Training loss: 0.1268284124195305 | Validation loss: 0.
41052319148924865
Epoch:          22 | Training loss: 0.12509025561872378 | Validation loss: 0
.41022564798874583
Epoch:          23 | Training loss: 0.12349918425691994 | Validation loss: 0
.40969111991660595
Epoch:          24 | Training loss: 0.12215190918733827 | Validation loss: 0
.40961171429951576
Epoch:          25 | Training loss: 0.12090131003241712 | Validation loss: 0
.4092746458657197

Hyper Parameters -- Learning Rate - 0.008002  Regularization Parameter- 0.0
02511886431509582
Epoch:           0 | Training loss: 0.5057922911199956 | Validation loss: 0.
6000763369223798
Epoch:           1 | Training loss: 0.4160116150149297 | Validation loss: 0.
55969202568869
Epoch:           2 | Training loss: 0.3646150851989502 | Validation loss: 0.
5382037228281124
Epoch:           3 | Training loss: 0.3330909414519042 | Validation loss: 0.
5276562863467806
Epoch:           4 | Training loss: 0.31301722961899264 | Validation loss: 0
.5235883815128328
Epoch:           5 | Training loss: 0.3000671691698531 | Validation loss: 0.
5223748985919126

Hyper Parameters -- Learning Rate - 0.008002  Regularization Parameter- 0.0
1584893192461114
Epoch:           0 | Training loss: 0.5363032075490097 | Validation loss: 0.
6305872206027615
```

In [46]:
```python
#get the best hyper parameters
temp = np.array(train_loss_history)
train_loss_history_sortidx = np.argsort(temp)

best_train_loss_BOW_tfidf = temp[train_loss_history_sortidx[0]]
best_validation_loss_BOW_tfidf = validation_loss_history[train_loss_history
best_hyperparams_BOW_tfidf=hyperparam_history[train_loss_history_sortidx[0

print("BOW-TFIDF")
print(f'Best Training loss - {best_train_loss_BOW_tfidf},best_validation_lo
```

```
BOW-TFIDF
Best Training loss - 0.01744929454307362,best_validation_loss-0.33138276204
76839,
best_hyperparams-[0.008002, 1e-05]
```

In [47]:
```
weight_tfidf, train_loss_count_tfidf, dev_loss_count_tfidf = SGD(X_tr=trai
                                    Y_tr=train_labels,
                                    X_dev=dev_tf_idf,
                                    Y_dev=dev_labels,
                                    lr=best_hyperparams_BOW_tfidf
                                    alpha=best_hyperparams_BOW_tf:
                                    tolerance=0.00001,
                                    epochs=1000,
                                    print_progress=True)
```

```
Epoch:          0 | Training loss: 0.5000687628863478 | Validation loss: 0.
5943528148320568
Epoch:          1 | Training loss: 0.39920986884994153 | Validation loss: 0
.5428902906558546
Epoch:          2 | Training loss: 0.33499138039352355 | Validation loss: 0
.508580032542277
Epoch:          3 | Training loss: 0.29000179667592907 | Validation loss: 0
.4845671543225173
Epoch:          4 | Training loss: 0.25627014471622933 | Validation loss: 0
.46684129906035027
Epoch:          5 | Training loss: 0.2297458089909241 | Validation loss: 0.
45205353662995096
Epoch:          6 | Training loss: 0.20825335037158837 | Validation loss: 0
.440253446789454
Epoch:          7 | Training loss: 0.19063950647322533 | Validation loss: 0
.4307245702563378
Epoch:          8 | Training loss: 0.17571415147854116 | Validation loss: 0
.4223184849980601
Epoch:          9 | Training loss: 0.16313514118760217 | Validation loss: 0
.4154286345989037
Epoch:         10 | Training loss: 0.15233302691037892 | Validation loss: 0
.4095581931210676
Epoch:         11 | Training loss: 0.14248769777094802 | Validation loss: 0
.4033856303816895
Epoch:         12 | Training loss: 0.13402776573644645 | Validation loss: 0
.3985700575132637
Epoch:         13 | Training loss: 0.12659288795590481 | Validation loss: 0
.3944502399601706
Epoch:         14 | Training loss: 0.11984430551756174 | Validation loss: 0
.3903455132172136
Epoch:         15 | Training loss: 0.11383599085876578 | Validation loss: 0
.3868023405782895
Epoch:         16 | Training loss: 0.10840242385149411 | Validation loss: 0
.3837186499239702
Epoch:         17 | Training loss: 0.10347369225721091 | Validation loss: 0
.3808620681655126
Epoch:         18 | Training loss: 0.09894391240847246 | Validation loss: 0
.3779948549001507
Epoch:         19 | Training loss: 0.09479263724454472 | Validation loss: 0
.37558441628371925
Epoch:         20 | Training loss: 0.09098871924656077 | Validation loss: 0
.3732604072060216
Epoch:         21 | Training loss: 0.08748261549740667 | Validation loss: 0
.3711773375441949
Epoch:         22 | Training loss: 0.08427194176593678 | Validation loss: 0
.36940727045842037
Epoch:         23 | Training loss: 0.08123619623984052 | Validation loss: 0
.36742806644112663
Epoch:         24 | Training loss: 0.078471832923569 | Validation loss: 0.
```

```
365931564740213
Epoch:          25 | Training loss: 0.0758300103311477 | Validation loss: 0.
3642032708495659
Epoch:          26 | Training loss: 0.07340995328355328 | Validation loss: 0
.36284864239845566
Epoch:          27 | Training loss: 0.07111099828057926 | Validation loss: 0
.3613707816523887
Epoch:          28 | Training loss: 0.06896805999201652 | Validation loss: 0
.36005571733005015
Epoch:          29 | Training loss: 0.06696821305405734 | Validation loss: 0
.3589500726377199
Epoch:          30 | Training loss: 0.06505900340137155 | Validation loss: 0
.3576963856805789
Epoch:          31 | Training loss: 0.06327138240390888 | Validation loss: 0
.35662330068380554
Epoch:          32 | Training loss: 0.06158389751687704 | Validation loss: 0
.35562200620074175
Epoch:          33 | Training loss: 0.05998304066038968 | Validation loss: 0
.3545915982541497
Epoch:          34 | Training loss: 0.05846767805412077 | Validation loss: 0
.3537046399996238
Epoch:          35 | Training loss: 0.057030512281680615 | Validation loss:
0.35283445001143626
Epoch:          36 | Training loss: 0.05566514411310914 | Validation loss: 0
.35198189105898847
Epoch:          37 | Training loss: 0.05436655515442238 | Validation loss: 0
.35121852830235784
Epoch:          38 | Training loss: 0.05313005394056189 | Validation loss: 0
.35045231369952434
Epoch:          39 | Training loss: 0.05195298579768281 | Validation loss: 0
.3497083703444011
Epoch:          40 | Training loss: 0.05082831246401901 | Validation loss: 0
.3490283060562943
Epoch:          41 | Training loss: 0.04975474675976106 | Validation loss: 0
.34836949714068877
Epoch:          42 | Training loss: 0.048725894556434356 | Validation loss:
0.3477654647826584
Epoch:          43 | Training loss: 0.047744689540984465 | Validation loss:
0.3471533286132313
Epoch:          44 | Training loss: 0.04680148307650878 | Validation loss: 0
.34661173051075067
Epoch:          45 | Training loss: 0.04589910487292043 | Validation loss: 0
.3460751346028658
Epoch:          46 | Training loss: 0.04503588589591633 | Validation loss: 0
.3456048042068136
Epoch:          47 | Training loss: 0.044207019153829595 | Validation loss:
0.34513449972913707
Epoch:          48 | Training loss: 0.04340392498276445 | Validation loss: 0
.3445985532478361
Epoch:          49 | Training loss: 0.042637540722205304 | Validation loss:
0.34407803320067815
Epoch:          50 | Training loss: 0.041897683744451686 | Validation loss:
0.343644673588846
Epoch:          51 | Training loss: 0.041186406606258635 | Validation loss:
0.3432171744362746
Epoch:          52 | Training loss: 0.04050214149427618 | Validation loss: 0
.34280107332000886
Epoch:          53 | Training loss: 0.039838472686686846 | Validation loss:
0.3424492154248247
Epoch:          54 | Training loss: 0.03920083530317034 | Validation loss: 0
.34207726694126506
```

```
Epoch:            55 | Training loss: 0.038586243896331 | Validation loss: 0.3
416829828891649
Epoch:            56 | Training loss: 0.037990995766305054 | Validation loss:
0.3413623338245357
Epoch:            57 | Training loss: 0.037416608888609725 | Validation loss:
0.3410251916844907
Epoch:            58 | Training loss: 0.036862197232481526 | Validation loss:
0.34074158648316233
Epoch:            59 | Training loss: 0.03632418577979033 | Validation loss: 0
.3404001600189022
Epoch:            60 | Training loss: 0.03580426195842193 | Validation loss: 0
.3400921748685252
Epoch:            61 | Training loss: 0.03530095823851452 | Validation loss: 0
.3398081961741603
Epoch:            62 | Training loss: 0.03481335658487021 | Validation loss: 0
.3395307243473487
Epoch:            63 | Training loss: 0.03434078716764366 | Validation loss: 0
.3392590047153974
Epoch:            64 | Training loss: 0.033882648325428456 | Validation loss:
0.3389668115105515
Epoch:            65 | Training loss: 0.03343850865205626 | Validation loss: 0
.3387050553369445
Epoch:            66 | Training loss: 0.033006930826666184 | Validation loss:
0.3385074418202704
Epoch:            67 | Training loss: 0.03258920513097954 | Validation loss: 0
.3383038340574391
Epoch:            68 | Training loss: 0.03218163261075827 | Validation loss: 0
.338046363280083
Epoch:            69 | Training loss: 0.03178629337640348 | Validation loss: 0
.33780109422050436
Epoch:            70 | Training loss: 0.031402514070550426 | Validation loss:
0.3376093395616946
Epoch:            71 | Training loss: 0.031029560074560487 | Validation loss:
0.33735488880841347
Epoch:            72 | Training loss: 0.03066609809750166 | Validation loss: 0
.3371646563922275
Epoch:            73 | Training loss: 0.030312745844919605 | Validation loss:
0.33700183932381633
Epoch:            74 | Training loss: 0.029968846446398203 | Validation loss:
0.33680381273570686
Epoch:            75 | Training loss: 0.0296340976847317 | Validation loss: 0.
3366198013180812
Epoch:            76 | Training loss: 0.02930830664275227 | Validation loss: 0
.3364621001448229
Epoch:            77 | Training loss: 0.028990597794295865 | Validation loss:
0.3362849941568476
Epoch:            78 | Training loss: 0.028681079741042836 | Validation loss:
0.33611683807384296
Epoch:            79 | Training loss: 0.028379361638838807 | Validation loss:
0.3359514616461552
Epoch:            80 | Training loss: 0.02808527811401247 | Validation loss: 0
.3358026521825832b
Epoch:            81 | Training loss: 0.027798322924846183 | Validation loss:
0.3356434873278126
Epoch:            82 | Training loss: 0.027518510138858504 | Validation loss:
0.33550830805641896
Epoch:            83 | Training loss: 0.02724573828754203 | Validation loss: 0
.33538803309271953
Epoch:            84 | Training loss: 0.026978785788872795 | Validation loss:
0.3352062187187219
Epoch:            85 | Training loss: 0.026718982460657854 | Validation loss:
```

0.33505200424436715
Epoch: 86 | Training loss: 0.02646421128843187 | Validation loss: 0
.3349557961906654
Epoch: 87 | Training loss: 0.02621588230609095 | Validation loss: 0
.33482626147780936
Epoch: 88 | Training loss: 0.025973306720391248 | Validation loss:
0.334695588240145
Epoch: 89 | Training loss: 0.025736477503264833 | Validation loss:
0.3345627173753212
Epoch: 90 | Training loss: 0.025504439328551183 | Validation loss:
0.33445741962174685
Epoch: 91 | Training loss: 0.025278057005136287 | Validation loss:
0.33433456728305166
Epoch: 92 | Training loss: 0.025055991256853295 | Validation loss:
0.334248096385748
Epoch: 93 | Training loss: 0.02483917047448617 | Validation loss: 0
.3341666762470636
Epoch: 94 | Training loss: 0.024627020160449292 | Validation loss:
0.334040682245154
Epoch: 95 | Training loss: 0.024419490226773043 | Validation loss:
0.3339347650191625
Epoch: 96 | Training loss: 0.024216176467809953 | Validation loss:
0.33386107894527284
Epoch: 97 | Training loss: 0.02401729117559786 | Validation loss: 0
.3337511055608183
Epoch: 98 | Training loss: 0.023822449933726477 | Validation loss:
0.3336680807760572
Epoch: 99 | Training loss: 0.023631693085793673 | Validation loss:
0.3335947989473549
Epoch: 100 | Training loss: 0.023444789830848127 | Validation loss:
0.3335013088546437
Epoch: 101 | Training loss: 0.023261700463329465 | Validation loss:
0.33342095818581724
Epoch: 102 | Training loss: 0.023082305451976218 | Validation loss:
0.33334607710168085
Epoch: 103 | Training loss: 0.022906521582143832 | Validation loss:
0.3332759015791804
Epoch: 104 | Training loss: 0.0227340970849175 | Validation loss: 0.
33318702999270644
Epoch: 105 | Training loss: 0.022565143720884504 | Validation loss:
0.33312356323495407
Epoch: 106 | Training loss: 0.022399469327307974 | Validation loss:
0.33305655261512557
Epoch: 107 | Training loss: 0.0222368847679602 | Validation loss: 0.
3329729849120309
Epoch: 108 | Training loss: 0.02207749680342985 | Validation loss: 0
.33289469335810784
Epoch: 109 | Training loss: 0.02192113061749038 | Validation loss: 0
.33282530716963094
Epoch: 110 | Training loss: 0.021767645850881773 | Validation loss:
0.3327662542743807
Epoch: 111 | Training loss: 0.02161702908963536 | Validation loss: 0
.33271608733312436
Epoch: 112 | Training loss: 0.021469228297094942 | Validation loss:
0.33264829330888546
Epoch: 113 | Training loss: 0.021324147223538807 | Validation loss:
0.33258670277555824
Epoch: 114 | Training loss: 0.02118166049449371 | Validation loss: 0
.33254272246460137
Epoch: 115 | Training loss: 0.021041774047631835 | Validation loss:
0.33249063420634306

```
Epoch:          116 | Training loss: 0.020904391487915893 | Validation loss:
0.3324353822707095
Epoch:          117 | Training loss: 0.02076947421132589 | Validation loss: 0
.3323918789259984
Epoch:          118 | Training loss: 0.02063692156264473 | Validation loss: 0
.3323479928875377
Epoch:          119 | Training loss: 0.020506699687832364 | Validation loss:
0.3322961673250691
Epoch:          120 | Training loss: 0.020378755118865943 | Validation loss:
0.33225394356891913
Epoch:          121 | Training loss: 0.02025301591277404 | Validation loss: 0
.33221187694082394
Epoch:          122 | Training loss: 0.020129367463060432 | Validation loss:
0.33215894402804735
Epoch:          123 | Training loss: 0.020007895082795914 | Validation loss:
0.33212110423885854
Epoch:          124 | Training loss: 0.019888429092080002 | Validation loss:
0.3320748502490112
Epoch:          125 | Training loss: 0.019770983660456536 | Validation loss:
0.33203317401255716
Epoch:          126 | Training loss: 0.0196555055539041 | Validation loss: 0.
3319959486378686
Epoch:          127 | Training loss: 0.01954193074632353 | Validation loss: 0
.33195592261116164
Epoch:          128 | Training loss: 0.019430230777789517 | Validation loss:
0.331910043437494
Epoch:          129 | Training loss: 0.01932034696614566 | Validation loss: 0
.3318776262994879
Epoch:          130 | Training loss: 0.019212250420639027 | Validation loss:
0.33184257203303985
Epoch:          131 | Training loss: 0.019105897003508832 | Validation loss:
0.3318090286991676
Epoch:          132 | Training loss: 0.019001256499751953 | Validation loss:
0.33177267734265853
Epoch:          133 | Training loss: 0.018898267193748496 | Validation loss:
0.3317421755855795
Epoch:          134 | Training loss: 0.01879688897932875 | Validation loss: 0
.33171568541427576
Epoch:          135 | Training loss: 0.018697114552796813 | Validation loss:
0.3316863788727208
Epoch:          136 | Training loss: 0.0185989094413352 | Validation loss: 0.
33165491499624183
Epoch:          137 | Training loss: 0.01850219165944013 | Validation loss: 0
.33163282782057507
Epoch:          138 | Training loss: 0.018407008644148185 | Validation loss:
0.3316006614351423
Epoch:          139 | Training loss: 0.018313214790264962 | Validation loss:
0.3315875633466498
Epoch:          140 | Training loss: 0.018220891429279976 | Validation loss:
0.3315590507014351
Epoch:          141 | Training loss: 0.018129993139736483 | Validation loss:
0.3315282265213715
Epoch:          142 | Training loss: 0.01804050603452024 | Validation loss: 0
.3314962386870355
Epoch:          143 | Training loss: 0.017952196458610216 | Validation loss:
0.3314833432620698
Epoch:          144 | Training loss: 0.017865256602693468 | Validation loss:
0.3314647096970907
Epoch:          145 | Training loss: 0.017779596364837884 | Validation loss:
0.3314479889361393
Epoch:          146 | Training loss: 0.017695192070307474 | Validation loss:
```

```
                         0.3314326987869932
Epoch:        147 | Training loss: 0.017612022061507505 | Validation loss:
0.33141926216947515
Epoch:        148 | Training loss: 0.017530066464825536 | Validation loss:
0.3314015231148633
Epoch:        149 | Training loss: 0.01744929454307362 | Validation loss: 0
.3313827620476839
```

In [48]:
```python
plt.plot(train_loss_count_tfidf, label='Training loss')
plt.plot(dev_loss_count_tfidf, label='Validation loss')

plt.xlabel('Epochs')
plt.ylabel('Loss')

plt.title('Training loss vs Validation loss (BOW – TFIDF)')

plt.legend()

plt.show()
```
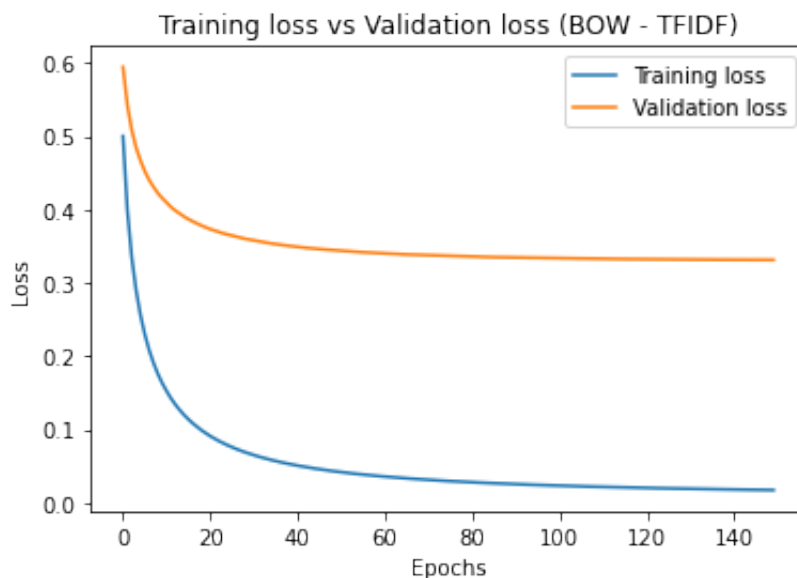

In [49]:
```python
preds_te_count = predict_class(test_tf_idf, weight)

print('Accuracy:', accuracy_score(test_labels,preds_te_count))
print('Precision:', precision_score(test_labels,preds_te_count))
print('Recall:', recall_score(test_labels,preds_te_count))
print('F1-Score:', f1_score(test_labels,preds_te_count))
```

```
Accuracy: 0.855
Precision: 0.8585858585858586
Recall: 0.85
F1-Score: 0.8542713567839195
```

Top 10 negative and positive Words from BOW-TFIDF

In [50]:
```python
top_negative_words = weight_tfidf.argsort()[:10]
for i in top_negative_words:
    print(vocab_word[i])
```

```
('worst',)
('boring',)
('unfortunately',)
('supposed',)
('waste',)
('ridiculous',)
('awful',)
('poor',)
('fails',)
('minute',)
```

In [51]:
```python
top_positive_words = weight_tfidf.argsort()[::-1][:10]
for i in top_positive_words:
    print(vocab_word[i])
```

```
('hilarious',)
('perfectly',)
('t',)
('memorable',)
('terrific',)
('s', 'life')
('overall',)
('very', 'well')
('excellent',)
('definitely',)
```

the top +ve and -ve words seems to be more accurate compared to the BOW-Count

Now repeat the training and evaluation process for BOW-tfidf, BOCN-count, BOCN-tfidf, BOW+BOCN including hyperparameter tuning for each model...

BOCN - Count

In [52]:
```python
#generate hyperparameters using logspace
lr_c = np.logspace(-7, -4, num = 5)
alpha_c = np.logspace(-6, -3, num = 5)

# lr_c = np.linspace(0.000001, 0.0001, num = 5,endpoint=False)
# alpha_c = np.logspace(-5, -1, num = 5,endpoint=False)
```

In [53]:
```python
lr_c
```

Out[53]:
```
array([1.00000000e-07, 5.62341325e-07, 3.16227766e-06, 1.77827941e-05,
       1.00000000e-04])
```

In [54]:

```python
#hyper paramater tuning for BOCN count
train_loss_history =[]
validation_loss_history=[]
hyperparam_history=[]
#
for lr_i in lr_c:
    for alpha_i in alpha_c:
        print('\nHyper Parameters -- Learning Rate -',lr_i,' Regularizatio
        weight, train_loss_count, dev_loss_count = SGD(X_tr=train_char_cou
                                            Y_tr=train_labels,
                                            X_dev=dev_char_count_vector,
                                            Y_dev=dev_labels,
                                            lr=lr_i,
                                            alpha=alpha_i,
                                            tolerance=0.00001,
                                            epochs=100,
                                            print_progress=True)
        if len(train_loss_count) > 5:
            train_loss_history.append(train_loss_count[-1])
            validation_loss_history.append(dev_loss_count[-1])
            hyperparam_history.append([lr_i,alpha_i])
```

```
Hyper Parameters -- Learning Rate - 1e-07  Regularization Parameter- 1e-06
Epoch:          0 | Training loss: 0.689962686898812 | Validation loss: 0.6
889415575465541
Epoch:          1 | Training loss: 0.6883211280031295 | Validation loss: 0.
6877920654901887
Epoch:          2 | Training loss: 0.6866766075517113 | Validation loss: 0.
6861580285000408
Epoch:          3 | Training loss: 0.6852524053231284 | Validation loss: 0.
6847007236497583
Epoch:          4 | Training loss: 0.6834564822307794 | Validation loss: 0.
6838886730155047
Epoch:          5 | Training loss: 0.6818739232746787 | Validation loss: 0.
682516264854506
Epoch:          6 | Training loss: 0.6803727457041716 | Validation loss: 0.
6810946264776212
Epoch:          7 | Training loss: 0.6789680185993506 | Validation loss: 0.
6808051955572355
Epoch:          8 | Training loss: 0.6772649388694874 | Validation loss: 0.
6790095336134163
Epoch:          9 | Training loss: 0.6757799148681474 | Validation loss: 0.
6776172616379439

Hyper Parameters -- Learning Rate - 1e-07  Regularization Parameter- 5.6234
13251903491e-06
Epoch:          0 | Training loss: 0.6899626869004841 | Validation loss: 0.
6889415575482328
Epoch:          1 | Training loss: 0.6883211280079503 | Validation loss: 0.
6877920654950141
Epoch:          2 | Training loss: 0.6866766075621973 | Validation loss: 0.
6861580285105268
Epoch:          3 | Training loss: 0.6852524053414609 | Validation loss: 0.
68470072366808
Epoch:          4 | Training loss: 0.6834564822579325 | Validation loss: 0.
6838886730426339
Epoch:          5 | Training loss: 0.6818739233134077 | Validation loss: 0.
```

682516264894144
Epoch: 6 | Training loss: 0.6803727457566111 | Validation loss: 0.6810946265300097
Epoch: 7 | Training loss: 0.6789680186665422 | Validation loss: 0.6808051956243557
Epoch: 8 | Training loss: 0.677264938954177 | Validation loss: 0.67900953369801
Epoch: 9 | Training loss: 0.6757799149721292 | Validation loss: 0.6776172617418075

Hyper Parameters -- Learning Rate - 1e-07 Regularization Parameter- 3.1622776601683795e-05
Epoch: 0 | Training loss: 0.6899626869098878 | Validation loss: 0.6889415575576744
Epoch: 1 | Training loss: 0.6883211280350591 | Validation loss: 0.6877920655221496
Epoch: 2 | Training loss: 0.6866766076211639 | Validation loss: 0.6861580285694926
Epoch: 3 | Training loss: 0.685252405444553 | Validation loss: 0.6847007237711094
Epoch: 4 | Training loss: 0.6834564824106257 | Validation loss: 0.6838886731951922
Epoch: 5 | Training loss: 0.6818739235311969 | Validation loss: 0.6825162651117328
Epoch: 6 | Training loss: 0.6803727460515008 | Validation loss: 0.6810946268246123
Epoch: 7 | Training loss: 0.6789680190443874 | Validation loss: 0.6808051960018002
Epoch: 8 | Training loss: 0.6772649394304221 | Validation loss: 0.6790095341737148
Epoch: 9 | Training loss: 0.675779915556862 | Validation loss: 0.6776172623258756

Hyper Parameters -- Learning Rate - 1e-07 Regularization Parameter- 0.00017782794100389227
Epoch: 0 | Training loss: 0.6899626869627674 | Validation loss: 0.6889415576107675
Epoch: 1 | Training loss: 0.6883211281875029 | Validation loss: 0.6877920656747445
Epoch: 2 | Training loss: 0.6866766079527581 | Validation loss: 0.6861580289010815
Epoch: 3 | Training loss: 0.685252406024282 | Validation loss: 0.684700724350487
Epoch: 4 | Training loss: 0.683456483269283 | Validation loss: 0.6838886740530903
Epoch: 5 | Training loss: 0.681873924755915 | Validation loss: 0.6825162663353249
Epoch: 6 | Training loss: 0.6803727477097864 | Validation loss: 0.681094628481284
Epoch: 7 | Training loss: 0.6789680211691669 | Validation loss: 0.6808051981243264
Epoch: 8 | Training loss: 0.6772649421085443 | Validation loss: 0.679009536848799
Epoch: 9 | Training loss: 0.675779918845057 | Validation loss: 0.6776172656103319

Hyper Parameters -- Learning Rate - 1e-07 Regularization Parameter- 0.001
Epoch: 0 | Training loss: 0.689962687260132 | Validation loss: 0.6889415579093326
Epoch: 1 | Training loss: 0.6883211290447582 | Validation loss: 0.6877920665328481

```
Epoch:           2 | Training loss: 0.686676609817449 | Validation loss: 0.6
861580307657431
Epoch:           3 | Training loss: 0.6852524092843382 | Validation loss: 0.
6847007276085674
Epoch:           4 | Training loss: 0.6834564880978681 | Validation loss: 0.
6838886788774056
Epoch:           5 | Training loss: 0.6818739316430109 | Validation loss: 0.
6825162732160892
Epoch:           6 | Training loss: 0.6803727570350119 | Validation loss: 0.
681094637797434
Epoch:           7 | Training loss: 0.6789680331176807 | Validation loss: 0.
6808052100601681
Epoch:           8 | Training loss: 0.6772649571687324 | Validation loss: 0.
6790095518919023
Epoch:           9 | Training loss: 0.6757799373359352 | Validation loss: 0.
677617284080186

Hyper Parameters -- Learning Rate – 5.62341325190349e–07  Regularization Pa
rameter– 1e–06
Epoch:           0 | Training loss: 0.6825168962028874 | Validation loss: 0.
6832093274430328
Epoch:           1 | Training loss: 0.6739242209437657 | Validation loss: 0.
6762917699756474
Epoch:           2 | Training loss: 0.6661073485883872 | Validation loss: 0.
6707091412663942
Epoch:           3 | Training loss: 0.6643115642047236 | Validation loss: 0.
6674162527279515
Epoch:           4 | Training loss: 0.6590216460435844 | Validation loss: 0.
6633410846523836
Epoch:           5 | Training loss: 0.6467060334028535 | Validation loss: 0.
6570243537195699
Epoch:           6 | Training loss: 0.6386996364648477 | Validation loss: 0.
6494446012882814
Epoch:           7 | Training loss: 0.6331983270640259 | Validation loss: 0.
6458114429393131
Epoch:           8 | Training loss: 0.6271622367921725 | Validation loss: 0.
6402199244090135
Epoch:           9 | Training loss: 0.6221584431020964 | Validation loss: 0.
6361901826287084

Hyper Parameters -- Learning Rate – 5.62341325190349e–07  Regularization Pa
rameter– 5.623413251903491e–06
Epoch:           0 | Training loss: 0.6825168962366984 | Validation loss: 0.
6832093274768227
Epoch:           1 | Training loss: 0.6739242210739588 | Validation loss: 0.
676291770105687
Epoch:           2 | Training loss: 0.6661073488703978 | Validation loss: 0.
6707091415480722
Epoch:           3 | Training loss: 0.6643115646929058 | Validation loss: 0.
6674162532155218
Epoch:           4 | Training loss: 0.6590216467790518 | Validation loss: 0.
6633410853869398
Epoch:           5 | Training loss: 0.6467060344213805 | Validation loss: 0.
65702435473681
Epoch:           6 | Training loss: 0.6386996378141928 | Validation loss: 0.
6494446026359871
Epoch:           7 | Training loss: 0.6331983287770706 | Validation loss: 0.
6458114446501895
Epoch:           8 | Training loss: 0.6271622388967059 | Validation loss: 0.
6402199265109302
Epoch:           9 | Training loss: 0.6221584456291063 | Validation loss: 0.
```

6361901851526668

Hyper Parameters -- Learning Rate - 5.62341325190349e-07 Regularization Pa
rameter- 3.1622776601683795e-05
Epoch: 0 | Training loss: 0.6825168964268328 | Validation loss: 0.
6832093276668383
Epoch: 1 | Training loss: 0.6739242218060871 | Validation loss: 0.
6762917708369526
Epoch: 2 | Training loss: 0.6661073504562599 | Validation loss: 0.
6707091431320638
Epoch: 3 | Training loss: 0.6643115674381553 | Validation loss: 0.
667416255957331
Epoch: 4 | Training loss: 0.6590216509148893 | Validation loss: 0.
663341089517652
Epoch: 5 | Training loss: 0.6467060401489796 | Validation loss: 0.
6570243604571704
Epoch: 6 | Training loss: 0.6386996454021171 | Validation loss: 0.
6494446102146938
Epoch: 7 | Training loss: 0.6331983384102298 | Validation loss: 0.
6458114542711555
Epoch: 8 | Training loss: 0.6271622507313657 | Validation loss: 0.
6402199383308763
Epoch: 9 | Training loss: 0.6221584598395267 | Validation loss: 0.
6361901993459278

Hyper Parameters -- Learning Rate - 5.62341325190349e-07 Regularization Pa
rameter- 0.00017782794100389227
Epoch: 0 | Training loss: 0.6825168974960358 | Validation loss: 0.
6832093287353738
Epoch: 1 | Training loss: 0.6739242259231482 | Validation loss: 0.
676291774949161
Epoch: 2 | Training loss: 0.6661073593742177 | Validation loss: 0.
6707091520395022
Epoch: 3 | Training loss: 0.6643115828758281 | Validation loss: 0.
667416271375657
Epoch: 4 | Training loss: 0.6590216741724131 | Validation loss: 0.
6633411127463549
Epoch: 5 | Training loss: 0.6467060723576357 | Validation loss: 0.
6570243926251211
Epoch: 6 | Training loss: 0.6386996880721513 | Validation loss: 0.
6494446528328929
Epoch: 7 | Training loss: 0.6331983925814628 | Validation loss: 0.
6458115083738215
Epoch: 8 | Training loss: 0.627162317282548 | Validation loss: 0.6
402200047993181
Epoch: 9 | Training loss: 0.6221585397505933 | Validation loss: 0.
636190279160499

Hyper Parameters -- Learning Rate - 5.62341325190349e-07 Regularization Pa
rameter- 0.001
Epoch: 0 | Training loss: 0.6825169035086073 | Validation loss: 0.
6832093347441895
Epoch: 1 | Training loss: 0.6739242490750829 | Validation loss: 0.
6762917980738093
Epoch: 2 | Training loss: 0.6661074095235796 | Validation loss: 0.
6707092021297092
Epoch: 3 | Training loss: 0.6643116696882401 | Validation loss: 0.
6674163580792737
Epoch: 4 | Training loss: 0.659021804959077 | Validation loss: 0.6
33412433709468
Epoch: 5 | Training loss: 0.6467062534802135 | Validation loss: 0.

6570245735187951
Epoch: 6 | Training loss: 0.6386999280233775 | Validation loss: 0.
6494448924926295
Epoch: 7 | Training loss: 0.6331986972086794 | Validation loss: 0.
6458118126154571
Epoch: 8 | Training loss: 0.6271626915273293 | Validation loss: 0.
640220378578815
Epoch: 9 | Training loss: 0.6221589891235199 | Validation loss: 0.
636190727990792

Hyper Parameters -- Learning Rate - 3.162277660168379e-06 Regularization P
arameter- 1e-06
Epoch: 0 | Training loss: 0.6542845694411505 | Validation loss: 0.
6657195350794239
Epoch: 1 | Training loss: 0.6230437026470058 | Validation loss: 0.
6372112595440422
Epoch: 2 | Training loss: 0.5978921883310198 | Validation loss: 0.
6188192740618566
Epoch: 3 | Training loss: 0.5837228648604418 | Validation loss: 0.
610550383736873
Epoch: 4 | Training loss: 0.5546239444480642 | Validation loss: 0.
5889601019749006
Epoch: 5 | Training loss: 0.545651012297725 | Validation loss: 0.5
882516831593606

Hyper Parameters -- Learning Rate - 3.162277660168379e-06 Regularization P
arameter- 5.623413251903491e-06
Epoch: 0 | Training loss: 0.6542845703289432 | Validation loss: 0.
6657195359662818
Epoch: 1 | Training loss: 0.6230437057692676 | Validation loss: 0.
637211262662414
Epoch: 2 | Training loss: 0.5978921945062358 | Validation loss: 0.
6188192802301306
Epoch: 3 | Training loss: 0.5837228746183052 | Validation loss: 0.
6105503934836455
Epoch: 4 | Training loss: 0.5546239582420506 | Validation loss: 0.
5889601157525038
Epoch: 5 | Training loss: 0.5456510305133413 | Validation loss: 0.
5882517013524372

Hyper Parameters -- Learning Rate - 3.162277660168379e-06 Regularization P
arameter- 3.1622776601683795e-05
Epoch: 0 | Training loss: 0.6542845753213682 | Validation loss: 0.
6657195409534498
Epoch: 1 | Training loss: 0.6230437233270356 | Validation loss: 0.
6372112801983076
Epoch: 2 | Training loss: 0.5978922292320271 | Validation loss: 0.
6188193149168846
Epoch: 3 | Training loss: 0.5837229294908041 | Validation loss: 0.
6105504482937745
Epoch: 4 | Training loss: 0.5546240358113357 | Validation loss: 0.
5889601932296601
Epoch: 5 | Training loss: 0.545651132947279 | Validation loss: 0.5
882518036596247

Hyper Parameters -- Learning Rate - 3.162277660168379e-06 Regularization P
arameter- 0.00017782794100389227
Epoch: 0 | Training loss: 0.6542846033958365 | Validation loss: 0.
6657195689983562
Epoch: 1 | Training loss: 0.6230438220616205 | Validation loss: 0.
6372113788098833

```
Epoch:          2 | Training loss: 0.5978924245095001 | Validation loss: 0.
618819509974834
Epoch:          3 | Training loss: 0.5837232380615351 | Validation loss: 0.
6105507565137739
Epoch:          4 | Training loss: 0.5546244720154723 | Validation loss: 0.
588960628915718
Epoch:          5 | Training loss: 0.5456517089756272 | Validation loss: 0.
5882523789752055

Hyper Parameters -- Learning Rate - 3.162277660168379e-06  Regularization P
arameter- 0.001
Epoch:          0 | Training loss: 0.6542847612701693 | Validation loss: 0.
6657197267064506
Epoch:          1 | Training loss: 0.6230443772869602 | Validation loss: 0.
6372119333434926
Epoch:          2 | Training loss: 0.5978935226353376 | Validation loss: 0.
6188206068662007
Epoch:          3 | Training loss: 0.5837249732820938 | Validation loss: 0.
6105524897620238
Epoch:          4 | Training loss: 0.5546269249712953 | Validation loss: 0.
588963078958171
Epoch:          5 | Training loss: 0.545654948220624 | Validation loss: 0.5
882556142120172

Hyper Parameters -- Learning Rate - 1.778279410038923e-05  Regularization P
arameter- 1e-06
Epoch:          0 | Training loss: 0.7662828088048864 | Validation loss: 0.
81871725894261
Epoch:          1 | Training loss: 0.48040144471567 | Validation loss: 0.54
79433309609378

Hyper Parameters -- Learning Rate - 1.778279410038923e-05  Regularization P
arameter- 5.623413251903491e-06
Epoch:          0 | Training loss: 0.7662828284659392 | Validation loss: 0.
8187172785783203
Epoch:          1 | Training loss: 0.48040149789117076 | Validation loss: 0
.5479433840773466

Hyper Parameters -- Learning Rate - 1.778279410038923e-05  Regularization P
arameter- 3.1622776601683795e-05
Epoch:          0 | Training loss: 0.766282939028164 | Validation loss: 0.8
187173889980341
Epoch:          1 | Training loss: 0.4804017969189829 | Validation loss: 0.
5479436827728592

Hyper Parameters -- Learning Rate - 1.778279410038923e-05  Regularization P
arameter- 0.00017782794100389227
Epoch:          0 | Training loss: 0.7662835607652295 | Validation loss: 0.
8187180099337009
Epoch:          1 | Training loss: 0.48040347847588 | Validation loss: 0.54
79453624610995

Hyper Parameters -- Learning Rate - 1.778279410038923e-05  Regularization P
arameter- 0.001
Epoch:          0 | Training loss: 0.7662870570492362 | Validation loss: 0.
818721501711112
Epoch:          1 | Training loss: 0.4804129345631689 | Validation loss: 0.
5479548080401649

Hyper Parameters -- Learning Rate - 0.0001  Regularization Parameter- 1e-06
Epoch:          0 | Training loss: 1.5385914312337032 | Validation loss: 1.
```

```
7095817901527142
Epoch:          1 | Training loss: 0.42968066829854 | Validation loss: 0.67
61182597621107


Hyper Parameters -- Learning Rate - 0.0001  Regularization Parameter- 5.623
413251903491e-06
Epoch:          0 | Training loss: 1.5385919378083204 | Validation loss: 1.
7095822969120176
Epoch:          1 | Training loss: 0.4296817633030318 | Validation loss: 0.
6761193546599812


Hyper Parameters -- Learning Rate - 0.0001  Regularization Parameter- 3.162
2776601683795e-05
Epoch:          0 | Training loss: 1.538594786486694 | Validation loss: 1.7
095851466289582
Epoch:          1 | Training loss: 0.42968792096562214 | Validation loss: 0
.6761255117229922


Hyper Parameters -- Learning Rate - 0.0001  Regularization Parameter- 0.000
17782794100389227
Epoch:          0 | Training loss: 1.538610805780966 | Validation loss: 1.7
096011717635224
Epoch:          1 | Training loss: 0.4297225480414627 | Validation loss: 0.
6761601354271553


Hyper Parameters -- Learning Rate - 0.0001  Regularization Parameter- 0.001
Epoch:          0 | Training loss: 1.538700888846958 | Validation loss: 1.7
096912876717778
Epoch:          1 | Training loss: 0.42991727022224935 | Validation loss: 0
.6763548386475874
```

In [58]:
```python
#get the best hyper parameters
temp = np.array(train_loss_history)
train_loss_history_sortidx = np.argsort(temp)

best_train_loss_BOCN = temp[train_loss_history_sortidx[0]]
best_validation_loss_BOCN = validation_loss_history[train_loss_history_sort
best_hyperparams_BOCN=hyperparam_history[train_loss_history_sortidx[0]]

print("BOCN")
print(f'Best Training loss - {best_train_loss_BOCN},best_validation_loss-{I
```

```
BOCN
Best Training loss - 0.545651012297725,best_validation_loss-0.5882516831593
606,
best_hyperparams-[3.162277660168379e-06, 1e-06]
```

In [132…
```python
weight_c, train_loss_count_c, dev_loss_count_c = SGD(X_tr=train_char_count_
                                     Y_tr=train_labels,
                                     X_dev=dev_char_count_vector,
                                     Y_dev=dev_labels,
                                     lr=best_hyperparams_BOCN[0],
                                     alpha=best_hyperparams_BOCN[1
                                     tolerance=1.0e-06,
                                     epochs=100,
                                     print_progress=True)
```

```
Epoch:          0 | Training loss: 0.6542845694411505 | Validation loss: 0.
6657195350794239
Epoch:          1 | Training loss: 0.6230437026470058 | Validation loss: 0.
6372112595440422
Epoch:          2 | Training loss: 0.5978921883310198 | Validation loss: 0.
6188192740618566
Epoch:          3 | Training loss: 0.5837228648604418 | Validation loss: 0.
610550383736873
Epoch:          4 | Training loss: 0.5546239444480642 | Validation loss: 0.
5889601019749006
Epoch:          5 | Training loss: 0.545651012297725 | Validation loss: 0.5
882516831593606
```

In [133…
```python
plt.plot(train_loss_count_c, label='Training loss')
plt.plot(dev_loss_count_c, label='Validation loss')

plt.xlabel('Epochs')
plt.ylabel('Loss')

plt.title('Training loss vs Validation loss (BOCN-Count)')

plt.legend()

plt.show()
```
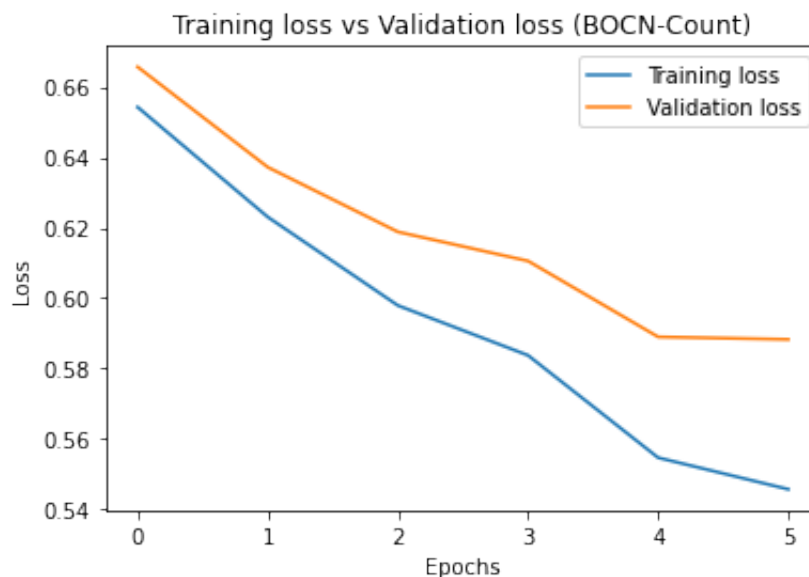

In [134…
```python
preds_te_count = predict_class(test_char_count_vector, weight_c)

print('Accuracy:', accuracy_score(test_labels,preds_te_count))
print('Precision:', precision_score(test_labels,preds_te_count))
print('Recall:', recall_score(test_labels,preds_te_count))
print('F1-Score:', f1_score(test_labels,preds_te_count))
```

```
Accuracy: 0.7575
Precision: 0.8601398601398601
Recall: 0.615
F1-Score: 0.7172011661807579
```

Top 10 negative and positive characters BOCN (raw)

In [135…
```python
top_negative_words = weight_c.argsort()[:10]
for i in top_negative_words:
    print(vocab_char[i])
```

```
ba
ha
ad
lo
ed
tt
te
oo
nt
in
```

In [136…
```python
top_positive_words = weight_c.argsort()[::-1][:10]
for i in top_positive_words:
    print(vocab_char[i])
```

```
an
nd
and
is
al
ti
tr
fe
ce
ar
```

BOCN - TFIDF

In [138…
```python
lr_ctf = np.linspace(0.00001, 0.0001, num = 5,endpoint=False)
alpha_ctf = np.logspace(-7, -3, num = 5)
```

In [75]:
```python
lr_ctf
```

Out[75]:
```
array([1.0e-05, 2.8e-05, 4.6e-05, 6.4e-05, 8.2e-05])
```

In [144…
```python
#hyper paramater tuning for BOCN-tfidf
train_loss_history =[]
validation_loss_history=[]
hyperparam_history=[]
#
for lr_i in lr_ctf:
    for alpha_i in alpha_ctf:
        print('\nHyper Parameters -- Learning Rate -',lr_i,' Regularizatio
        weight, train_loss_count, dev_loss_count = SGD(X_tr=train_char_tf_
                                    Y_tr=train_labels,
                                    X_dev=dev_char_tf_idf,
                                    Y_dev=dev_labels,
                                    lr=lr_i,
                                    alpha=alpha_i,
                                    tolerance=0.0001,
                                    epochs=300,
                                    print_progress=True)
        if len(train_loss_count) > 5:
            train_loss_history.append(train_loss_count[-1])
            validation_loss_history.append(dev_loss_count[-1])
            hyperparam_history.append([lr_i,alpha_i])
```

```
Hyper Parameters -- Learning Rate - 1e-05  Regularization Parameter- 1e-07
Epoch:          0 | Training loss: 0.6923097050658443 | Validation loss: 0.
691434878834223
Epoch:          1 | Training loss: 0.6916736978092416 | Validation loss: 0.
6902072141306621
Epoch:          2 | Training loss: 0.691041310581203 | Validation loss: 0.6
889905217994519
Epoch:          3 | Training loss: 0.6904293177719095 | Validation loss: 0.
6878384738718647
Epoch:          4 | Training loss: 0.6898063584677643 | Validation loss: 0.
6866520309275623
Epoch:          5 | Training loss: 0.6891657728388537 | Validation loss: 0.
6855150351283098
Epoch:          6 | Training loss: 0.6885489178259216 | Validation loss: 0.
6844006351054539
Epoch:          7 | Training loss: 0.6879275119448535 | Validation loss: 0.
6831700715041151
Epoch:          8 | Training loss: 0.6873171366132588 | Validation loss: 0.
6820315145289538
Epoch:          9 | Training loss: 0.6866864582322433 | Validation loss: 0.
6809531801897143
Epoch:         10 | Training loss: 0.6862197228097303 | Validation loss: 0.
6797612973997704
Epoch:         11 | Training loss: 0.6854641319524455 | Validation loss: 0.
6787645681967001
Epoch:         12 | Training loss: 0.6848652056186443 | Validation loss: 0.
6776410314056708
Epoch:         13 | Training loss: 0.6843401293405951 | Validation loss: 0.
6764415696966785
Epoch:         14 | Training loss: 0.6836434450614824 | Validation loss: 0.
675696076464408
Epoch:         15 | Training loss: 0.6830407045632522 | Validation loss: 0.
6746179936356802
Epoch:         16 | Training loss: 0.6825403661660226 | Validation loss: 0.
6732300449948206
Epoch:         17 | Training loss: 0.681876258372899 | Validation loss: 0.6
```

```
723268981748405
Epoch:          18 | Training loss: 0.681249970079766 | Validation loss: 0.6
715401405834323
Epoch:          19 | Training loss: 0.6806558030405516 | Validation loss: 0.
6705914409730732
Epoch:          20 | Training loss: 0.6800745470153491 | Validation loss: 0.
6694446595296744
Epoch:          21 | Training loss: 0.6794769141824601 | Validation loss: 0.
6686046834306596
Epoch:          22 | Training loss: 0.6788897893023201 | Validation loss: 0.
6677988376257517
Epoch:          23 | Training loss: 0.6783253158903522 | Validation loss: 0.
6671754869504061
Epoch:          24 | Training loss: 0.6778244008140156 | Validation loss: 0.
6651791353379863


Hyper Parameters -- Learning Rate - 1e-05  Regularization Parameter- 1e-06
Epoch:           0 | Training loss: 0.6923097050763879 | Validation loss: 0.
6914348788447668
Epoch:           1 | Training loss: 0.691673697844029 | Validation loss: 0.6
902072141654512
Epoch:           2 | Training loss: 0.6910413106574468 | Validation loss: 0.
6889905218756996
Epoch:           3 | Training loss: 0.6904293179056733 | Validation loss: 0.
6878384740056346
Epoch:           4 | Training loss: 0.6898063586683408 | Validation loss: 0.
6866520311281487
Epoch:           5 | Training loss: 0.6891657731298699 | Validation loss: 0.
6855150354193367
Epoch:           6 | Training loss: 0.6885489182201734 | Validation loss: 0.
6844006354997185
Epoch:           7 | Training loss: 0.6879275124537159 | Validation loss: 0.
6831700720129951
Epoch:           8 | Training loss: 0.6873171372551232 | Validation loss: 0.
6820315151708384
Epoch:           9 | Training loss: 0.6866864590238947 | Validation loss: 0.
6809531809813876
Epoch:          10 | Training loss: 0.6862197237624768 | Validation loss: 0.
6797612983525468
Epoch:          11 | Training loss: 0.6854641330866821 | Validation loss: 0.
6787645693309627
Epoch:          12 | Training loss: 0.6848652069460749 | Validation loss: 0.
6776410327331328
Epoch:          13 | Training loss: 0.6843401308752639 | Validation loss: 0.
6764415712313864
Epoch:          14 | Training loss: 0.6836434468236008 | Validation loss: 0.
6756960782265586
Epoch:          15 | Training loss: 0.6830407065634412 | Validation loss: 0.
6746179956359061
Epoch:          16 | Training loss: 0.6825403684160866 | Validation loss: 0.
6732300472449346
Epoch:          17 | Training loss: 0.6818762608917499 | Validation loss: 0.
6723269006937395
Epoch:          18 | Training loss: 0.6812499728826888 | Validation loss: 0.
6715401433864007
Epoch:          19 | Training loss: 0.6806558061406246 | Validation loss: 0.
670591444073195
Epoch:          20 | Training loss: 0.6800745504254704 | Validation loss: 0.
6694446629398536
Epoch:          21 | Training loss: 0.6794769179188442 | Validation loss: 0.
6686046871671014
```

```
Epoch:         22 | Training loss: 0.6788897933793415 | Validation loss: 0.
6677988417028322
Epoch:         23 | Training loss: 0.6783253203232799 | Validation loss: 0.
66717549138339
Epoch:         24 | Training loss: 0.677824405608899 | Validation loss: 0.6
651791401329571


Hyper Parameters -- Learning Rate - 1e-05  Regularization Parameter- 1e-05
Epoch:          0 | Training loss: 0.6923097051818231 | Validation loss: 0.
6914348789502034
Epoch:          1 | Training loss: 0.6916736981919024 | Validation loss: 0.
6902072145133415
Epoch:          2 | Training loss: 0.6910413114198861 | Validation loss: 0.
6889905226381788
Epoch:          3 | Training loss: 0.6904293192433114 | Validation loss: 0.
6878384753433329
Epoch:          4 | Training loss: 0.6898063606741076 | Validation loss: 0.
6866520331340117
Epoch:          5 | Training loss: 0.6891657760400322 | Validation loss: 0.
6855150383296043
Epoch:          6 | Training loss: 0.688548922162692 | Validation loss: 0.6
844006394423664
Epoch:          7 | Training loss: 0.6879275175423407 | Validation loss: 0.
6831700771017956
Epoch:          8 | Training loss: 0.6873171436737661 | Validation loss: 0.
6820315215896834
Epoch:          9 | Training loss: 0.6866864669404099 | Validation loss: 0.
6809531888981213
Epoch:         10 | Training loss: 0.6862197332899403 | Validation loss: 0.
6797613078803134
Epoch:         11 | Training loss: 0.6854641444290483 | Validation loss: 0.
6787645806735906
Epoch:         12 | Training loss: 0.6848652202203802 | Validation loss: 0.
6776410460077525
Epoch:         13 | Training loss: 0.6843401462219518 | Validation loss: 0.
6764415865784642
Epoch:         14 | Training loss: 0.6836434644447845 | Validation loss: 0.
6756960958480659
Epoch:         15 | Training loss: 0.6830407265653301 | Validation loss: 0.
6746180156381628
Epoch:         16 | Training loss: 0.6825403909167261 | Validation loss: 0.
6732300697460732
Epoch:         17 | Training loss: 0.6818762860802593 | Validation loss: 0.
6723269258827301
Epoch:         18 | Training loss: 0.6812500009119166 | Validation loss: 0.
6715401714160862
Epoch:         19 | Training loss: 0.6806558371413549 | Validation loss: 0.
6705914750744126
Epoch:         20 | Training loss: 0.6800745845266851 | Validation loss: 0.
6694446970416468
Epoch:         21 | Training loss: 0.6794769552826839 | Validation loss: 0.
6686047245315189
Epoch:         22 | Training loss: 0.6788898341495554 | Validation loss: 0.
6677988824736368
Epoch:         23 | Training loss: 0.6783253646525567 | Validation loss: 0.
6671755357132299
Epoch:         24 | Training loss: 0.6778244535577324 | Validation loss: 0.
665179188082664


Hyper Parameters -- Learning Rate - 1e-05  Regularization Parameter- 0.0001
Epoch:          0 | Training loss: 0.6923097062361756 | Validation loss: 0.
```

```
6914348800045693
Epoch:              1 | Training loss: 0.6916737016706358 | Validation loss: 0.
6902072179922435
Epoch:              2 | Training loss: 0.6910413190442798 | Validation loss: 0.
6889905302629703
Epoch:              3 | Training loss: 0.6904293326196923 | Validation loss: 0.
6878384887203164
Epoch:              4 | Training loss: 0.6898063807317748 | Validation loss: 0.
6866520531926423
Epoch:              5 | Training loss: 0.6891658051416554 | Validation loss: 0.
6855150674322812
Epoch:              6 | Training loss: 0.6885489615878766 | Validation loss: 0.
6844006788688444
Epoch:              7 | Training loss: 0.6879275684285886 | Validation loss: 0.
6831701279897985
Epoch:              8 | Training loss: 0.6873172078601965 | Validation loss: 0.
6820315857781347
Epoch:              9 | Training loss: 0.6866865461055628 | Validation loss: 0.
6809532680654595
Epoch:             10 | Training loss: 0.6862198285645762 | Validation loss: 0.
6797614031579786
Epoch:             11 | Training loss: 0.6854642578527109 | Validation loss: 0.
6787646940998687
Epoch:             12 | Training loss: 0.6848653529634348 | Validation loss: 0.
677641178753951
Epoch:             13 | Training loss: 0.6843402996888326 | Validation loss: 0.
6764417400492438
Epoch:             14 | Training loss: 0.6836436406566218 | Validation loss: 0.
6756962720631384
Epoch:             15 | Training loss: 0.6830409265842201 | Validation loss: 0.
6746182156607327
Epoch:             16 | Training loss: 0.6825406159231215 | Validation loss: 0.
6732302947574592
Epoch:             17 | Training loss: 0.6818765379653544 | Validation loss: 0.
6723271777726376
Epoch:             18 | Training loss: 0.6812502812041953 | Validation loss: 0.
6715404517129432
Epoch:             19 | Training loss: 0.6806561471486594 | Validation loss: 0.
670591785086592
Epoch:             20 | Training loss: 0.680074925538834 | Validation loss: 0.6
94450380595811
Epoch:             21 | Training loss: 0.6794773289210821 | Validation loss: 0.
6686050981756952
Epoch:             22 | Training loss: 0.6788902418516957 | Validation loss: 0.
6677992901816858
Epoch:             23 | Training loss: 0.6783258079453262 | Validation loss: 0.
6671759790116272
Epoch:             24 | Training loss: 0.6778249330460681 | Validation loss: 0.
6651796675797358


Hyper Parameters -- Learning Rate – 1e-05  Regularization Parameter- 0.001
Epoch:              0 | Training loss: 0.6923097167797008 | Validation loss: 0.
6914348905482265
Epoch:              1 | Training loss: 0.691673736457972 | Validation loss: 0.6
902072527812657
Epoch:              2 | Training loss: 0.6910413952882155 | Validation loss: 0.
6889906065108856
Epoch:              3 | Training loss: 0.6904294663835021 | Validation loss: 0.
6878386224901507
Epoch:              4 | Training loss: 0.6898065813084486 | Validation loss: 0.
6866522537789492
```

```
Epoch:          5 | Training loss: 0.6891660961578894 | Validation loss: 0.
6855153584590522
Epoch:          6 | Training loss: 0.6885493558397295 | Validation loss: 0.
6844010731336292
Epoch:          7 | Training loss: 0.687928077291076 | Validation loss: 0.6
83170636869836
Epoch:          8 | Training loss: 0.6873178497245095 | Validation loss: 0.
6820322276626579
Epoch:          9 | Training loss: 0.6866873377571051 | Validation loss: 0.
6809540597388554
Epoch:         10 | Training loss: 0.6862207813109543 | Validation loss: 0.
6797623559346494
Epoch:         11 | Training loss: 0.6854653920893634 | Validation loss: 0.
6787658283626766
Epoch:         12 | Training loss: 0.6848666803940123 | Validation loss: 0.
6776425062159691
Epoch:         13 | Training loss: 0.684341834357683 | Validation loss: 0.6
764432747570811
Epoch:         14 | Training loss: 0.683645402775047 | Validation loss: 0.6
756980342139162
Epoch:         15 | Training loss: 0.683042926773185 | Validation loss: 0.6
74620215886496
Epoch:         16 | Training loss: 0.6825428659871532 | Validation loss: 0.
6732325448713979
Epoch:         17 | Training loss: 0.6818790568163965 | Validation loss: 0.
6723296966718039
Epoch:         18 | Training loss: 0.6812530841270898 | Validation loss: 0.
6715432546816189
Epoch:         19 | Training loss: 0.6806592472218295 | Validation loss: 0.
6705948852085101
Epoch:         20 | Training loss: 0.6800783356604672 | Validation loss: 0.
6694484482390679
Epoch:         21 | Training loss: 0.6794810653052319 | Validation loss: 0.
6686088346176254
Epoch:         22 | Training loss: 0.6788943188732884 | Validation loss: 0.
667803367262367
Epoch:         23 | Training loss: 0.6783302408732385 | Validation loss: 0.
6671804119958188
Epoch:         24 | Training loss: 0.6778297279296698 | Validation loss: 0.
6651844625506971


Hyper Parameters -- Learning Rate – 2.8000000000000003e-05  Regularization
Parameter- 1e-07
Epoch:          0 | Training loss: 0.6911768756206623 | Validation loss: 0.
6892302600501271
Epoch:          1 | Training loss: 0.6894317452382112 | Validation loss: 0.
6859391525909951
Epoch:          2 | Training loss: 0.6876679329905059 | Validation loss: 0.
682789478059807
Epoch:          3 | Training loss: 0.6863640083746503 | Validation loss: 0.
6808713630727476
Epoch:          4 | Training loss: 0.6842526972718471 | Validation loss: 0.
6765752282910193
Epoch:          5 | Training loss: 0.6826342343146746 | Validation loss: 0.
6743517486735209
Epoch:          6 | Training loss: 0.6809244020794973 | Validation loss: 0.
6714344414530597
Epoch:          7 | Training loss: 0.6794057435260588 | Validation loss: 0.
6675631509589303
Epoch:          8 | Training loss: 0.677637592567806 | Validation loss: 0.6
651681194998359
```

```
Epoch:             9 | Training loss: 0.6760045584013277 | Validation loss: 0.
6626180311894926
Epoch:            10 | Training loss: 0.6759585382831026 | Validation loss: 0.
6588111251526313
Epoch:            11 | Training loss: 0.6727815699134192 | Validation loss: 0.
6583234705675726
Epoch:            12 | Training loss: 0.6714078060627973 | Validation loss: 0.
6544960566888548
Epoch:            13 | Training loss: 0.6704392313566504 | Validation loss: 0.
6511285323955552

Hyper Parameters -- Learning Rate - 2.8000000000000003e-05  Regularization
Parameter- 1e-06
Epoch:             0 | Training loss: 0.6911768756888703 | Validation loss: 0.
6892302601183387
Epoch:             1 | Training loss: 0.6894317454893746 | Validation loss: 0.
6859391528421698
Epoch:             2 | Training loss: 0.6876679335544769 | Validation loss: 0.
6827894786237961
Epoch:             3 | Training loss: 0.6863640093851923 | Validation loss: 0.
6808713640833011
Epoch:             4 | Training loss: 0.6842526988095946 | Validation loss: 0.
6765752298287928
Epoch:             5 | Training loss: 0.6826342365237753 | Validation loss: 0.
6743517508826574
Epoch:             6 | Training loss: 0.6809244050678819 | Validation loss: 0.
6714344444414913
Epoch:             7 | Training loss: 0.6794057474002357 | Validation loss: 0.
6675631548331793
Epoch:             8 | Training loss: 0.6776375974458425 | Validation loss: 0.
6651681243779454
Epoch:             9 | Training loss: 0.6760045643946203 | Validation loss: 0.
6626180371828788
Epoch:            10 | Training loss: 0.6759585455076329 | Validation loss: 0.
6588111323773379
Epoch:            11 | Training loss: 0.6727815784566652 | Validation loss: 0.
6583234791109117
Epoch:            12 | Training loss: 0.6714078160341236 | Validation loss: 0.
6544960666603477
Epoch:            13 | Training loss: 0.6704392428677829 | Validation loss: 0.
6511285439068933

Hyper Parameters -- Learning Rate - 2.8000000000000003e-05  Regularization
Parameter- 1e-05
Epoch:             0 | Training loss: 0.6911768763709497 | Validation loss: 0.
6892302608004539
Epoch:             1 | Training loss: 0.6894317480010087 | Validation loss: 0.
6859391553539166
Epoch:             2 | Training loss: 0.687667939194187 | Validation loss: 0.6
827894842636867
Epoch:             3 | Training loss: 0.6863640194906133 | Validation loss: 0.
6808713741888366
Epoch:             4 | Training loss: 0.6842527141870696 | Validation loss: 0.
676575245206529
Epoch:             5 | Training loss: 0.682634258614782 | Validation loss: 0.6
743517729740227
Epoch:             6 | Training loss: 0.6809244349517274 | Validation loss: 0.
6714344743258053
Epoch:             7 | Training loss: 0.6794057861420058 | Validation loss: 0.
6675631935756704
Epoch:             8 | Training loss: 0.6776376462262089 | Validation loss: 0.
```

6651681731590411
Epoch: 9 | Training loss: 0.676004624327546 | Validation loss: 0.6
6261809711674
Epoch: 10 | Training loss: 0.6759586177529374 | Validation loss: 0.
6588112046244052
Epoch: 11 | Training loss: 0.672781663889126 | Validation loss: 0.6
583235645443029
Epoch: 12 | Training loss: 0.671407915747387 | Validation loss: 0.6
544961663752757
Epoch: 13 | Training loss: 0.6704393579791077 | Validation loss: 0.
651128659020275

Hyper Parameters -- Learning Rate - 2.8000000000000003e-05 Regularization
Parameter- 0.0001
Epoch: 0 | Training loss: 0.6911768831917434 | Validation loss: 0.
6892302676216054
Epoch: 1 | Training loss: 0.6894317731173495 | Validation loss: 0.
6859391804713835
Epoch: 2 | Training loss: 0.6876679955912888 | Validation loss: 0.
6827895406625938
Epoch: 3 | Training loss: 0.6863641205448248 | Validation loss: 0.
6808714752441921
Epoch: 4 | Training loss: 0.6842528679618193 | Validation loss: 0.
6765753989838899
Epoch: 5 | Training loss: 0.6826344795248511 | Validation loss: 0.
6743519938876767
Epoch: 6 | Training loss: 0.6809247337901828 | Validation loss: 0.
6714347731689472
Epoch: 7 | Training loss: 0.6794061735597072 | Validation loss: 0.
6675635810005807
Epoch: 8 | Training loss: 0.6776381340298742 | Validation loss: 0.
6651686609699995
Epoch: 9 | Training loss: 0.6760052236568077 | Validation loss: 0.
662618696455356
Epoch: 10 | Training loss: 0.675959340205987 | Validation loss: 0.6
58811927095083
Epoch: 11 | Training loss: 0.672782518213738 | Validation loss: 0.6
583244188782209
Epoch: 12 | Training loss: 0.6714089128800269 | Validation loss: 0.
6544971635245633
Epoch: 13 | Training loss: 0.670440509092366 | Validation loss: 0.6
511298101541014

Hyper Parameters -- Learning Rate - 2.8000000000000003e-05 Regularization
Parameter- 0.001
Epoch: 0 | Training loss: 0.6911769513996805 | Validation loss: 0.
6892303358331213
Epoch: 1 | Training loss: 0.6894320242807602 | Validation loss: 0.
6859394316460553
Epoch: 2 | Training loss: 0.687668559562315 | Validation loss: 0.6
827901046516712
Epoch: 3 | Training loss: 0.6863651310869597 | Validation loss: 0.
6808724857977678
Epoch: 4 | Training loss: 0.6842544057093595 | Validation loss: 0.
6765769367575412
Epoch: 5 | Training loss: 0.682636688625615 | Validation loss: 0.6
743542030242896
Epoch: 6 | Training loss: 0.6809277221748563 | Validation loss: 0.
6714377616004831
Epoch: 7 | Training loss: 0.6794100477368991 | Validation loss: 0.
6675674552498603

```
Epoch:          8 | Training loss: 0.6776430120667776 | Validation loss: 0.
665173539079834
Epoch:          9 | Training loss: 0.6760112169497647 | Validation loss: 0.
6626246898418566
Epoch:         10 | Training loss: 0.6759665647369333 | Validation loss: 0.
65588191518023107
Epoch:         11 | Training loss: 0.6727910614604428 | Validation loss: 0.
6583329622179841
Epoch:         12 | Training loss: 0.6714188842071648 | Validation loss: 0.
6545071350181777
Epoch:         13 | Training loss: 0.6704520202258621 | Validation loss: 0.
6511413214932799


Hyper Parameters -- Learning Rate - 4.6e-05  Regularization Parameter- 1e-0
7
Epoch:          0 | Training loss: 0.6900790098050679 | Validation loss: 0.
6871827744568333
Epoch:          1 | Training loss: 0.6872174250479163 | Validation loss: 0.
6817711670025566
Epoch:          2 | Training loss: 0.6843560621607965 | Validation loss: 0.
67681773599618249
Epoch:          3 | Training loss: 0.6830128733192897 | Validation loss: 0.
6763484371630406
Epoch:          4 | Training loss: 0.6790357884514501 | Validation loss: 0.
6688415989723484
Epoch:          5 | Training loss: 0.6762455022731914 | Validation loss: 0.
6640660622376228
Epoch:          6 | Training loss: 0.6735817563265669 | Validation loss: 0.
6598601120989158
Epoch:          7 | Training loss: 0.6712934753988162 | Validation loss: 0.
6538210618384803
Epoch:          8 | Training loss: 0.6684378957921223 | Validation loss: 0.
6514233864062866
Epoch:          9 | Training loss: 0.6660262696743723 | Validation loss: 0.
64696418932815
Epoch:         10 | Training loss: 0.6672305745449177 | Validation loss: 0.
6402276905337101


Hyper Parameters -- Learning Rate - 4.6e-05  Regularization Parameter- 1e-0
6
Epoch:          0 | Training loss: 0.690079009981679 | Validation loss: 0.6
871827746334518
Epoch:          1 | Training loss: 0.6872174257187775 | Validation loss: 0.
6817711676734381
Epoch:          2 | Training loss: 0.6843560636600912 | Validation loss: 0.
6768177374611564
Epoch:          3 | Training loss: 0.6830128760037553 | Validation loss: 0.
6763484398475083
Epoch:          4 | Training loss: 0.6790357925413432 | Validation loss: 0.
6688416030622585
Epoch:          5 | Training loss: 0.6762455081032969 | Validation loss: 0.
6640660680678105
Epoch:          6 | Training loss: 0.6735817642020699 | Validation loss: 0.
6598601199745205
Epoch:          7 | Training loss: 0.6712934855973692 | Validation loss: 0.
6538210720371825
Epoch:          8 | Training loss: 0.6684379085923691 | Validation loss: 0.
6514233992066746
Epoch:          9 | Training loss: 0.6660262853551859 | Validation loss: 0.
6469642050091781
Epoch:         10 | Training loss: 0.6672305934019336 | Validation loss: 0.
```

```
6402277093912276

Hyper Parameters -- Learning Rate - 4.6e-05  Regularization Parameter- 1e-0
5
Epoch:           0 | Training loss: 0.6900790117477907 | Validation loss: 0.
6871827763996373
Epoch:           1 | Training loss: 0.687217432427389 | Validation loss: 0.6
81771174382256
Epoch:           2 | Training loss: 0.6843560786530373 | Validation loss: 0.
67681775245447705
Epoch:           3 | Training loss: 0.6830129028484114 | Validation loss: 0.
6763484666921847
Epoch:           4 | Training loss: 0.6790358334402748 | Validation loss: 0.
6688416439613613
Epoch:           5 | Training loss: 0.6762455664043516 | Validation loss: 0.
6640661263696869
Epoch:           6 | Training loss: 0.6735818429570987 | Validation loss: 0.
6598601987305672
Epoch:           7 | Training loss: 0.6712935875828991 | Validation loss: 0.
6538211740242038
Epoch:           8 | Training loss: 0.6684380365948358 | Validation loss: 0.
6514235272105539
Epoch:           9 | Training loss: 0.6660264421633219 | Validation loss: 0.
6469643618194578
Epoch:          10 | Training loss: 0.6672307819720914 | Validation loss: 0.
6402278979664047


Hyper Parameters -- Learning Rate - 4.6e-05  Regularization Parameter- 0.00
01
Epoch:           0 | Training loss: 0.6900790294089062 | Validation loss: 0.
6871827940614921
Epoch:           1 | Training loss: 0.6872174995135037 | Validation loss: 0.
6817712414704329
Epoch:           2 | Training loss: 0.6843562285824988 | Validation loss: 0.
6768179023876137
Epoch:           3 | Training loss: 0.6830131712949731 | Validation loss: 0.
6763487351389503
Epoch:           4 | Training loss: 0.6790362424295935 | Validation loss: 0.
6688420529523902
Epoch:           5 | Training loss: 0.6762461494149024 | Validation loss: 0.
6640667093884531
Epoch:           6 | Training loss: 0.6735826305073928 | Validation loss: 0.
6598609862910382
Epoch:           7 | Training loss: 0.6712946074382058 | Validation loss: 0.
6538221938944259
Epoch:           8 | Training loss: 0.6684393166195143 | Validation loss: 0.
6514248072493587
Epoch:           9 | Training loss: 0.6660280102446969 | Validation loss: 0.
646965929922269
Epoch:          10 | Training loss: 0.6672326676736882 | Validation loss: 0.
6402297837181931


Hyper Parameters -- Learning Rate - 4.6e-05  Regularization Parameter- 0.00
1
Epoch:           0 | Training loss: 0.6900792060200632 | Validation loss: 0.
6871829706800408
Epoch:           1 | Training loss: 0.6872181703746628 | Validation loss: 0.
6817719123522146
Epoch:           2 | Training loss: 0.6843577278771558 | Validation loss: 0.
6768194017190854
Epoch:           3 | Training loss: 0.6830158557606887 | Validation loss: 0.
```

```
6763514196067052
Epoch:          4 | Training loss: 0.6790403323229681 | Validation loss: 0.
6688461428628679
Epoch:          5 | Training loss: 0.6762519795207376 | Validation loss: 0.
6640725395764437
Epoch:          6 | Training loss: 0.6735905060108492 | Validation loss: 0.
6598688618962666
Epoch:          7 | Training loss: 0.6713048059920353 | Validation loss: 0.
6538323925974092
Epoch:          8 | Training loss: 0.6684521168673722 | Validation loss: 0.
6514376076384789
Epoch:          9 | Training loss: 0.6660436910599014 | Validation loss: 0.
646981610951835
Epoch:         10 | Training loss: 0.6672515246915662 | Validation loss: 0.
6402486412379873


Hyper Parameters -- Learning Rate - 6.4e-05  Regularization Parameter- 1e-0
7
Epoch:          0 | Training loss: 0.6890082884992939 | Validation loss: 0.
6852497538513705
Epoch:          1 | Training loss: 0.6850031427855531 | Validation loss: 0.
6777608405547185
Epoch:          2 | Training loss: 0.6811454632324884 | Validation loss: 0.
6710280625497193


Hyper Parameters -- Learning Rate - 6.4e-05  Regularization Parameter- 1e-0
6
Epoch:          0 | Training loss: 0.6890082888353909 | Validation loss: 0.
6852497541874786
Epoch:          1 | Training loss: 0.6850031440752572 | Validation loss: 0.
6777608418444507
Epoch:          2 | Training loss: 0.6811454661038723 | Validation loss: 0.
6710280654211647


Hyper Parameters -- Learning Rate - 6.4e-05  Regularization Parameter- 1e-0
5
Epoch:          0 | Training loss: 0.6890082921963608 | Validation loss: 0.
6852497575485573
Epoch:          1 | Training loss: 0.6850031569722981 | Validation loss: 0.
6777608547417715
Epoch:          2 | Training loss: 0.6811454948177134 | Validation loss: 0.
6710280941356197


Hyper Parameters -- Learning Rate - 6.4e-05  Regularization Parameter- 0.00
01
Epoch:          0 | Training loss: 0.6890083258060601 | Validation loss: 0.
685249791159346
Epoch:          1 | Training loss: 0.6850032859427085 | Validation loss: 0.
6777609837149818
Epoch:          2 | Training loss: 0.681145781956124 | Validation loss: 0.6
710283812801704


Hyper Parameters -- Learning Rate - 6.4e-05  Regularization Parameter- 0.00
1
Epoch:          0 | Training loss: 0.6890086619030563 | Validation loss: 0.
6852501272672363
Epoch:          1 | Training loss: 0.6850045756468457 | Validation loss: 0.
6777622734471157
Epoch:          2 | Training loss: 0.6811486533403414 | Validation loss: 0.
6710312527257892
```

```
Hyper Parameters -- Learning Rate - 8.2e-05  Regularization Parameter- 1e-0
7
Epoch:          0 | Training loss: 0.6879443522844564 | Validation loss: 0.
6833853806582519
Epoch:          1 | Training loss: 0.6828077352825561 | Validation loss: 0.
6739729299810047
Epoch:          2 | Training loss: 0.6780452208025601 | Validation loss: 0.
6654338412430537

Hyper Parameters -- Learning Rate - 8.2e-05  Regularization Parameter- 1e-0
6
Epoch:          0 | Training loss: 0.6879443528298523 | Validation loss: 0.
6833853812036628
Epoch:          1 | Training loss: 0.682807737385804 | Validation loss: 0.6
739729320842867
Epoch:          2 | Training loss: 0.6780452254708268 | Validation loss: 0.
6654338459114123

Hyper Parameters -- Learning Rate - 8.2e-05  Regularization Parameter- 1e-0
5
Epoch:          0 | Training loss: 0.6879443582838121 | Validation loss: 0.
6833853866577718
Epoch:          1 | Training loss: 0.6828077584182822 | Validation loss: 0.
6739729531171043
Epoch:          2 | Training loss: 0.6780452721534947 | Validation loss: 0.
6654338925949989

Hyper Parameters -- Learning Rate - 8.2e-05  Regularization Parameter- 0.00
01
Epoch:          0 | Training loss: 0.6879444128234098 | Validation loss: 0.
6833854411988625
Epoch:          1 | Training loss: 0.6828079687430649 | Validation loss: 0.
673973163445282
Epoch:          2 | Training loss: 0.678045738980177 | Validation loss: 0.6
654343594308656

Hyper Parameters -- Learning Rate - 8.2e-05  Regularization Parameter- 0.00
1
Epoch:          0 | Training loss: 0.6879449582193945 | Validation loss: 0.
6833859866097776
Epoch:          1 | Training loss: 0.6828100719909611 | Validation loss: 0.
6739752667271302
Epoch:          2 | Training loss: 0.678050407247231 | Validation loss: 0.6
65439027789766
```

In [145…
```python
#get the best hyper parameters
temp = np.array(train_loss_history)
train_loss_history_sortidx = np.argsort(temp)

best_train_loss_BOCN_tfidf = temp[train_loss_history_sortidx[0]]
best_validation_loss_BOCN_tfidf = validation_loss_history[train_loss_histor
best_hyperparams_BOCN_tfidf=hyperparam_history[train_loss_history_sortidx[

print("BOCN-TFIDF")
print(f'Best Training loss - {best_train_loss_BOCN_tfidf},best_validation_
```

```
BOCN-TFIDF
Best Training loss - 0.6672305745449177,best_validation_loss-0.640227690533
7101,
best_hyperparams-[4.6e-05, 1e-07]
```

In [146…

```python
#train with best hyperparameters (BOCN-TFIDF)
weight_c, train_loss_count_c, dev_loss_count_c = SGD(X_tr=train_char_tf_id
                                    Y_tr=train_labels,
                                    X_dev=dev_char_tf_idf,
                                    Y_dev=dev_labels,
                                    lr=best_hyperparams_BOCN_tfid
                                    alpha=best_hyperparams_BOCN_t
                                    tolerance=0.0001,
                                    epochs=100,
                                    print_progress=True)
```

```
Epoch:         0 | Training loss: 0.6900790098050679 | Validation loss: 0.
6871827744568333
Epoch:         1 | Training loss: 0.6872174250479163 | Validation loss: 0.
6817711670025566
Epoch:         2 | Training loss: 0.6843560621607965 | Validation loss: 0.
6768177359618249
Epoch:         3 | Training loss: 0.6830128733192897 | Validation loss: 0.
6763484371630406
Epoch:         4 | Training loss: 0.6790357884514501 | Validation loss: 0.
6688415989723484
Epoch:         5 | Training loss: 0.6762455022731914 | Validation loss: 0.
6640660622376228
Epoch:         6 | Training loss: 0.6735817563265669 | Validation loss: 0.
6598601120989158
Epoch:         7 | Training loss: 0.6712934753988162 | Validation loss: 0.
6538210618384803
Epoch:         8 | Training loss: 0.6684378957921223 | Validation loss: 0.
6514233864062866
Epoch:         9 | Training loss: 0.6660262696743723 | Validation loss: 0.
64696418932815
Epoch:        10 | Training loss: 0.6672305745449177 | Validation loss: 0.
6402276905337101
```
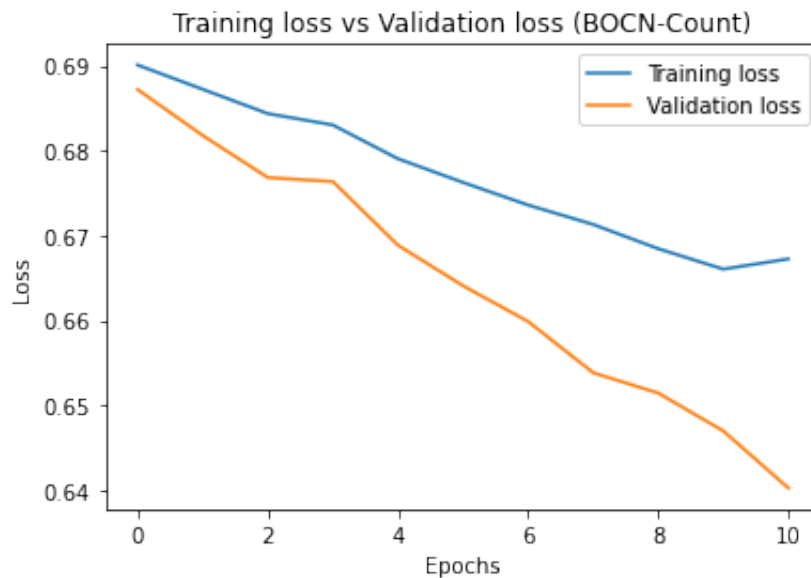
In [147…

```python
plt.plot(train_loss_count_c, label='Training loss')
plt.plot(dev_loss_count_c, label='Validation loss')

plt.xlabel('Epochs')
plt.ylabel('Loss')

plt.title('Training loss vs Validation loss (BOCN-Count)')

plt.legend()

plt.show()
```

Training loss vs Validation loss (BOCN-Count)

```
In [148…    preds_te_count = predict_class(test_char_tf_idf, weight_c)

            print('Accuracy:', accuracy_score(test_labels,preds_te_count))
            print('Precision:', precision_score(test_labels,preds_te_count))
            print('Recall:', recall_score(test_labels,preds_te_count))
            print('F1-Score:', f1_score(test_labels,preds_te_count))
```

```
Accuracy: 0.65
Precision: 0.5920245398773006
Recall: 0.965
F1-Score: 0.7338403041825096
```

Top 10 Negative and Positive Characters BOCN(TFIDF)

```
In [149…    top_negative_words = weight_c.argsort()[:10]
            for i in top_negative_words:
                print(vocab_char[i])
```

```
fe
and
tr
per
ion
wors
tio
rf
tion
man
```

```
In [150…    top_positive_words = weight_c.argsort()[::-1][:10]
            for i in top_positive_words:
                print(vocab_char[i])
```

```
th
ba
ha
he
tt
in
thi
oo
to
ad
```

BOW+BOCN

In [103…
```python
#i have joined the BOW count vector with BOCN count vector and labels using

#training data
train_BOW_BOCN_count_vector = np.vstack((train_count_vector,train_char_cou

print('new train data array with BOW and BOCN count -',train_BOW_BOCN_coun

train_labels_new = np.hstack((train_labels,train_labels))

print('new array with train labels -',train_labels_new.shape)

#testing data
test_BOW_BOCN_count_vector = np.vstack((test_count_vector,test_char_count_v

print('new test data array with BOW and BOCN count -',test_BOW_BOCN_count_v

test_labels_new = np.hstack((test_labels,test_labels))

print('new array with train labels -',test_labels_new.shape)

#validation data
dev_BOW_BOCN_count_vector = np.vstack((dev_count_vector,dev_char_count_vect

print('new validation data array with BOW and BOCN count -',dev_BOW_BOCN_co

dev_labels_new = np.hstack((dev_labels,dev_labels))

print('new array with train labels -',dev_labels_new.shape)
```

```
new train data array with BOW and BOCN count - (2800, 10000)
new array with train labels - (2800,)
new test data array with BOW and BOCN count - (800, 10000)
new array with train labels - (800,)
new validation data array with BOW and BOCN count - (400, 10000)
new array with train labels - (400,)
```

In [109…
```python
lr = np.logspace(-7, -4, num = 5)
alpha = np.logspace(-6, -3, num = 5)
```

In [151…

```python
#hyper paramater tuning for BOW-Count
train_loss_history =[]
validation_loss_history=[]
hyperparam_history=[]
#
for lr_i in lr:
    for alpha_i in alpha:
        print('\nHyper Parameters -- Learning Rate -',lr_i,' Regularizatio
        weight, train_loss_count, dev_loss_count = SGD(X_tr=train_BOW_BOCN
                                         Y_tr=train_labels_new,
                                         X_dev=dev_BOW_BOCN_count_vect
                                         Y_dev=dev_labels_new,
                                         lr=lr_i,
                                         alpha=alpha_i,
                                         tolerance=0.0001,
                                         epochs=400,
                                         print_progress=True)
        if len(train_loss_count) > 5:
            train_loss_history.append(train_loss_count[-1])
            validation_loss_history.append(dev_loss_count[-1])
            hyperparam_history.append([lr_i,alpha_i])
```

```
Hyper Parameters -- Learning Rate - 1e-07  Regularization Parameter- 1e-06
Epoch:          0 | Training loss: 0.6914988723371794 | Validation loss: 0.
6910366921400016
Epoch:          1 | Training loss: 0.6906433838251786 | Validation loss: 0.
6901687257731097
Epoch:          2 | Training loss: 0.6898480819482578 | Validation loss: 0.
6899762427117031
Epoch:          3 | Training loss: 0.6889836180180043 | Validation loss: 0.
6887675108274282
Epoch:          4 | Training loss: 0.6880862299850675 | Validation loss: 0.
6885030132963333
Epoch:          5 | Training loss: 0.6872352692115632 | Validation loss: 0.
687810926729751
Epoch:          6 | Training loss: 0.6864495400645508 | Validation loss: 0.
6872754463998534
Epoch:          7 | Training loss: 0.6855515977152251 | Validation loss: 0.
6863246072840837
Epoch:          8 | Training loss: 0.6847501892085522 | Validation loss: 0.
6856497560338164
Epoch:          9 | Training loss: 0.6839519394798088 | Validation loss: 0.
6850338510460636
Epoch:         10 | Training loss: 0.6831849832516707 | Validation loss: 0.
6846160192225793
Epoch:         11 | Training loss: 0.6824669829151961 | Validation loss: 0.
683713474206681
Epoch:         12 | Training loss: 0.6816166168220474 | Validation loss: 0.
6832140060370623
Epoch:         13 | Training loss: 0.6808497982559146 | Validation loss: 0.
6826841662183735
Epoch:         14 | Training loss: 0.680181505065827 | Validation loss: 0.6
82400522896496
```

Epoch: 15 | Training loss: 0.6793597659850172 | Validation loss: 0.
681577540404925

Hyper Parameters -- Learning Rate – 1e-07 Regularization Parameter- 5.6234
13251903491e-06
Epoch: 0 | Training loss: 0.691498872338859 | Validation loss: 0.6
910366921416827
Epoch: 1 | Training loss: 0.6906433838306654 | Validation loss: 0.
6901687257785974
Epoch: 2 | Training loss: 0.689848081958793 | Validation loss: 0.6
899762427222381
Epoch: 3 | Training loss: 0.6889836180373167 | Validation loss: 0.
6887675108467376
Epoch: 4 | Training loss: 0.6880862300136313 | Validation loss: 0.
688503013324892
Epoch: 5 | Training loss: 0.6872352692523371 | Validation loss: 0.
6878109267705154
Epoch: 6 | Training loss: 0.6864495401194747 | Validation loss: 0.
6872754464547637
Epoch: 7 | Training loss: 0.6855515977867784 | Validation loss: 0.
6863246073556182
Epoch: 8 | Training loss: 0.6847501892984516 | Validation loss: 0.
6856497561236905
Epoch: 9 | Training loss: 0.6839519395899328 | Validation loss: 0.
6850338511561566
Epoch: 10 | Training loss: 0.6831849833836406 | Validation loss: 0.
6846160193545119
Epoch: 11 | Training loss: 0.6824669830718992 | Validation loss: 0.
6837134743633386
Epoch: 12 | Training loss: 0.6816166170043061 | Validation loss: 0.
683214006219268
Epoch: 13 | Training loss: 0.6808497984658265 | Validation loss: 0.
6826841664282237
Epoch: 14 | Training loss: 0.6801815053049334 | Validation loss: 0.
6824005231355319
Epoch: 15 | Training loss: 0.6793597662556315 | Validation loss: 0.
6815775406754585

Hyper Parameters -- Learning Rate – 1e-07 Regularization Parameter- 3.1622
776601683795e-05
Epoch: 0 | Training loss: 0.6914988723483043 | Validation loss: 0.
6910366921511367
Epoch: 1 | Training loss: 0.6906433838615187 | Validation loss: 0.
6901687258094569
Epoch: 2 | Training loss: 0.6898480820180372 | Validation loss: 0.
6899762427814814
Epoch: 3 | Training loss: 0.6889836181459169 | Validation loss: 0.
6887675109553214
Epoch: 4 | Training loss: 0.6880862301742573 | Validation loss: 0.
6885030134854894
Epoch: 5 | Training loss: 0.6872352694816256 | Validation loss: 0.
6878109269997512
Epoch: 6 | Training loss: 0.6864495404283338 | Validation loss: 0.
6872754467635473
Epoch: 7 | Training loss: 0.6855515981891519 | Validation loss: 0.
6863246077578863
Epoch: 8 | Training loss: 0.6847501898039917 | Validation loss: 0.
6856497566290901
Epoch: 9 | Training loss: 0.683951940209206 | Validation loss: 0.6
850338517752553
Epoch: 10 | Training loss: 0.6831849841257621 | Validation loss: 0.

```
6846160200964236
Epoch:              11 | Training loss: 0.6824669839531048 | Validation loss: 0.
6837134752442889
Epoch:              12 | Training loss: 0.6816166180292226 | Validation loss: 0.
6832140072438859
Epoch:              13 | Training loss: 0.6808497996462477 | Validation loss: 0.
6826841676082986
Epoch:              14 | Training loss: 0.6801815066495278 | Validation loss: 0.
6824005244797293
Epoch:              15 | Training loss: 0.6793597677774078 | Validation loss: 0.
68157754219678


Hyper Parameters -- Learning Rate – 1e–07  Regularization Parameter- 0.0001
7782794100389227
Epoch:               0 | Training loss: 0.6914988724014184 | Validation loss: 0.
6910366922042996
Epoch:               1 | Training loss: 0.6906433840350203 | Validation loss: 0.
6901687259829924
Epoch:               2 | Training loss: 0.6898480823511912 | Validation loss: 0.
6899762431146305
Epoch:               3 | Training loss: 0.6889836187566215 | Validation loss: 0.
6887675115659339
Epoch:               4 | Training loss: 0.6880862310775241 | Validation loss: 0.
6885030143885945
Epoch:               5 | Training loss: 0.6872352707710093 | Validation loss: 0.
6878109282888376
Epoch:               6 | Training loss: 0.6864495421651771 | Validation loss: 0.
6872754484999655
Epoch:               7 | Training loss: 0.6855516004518639 | Validation loss: 0.
6863246100200061
Epoch:               8 | Training loss: 0.6847501926468528 | Validation loss: 0.
6856497594711596
Epoch:               9 | Training loss: 0.6839519436916344 | Validation loss: 0.
6850338552567036
Epoch:              10 | Training loss: 0.6831849882990176 | Validation loss: 0.
6846160242685003
Epoch:              11 | Training loss: 0.6824669889084878 | Validation loss: 0.
6837134801982367
Epoch:              12 | Training loss: 0.6816166237927509 | Validation loss: 0.
683214013005736
Epoch:              13 | Training loss: 0.6808498062842444 | Validation loss: 0.
6826841742443471
Epoch:              14 | Training loss: 0.6801815142107374 | Validation loss: 0.
6824005320387068
Epoch:              15 | Training loss: 0.6793597763349839 | Validation loss: 0.
6815775507517989


Hyper Parameters -- Learning Rate – 1e–07  Regularization Parameter- 0.001
Epoch:               0 | Training loss: 0.6914988727001015 | Validation loss: 0.
6910366925032579
Epoch:               1 | Training loss: 0.6906433850106921 | Validation loss: 0.
6901687269588558
Epoch:               2 | Training loss: 0.6898480842246549 | Validation loss: 0.
6899762449880659
Epoch:               3 | Training loss: 0.6889836221908662 | Validation loss: 0.
6887675149996602
Epoch:               4 | Training loss: 0.6880862361569663 | Validation loss: 0.
6885030194671278
Epoch:               5 | Training loss: 0.6872352780217468 | Validation loss: 0.
6878109355379038
Epoch:               6 | Training loss: 0.6864495519321642 | Validation loss: 0.
```

6872754582645618
Epoch: 7 | Training loss: 0.6855516131760294 | Validation loss: 0.
6863246227408402
Epoch: 8 | Training loss: 0.6847502086334362 | Validation loss: 0.
6856497754532915
Epoch: 9 | Training loss: 0.683951963274769 | Validation loss: 0.6
850338748343248
Epoch: 10 | Training loss: 0.6831850117669579 | Validation loss: 0.
6846160477298112
Epoch: 11 | Training loss: 0.6824670167746544 | Validation loss: 0.
683713508056332
Epoch: 12 | Training loss: 0.6816166562034521 | Validation loss: 0.
6832140454069995
Epoch: 13 | Training loss: 0.680849843612442 | Validation loss: 0.6
826842115615895
Epoch: 14 | Training loss: 0.6801815567305437 | Validation loss: 0.
6824005745459604
Epoch: 15 | Training loss: 0.6793598244577707 | Validation loss: 0.
6815775988602063

Hyper Parameters -- Learning Rate - 5.62341325190349e-07 Regularization Pa
rameter- 1e-06
Epoch: 0 | Training loss: 0.6875404070696487 | Validation loss: 0.
6880718502659505
Epoch: 1 | Training loss: 0.6829362153623643 | Validation loss: 0.
6843329130701133
Epoch: 2 | Training loss: 0.6795681512922334 | Validation loss: 0.
6826076228940033
Epoch: 3 | Training loss: 0.6762240411512797 | Validation loss: 0.
6784852302215958

Hyper Parameters -- Learning Rate - 5.62341325190349e-07 Regularization Pa
rameter- 5.623413251903491e-06
Epoch: 0 | Training loss: 0.6875404071057634 | Validation loss: 0.
6880718503020578
Epoch: 1 | Training loss: 0.682936215501301 | Validation loss: 0.6
843329132090143
Epoch: 2 | Training loss: 0.6795681515937906 | Validation loss: 0.
6826076231954704
Epoch: 3 | Training loss: 0.6762240416723949 | Validation loss: 0.
6784852307425561

Hyper Parameters -- Learning Rate - 5.62341325190349e-07 Regularization Pa
rameter- 3.1622776601683795e-05
Epoch: 0 | Training loss: 0.6875404073088509 | Validation loss: 0.
6880718505051039
Epoch: 1 | Training loss: 0.6829362162826 | Validation loss: 0.684
3329139901126
Epoch: 2 | Training loss: 0.6795681532895718 | Validation loss: 0.
6826076248907443
Epoch: 3 | Training loss: 0.6762240446028402 | Validation loss: 0.
6784852336721312

Hyper Parameters -- Learning Rate - 5.62341325190349e-07 Regularization Pa
rameter- 0.00017782794100389227
Epoch: 0 | Training loss: 0.6875404084508966 | Validation loss: 0.
6880718516469164
Epoch: 1 | Training loss: 0.682936220676167 | Validation loss: 0.6
843329183825506
Epoch: 2 | Training loss: 0.6795681628256498 | Validation loss: 0.
6826076344239698

```
Epoch:           3 | Training loss: 0.6762240610819458 | Validation loss: 0.
6784852501463433

Hyper Parameters -- Learning Rate - 5.62341325190349e-07  Regularization Pa
rameter- 0.001
Epoch:           0 | Training loss: 0.6875404148730905 | Validation loss: 0.
6880718580678002
Epoch:           1 | Training loss: 0.6829362453830097 | Validation loss: 0.
6843329430830454
Epoch:           2 | Training loss: 0.6795682164509576 | Validation loss: 0.
6826076880332362
Epoch:           3 | Training loss: 0.6762241537507653 | Validation loss: 0.
6784853427876437

Hyper Parameters -- Learning Rate - 3.162277660168379e-06  Regularization P
arameter- 1e-06
Epoch:           0 | Training loss: 0.6687105911319241 | Validation loss: 0.
6732567688769214

Hyper Parameters -- Learning Rate - 3.162277660168379e-06  Regularization P
arameter- 5.623413251903491e-06
Epoch:           0 | Training loss: 0.6687105921158331 | Validation loss: 0.
6732567698605376

Hyper Parameters -- Learning Rate - 3.162277660168379e-06  Regularization P
arameter- 3.1622776601683795e-05
Epoch:           0 | Training loss: 0.6687105976487596 | Validation loss: 0.
6732567753918187

Hyper Parameters -- Learning Rate - 3.162277660168379e-06  Regularization P
arameter- 0.00017782794100389227
Epoch:           0 | Training loss: 0.6687106287626918 | Validation loss: 0.
6732568064964974

Hyper Parameters -- Learning Rate - 3.162277660168379e-06  Regularization P
arameter- 0.001
Epoch:           0 | Training loss: 0.6687108037291882 | Validation loss: 0.
673256981410957

Hyper Parameters -- Learning Rate - 1.778279410038923e-05  Regularization P
arameter- 1e-06
Epoch:           0 | Training loss: 0.6075508561538746 | Validation loss: 0.
6298189802843563
Epoch:           1 | Training loss: 0.573287308157641 | Validation loss: 0.6
085986392903506
Epoch:           2 | Training loss: 0.5442197672010288 | Validation loss: 0.
590417154802116

Hyper Parameters -- Learning Rate - 1.778279410038923e-05  Regularization P
arameter- 5.623413251903491e-06
Epoch:           0 | Training loss: 0.6075508779133073 | Validation loss: 0.
6298190020375813
Epoch:           1 | Training loss: 0.5732873691426807 | Validation loss: 0.
6085987002583816
Epoch:           2 | Training loss: 0.5442198726087041 | Validation loss: 0.
5904172601818682

Hyper Parameters -- Learning Rate - 1.778279410038923e-05  Regularization P
arameter- 3.1622776601683795e-05
Epoch:           0 | Training loss: 0.6075510002755894 | Validation loss: 0.
629819124364954
```

```
Epoch:           1 | Training loss: 0.573287712086761 | Validation loss: 0.6
085990431068139
Epoch:           2 | Training loss: 0.5442204653596203 | Validation loss: 0.
5904178527757616


Hyper Parameters -- Learning Rate - 1.778279410038923e-05  Regularization P
arameter- 0.00017782794100389227
Epoch:           0 | Training loss: 0.6075516883692607 | Validation loss: 0.
6298198122623159
Epoch:           1 | Training loss: 0.5732896406030109 | Validation loss: 0.
6086009710851961
Epoch:           2 | Training loss: 0.5442237986429019 | Validation loss: 0.
5904211851760399


Hyper Parameters -- Learning Rate - 1.778279410038923e-05  Regularization P
arameter- 0.001
Epoch:           0 | Training loss: 0.6075555578040868 | Validation loss: 0.
6298236805932138
Epoch:           1 | Training loss: 0.5733004854457316 | Validation loss: 0.
6086118129032656
Epoch:           2 | Training loss: 0.5442425430698927 | Validation loss: 0.
5904399246375394


Hyper Parameters -- Learning Rate - 0.0001  Regularization Parameter- 1e-06
Epoch:           0 | Training loss: 0.7187504184632367 | Validation loss: 0.
8178784760098141
Epoch:           1 | Training loss: 0.46459429474166736 | Validation loss: 0
.5627547775663957
Epoch:           2 | Training loss: 0.4102320275083679 | Validation loss: 0.
5438768023962375


Hyper Parameters -- Learning Rate - 0.0001  Regularization Parameter- 5.623
413251903491e-06
Epoch:           0 | Training loss: 0.7187510390189372 | Validation loss: 0.
8178790967879026
Epoch:           1 | Training loss: 0.4645955671472732 | Validation loss: 0.
5627560496778525
Epoch:           2 | Training loss: 0.4102339763897723 | Validation loss: 0.
5438787507503511


Hyper Parameters -- Learning Rate - 0.0001  Regularization Parameter- 3.162
2776601683795e-05
Epoch:           0 | Training loss: 0.7187545286600358 | Validation loss: 0.
8178825876795679
Epoch:           1 | Training loss: 0.4646027224097177 | Validation loss: 0.
5627632032861737
Epoch:           2 | Training loss: 0.410244935755087 | Validation loss: 0.5
438897071504911


Hyper Parameters -- Learning Rate - 0.0001  Regularization Parameter- 0.000
17782794100389227
Epoch:           0 | Training loss: 0.7187741523532082 | Validation loss: 0.
8179022184051967
Epoch:           1 | Training loss: 0.4646429594042212 | Validation loss: 0.
5628034309788592
Epoch:           2 | Training loss: 0.4103065647888421 | Validation loss: 0.
5439513195098469


Hyper Parameters -- Learning Rate - 0.0001  Regularization Parameter- 0.001
Epoch:           0 | Training loss: 0.7188845044624522 | Validation loss: 0.
8180126100607036
```

```
Epoch:             1 | Training loss: 0.4648692285527607 | Validation loss: 0.
563029647819462
Epoch:             2 | Training loss: 0.41065313011197485 | Validation loss: 0
.5442977910660111
```

In [152…

```python
#get the best hyper parameters
temp = np.array(train_loss_history)
train_loss_history_sortidx = np.argsort(temp)

best_train_loss_BOW_BOCN = temp[train_loss_history_sortidx[0]]
best_validation_loss_BOW_BOCN = validation_loss_history[train_loss_history_
best_hyperparams_BOW_BOCN=hyperparam_history[train_loss_history_sortidx[0]

print("BOW-BOCN Count")
print(f'Best Training loss - {best_train_loss_BOCN_tfidf},best_validation_
```

```
BOW-BOCN Count
Best Training loss - 0.6672305745449177,best_validation_loss-0.640227690533
7101,
best_hyperparams-[4.6e-05, 1e-07]
```

In [153…

```python
#train with best hyperparameters (BOW-BOCN)
weight_c, train_loss_count_c, dev_loss_count_c = SGD(X_tr=train_BOW_BOCN_cc
                                        Y_tr=train_labels_new,
                                        X_dev=dev_BOW_BOCN_count_vecto
                                        Y_dev=dev_labels_new,
                                        lr=best_hyperparams_BOW_BOCN[(
                                        alpha=best_hyperparams_BOW_BO(
                                        tolerance=0.00001,
                                        epochs=100,
                                        print_progress=True)
```

```
Epoch:           0 | Training loss: 0.6914988723371794 | Validation loss: 0.
6910366921400016
Epoch:           1 | Training loss: 0.6906433838251786 | Validation loss: 0.
6901687257731097
Epoch:           2 | Training loss: 0.6898480819482578 | Validation loss: 0.
6899762427117031
Epoch:           3 | Training loss: 0.6889836180180043 | Validation loss: 0.
6887675108274282
Epoch:           4 | Training loss: 0.6880862299850675 | Validation loss: 0.
6885030132963333
Epoch:           5 | Training loss: 0.6872352692115632 | Validation loss: 0.
687810926729751
Epoch:           6 | Training loss: 0.6864495400645508 | Validation loss: 0.
6872754463998534
Epoch:           7 | Training loss: 0.6855515977152251 | Validation loss: 0.
6863246072840837
Epoch:           8 | Training loss: 0.6847501892085522 | Validation loss: 0.
6856497560338164
Epoch:           9 | Training loss: 0.6839519394798088 | Validation loss: 0.
6850338510460636
Epoch:          10 | Training loss: 0.6831849832516707 | Validation loss: 0.
6846160192225793
Epoch:          11 | Training loss: 0.6824669829151961 | Validation loss: 0.
683713474206681
Epoch:          12 | Training loss: 0.6816166168220474 | Validation loss: 0.
6832140060370623
Epoch:          13 | Training loss: 0.6808497982559146 | Validation loss: 0.
6826841662183735
Epoch:          14 | Training loss: 0.680181505065827 | Validation loss: 0.6
82400522896496
Epoch:          15 | Training loss: 0.6793597659850172 | Validation loss: 0.
681577540404925
Epoch:          16 | Training loss: 0.6788303406485361 | Validation loss: 0.
6815098291993109
Epoch:          17 | Training loss: 0.677904014957075 | Validation loss: 0.6
803228785025351
Epoch:          18 | Training loss: 0.6772225646321893 | Validation loss: 0.
679711946813115
```

```python
In [154…
plt.plot(train_loss_count_c, label='Training loss')
plt.plot(dev_loss_count_c, label='Validation loss')

plt.xlabel('Epochs')
plt.ylabel('Loss')

plt.title('Training loss vs Validation loss (BOCN-Count)')

plt.legend()

plt.show()
```
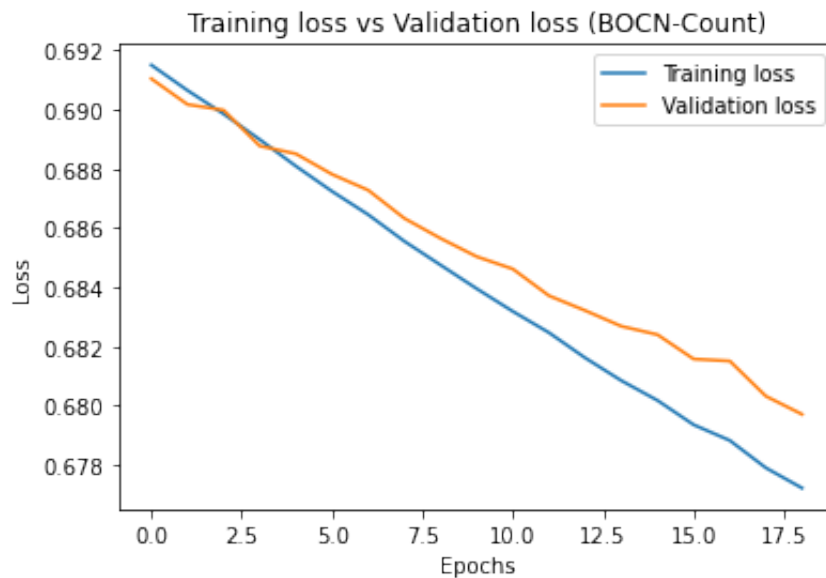
Training loss vs Validation loss (BOCN-Count)

```
In [155…    preds_te_count = predict_class(test_BOW_BOCN_count_vector, weight_c)
            print('Accuracy:', accuracy_score(test_labels_new,preds_te_count))
            print('Precision:', precision_score(test_labels_new,preds_te_count))
            print('Recall:', recall_score(test_labels_new,preds_te_count))
            print('F1-Score:', f1_score(test_labels_new,preds_te_count))
```

```
Accuracy: 0.6275
Precision: 0.580952380952381
Recall: 0.915
F1-Score: 0.7106796116504853
```

Full Results

Add here your results:

LR	Precision	Recall	F1-Score
BOW-count	0.8349	0.834	0.8472
BOW-tfidf	0.8585	0.85	0.8542
BOCN-count	0.6775	0.935	0.7857
BOCN-tfidf	0.5941	0.965	0.7391
BOW+BOCN	0.5809	0.915	0.7106

Please discuss why your best performing model is better than the rest.

Based on the observations, BOW-tfidf is the best performing model out of all the models trained. The precision score is 0.8585 = 85.85% and Recall is 0.85.

The model's performance is better than the other models because it is trained on ngrams model (unigram,bigram,trigram) with TFIDF weighting. we know that TFIDF performs better than raw frequencies in most of the cases. The BOCN models (count and TFIDF) worse than the BOW models. The BOW+BOCN(raw) model has the worst precision among the models. On contrary, BOW-TFIDF has the highest precision.