RNN_Non_Ternary

June 15, 2019

In [26]:
```
from __future__ import print_function

from keras.models import Sequential
from keras.layers import Input, LSTM, Dense, Dropout, GRU, Flatten
from keras import optimizers
import numpy as np
import csv
import os
import matplotlib.pyplot as plt
from sklearn.metrics import r2_score
```

In [2]:
```
nteams = 20
nmatches = (nteams-1)*2
```

Data Pre-processing

In [3]:
```
def season_team_map(season_dir):
    readme = season_dir + '/README.md'
    f = open(readme, 'r')

    s = "  "

    # skip to teams
    while(s[1] != '1'):
        s = f.readline()
        if(len(s)<=1):
            s = "  "

    team_map = {}

    for i in range(20):
        team_map[s[4:].split('  ')[0]] = i
        s = f.readline()

    f.close()

    return team_map
```

```
In [4]: def season_team_map_div_2(season_dir):
            readme = season_dir + '/README.md'
            f = open(readme, 'r')

            s = "  "

            # skip to teams
            while(s[1] != '1'):
                s = f.readline()
                if(len(s)<=1):
                    s = "  "

            s = f.readline()
            if(len(s)<=1):
                s = "  "

             # skip to div 2 teams
            while(s[:3] != ' 1.'):
                s = f.readline()
                if(len(s)<=1):
                    s = "  "

            team_map = {}

            for i in range(20):
                team_map[s[4:].split('  ')[0]] = i
                s = f.readline()

            f.close()

            return team_map

In [5]: def season_game_mat(season_dir, team_map, div=1):
            game_mat = np.zeros((nteams, nmatches), dtype=int)
            team_index = np.zeros(nteams, dtype=int)

            csvfile = ''

            for entry in os.scandir(season_dir):
                if(div==1):
                    if '/1-' in entry.path:
                        csvfile = entry.path
                elif(div==2):
                    if '/2-' in entry.path:
                        csvfile = entry.path

            with open(csvfile) as gf:
                reader = csv.reader(gf)
```

```
            header = next(reader)
            if(header[0] == 'Round'):
                new_format = 1
            else:
                new_format = 0;
            for row in reader:
                if(new_format):
                    team1 = team_map[row[2].split(' (')[0]]
                    team2 = team_map[row[5].split(' (')[0]]

                    score = row[3].split('-')
                else:
                    team1 = team_map[row[1]]
                    team2 = team_map[row[2]]

                    score = row[3].split('-')
                # 1 for win, 0 for draw, -1 for loss

                game_mat[team1, team_index[team1]] = int(score[0]) - int(score[1])
                game_mat[team2, team_index[team2]] = int(score[1]) - int(score[0])

                team_index[team1] += 1
                team_index[team2] += 1

        return np.transpose(game_mat)
```

In [6]:
```
country_dirs = []
season_dirs = []

nseasons = 0
team_maps = []
game_mats = []

for entry in os.scandir('./data'):
    if entry.is_dir():
        country_dirs.append(entry.path)

for cdir in country_dirs:
    for entry in os.scandir(cdir):
        if entry.is_dir():
            season_dir = entry.path
            team_maps.append(season_team_map(season_dir))
            game_mats.append(season_game_mat(season_dir, team_maps[nseasons]))
            nseasons += 1
            if(cdir=='./data/fr-france-master' and int(entry.name.split('-')[0])>=2002
                team_maps.append(season_team_map_div_2(season_dir))
                game_mats.append(season_game_mat(season_dir, team_maps[nseasons], div=
                nseasons += 1
```

```
In [7]: def eucl_error(outputs, targets):
            return np.mean(np.abs(targets - outputs))

In [8]: def ternarize(x):
            if(x > 0.5):
                return 1
            if(x < -0.5):
                return -1
            return 0

        def disc_error(outputs, targets):
            ternarize_fn = np.vectorize(ternarize)
            ternarized_outputs = ternarize_fn(np.round(outputs))
            ternarized_targets = ternarize_fn(np.round(targets))
            err = 0
            n = 0
            for i in range(len(outputs)):
                for j in range(len(outputs[i])):
                    if(int(ternarized_outputs[i][j]) != int(ternarized_targets[i][j])):
                        err += 1
                    n += 1
            return float(err)/n

In [9]: ntraining = int(nseasons*0.7)
        ntesting = nseasons - ntraining

        training_game_mats = game_mats[:ntraining]
        testing_game_mats = game_mats[ntesting:]

        X_training = np.reshape(np.array(training_game_mats), (ntraining*nmatches, nteams))
        lengths = np.full(ntraining, nmatches)

In [10]: nseasons

Out[10]: 88

In [11]: ntraining

Out[11]: 61

In [12]: X_trainings = []
         Y_trainings = []
         for i in range(1, nmatches):
             X_training = []
             Y_training = []
             for game_mat in training_game_mats:
                 for j in range(nmatches-i):
                     X_training.append(np.ndarray.flatten(game_mat[j:j+i]))
                     Y_training.append(game_mat[j+i])
```

```
            X_training = np.array(X_training).reshape(-1,i,nteams)
            Y_training = np.array(Y_training).reshape(-1,nteams)
            X_trainings.append(X_training)
            Y_trainings.append(Y_training)
```

In [13]:
```
X_testings = []
Y_testings = []
for i in range(1, nmatches):
    X_testing = []
    Y_testing = []
    for game_mat in testing_game_mats:
        for j in range(nmatches-i):
            X_testing.append(np.ndarray.flatten(game_mat[j:j+i]))
            Y_testing.append(game_mat[j+i])

    X_testing = np.array(X_testing).reshape(-1,i,nteams)
    Y_testing = np.array(Y_testing).reshape(-1,nteams)
    X_testings.append(X_testing)
    Y_testings.append(Y_testing)
```

In [36]:
```
layer_sizes = [300]
layers = [1]
min_sequence_length = 1
max_sequence_length = 7
epochs = [130]
batch_sizes = [32]
learning_rates = [0.001]
dropouts = [0.2]
cell_types = ["Attention"]
```

In [38]:
```
rnns = {}
for layer_size in layer_sizes:
    for layer_num in layers:
        for epochs_num in epochs:
            for batch_size in batch_sizes:
                for lr in learning_rates:
                    for dropout in dropouts:
                        for ct in cell_types:
                            key = str(layer_size)+"_"+str(layer_num)+"_"+str(epochs_nu
                            rnns[key] = []
```

In [39]:
```
histories = {}
for layer_size in layer_sizes:
    for layer_num in layers:
        for epochs_num in epochs:
            for batch_size in batch_sizes:
                for lr in learning_rates:
                    for dropout in dropouts:
```

```
                                for ct in cell_types:
                                    key = str(layer_size)+"_"+str(layer_num)+"_"+str(epochs_nu
                                    histories[key] = []
```

In [40]:
```
for i in range(min_sequence_length, max_sequence_length+1):
    print("Sequence Length of " + str(i))
    for size in layer_sizes:
        for layer_num in layers:
            for epochs_num in epochs:
                for batch_size in batch_sizes:
                    for lr in learning_rates:
                        for dropout in dropouts:
                            for ct in cell_types:
                                key = str(layer_size)+"_"+str(layer_num)+"_"+str(epoch
                                print(key)
                                model = Sequential()

                                if(ct=="LSTM"):
                                    if(layer_num==1):
                                        model.add(LSTM(size, input_shape=(i+1, nteams)
                                        model.add(Dropout(dropout))
                                    else:
                                        model.add(LSTM(int(size/layer_num), input_shap
                                        model.add(Dropout(dropout))
                                        model.add(LSTM(int(size/layer_num)))
                                        model.add(Dropout(dropout))
                                elif(ct=="GRU"):
                                    if(layer_num==1):
                                        model.add(GRU(size, input_shape=(i+1, nteams))
                                        model.add(Dropout(dropout))
                                    else:
                                        model.add(GRU(int(size/layer_num), input_shape
                                        model.add(Dropout(dropout))
                                        model.add(GRU(int(size/layer_num)))
                                        model.add(Dropout(dropout))
                                elif(ct=="Attention"):
                                    model.add(LSTM(int(size), input_shape=(i+1, nteams
                                    model.add(Dropout(dropout))
                                    model.add(Flatten())

                                model.add(Dense(nteams, activation='tanh'))

                                opt = optimizers.Adam(lr=lr)
                                model.compile(loss='mean_squared_error', optimizer=opt
                                histories[key].append(model.fit(X_trainings[i], np.arr
                                rnns[key].append(model)
```

```
Sequence Length of 1
300_1_130_32_0.001_0.2_Attention
```

```
Epoch 1/130
2196/2196 [==============================] - 2s 819us/step - loss: 2.7001
Epoch 2/130
2196/2196 [==============================] - 1s 503us/step - loss: 2.6240
Epoch 3/130
2196/2196 [==============================] - 1s 520us/step - loss: 2.5996
Epoch 4/130
2196/2196 [==============================] - 1s 616us/step - loss: 2.5826
Epoch 5/130
2196/2196 [==============================] - 1s 544us/step - loss: 2.5651
Epoch 6/130
2196/2196 [==============================] - 2s 698us/step - loss: 2.5470 0
Epoch 7/130
2196/2196 [==============================] - ETA: 0s - loss: 2.527 - 1s 606us/step - loss: 2.52
Epoch 8/130
2196/2196 [==============================] - 2s 713us/step - loss: 2.4999 0s - loss
Epoch 9/130
2196/2196 [==============================] - 2s 841us/step - loss: 2.4664
Epoch 10/130
2196/2196 [==============================] - 1s 508us/step - loss: 2.4252
Epoch 11/130
2196/2196 [==============================] - 1s 472us/step - loss: 2.3831
Epoch 12/130
2196/2196 [==============================] - 1s 445us/step - loss: 2.3348
Epoch 13/130
2196/2196 [==============================] - 1s 458us/step - loss: 2.2799
Epoch 14/130
2196/2196 [==============================] - 1s 450us/step - loss: 2.2304
Epoch 15/130
2196/2196 [==============================] - 1s 524us/step - loss: 2.1814
Epoch 16/130
2196/2196 [==============================] - 1s 495us/step - loss: 2.1346
Epoch 17/130
2196/2196 [==============================] - 1s 472us/step - loss: 2.0800
Epoch 18/130
2196/2196 [==============================] - 1s 430us/step - loss: 2.0394
Epoch 19/130
2196/2196 [==============================] - 1s 493us/step - loss: 1.9966
Epoch 20/130
2196/2196 [==============================] - 1s 524us/step - loss: 1.9486
Epoch 21/130
2196/2196 [==============================] - 1s 496us/step - loss: 1.9116
Epoch 22/130
2196/2196 [==============================] - 1s 442us/step - loss: 1.8712
Epoch 23/130
2196/2196 [==============================] - 1s 454us/step - loss: 1.8368
Epoch 24/130
2196/2196 [==============================] - 1s 471us/step - loss: 1.7985
```

```
Epoch 25/130
2196/2196 [==============================] - 1s 501us/step - loss: 1.7689
Epoch 26/130
2196/2196 [==============================] - 1s 431us/step - loss: 1.7385
Epoch 27/130
2196/2196 [==============================] - 1s 427us/step - loss: 1.7173
Epoch 28/130
2196/2196 [==============================] - 1s 420us/step - loss: 1.6907
Epoch 29/130
2196/2196 [==============================] - 1s 411us/step - loss: 1.6655
Epoch 30/130
2196/2196 [==============================] - 1s 415us/step - loss: 1.6386
Epoch 31/130
2196/2196 [==============================] - 1s 423us/step - loss: 1.6185
Epoch 32/130
2196/2196 [==============================] - 1s 427us/step - loss: 1.5980
Epoch 33/130
2196/2196 [==============================] - 1s 423us/step - loss: 1.5792
Epoch 34/130
2196/2196 [==============================] - 1s 435us/step - loss: 1.5659
Epoch 35/130
2196/2196 [==============================] - 1s 433us/step - loss: 1.5425
Epoch 36/130
2196/2196 [==============================] - 1s 675us/step - loss: 1.5303
Epoch 37/130
2196/2196 [==============================] - 1s 537us/step - loss: 1.5157
Epoch 38/130
2196/2196 [==============================] - 1s 662us/step - loss: 1.5018
Epoch 39/130
2196/2196 [==============================] - 2s 819us/step - loss: 1.4831
Epoch 40/130
2196/2196 [==============================] - 2s 692us/step - loss: 1.4714
Epoch 41/130
2196/2196 [==============================] - 1s 582us/step - loss: 1.4639
Epoch 42/130
2196/2196 [==============================] - 1s 596us/step - loss: 1.4528
Epoch 43/130
2196/2196 [==============================] - 1s 571us/step - loss: 1.4399
Epoch 44/130
2196/2196 [==============================] - 1s 567us/step - loss: 1.4327
Epoch 45/130
2196/2196 [==============================] - 1s 467us/step - loss: 1.4217
Epoch 46/130
2196/2196 [==============================] - 1s 449us/step - loss: 1.4139
Epoch 47/130
2196/2196 [==============================] - 1s 621us/step - loss: 1.4037
Epoch 48/130
2196/2196 [==============================] - 1s 677us/step - loss: 1.3978
```

```
Epoch 49/130
2196/2196 [==============================] - 1s 637us/step - loss: 1.3974
Epoch 50/130
2196/2196 [==============================] - 1s 642us/step - loss: 1.3842
Epoch 51/130
2196/2196 [==============================] - 1s 503us/step - loss: 1.3794
Epoch 52/130
2196/2196 [==============================] - 1s 592us/step - loss: 1.3737
Epoch 53/130
2196/2196 [==============================] - ETA: 0s - loss: 1.366 - 1s 633us/step - loss: 1.36
Epoch 54/130
2196/2196 [==============================] - 2s 974us/step - loss: 1.3608
Epoch 55/130
2196/2196 [==============================] - 1s 664us/step - loss: 1.3581
Epoch 56/130
2196/2196 [==============================] - 2s 791us/step - loss: 1.3534
Epoch 57/130
2196/2196 [==============================] - 2s 1ms/step - loss: 1.3465A: 0s - l
Epoch 58/130
2196/2196 [==============================] - 2s 751us/step - loss: 1.3425
Epoch 59/130
2196/2196 [==============================] - 2s 711us/step - loss: 1.3367
Epoch 60/130
2196/2196 [==============================] - 1s 618us/step - loss: 1.3323
Epoch 61/130
2196/2196 [==============================] - 2s 691us/step - loss: 1.3322
Epoch 62/130
2196/2196 [==============================] - 1s 537us/step - loss: 1.3269
Epoch 63/130
2196/2196 [==============================] - 1s 622us/step - loss: 1.3221
Epoch 64/130
2196/2196 [==============================] - 1s 619us/step - loss: 1.3187
Epoch 65/130
2196/2196 [==============================] - 2s 705us/step - loss: 1.3108
Epoch 66/130
2196/2196 [==============================] - 2s 688us/step - loss: 1.3127
Epoch 67/130
2196/2196 [==============================] - 1s 560us/step - loss: 1.3087
Epoch 68/130
2196/2196 [==============================] - 1s 556us/step - loss: 1.3039
Epoch 69/130
2196/2196 [==============================] - 2s 702us/step - loss: 1.3012
Epoch 70/130
2196/2196 [==============================] - 1s 598us/step - loss: 1.3025
Epoch 71/130
2196/2196 [==============================] - 1s 539us/step - loss: 1.2966
Epoch 72/130
2196/2196 [==============================] - 1s 538us/step - loss: 1.2951
```

```
Epoch 73/130
2196/2196 [==============================] - 1s 586us/step - loss: 1.2941
Epoch 74/130
2196/2196 [==============================] - 1s 600us/step - loss: 1.2916
Epoch 75/130
2196/2196 [==============================] - 1s 581us/step - loss: 1.2898
Epoch 76/130
2196/2196 [==============================] - 1s 541us/step - loss: 1.2874
Epoch 77/130
2196/2196 [==============================] - 1s 551us/step - loss: 1.2877
Epoch 78/130
2196/2196 [==============================] - 1s 477us/step - loss: 1.2798
Epoch 79/130
2196/2196 [==============================] - 1s 511us/step - loss: 1.2809
Epoch 80/130
2196/2196 [==============================] - 1s 507us/step - loss: 1.2771
Epoch 81/130
2196/2196 [==============================] - 1s 508us/step - loss: 1.2768
Epoch 82/130
2196/2196 [==============================] - 1s 574us/step - loss: 1.2741
Epoch 83/130
2196/2196 [==============================] - 2s 699us/step - loss: 1.2708
Epoch 84/130
2196/2196 [==============================] - 1s 628us/step - loss: 1.2738
Epoch 85/130
2196/2196 [==============================] - 1s 502us/step - loss: 1.2721
Epoch 86/130
2196/2196 [==============================] - 1s 567us/step - loss: 1.2712
Epoch 87/130
2196/2196 [==============================] - 1s 588us/step - loss: 1.2685
Epoch 88/130
2196/2196 [==============================] - 1s 639us/step - loss: 1.2678
Epoch 89/130
2196/2196 [==============================] - 1s 674us/step - loss: 1.2661
Epoch 90/130
2196/2196 [==============================] - 1s 641us/step - loss: 1.2663
Epoch 91/130
2196/2196 [==============================] - 1s 547us/step - loss: 1.2628
Epoch 92/130
2196/2196 [==============================] - 1s 465us/step - loss: 1.2624
Epoch 93/130
2196/2196 [==============================] - 1s 486us/step - loss: 1.2628
Epoch 94/130
2196/2196 [==============================] - 1s 511us/step - loss: 1.2568
Epoch 95/130
2196/2196 [==============================] - 1s 601us/step - loss: 1.2580
Epoch 96/130
2196/2196 [==============================] - 2s 685us/step - loss: 1.2566
```

```
Epoch 97/130
2196/2196 [==============================] - 1s 659us/step - loss: 1.2567
Epoch 98/130
2196/2196 [==============================] - 2s 740us/step - loss: 1.2541
Epoch 99/130
2196/2196 [==============================] - 2s 719us/step - loss: 1.2531
Epoch 100/130
2196/2196 [==============================] - 1s 524us/step - loss: 1.2514
Epoch 101/130
2196/2196 [==============================] - 1s 632us/step - loss: 1.2511
Epoch 102/130
2196/2196 [==============================] - 2s 726us/step - loss: 1.2489
Epoch 103/130
2196/2196 [==============================] - 1s 678us/step - loss: 1.2500
Epoch 104/130
2196/2196 [==============================] - 1s 575us/step - loss: 1.2472
Epoch 105/130
2196/2196 [==============================] - 1s 451us/step - loss: 1.2462
Epoch 106/130
2196/2196 [==============================] - 1s 493us/step - loss: 1.2455
Epoch 107/130
2196/2196 [==============================] - 1s 454us/step - loss: 1.2461
Epoch 108/130
2196/2196 [==============================] - 1s 430us/step - loss: 1.2451
Epoch 109/130
2196/2196 [==============================] - 1s 453us/step - loss: 1.2429
Epoch 110/130
2196/2196 [==============================] - 1s 433us/step - loss: 1.2411
Epoch 111/130
2196/2196 [==============================] - 1s 523us/step - loss: 1.2408
Epoch 112/130
2196/2196 [==============================] - 1s 516us/step - loss: 1.2416
Epoch 113/130
2196/2196 [==============================] - 1s 456us/step - loss: 1.2387
Epoch 114/130
2196/2196 [==============================] - 1s 466us/step - loss: 1.2388
Epoch 115/130
2196/2196 [==============================] - 1s 459us/step - loss: 1.2393
Epoch 116/130
2196/2196 [==============================] - 1s 531us/step - loss: 1.2382
Epoch 117/130
2196/2196 [==============================] - 2s 720us/step - loss: 1.2379
Epoch 118/130
2196/2196 [==============================] - 2s 742us/step - loss: 1.2349
Epoch 119/130
2196/2196 [==============================] - 1s 557us/step - loss: 1.2354
Epoch 120/130
2196/2196 [==============================] - 1s 479us/step - loss: 1.2341
```

```
Epoch 121/130
2196/2196 [==============================] - 1s 456us/step - loss: 1.2334
Epoch 122/130
2196/2196 [==============================] - 2s 714us/step - loss: 1.2353
Epoch 123/130
2196/2196 [==============================] - 1s 623us/step - loss: 1.2325
Epoch 124/130
2196/2196 [==============================] - 1s 544us/step - loss: 1.2335
Epoch 125/130
2196/2196 [==============================] - 1s 525us/step - loss: 1.2300
Epoch 126/130
2196/2196 [==============================] - 1s 673us/step - loss: 1.2296
Epoch 127/130
2196/2196 [==============================] - 1s 619us/step - loss: 1.2286
Epoch 128/130
2196/2196 [==============================] - 1s 557us/step - loss: 1.2297
Epoch 129/130
2196/2196 [==============================] - 1s 482us/step - loss: 1.2279
Epoch 130/130
2196/2196 [==============================] - 1s 495us/step - loss: 1.2266
Sequence Length of 2
300_1_130_32_0.001_0.2_Attention
Epoch 1/130
2135/2135 [==============================] - 2s 1ms/step - loss: 2.6904
Epoch 2/130
2135/2135 [==============================] - 1s 619us/step - loss: 2.6204
Epoch 3/130
2135/2135 [==============================] - 1s 642us/step - loss: 2.5945 0s - loss
Epoch 4/130
2135/2135 [==============================] - 1s 634us/step - loss: 2.5715
Epoch 5/130
2135/2135 [==============================] - 1s 620us/step - loss: 2.5514
Epoch 6/130
2135/2135 [==============================] - 1s 680us/step - loss: 2.5189
Epoch 7/130
2135/2135 [==============================] - 2s 867us/step - loss: 2.4860
Epoch 8/130
2135/2135 [==============================] - 2s 885us/step - loss: 2.4378
Epoch 9/130
2135/2135 [==============================] - 2s 880us/step - loss: 2.3787
Epoch 10/130
2135/2135 [==============================] - 2s 890us/step - loss: 2.3109
Epoch 11/130
2135/2135 [==============================] - 2s 772us/step - loss: 2.2375
Epoch 12/130
2135/2135 [==============================] - 2s 790us/step - loss: 2.1639
Epoch 13/130
2135/2135 [==============================] - 2s 727us/step - loss: 2.0883
```

```
Epoch 14/130
2135/2135 [==============================] - 1s 630us/step - loss: 2.0175
Epoch 15/130
2135/2135 [==============================] - 2s 721us/step - loss: 1.9512
Epoch 16/130
2135/2135 [==============================] - 2s 950us/step - loss: 1.8837
Epoch 17/130
2135/2135 [==============================] - 1s 696us/step - loss: 1.8267
Epoch 18/130
2135/2135 [==============================] - 1s 643us/step - loss: 1.7718
Epoch 19/130
2135/2135 [==============================] - 1s 567us/step - loss: 1.7192
Epoch 20/130
2135/2135 [==============================] - 1s 545us/step - loss: 1.6749
Epoch 21/130
2135/2135 [==============================] - 1s 559us/step - loss: 1.6341
Epoch 22/130
2135/2135 [==============================] - 1s 669us/step - loss: 1.5980
Epoch 23/130
2135/2135 [==============================] - 1s 684us/step - loss: 1.5636
Epoch 24/130
2135/2135 [==============================] - 1s 580us/step - loss: 1.5321
Epoch 25/130
2135/2135 [==============================] - 1s 556us/step - loss: 1.5075
Epoch 26/130
2135/2135 [==============================] - 1s 543us/step - loss: 1.4867
Epoch 27/130
2135/2135 [==============================] - 1s 542us/step - loss: 1.4606
Epoch 28/130
2135/2135 [==============================] - 1s 557us/step - loss: 1.4391
Epoch 29/130
2135/2135 [==============================] - 1s 668us/step - loss: 1.4242
Epoch 30/130
2135/2135 [==============================] - 2s 801us/step - loss: 1.4107
Epoch 31/130
2135/2135 [==============================] - 1s 579us/step - loss: 1.3941
Epoch 32/130
2135/2135 [==============================] - 1s 571us/step - loss: 1.3831
Epoch 33/130
2135/2135 [==============================] - 1s 566us/step - loss: 1.3680
Epoch 34/130
2135/2135 [==============================] - 1s 563us/step - loss: 1.3615
Epoch 35/130
2135/2135 [==============================] - 1s 588us/step - loss: 1.3489
Epoch 36/130
2135/2135 [==============================] - 1s 631us/step - loss: 1.3401
Epoch 37/130
2135/2135 [==============================] - 1s 577us/step - loss: 1.3323
```

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Epoch 38/130
2135/2135 [==============================] - 1s 608us/step - loss: 1.3224
Epoch 39/130
2135/2135 [==============================] - 1s 563us/step - loss: 1.3183
Epoch 40/130
2135/2135 [==============================] - 1s 547us/step - loss: 1.3098
Epoch 41/130
2135/2135 [==============================] - 1s 558us/step - loss: 1.3081
Epoch 42/130
2135/2135 [==============================] - 1s 553us/step - loss: 1.3010
Epoch 43/130
2135/2135 [==============================] - 1s 546us/step - loss: 1.2989
Epoch 44/130
2135/2135 [==============================] - 1s 564us/step - loss: 1.2932
Epoch 45/130
2135/2135 [==============================] - 1s 561us/step - loss: 1.2896
Epoch 46/130
2135/2135 [==============================] - 1s 564us/step - loss: 1.2859
Epoch 47/130
2135/2135 [==============================] - 1s 592us/step - loss: 1.2836
Epoch 48/130
2135/2135 [==============================] - 1s 575us/step - loss: 1.2794
Epoch 49/130
2135/2135 [==============================] - 1s 637us/step - loss: 1.2754
Epoch 50/130
2135/2135 [==============================] - 1s 568us/step - loss: 1.2743
Epoch 51/130
2135/2135 [==============================] - 1s 568us/step - loss: 1.2685
Epoch 52/130
2135/2135 [==============================] - 1s 559us/step - loss: 1.2654
Epoch 53/130
2135/2135 [==============================] - 1s 571us/step - loss: 1.2632
Epoch 54/130
2135/2135 [==============================] - 1s 568us/step - loss: 1.2599
Epoch 55/130
2135/2135 [==============================] - 1s 591us/step - loss: 1.2612
Epoch 56/130
2135/2135 [==============================] - 1s 574us/step - loss: 1.2581
Epoch 57/130
2135/2135 [==============================] - 1s 556us/step - loss: 1.2565
Epoch 58/130
2135/2135 [==============================] - 1s 540us/step - loss: 1.2539
Epoch 59/130
2135/2135 [==============================] - 1s 544us/step - loss: 1.2517
Epoch 60/130
2135/2135 [==============================] - 1s 526us/step - loss: 1.2523
Epoch 61/130
2135/2135 [==============================] - 1s 488us/step - loss: 1.2492
```

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Epoch 62/130
2135/2135 [==============================] - 1s 494us/step - loss: 1.2466
Epoch 63/130
2135/2135 [==============================] - 1s 492us/step - loss: 1.2441
Epoch 64/130
2135/2135 [==============================] - 1s 497us/step - loss: 1.2443
Epoch 65/130
2135/2135 [==============================] - 1s 588us/step - loss: 1.2442
Epoch 66/130
2135/2135 [==============================] - 1s 553us/step - loss: 1.2409
Epoch 67/130
2135/2135 [==============================] - 1s 505us/step - loss: 1.2395 0s
Epoch 68/130
2135/2135 [==============================] - 1s 504us/step - loss: 1.2384
Epoch 69/130
2135/2135 [==============================] - 1s 503us/step - loss: 1.2354
Epoch 70/130
2135/2135 [==============================] - 1s 502us/step - loss: 1.2371
Epoch 71/130
2135/2135 [==============================] - 1s 503us/step - loss: 1.2350
Epoch 72/130
2135/2135 [==============================] - 1s 503us/step - loss: 1.2344
Epoch 73/130
2135/2135 [==============================] - 1s 501us/step - loss: 1.2343
Epoch 74/130
2135/2135 [==============================] - 1s 540us/step - loss: 1.2339
Epoch 75/130
2135/2135 [==============================] - 1s 487us/step - loss: 1.2315
Epoch 76/130
2135/2135 [==============================] - 1s 505us/step - loss: 1.2306
Epoch 77/130
2135/2135 [==============================] - 1s 496us/step - loss: 1.2291 0s
Epoch 78/130
2135/2135 [==============================] - 1s 493us/step - loss: 1.2279
Epoch 79/130
2135/2135 [==============================] - 1s 501us/step - loss: 1.2260
Epoch 80/130
2135/2135 [==============================] - 1s 499us/step - loss: 1.2265
Epoch 81/130
2135/2135 [==============================] - 1s 500us/step - loss: 1.2271
Epoch 82/130
2135/2135 [==============================] - 1s 500us/step - loss: 1.2249
Epoch 83/130
2135/2135 [==============================] - 1s 501us/step - loss: 1.2234
Epoch 84/130
2135/2135 [==============================] - 1s 591us/step - loss: 1.2234
Epoch 85/130
2135/2135 [==============================] - 1s 567us/step - loss: 1.2219
```

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Epoch 86/130
2135/2135 [==============================] - 1s 502us/step - loss: 1.2203
Epoch 87/130
2135/2135 [==============================] - 1s 499us/step - loss: 1.2209
Epoch 88/130
2135/2135 [==============================] - 1s 496us/step - loss: 1.2197
Epoch 89/130
2135/2135 [==============================] - 1s 495us/step - loss: 1.2199
Epoch 90/130
2135/2135 [==============================] - 1s 493us/step - loss: 1.2191
Epoch 91/130
2135/2135 [==============================] - 1s 502us/step - loss: 1.2177
Epoch 92/130
2135/2135 [==============================] - 1s 495us/step - loss: 1.2162
Epoch 93/130
2135/2135 [==============================] - 1s 510us/step - loss: 1.2165
Epoch 94/130
2135/2135 [==============================] - 1s 531us/step - loss: 1.2157
Epoch 95/130
2135/2135 [==============================] - 1s 540us/step - loss: 1.2142
Epoch 96/130
2135/2135 [==============================] - 1s 490us/step - loss: 1.2151
Epoch 97/130
2135/2135 [==============================] - 1s 489us/step - loss: 1.2134
Epoch 98/130
2135/2135 [==============================] - 1s 495us/step - loss: 1.2126
Epoch 99/130
2135/2135 [==============================] - 1s 487us/step - loss: 1.2125
Epoch 100/130
2135/2135 [==============================] - 1s 494us/step - loss: 1.2125
Epoch 101/130
2135/2135 [==============================] - 1s 490us/step - loss: 1.2108
Epoch 102/130
2135/2135 [==============================] - 1s 490us/step - loss: 1.2112 0s
Epoch 103/130
2135/2135 [==============================] - 1s 539us/step - loss: 1.2096
Epoch 104/130
2135/2135 [==============================] - 1s 496us/step - loss: 1.2099
Epoch 105/130
2135/2135 [==============================] - 1s 490us/step - loss: 1.2089
Epoch 106/130
2135/2135 [==============================] - 1s 482us/step - loss: 1.2080
Epoch 107/130
2135/2135 [==============================] - 1s 482us/step - loss: 1.2074
Epoch 108/130
2135/2135 [==============================] - 1s 502us/step - loss: 1.2069
Epoch 109/130
2135/2135 [==============================] - 1s 490us/step - loss: 1.2057
```

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Epoch 110/130
2135/2135 [==============================] - 1s 493us/step - loss: 1.2044
Epoch 111/130
2135/2135 [==============================] - 1s 490us/step - loss: 1.2056
Epoch 112/130
2135/2135 [==============================] - 1s 486us/step - loss: 1.2036
Epoch 113/130
2135/2135 [==============================] - 1s 587us/step - loss: 1.2026
Epoch 114/130
2135/2135 [==============================] - 1s 570us/step - loss: 1.2042
Epoch 115/130
2135/2135 [==============================] - 1s 504us/step - loss: 1.2020
Epoch 116/130
2135/2135 [==============================] - 1s 499us/step - loss: 1.2018
Epoch 117/130
2135/2135 [==============================] - 1s 485us/step - loss: 1.2019
Epoch 118/130
2135/2135 [==============================] - 1s 482us/step - loss: 1.2016
Epoch 119/130
2135/2135 [==============================] - 1s 490us/step - loss: 1.2013
Epoch 120/130
2135/2135 [==============================] - 1s 489us/step - loss: 1.2005
Epoch 121/130
2135/2135 [==============================] - 1s 486us/step - loss: 1.1980
Epoch 122/130
2135/2135 [==============================] - 1s 527us/step - loss: 1.1977
Epoch 123/130
2135/2135 [==============================] - 1s 552us/step - loss: 1.1991
Epoch 124/130
2135/2135 [==============================] - 1s 504us/step - loss: 1.1982
Epoch 125/130
2135/2135 [==============================] - 1s 485us/step - loss: 1.1985
Epoch 126/130
2135/2135 [==============================] - 1s 491us/step - loss: 1.1961
Epoch 127/130
2135/2135 [==============================] - 1s 492us/step - loss: 1.1961
Epoch 128/130
2135/2135 [==============================] - 1s 490us/step - loss: 1.1958
Epoch 129/130
2135/2135 [==============================] - 1s 480us/step - loss: 1.1956
Epoch 130/130
2135/2135 [==============================] - 1s 482us/step - loss: 1.1955
Sequence Length of 3
300_1_130_32_0.001_0.2_Attention
Epoch 1/130
2074/2074 [==============================] - 2s 1ms/step - loss: 2.6814
Epoch 2/130
2074/2074 [==============================] - 1s 568us/step - loss: 2.6159
```

```
Epoch 3/130
2074/2074 [==============================] - 1s 568us/step - loss: 2.5867
Epoch 4/130
2074/2074 [==============================] - 1s 572us/step - loss: 2.5590
Epoch 5/130
2074/2074 [==============================] - 1s 572us/step - loss: 2.5336
Epoch 6/130
2074/2074 [==============================] - 1s 574us/step - loss: 2.5019
Epoch 7/130
2074/2074 [==============================] - 1s 592us/step - loss: 2.4566
Epoch 8/130
2074/2074 [==============================] - 1s 624us/step - loss: 2.4002
Epoch 9/130
2074/2074 [==============================] - 1s 699us/step - loss: 2.3330
Epoch 10/130
2074/2074 [==============================] - 1s 601us/step - loss: 2.2461
Epoch 11/130
2074/2074 [==============================] - 1s 586us/step - loss: 2.1521
Epoch 12/130
2074/2074 [==============================] - 1s 583us/step - loss: 2.0631
Epoch 13/130
2074/2074 [==============================] - 1s 586us/step - loss: 1.9771
Epoch 14/130
2074/2074 [==============================] - 1s 588us/step - loss: 1.9007
Epoch 15/130
2074/2074 [==============================] - 1s 580us/step - loss: 1.8275
Epoch 16/130
2074/2074 [==============================] - 1s 576us/step - loss: 1.7571
Epoch 17/130
2074/2074 [==============================] - 1s 675us/step - loss: 1.6970
Epoch 18/130
2074/2074 [==============================] - 1s 640us/step - loss: 1.6488
Epoch 19/130
2074/2074 [==============================] - 1s 588us/step - loss: 1.5962
Epoch 20/130
2074/2074 [==============================] - 1s 582us/step - loss: 1.5566
Epoch 21/130
2074/2074 [==============================] - 1s 571us/step - loss: 1.5211
Epoch 22/130
2074/2074 [==============================] - 1s 581us/step - loss: 1.4856
Epoch 23/130
2074/2074 [==============================] - 1s 589us/step - loss: 1.4625
Epoch 24/130
2074/2074 [==============================] - 1s 589us/step - loss: 1.4349
Epoch 25/130
2074/2074 [==============================] - 1s 627us/step - loss: 1.4149
Epoch 26/130
2074/2074 [==============================] - 1s 585us/step - loss: 1.3968
```

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Epoch 27/130
2074/2074 [==============================] - 1s 588us/step - loss: 1.3794
Epoch 28/130
2074/2074 [==============================] - 1s 599us/step - loss: 1.3685
Epoch 29/130
2074/2074 [==============================] - 1s 586us/step - loss: 1.3552
Epoch 30/130
2074/2074 [==============================] - 1s 587us/step - loss: 1.3438
Epoch 31/130
2074/2074 [==============================] - 1s 598us/step - loss: 1.3347
Epoch 32/130
2074/2074 [==============================] - 1s 601us/step - loss: 1.3254
Epoch 33/130
2074/2074 [==============================] - 1s 617us/step - loss: 1.3149
Epoch 34/130
2074/2074 [==============================] - 1s 672us/step - loss: 1.3082
Epoch 35/130
2074/2074 [==============================] - 1s 593us/step - loss: 1.2985
Epoch 36/130
2074/2074 [==============================] - 1s 600us/step - loss: 1.2945
Epoch 37/130
2074/2074 [==============================] - 1s 585us/step - loss: 1.2874
Epoch 38/130
2074/2074 [==============================] - 1s 574us/step - loss: 1.2823
Epoch 39/130
2074/2074 [==============================] - 1s 574us/step - loss: 1.2783
Epoch 40/130
2074/2074 [==============================] - 1s 574us/step - loss: 1.2759
Epoch 41/130
2074/2074 [==============================] - 1s 595us/step - loss: 1.2716
Epoch 42/130
2074/2074 [==============================] - 1s 635us/step - loss: 1.2671
Epoch 43/130
2074/2074 [==============================] - 1s 645us/step - loss: 1.2645
Epoch 44/130
2074/2074 [==============================] - 1s 581us/step - loss: 1.2633
Epoch 45/130
2074/2074 [==============================] - 1s 587us/step - loss: 1.2587
Epoch 46/130
2074/2074 [==============================] - 1s 587us/step - loss: 1.2558
Epoch 47/130
2074/2074 [==============================] - 1s 584us/step - loss: 1.2541
Epoch 48/130
2074/2074 [==============================] - 1s 584us/step - loss: 1.2519
Epoch 49/130
2074/2074 [==============================] - 1s 586us/step - loss: 1.2474
Epoch 50/130
2074/2074 [==============================] - 1s 631us/step - loss: 1.2474
```

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Epoch 51/130
2074/2074 [==============================] - 1s 614us/step - loss: 1.2440
Epoch 52/130
2074/2074 [==============================] - 1s 586us/step - loss: 1.2406
Epoch 53/130
2074/2074 [==============================] - 1s 580us/step - loss: 1.2421
Epoch 54/130
2074/2074 [==============================] - 1s 575us/step - loss: 1.2395
Epoch 55/130
2074/2074 [==============================] - 1s 586us/step - loss: 1.2361
Epoch 56/130
2074/2074 [==============================] - 1s 588us/step - loss: 1.2346
Epoch 57/130
2074/2074 [==============================] - 1s 593us/step - loss: 1.2334
Epoch 58/130
2074/2074 [==============================] - 1s 593us/step - loss: 1.2324
Epoch 59/130
2074/2074 [==============================] - 1s 661us/step - loss: 1.2319
Epoch 60/130
2074/2074 [==============================] - 1s 611us/step - loss: 1.2287
Epoch 61/130
2074/2074 [==============================] - 1s 577us/step - loss: 1.2280
Epoch 62/130
2074/2074 [==============================] - 1s 591us/step - loss: 1.2278
Epoch 63/130
2074/2074 [==============================] - 1s 588us/step - loss: 1.2268
Epoch 64/130
2074/2074 [==============================] - 1s 590us/step - loss: 1.2253
Epoch 65/130
2074/2074 [==============================] - 1s 591us/step - loss: 1.2239
Epoch 66/130
2074/2074 [==============================] - 1s 583us/step - loss: 1.2234
Epoch 67/130
2074/2074 [==============================] - 1s 621us/step - loss: 1.2220
Epoch 68/130
2074/2074 [==============================] - 1s 599us/step - loss: 1.2212
Epoch 69/130
2074/2074 [==============================] - 1s 588us/step - loss: 1.2199
Epoch 70/130
2074/2074 [==============================] - 1s 581us/step - loss: 1.2180
Epoch 71/130
2074/2074 [==============================] - 1s 592us/step - loss: 1.2170
Epoch 72/130
2074/2074 [==============================] - 1s 600us/step - loss: 1.2164
Epoch 73/130
2074/2074 [==============================] - 1s 581us/step - loss: 1.2152
Epoch 74/130
2074/2074 [==============================] - 1s 584us/step - loss: 1.2151
```

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Epoch 75/130
2074/2074 [==============================] - 1s 622us/step - loss: 1.2125
Epoch 76/130
2074/2074 [==============================] - 1s 680us/step - loss: 1.2115
Epoch 77/130
2074/2074 [==============================] - 1s 585us/step - loss: 1.2110
Epoch 78/130
2074/2074 [==============================] - 1s 581us/step - loss: 1.2101
Epoch 79/130
2074/2074 [==============================] - 1s 582us/step - loss: 1.2085
Epoch 80/130
2074/2074 [==============================] - 1s 589us/step - loss: 1.2084
Epoch 81/130
2074/2074 [==============================] - 1s 588us/step - loss: 1.2073
Epoch 82/130
2074/2074 [==============================] - 1s 680us/step - loss: 1.2066
Epoch 83/130
2074/2074 [==============================] - 1s 626us/step - loss: 1.2062
Epoch 84/130
2074/2074 [==============================] - 1s 657us/step - loss: 1.2046
Epoch 85/130
2074/2074 [==============================] - 1s 616us/step - loss: 1.2054
Epoch 86/130
2074/2074 [==============================] - 1s 591us/step - loss: 1.2050
Epoch 87/130
2074/2074 [==============================] - 1s 616us/step - loss: 1.2040
Epoch 88/130
2074/2074 [==============================] - 1s 618us/step - loss: 1.2027
Epoch 89/130
2074/2074 [==============================] - 1s 702us/step - loss: 1.2030
Epoch 90/130
2074/2074 [==============================] - 2s 953us/step - loss: 1.2013
Epoch 91/130
2074/2074 [==============================] - 2s 1ms/step - loss: 1.2024A: 4s - loss: 1
Epoch 92/130
2074/2074 [==============================] - 2s 1ms/step - loss: 1.2007
Epoch 93/130
2074/2074 [==============================] - 2s 903us/step - loss: 1.1996
Epoch 94/130
2074/2074 [==============================] - 2s 1ms/step - loss: 1.1982A: 0s - lo - ETA: 0s - l
Epoch 95/130
2074/2074 [==============================] - 2s 1ms/step - loss: 1.1984A: 0s - loss:
Epoch 96/130
2074/2074 [==============================] - 2s 1ms/step - loss: 1.1983
Epoch 97/130
2074/2074 [==============================] - 1s 705us/step - loss: 1.1978
Epoch 98/130
2074/2074 [==============================] - 1s 681us/step - loss: 1.1965
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Epoch 99/130
2074/2074 [==============================] - 1s 699us/step - loss: 1.1966
Epoch 100/130
2074/2074 [==============================] - 2s 726us/step - loss: 1.1956
Epoch 101/130
2074/2074 [==============================] - 1s 721us/step - loss: 1.1945
Epoch 102/130
2074/2074 [==============================] - 2s 971us/step - loss: 1.1958
Epoch 103/130
2074/2074 [==============================] - 2s 746us/step - loss: 1.1949
Epoch 104/130
2074/2074 [==============================] - 2s 725us/step - loss: 1.1936
Epoch 105/130
2074/2074 [==============================] - 2s 1ms/step - loss: 1.1923
Epoch 106/130
2074/2074 [==============================] - 2s 890us/step - loss: 1.1929 1s - loss: 1.112
Epoch 107/130
2074/2074 [==============================] - 2s 1ms/step - loss: 1.1917
Epoch 108/130
2074/2074 [==============================] - 2s 836us/step - loss: 1.1915
Epoch 109/130
2074/2074 [==============================] - 2s 860us/step - loss: 1.1909
Epoch 110/130
2074/2074 [==============================] - 2s 738us/step - loss: 1.1908
Epoch 111/130
2074/2074 [==============================] - 1s 616us/step - loss: 1.1899
Epoch 112/130
2074/2074 [==============================] - 1s 607us/step - loss: 1.1894
Epoch 113/130
2074/2074 [==============================] - 1s 628us/step - loss: 1.1879
Epoch 114/130
2074/2074 [==============================] - 1s 624us/step - loss: 1.1876
Epoch 115/130
2074/2074 [==============================] - 1s 684us/step - loss: 1.1874
Epoch 116/130
2074/2074 [==============================] - 1s 625us/step - loss: 1.1867
Epoch 117/130
2074/2074 [==============================] - 1s 609us/step - loss: 1.1866
Epoch 118/130
2074/2074 [==============================] - 1s 612us/step - loss: 1.1868
Epoch 119/130
2074/2074 [==============================] - 1s 615us/step - loss: 1.1867
Epoch 120/130
2074/2074 [==============================] - 1s 612us/step - loss: 1.1858
Epoch 121/130
2074/2074 [==============================] - 1s 675us/step - loss: 1.1849
Epoch 122/130
2074/2074 [==============================] - 1s 634us/step - loss: 1.1851
```

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Epoch 123/130
2074/2074 [==============================] - 1s 642us/step - loss: 1.1848
Epoch 124/130
2074/2074 [==============================] - 1s 620us/step - loss: 1.1846
Epoch 125/130
2074/2074 [==============================] - 1s 620us/step - loss: 1.1844
Epoch 126/130
2074/2074 [==============================] - 1s 618us/step - loss: 1.1826
Epoch 127/130
2074/2074 [==============================] - 1s 601us/step - loss: 1.1826
Epoch 128/130
2074/2074 [==============================] - 1s 606us/step - loss: 1.1823
Epoch 129/130
2074/2074 [==============================] - 1s 622us/step - loss: 1.1818
Epoch 130/130
2074/2074 [==============================] - 1s 615us/step - loss: 1.1811
Sequence Length of 4
300_1_130_32_0.001_0.2_Attention
Epoch 1/130
2013/2013 [==============================] - 2s 1ms/step - loss: 2.6825
Epoch 2/130
2013/2013 [==============================] - 2s 746us/step - loss: 2.6096
Epoch 3/130
2013/2013 [==============================] - 1s 663us/step - loss: 2.5814
Epoch 4/130
2013/2013 [==============================] - 1s 698us/step - loss: 2.5501
Epoch 5/130
2013/2013 [==============================] - 1s 698us/step - loss: 2.5195 0s
Epoch 6/130
2013/2013 [==============================] - 1s 721us/step - loss: 2.4760
Epoch 7/130
2013/2013 [==============================] - 2s 771us/step - loss: 2.4236
Epoch 8/130
2013/2013 [==============================] - 1s 665us/step - loss: 2.3554
Epoch 9/130
2013/2013 [==============================] - 1s 718us/step - loss: 2.2618 0s - los
Epoch 10/130
2013/2013 [==============================] - 1s 720us/step - loss: 2.1667
Epoch 11/130
2013/2013 [==============================] - 1s 701us/step - loss: 2.0721
Epoch 12/130
2013/2013 [==============================] - 1s 701us/step - loss: 1.9803
Epoch 13/130
2013/2013 [==============================] - 2s 787us/step - loss: 1.8908
Epoch 14/130
2013/2013 [==============================] - 2s 774us/step - loss: 1.8067
Epoch 15/130
2013/2013 [==============================] - 1s 701us/step - loss: 1.7372
```

```
Epoch 16/130
2013/2013 [==============================] - 1s 713us/step - loss: 1.6722
Epoch 17/130
2013/2013 [==============================] - 1s 685us/step - loss: 1.6191 0s - loss: 1.
Epoch 18/130
2013/2013 [==============================] - 1s 699us/step - loss: 1.5669 0s - loss:
Epoch 19/130
2013/2013 [==============================] - 1s 697us/step - loss: 1.5273 0s - loss: 1.4 - ETA
Epoch 20/130
2013/2013 [==============================] - 1s 681us/step - loss: 1.4922
Epoch 21/130
2013/2013 [==============================] - 1s 742us/step - loss: 1.4613
Epoch 22/130
2013/2013 [==============================] - 1s 686us/step - loss: 1.4328
Epoch 23/130
2013/2013 [==============================] - 1s 699us/step - loss: 1.4136
Epoch 24/130
2013/2013 [==============================] - 2s 778us/step - loss: 1.3939
Epoch 25/130
2013/2013 [==============================] - 1s 738us/step - loss: 1.3770
Epoch 26/130
2013/2013 [==============================] - 1s 702us/step - loss: 1.3601
Epoch 27/130
2013/2013 [==============================] - 1s 695us/step - loss: 1.3471 0s
Epoch 28/130
2013/2013 [==============================] - 2s 756us/step - loss: 1.3352
Epoch 29/130
2013/2013 [==============================] - 1s 671us/step - loss: 1.3234
Epoch 30/130
2013/2013 [==============================] - 1s 693us/step - loss: 1.3148
Epoch 31/130
2013/2013 [==============================] - 1s 692us/step - loss: 1.3092
Epoch 32/130
2013/2013 [==============================] - 1s 694us/step - loss: 1.3007
Epoch 33/130
2013/2013 [==============================] - 1s 681us/step - loss: 1.2947
Epoch 34/130
2013/2013 [==============================] - 1s 667us/step - loss: 1.2878
Epoch 35/130
2013/2013 [==============================] - 2s 752us/step - loss: 1.2832
Epoch 36/130
2013/2013 [==============================] - 2s 829us/step - loss: 1.2771
Epoch 37/130
2013/2013 [==============================] - 1s 730us/step - loss: 1.2730
Epoch 38/130
2013/2013 [==============================] - 1s 682us/step - loss: 1.2688
Epoch 39/130
2013/2013 [==============================] - 1s 681us/step - loss: 1.2660
```

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Epoch 40/130
2013/2013 [==============================] - 1s 681us/step - loss: 1.2646
Epoch 41/130
2013/2013 [==============================] - 1s 682us/step - loss: 1.2600
Epoch 42/130
2013/2013 [==============================] - 1s 679us/step - loss: 1.2563 0s - lo
Epoch 43/130
2013/2013 [==============================] - 2s 793us/step - loss: 1.2541
Epoch 44/130
2013/2013 [==============================] - 1s 702us/step - loss: 1.2513
Epoch 45/130
2013/2013 [==============================] - 1s 638us/step - loss: 1.2481
Epoch 46/130
2013/2013 [==============================] - 2s 784us/step - loss: 1.2438
Epoch 47/130
2013/2013 [==============================] - 1s 722us/step - loss: 1.2427
Epoch 48/130
2013/2013 [==============================] - 1s 684us/step - loss: 1.2429
Epoch 49/130
2013/2013 [==============================] - 1s 691us/step - loss: 1.2414
Epoch 50/130
2013/2013 [==============================] - 1s 723us/step - loss: 1.2394
Epoch 51/130
2013/2013 [==============================] - 1s 684us/step - loss: 1.2385
Epoch 52/130
2013/2013 [==============================] - 1s 640us/step - loss: 1.2364
Epoch 53/130
2013/2013 [==============================] - 1s 652us/step - loss: 1.2352
Epoch 54/130
2013/2013 [==============================] - 1s 658us/step - loss: 1.2332
Epoch 55/130
2013/2013 [==============================] - 1s 661us/step - loss: 1.2333
Epoch 56/130
2013/2013 [==============================] - 1s 676us/step - loss: 1.2302
Epoch 57/130
2013/2013 [==============================] - 1s 653us/step - loss: 1.2291
Epoch 58/130
2013/2013 [==============================] - 2s 787us/step - loss: 1.2298
Epoch 59/130
2013/2013 [==============================] - 1s 731us/step - loss: 1.2266
Epoch 60/130
2013/2013 [==============================] - 1s 668us/step - loss: 1.2257
Epoch 61/130
2013/2013 [==============================] - 1s 641us/step - loss: 1.2239
Epoch 62/130
2013/2013 [==============================] - 1s 642us/step - loss: 1.2233
Epoch 63/130
2013/2013 [==============================] - 1s 644us/step - loss: 1.2223
```

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Epoch 64/130
2013/2013 [==============================] - 1s 675us/step - loss: 1.2225
Epoch 65/130
2013/2013 [==============================] - 1s 719us/step - loss: 1.2201
Epoch 66/130
2013/2013 [==============================] - 1s 652us/step - loss: 1.2192
Epoch 67/130
2013/2013 [==============================] - 1s 645us/step - loss: 1.2172
Epoch 68/130
2013/2013 [==============================] - 1s 645us/step - loss: 1.2174
Epoch 69/130
2013/2013 [==============================] - 1s 652us/step - loss: 1.2169
Epoch 70/130
2013/2013 [==============================] - 1s 732us/step - loss: 1.2162
Epoch 71/130
2013/2013 [==============================] - 1s 634us/step - loss: 1.2145
Epoch 72/130
2013/2013 [==============================] - 1s 648us/step - loss: 1.2142
Epoch 73/130
2013/2013 [==============================] - 1s 695us/step - loss: 1.2117
Epoch 74/130
2013/2013 [==============================] - 1s 639us/step - loss: 1.2123
Epoch 75/130
2013/2013 [==============================] - 1s 631us/step - loss: 1.2110
Epoch 76/130
2013/2013 [==============================] - 1s 637us/step - loss: 1.2109
Epoch 77/130
2013/2013 [==============================] - 1s 635us/step - loss: 1.2101
Epoch 78/130
2013/2013 [==============================] - 1s 638us/step - loss: 1.2098
Epoch 79/130
2013/2013 [==============================] - 1s 643us/step - loss: 1.2080
Epoch 80/130
2013/2013 [==============================] - 1s 648us/step - loss: 1.2066
Epoch 81/130
2013/2013 [==============================] - 1s 698us/step - loss: 1.2064
Epoch 82/130
2013/2013 [==============================] - 1s 726us/step - loss: 1.2064
Epoch 83/130
2013/2013 [==============================] - 1s 628us/step - loss: 1.2068
Epoch 84/130
2013/2013 [==============================] - 1s 630us/step - loss: 1.2061
Epoch 85/130
2013/2013 [==============================] - 1s 637us/step - loss: 1.2054
Epoch 86/130
2013/2013 [==============================] - 1s 637us/step - loss: 1.2025
Epoch 87/130
2013/2013 [==============================] - 1s 630us/step - loss: 1.2048
```

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Epoch 88/130
2013/2013 [==============================] - 1s 625us/step - loss: 1.2019
Epoch 89/130
2013/2013 [==============================] - 1s 692us/step - loss: 1.2022
Epoch 90/130
2013/2013 [==============================] - 1s 640us/step - loss: 1.2007
Epoch 91/130
2013/2013 [==============================] - 1s 632us/step - loss: 1.2010
Epoch 92/130
2013/2013 [==============================] - 1s 619us/step - loss: 1.1993
Epoch 93/130
2013/2013 [==============================] - 1s 646us/step - loss: 1.1990
Epoch 94/130
2013/2013 [==============================] - 1s 704us/step - loss: 1.1998
Epoch 95/130
2013/2013 [==============================] - 1s 665us/step - loss: 1.1974
Epoch 96/130
2013/2013 [==============================] - 1s 620us/step - loss: 1.1956
Epoch 97/130
2013/2013 [==============================] - 1s 688us/step - loss: 1.1953
Epoch 98/130
2013/2013 [==============================] - 1s 637us/step - loss: 1.1946
Epoch 99/130
2013/2013 [==============================] - 1s 634us/step - loss: 1.1942
Epoch 100/130
2013/2013 [==============================] - 1s 625us/step - loss: 1.1948
Epoch 101/130
2013/2013 [==============================] - 1s 628us/step - loss: 1.1939
Epoch 102/130
2013/2013 [==============================] - 1s 642us/step - loss: 1.1936
Epoch 103/130
2013/2013 [==============================] - 1s 662us/step - loss: 1.1926
Epoch 104/130
2013/2013 [==============================] - 1s 648us/step - loss: 1.1920
Epoch 105/130
2013/2013 [==============================] - 1s 672us/step - loss: 1.1917
Epoch 106/130
2013/2013 [==============================] - 1s 696us/step - loss: 1.1911
Epoch 107/130
2013/2013 [==============================] - 1s 695us/step - loss: 1.1905
Epoch 108/130
2013/2013 [==============================] - 1s 625us/step - loss: 1.1891
Epoch 109/130
2013/2013 [==============================] - 1s 638us/step - loss: 1.1902
Epoch 110/130
2013/2013 [==============================] - 1s 651us/step - loss: 1.1895
Epoch 111/130
2013/2013 [==============================] - 1s 642us/step - loss: 1.1885
```

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Epoch 112/130
2013/2013 [==============================] - 1s 640us/step - loss: 1.1877
Epoch 113/130
2013/2013 [==============================] - 1s 672us/step - loss: 1.1871
Epoch 114/130
2013/2013 [==============================] - 1s 645us/step - loss: 1.1862
Epoch 115/130
2013/2013 [==============================] - 1s 657us/step - loss: 1.1856
Epoch 116/130
2013/2013 [==============================] - 1s 643us/step - loss: 1.1872
Epoch 117/130
2013/2013 [==============================] - 1s 629us/step - loss: 1.1855
Epoch 118/130
2013/2013 [==============================] - 1s 661us/step - loss: 1.1847
Epoch 119/130
2013/2013 [==============================] - 1s 737us/step - loss: 1.1843
Epoch 120/130
2013/2013 [==============================] - 1s 689us/step - loss: 1.1847
Epoch 121/130
2013/2013 [==============================] - 1s 643us/step - loss: 1.1845
Epoch 122/130
2013/2013 [==============================] - 1s 645us/step - loss: 1.1842
Epoch 123/130
2013/2013 [==============================] - 1s 647us/step - loss: 1.1835
Epoch 124/130
2013/2013 [==============================] - 1s 642us/step - loss: 1.1817
Epoch 125/130
2013/2013 [==============================] - 1s 634us/step - loss: 1.1822
Epoch 126/130
2013/2013 [==============================] - 1s 684us/step - loss: 1.1828
Epoch 127/130
2013/2013 [==============================] - 1s 645us/step - loss: 1.1806
Epoch 128/130
2013/2013 [==============================] - 1s 695us/step - loss: 1.1801
Epoch 129/130
2013/2013 [==============================] - 1s 699us/step - loss: 1.1812
Epoch 130/130
2013/2013 [==============================] - 1s 722us/step - loss: 1.1797
Sequence Length of 5
300_1_130_32_0.001_0.2_Attention
Epoch 1/130
1952/1952 [==============================] - 3s 1ms/step - loss: 2.6811
Epoch 2/130
1952/1952 [==============================] - 1s 687us/step - loss: 2.6089
Epoch 3/130
1952/1952 [==============================] - 1s 721us/step - loss: 2.5758
Epoch 4/130
1952/1952 [==============================] - ETA: 0s - loss: 2.535 - 1s 764us/step - loss: 2.54
```

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Epoch 5/130
1952/1952 [==============================] - 1s 723us/step - loss: 2.5026
Epoch 6/130
1952/1952 [==============================] - 1s 706us/step - loss: 2.4526
Epoch 7/130
1952/1952 [==============================] - 1s 707us/step - loss: 2.3934
Epoch 8/130
1952/1952 [==============================] - 1s 739us/step - loss: 2.3132
Epoch 9/130
1952/1952 [==============================] - 1s 738us/step - loss: 2.2184
Epoch 10/130
1952/1952 [==============================] - 2s 861us/step - loss: 2.1170
Epoch 11/130
1952/1952 [==============================] - 2s 798us/step - loss: 2.0144
Epoch 12/130
1952/1952 [==============================] - 1s 722us/step - loss: 1.9081
Epoch 13/130
1952/1952 [==============================] - 1s 714us/step - loss: 1.8255
Epoch 14/130
1952/1952 [==============================] - 1s 738us/step - loss: 1.7437
Epoch 15/130
1952/1952 [==============================] - 1s 734us/step - loss: 1.6744
Epoch 16/130
1952/1952 [==============================] - 1s 751us/step - loss: 1.6143
Epoch 17/130
1952/1952 [==============================] - 1s 725us/step - loss: 1.5636
Epoch 18/130
1952/1952 [==============================] - 2s 783us/step - loss: 1.5260
Epoch 19/130
1952/1952 [==============================] - 1s 722us/step - loss: 1.4859
Epoch 20/130
1952/1952 [==============================] - 1s 747us/step - loss: 1.4573
Epoch 21/130
1952/1952 [==============================] - 2s 865us/step - loss: 1.4263
Epoch 22/130
1952/1952 [==============================] - 1s 726us/step - loss: 1.4033 0s - loss: 1
Epoch 23/130
1952/1952 [==============================] - 1s 716us/step - loss: 1.3861 0s -
Epoch 24/130
1952/1952 [==============================] - 1s 723us/step - loss: 1.3697
Epoch 25/130
1952/1952 [==============================] - 2s 816us/step - loss: 1.3570
Epoch 26/130
1952/1952 [==============================] - 1s 725us/step - loss: 1.3426
Epoch 27/130
1952/1952 [==============================] - 1s 711us/step - loss: 1.3341
Epoch 28/130
1952/1952 [==============================] - 2s 804us/step - loss: 1.3223
```

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Epoch 29/130
1952/1952 [==============================] - 2s 841us/step - loss: 1.3134
Epoch 30/130
1952/1952 [==============================] - 1s 742us/step - loss: 1.3050
Epoch 31/130
1952/1952 [==============================] - 1s 726us/step - loss: 1.2997
Epoch 32/130
1952/1952 [==============================] - 2s 862us/step - loss: 1.2938
Epoch 33/130
1952/1952 [==============================] - 1s 741us/step - loss: 1.2883
Epoch 34/130
1952/1952 [==============================] - 1s 720us/step - loss: 1.2829
Epoch 35/130
1952/1952 [==============================] - 1s 722us/step - loss: 1.2784
Epoch 36/130
1952/1952 [==============================] - 1s 736us/step - loss: 1.2736
Epoch 37/130
1952/1952 [==============================] - 1s 721us/step - loss: 1.2694
Epoch 38/130
1952/1952 [==============================] - 1s 722us/step - loss: 1.2675
Epoch 39/130
1952/1952 [==============================] - 1s 763us/step - loss: 1.2635
Epoch 40/130
1952/1952 [==============================] - 1s 699us/step - loss: 1.2594 0s - loss
Epoch 41/130
1952/1952 [==============================] - 1s 713us/step - loss: 1.2568
Epoch 42/130
1952/1952 [==============================] - 1s 731us/step - loss: 1.2561
Epoch 43/130
1952/1952 [==============================] - 2s 807us/step - loss: 1.2536
Epoch 44/130
1952/1952 [==============================] - 1s 707us/step - loss: 1.2509
Epoch 45/130
1952/1952 [==============================] - 1s 708us/step - loss: 1.2497 0s - los
Epoch 46/130
1952/1952 [==============================] - 1s 765us/step - loss: 1.2471
Epoch 47/130
1952/1952 [==============================] - 1s 724us/step - loss: 1.2474
Epoch 48/130
1952/1952 [==============================] - 1s 706us/step - loss: 1.2426 0s - loss:
Epoch 49/130
1952/1952 [==============================] - 1s 705us/step - loss: 1.2411
Epoch 50/130
1952/1952 [==============================] - 1s 714us/step - loss: 1.2396
Epoch 51/130
1952/1952 [==============================] - 1s 709us/step - loss: 1.2386
Epoch 52/130
1952/1952 [==============================] - 1s 721us/step - loss: 1.2364
```

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Epoch 53/130
1952/1952 [==============================] - 1s 705us/step - loss: 1.2353
Epoch 54/130
1952/1952 [==============================] - 2s 873us/step - loss: 1.2350
Epoch 55/130
1952/1952 [==============================] - 1s 723us/step - loss: 1.2335
Epoch 56/130
1952/1952 [==============================] - 1s 720us/step - loss: 1.2326
Epoch 57/130
1952/1952 [==============================] - 1s 722us/step - loss: 1.2308
Epoch 58/130
1952/1952 [==============================] - 1s 722us/step - loss: 1.2296
Epoch 59/130
1952/1952 [==============================] - 1s 727us/step - loss: 1.2296
Epoch 60/130
1952/1952 [==============================] - 1s 723us/step - loss: 1.2272
Epoch 61/130
1952/1952 [==============================] - 1s 754us/step - loss: 1.2251
Epoch 62/130
1952/1952 [==============================] - 1s 716us/step - loss: 1.2250
Epoch 63/130
1952/1952 [==============================] - 1s 721us/step - loss: 1.2243
Epoch 64/130
1952/1952 [==============================] - 1s 716us/step - loss: 1.2222
Epoch 65/130
1952/1952 [==============================] - 2s 835us/step - loss: 1.2221
Epoch 66/130
1952/1952 [==============================] - 1s 719us/step - loss: 1.2227
Epoch 67/130
1952/1952 [==============================] - 1s 741us/step - loss: 1.2207
Epoch 68/130
1952/1952 [==============================] - 2s 783us/step - loss: 1.2191
Epoch 69/130
1952/1952 [==============================] - 1s 708us/step - loss: 1.2183
Epoch 70/130
1952/1952 [==============================] - 1s 719us/step - loss: 1.2191
Epoch 71/130
1952/1952 [==============================] - 1s 729us/step - loss: 1.2174
Epoch 72/130
1952/1952 [==============================] - 1s 725us/step - loss: 1.2169
Epoch 73/130
1952/1952 [==============================] - 1s 720us/step - loss: 1.2145
Epoch 74/130
1952/1952 [==============================] - 1s 697us/step - loss: 1.2144
Epoch 75/130
1952/1952 [==============================] - 1s 763us/step - loss: 1.2137
Epoch 76/130
1952/1952 [==============================] - 2s 811us/step - loss: 1.2125
```

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Epoch 77/130
1952/1952 [==============================] - 1s 751us/step - loss: 1.2131
Epoch 78/130
1952/1952 [==============================] - 1s 726us/step - loss: 1.2120
Epoch 79/130
1952/1952 [==============================] - 1s 712us/step - loss: 1.2105
Epoch 80/130
1952/1952 [==============================] - 1s 724us/step - loss: 1.2106
Epoch 81/130
1952/1952 [==============================] - 1s 716us/step - loss: 1.2101
Epoch 82/130
1952/1952 [==============================] - 2s 771us/step - loss: 1.2089
Epoch 83/130
1952/1952 [==============================] - 1s 710us/step - loss: 1.2081
Epoch 84/130
1952/1952 [==============================] - 1s 711us/step - loss: 1.2076
Epoch 85/130
1952/1952 [==============================] - 1s 716us/step - loss: 1.2078
Epoch 86/130
1952/1952 [==============================] - 1s 734us/step - loss: 1.2059
Epoch 87/130
1952/1952 [==============================] - 2s 836us/step - loss: 1.2048
Epoch 88/130
1952/1952 [==============================] - 2s 789us/step - loss: 1.2051
Epoch 89/130
1952/1952 [==============================] - 2s 817us/step - loss: 1.2055
Epoch 90/130
1952/1952 [==============================] - 2s 770us/step - loss: 1.2050
Epoch 91/130
1952/1952 [==============================] - 1s 741us/step - loss: 1.2037
Epoch 92/130
1952/1952 [==============================] - 2s 788us/step - loss: 1.2030
Epoch 93/130
1952/1952 [==============================] - 2s 857us/step - loss: 1.2033
Epoch 94/130
1952/1952 [==============================] - 2s 773us/step - loss: 1.2019
Epoch 95/130
1952/1952 [==============================] - 1s 750us/step - loss: 1.2008 0s - loss: 1
Epoch 96/130
1952/1952 [==============================] - 2s 820us/step - loss: 1.2010
Epoch 97/130
1952/1952 [==============================] - 1s 762us/step - loss: 1.1995
Epoch 98/130
1952/1952 [==============================] - 2s 819us/step - loss: 1.1988
Epoch 99/130
1952/1952 [==============================] - 1s 717us/step - loss: 1.2000
Epoch 100/130
1952/1952 [==============================] - 1s 721us/step - loss: 1.1980
```

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Epoch 101/130
1952/1952 [==============================] - 1s 707us/step - loss: 1.1980
Epoch 102/130
1952/1952 [==============================] - 1s 714us/step - loss: 1.1986
Epoch 103/130
1952/1952 [==============================] - 2s 773us/step - loss: 1.1978
Epoch 104/130
1952/1952 [==============================] - 1s 722us/step - loss: 1.1959
Epoch 105/130
1952/1952 [==============================] - 1s 706us/step - loss: 1.1960
Epoch 106/130
1952/1952 [==============================] - 1s 711us/step - loss: 1.1954
Epoch 107/130
1952/1952 [==============================] - 1s 726us/step - loss: 1.1954
Epoch 108/130
1952/1952 [==============================] - 1s 720us/step - loss: 1.1945
Epoch 109/130
1952/1952 [==============================] - 2s 826us/step - loss: 1.1940
Epoch 110/130
1952/1952 [==============================] - 1s 766us/step - loss: 1.1932
Epoch 111/130
1952/1952 [==============================] - 1s 717us/step - loss: 1.1937
Epoch 112/130
1952/1952 [==============================] - 1s 719us/step - loss: 1.1928
Epoch 113/130
1952/1952 [==============================] - 1s 719us/step - loss: 1.1920
Epoch 114/130
1952/1952 [==============================] - 1s 737us/step - loss: 1.1920
Epoch 115/130
1952/1952 [==============================] - 1s 714us/step - loss: 1.1907
Epoch 116/130
1952/1952 [==============================] - 1s 700us/step - loss: 1.1897
Epoch 117/130
1952/1952 [==============================] - 1s 728us/step - loss: 1.1897
Epoch 118/130
1952/1952 [==============================] - 1s 763us/step - loss: 1.1904
Epoch 119/130
1952/1952 [==============================] - 1s 717us/step - loss: 1.1900
Epoch 120/130
1952/1952 [==============================] - 2s 799us/step - loss: 1.1885
Epoch 121/130
1952/1952 [==============================] - 1s 706us/step - loss: 1.1884
Epoch 122/130
1952/1952 [==============================] - 1s 701us/step - loss: 1.1873
Epoch 123/130
1952/1952 [==============================] - 1s 704us/step - loss: 1.1873
Epoch 124/130
1952/1952 [==============================] - 1s 709us/step - loss: 1.1860
```

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Epoch 125/130
1952/1952 [==============================] - 2s 790us/step - loss: 1.1861
Epoch 126/130
1952/1952 [==============================] - 1s 689us/step - loss: 1.1854 0s - loss
Epoch 127/130
1952/1952 [==============================] - 1s 707us/step - loss: 1.1854
Epoch 128/130
1952/1952 [==============================] - 1s 706us/step - loss: 1.1849
Epoch 129/130
1952/1952 [==============================] - 1s 711us/step - loss: 1.1849 0s - loss: 1.18
Epoch 130/130
1952/1952 [==============================] - 1s 689us/step - loss: 1.1850
Sequence Length of 6
300_1_130_32_0.001_0.2_Attention
Epoch 1/130
1891/1891 [==============================] - 3s 1ms/step - loss: 2.6888
Epoch 2/130
1891/1891 [==============================] - 1s 755us/step - loss: 2.6101
Epoch 3/130
1891/1891 [==============================] - 1s 765us/step - loss: 2.5732
Epoch 4/130
1891/1891 [==============================] - 2s 810us/step - loss: 2.5347
Epoch 5/130
1891/1891 [==============================] - 1s 765us/step - loss: 2.4981
Epoch 6/130
1891/1891 [==============================] - 1s 778us/step - loss: 2.4513
Epoch 7/130
1891/1891 [==============================] - 1s 789us/step - loss: 2.3899
Epoch 8/130
1891/1891 [==============================] - 2s 870us/step - loss: 2.3125
Epoch 9/130
1891/1891 [==============================] - 2s 805us/step - loss: 2.2153
Epoch 10/130
1891/1891 [==============================] - 2s 878us/step - loss: 2.1143
Epoch 11/130
1891/1891 [==============================] - 2s 883us/step - loss: 2.0162
Epoch 12/130
1891/1891 [==============================] - 2s 805us/step - loss: 1.9338
Epoch 13/130
1891/1891 [==============================] - 2s 794us/step - loss: 1.8345
Epoch 14/130
1891/1891 [==============================] - 2s 839us/step - loss: 1.7628 0s - loss: 1.
Epoch 15/130
1891/1891 [==============================] - 1s 782us/step - loss: 1.6929
Epoch 16/130
1891/1891 [==============================] - 2s 797us/step - loss: 1.6351
Epoch 17/130
1891/1891 [==============================] - 2s 908us/step - loss: 1.5803
```

```
Epoch 18/130
1891/1891 [==============================] - 2s 887us/step - loss: 1.5411
Epoch 19/130
1891/1891 [==============================] - 1s 785us/step - loss: 1.5026
Epoch 20/130
1891/1891 [==============================] - 2s 806us/step - loss: 1.4691
Epoch 21/130
1891/1891 [==============================] - 2s 964us/step - loss: 1.4499
Epoch 22/130
1891/1891 [==============================] - 2s 816us/step - loss: 1.4192
Epoch 23/130
1891/1891 [==============================] - 2s 797us/step - loss: 1.3996
Epoch 24/130
1891/1891 [==============================] - 1s 781us/step - loss: 1.3842
Epoch 25/130
1891/1891 [==============================] - 2s 794us/step - loss: 1.3692
Epoch 26/130
1891/1891 [==============================] - 2s 811us/step - loss: 1.3552
Epoch 27/130
1891/1891 [==============================] - 2s 849us/step - loss: 1.3449
Epoch 28/130
1891/1891 [==============================] - 1s 791us/step - loss: 1.3345
Epoch 29/130
1891/1891 [==============================] - 2s 794us/step - loss: 1.3236
Epoch 30/130
1891/1891 [==============================] - 2s 796us/step - loss: 1.3186
Epoch 31/130
1891/1891 [==============================] - 2s 900us/step - loss: 1.3094
Epoch 32/130
1891/1891 [==============================] - 1s 783us/step - loss: 1.3033
Epoch 33/130
1891/1891 [==============================] - 1s 770us/step - loss: 1.2954
Epoch 34/130
1891/1891 [==============================] - 2s 868us/step - loss: 1.2914
Epoch 35/130
1891/1891 [==============================] - 2s 813us/step - loss: 1.2866
Epoch 36/130
1891/1891 [==============================] - 2s 807us/step - loss: 1.2837
Epoch 37/130
1891/1891 [==============================] - 1s 790us/step - loss: 1.2786
Epoch 38/130
1891/1891 [==============================] - 2s 793us/step - loss: 1.2751
Epoch 39/130
1891/1891 [==============================] - 2s 813us/step - loss: 1.2727
Epoch 40/130
1891/1891 [==============================] - 2s 807us/step - loss: 1.2677
Epoch 41/130
1891/1891 [==============================] - 2s 915us/step - loss: 1.2676
```

```
Epoch 42/130
1891/1891 [==============================] - 2s 821us/step - loss: 1.2643
Epoch 43/130
1891/1891 [==============================] - 2s 802us/step - loss: 1.2622
Epoch 44/130
1891/1891 [==============================] - 2s 807us/step - loss: 1.2601
Epoch 45/130
1891/1891 [==============================] - 2s 814us/step - loss: 1.2581
Epoch 46/130
1891/1891 [==============================] - 2s 793us/step - loss: 1.2517
Epoch 47/130
1891/1891 [==============================] - 2s 837us/step - loss: 1.2514
Epoch 48/130
1891/1891 [==============================] - 2s 824us/step - loss: 1.2517
Epoch 49/130
1891/1891 [==============================] - 2s 814us/step - loss: 1.2473
Epoch 50/130
1891/1891 [==============================] - 1s 784us/step - loss: 1.2476
Epoch 51/130
1891/1891 [==============================] - 2s 807us/step - loss: 1.2459
Epoch 52/130
1891/1891 [==============================] - 2s 885us/step - loss: 1.2447
Epoch 53/130
1891/1891 [==============================] - 2s 801us/step - loss: 1.2411
Epoch 54/130
1891/1891 [==============================] - 2s 865us/step - loss: 1.2412
Epoch 55/130
1891/1891 [==============================] - 1s 792us/step - loss: 1.2410
Epoch 56/130
1891/1891 [==============================] - 2s 813us/step - loss: 1.2390
Epoch 57/130
1891/1891 [==============================] - 2s 824us/step - loss: 1.2387
Epoch 58/130
1891/1891 [==============================] - 2s 813us/step - loss: 1.2376
Epoch 59/130
1891/1891 [==============================] - 1s 783us/step - loss: 1.2360
Epoch 60/130
1891/1891 [==============================] - 2s 808us/step - loss: 1.2348
Epoch 61/130
1891/1891 [==============================] - 2s 863us/step - loss: 1.2345
Epoch 62/130
1891/1891 [==============================] - 2s 924us/step - loss: 1.2334
Epoch 63/130
1891/1891 [==============================] - 1s 776us/step - loss: 1.2317
Epoch 64/130
1891/1891 [==============================] - 2s 801us/step - loss: 1.2345
Epoch 65/130
1891/1891 [==============================] - 2s 810us/step - loss: 1.2322
```

```
Epoch 66/130
1891/1891 [==============================] - 2s 823us/step - loss: 1.2282
Epoch 67/130
1891/1891 [==============================] - 2s 874us/step - loss: 1.2283
Epoch 68/130
1891/1891 [==============================] - 2s 823us/step - loss: 1.2281
Epoch 69/130
1891/1891 [==============================] - 2s 829us/step - loss: 1.2267
Epoch 70/130
1891/1891 [==============================] - 2s 835us/step - loss: 1.2252
Epoch 71/130
1891/1891 [==============================] - 2s 813us/step - loss: 1.2244
Epoch 72/130
1891/1891 [==============================] - 2s 926us/step - loss: 1.2237
Epoch 73/130
1891/1891 [==============================] - 2s 828us/step - loss: 1.2224
Epoch 74/130
1891/1891 [==============================] - 2s 870us/step - loss: 1.2219
Epoch 75/130
1891/1891 [==============================] - 2s 806us/step - loss: 1.2200
Epoch 76/130
1891/1891 [==============================] - 2s 806us/step - loss: 1.2212
Epoch 77/130
1891/1891 [==============================] - 2s 811us/step - loss: 1.2219
Epoch 78/130
1891/1891 [==============================] - 2s 814us/step - loss: 1.2223
Epoch 79/130
1891/1891 [==============================] - 2s 802us/step - loss: 1.2201
Epoch 80/130
1891/1891 [==============================] - 2s 842us/step - loss: 1.2202
Epoch 81/130
1891/1891 [==============================] - 2s 816us/step - loss: 1.2206
Epoch 82/130
1891/1891 [==============================] - 2s 905us/step - loss: 1.2195
Epoch 83/130
1891/1891 [==============================] - 2s 821us/step - loss: 1.2182
Epoch 84/130
1891/1891 [==============================] - 2s 808us/step - loss: 1.2163
Epoch 85/130
1891/1891 [==============================] - 2s 794us/step - loss: 1.2171
Epoch 86/130
1891/1891 [==============================] - 2s 803us/step - loss: 1.2151
Epoch 87/130
1891/1891 [==============================] - 2s 882us/step - loss: 1.2153
Epoch 88/130
1891/1891 [==============================] - 2s 806us/step - loss: 1.2149
Epoch 89/130
1891/1891 [==============================] - 1s 780us/step - loss: 1.2133
```

```
Epoch 90/130
1891/1891 [==============================] - 2s 815us/step - loss: 1.2138
Epoch 91/130
1891/1891 [==============================] - 2s 800us/step - loss: 1.2137
Epoch 92/130
1891/1891 [==============================] - 2s 866us/step - loss: 1.2117
Epoch 93/130
1891/1891 [==============================] - 2s 851us/step - loss: 1.2114
Epoch 94/130
1891/1891 [==============================] - 2s 824us/step - loss: 1.2105
Epoch 95/130
1891/1891 [==============================] - 2s 802us/step - loss: 1.2101
Epoch 96/130
1891/1891 [==============================] - 1s 791us/step - loss: 1.2096
Epoch 97/130
1891/1891 [==============================] - 1s 780us/step - loss: 1.2106
Epoch 98/130
1891/1891 [==============================] - 2s 796us/step - loss: 1.2080
Epoch 99/130
1891/1891 [==============================] - 2s 804us/step - loss: 1.2088
Epoch 100/130
1891/1891 [==============================] - 2s 851us/step - loss: 1.2084
Epoch 101/130
1891/1891 [==============================] - 2s 817us/step - loss: 1.2109
Epoch 102/130
1891/1891 [==============================] - 1s 785us/step - loss: 1.2074
Epoch 103/130
1891/1891 [==============================] - 2s 907us/step - loss: 1.2065
Epoch 104/130
1891/1891 [==============================] - 2s 808us/step - loss: 1.2072
Epoch 105/130
1891/1891 [==============================] - 1s 787us/step - loss: 1.2078
Epoch 106/130
1891/1891 [==============================] - 1s 776us/step - loss: 1.2065
Epoch 107/130
1891/1891 [==============================] - 2s 863us/step - loss: 1.2044
Epoch 108/130
1891/1891 [==============================] - 1s 784us/step - loss: 1.2039
Epoch 109/130
1891/1891 [==============================] - 1s 790us/step - loss: 1.2052
Epoch 110/130
1891/1891 [==============================] - 1s 772us/step - loss: 1.2053
Epoch 111/130
1891/1891 [==============================] - 1s 785us/step - loss: 1.2039
Epoch 112/130
1891/1891 [==============================] - 1s 788us/step - loss: 1.2057
Epoch 113/130
1891/1891 [==============================] - 2s 898us/step - loss: 1.2037
```

```
Epoch 114/130
1891/1891 [==============================] - 2s 855us/step - loss: 1.2028
Epoch 115/130
1891/1891 [==============================] - 1s 789us/step - loss: 1.2020
Epoch 116/130
1891/1891 [==============================] - 2s 803us/step - loss: 1.2017
Epoch 117/130
1891/1891 [==============================] - 2s 799us/step - loss: 1.2018
Epoch 118/130
1891/1891 [==============================] - 1s 784us/step - loss: 1.2022
Epoch 119/130
1891/1891 [==============================] - 1s 774us/step - loss: 1.2004
Epoch 120/130
1891/1891 [==============================] - 2s 833us/step - loss: 1.2001
Epoch 121/130
1891/1891 [==============================] - 2s 814us/step - loss: 1.1993
Epoch 122/130
1891/1891 [==============================] - 2s 795us/step - loss: 1.1995
Epoch 123/130
1891/1891 [==============================] - 1s 779us/step - loss: 1.1997
Epoch 124/130
1891/1891 [==============================] - 2s 903us/step - loss: 1.1990
Epoch 125/130
1891/1891 [==============================] - 2s 796us/step - loss: 1.1988
Epoch 126/130
1891/1891 [==============================] - 2s 812us/step - loss: 1.1973
Epoch 127/130
1891/1891 [==============================] - 2s 849us/step - loss: 1.1964
Epoch 128/130
1891/1891 [==============================] - 2s 795us/step - loss: 1.1966
Epoch 129/130
1891/1891 [==============================] - 2s 804us/step - loss: 1.1973
Epoch 130/130
1891/1891 [==============================] - 2s 810us/step - loss: 1.1962
Sequence Length of 7
300_1_130_32_0.001_0.2_Attention
Epoch 1/130
1830/1830 [==============================] - 3s 2ms/step - loss: 2.6813
Epoch 2/130
1830/1830 [==============================] - 2s 905us/step - loss: 2.5985
Epoch 3/130
1830/1830 [==============================] - 2s 923us/step - loss: 2.5573
Epoch 4/130
1830/1830 [==============================] - 2s 840us/step - loss: 2.5132
Epoch 5/130
1830/1830 [==============================] - 2s 848us/step - loss: 2.4668
Epoch 6/130
1830/1830 [==============================] - 2s 849us/step - loss: 2.4147
```

```
Epoch 7/130
1830/1830 [==============================] - 2s 884us/step - loss: 2.3449
Epoch 8/130
1830/1830 [==============================] - 2s 885us/step - loss: 2.2602
Epoch 9/130
1830/1830 [==============================] - 2s 935us/step - loss: 2.1587
Epoch 10/130
1830/1830 [==============================] - 2s 871us/step - loss: 2.0555
Epoch 11/130
1830/1830 [==============================] - 2s 872us/step - loss: 1.9546
Epoch 12/130
1830/1830 [==============================] - 2s 917us/step - loss: 1.8566
Epoch 13/130
1830/1830 [==============================] - 2s 918us/step - loss: 1.7696
Epoch 14/130
1830/1830 [==============================] - 2s 864us/step - loss: 1.6917
Epoch 15/130
1830/1830 [==============================] - 2s 913us/step - loss: 1.6316
Epoch 16/130
1830/1830 [==============================] - 2s 860us/step - loss: 1.5791
Epoch 17/130
1830/1830 [==============================] - 2s 865us/step - loss: 1.5289
Epoch 18/130
1830/1830 [==============================] - 2s 844us/step - loss: 1.4907
Epoch 19/130
1830/1830 [==============================] - 2s 905us/step - loss: 1.4535
Epoch 20/130
1830/1830 [==============================] - 2s 1ms/step - loss: 1.4279
Epoch 21/130
1830/1830 [==============================] - 2s 981us/step - loss: 1.4045
Epoch 22/130
1830/1830 [==============================] - 2s 1ms/step - loss: 1.3865A: 0s -
Epoch 23/130
1830/1830 [==============================] - 2s 901us/step - loss: 1.3702
Epoch 24/130
1830/1830 [==============================] - 2s 923us/step - loss: 1.3573
Epoch 25/130
1830/1830 [==============================] - 2s 916us/step - loss: 1.3436
Epoch 26/130
1830/1830 [==============================] - 2s 887us/step - loss: 1.3312
Epoch 27/130
1830/1830 [==============================] - 2s 940us/step - loss: 1.3230
Epoch 28/130
1830/1830 [==============================] - 2s 894us/step - loss: 1.3148
Epoch 29/130
1830/1830 [==============================] - 2s 903us/step - loss: 1.3093
Epoch 30/130
1830/1830 [==============================] - 2s 853us/step - loss: 1.3016
```

```
Epoch 31/130
1830/1830 [==============================] - 2s 940us/step - loss: 1.2946
Epoch 32/130
1830/1830 [==============================] - 2s 974us/step - loss: 1.2888
Epoch 33/130
1830/1830 [==============================] - 2s 964us/step - loss: 1.2850
Epoch 34/130
1830/1830 [==============================] - 2s 925us/step - loss: 1.2797
Epoch 35/130
1830/1830 [==============================] - 2s 882us/step - loss: 1.2744
Epoch 36/130
1830/1830 [==============================] - 2s 889us/step - loss: 1.2715
Epoch 37/130
1830/1830 [==============================] - 2s 862us/step - loss: 1.2692
Epoch 38/130
1830/1830 [==============================] - 2s 863us/step - loss: 1.2665
Epoch 39/130
1830/1830 [==============================] - 2s 867us/step - loss: 1.2634
Epoch 40/130
1830/1830 [==============================] - 2s 927us/step - loss: 1.2607
Epoch 41/130
1830/1830 [==============================] - 2s 976us/step - loss: 1.2577
Epoch 42/130
1830/1830 [==============================] - 2s 845us/step - loss: 1.2559
Epoch 43/130
1830/1830 [==============================] - 2s 863us/step - loss: 1.2538
Epoch 44/130
1830/1830 [==============================] - 2s 862us/step - loss: 1.2523
Epoch 45/130
1830/1830 [==============================] - 2s 858us/step - loss: 1.2512
Epoch 46/130
1830/1830 [==============================] - 2s 930us/step - loss: 1.2513
Epoch 47/130
1830/1830 [==============================] - 2s 884us/step - loss: 1.2468
Epoch 48/130
1830/1830 [==============================] - 2s 860us/step - loss: 1.2461
Epoch 49/130
1830/1830 [==============================] - 2s 854us/step - loss: 1.2456
Epoch 50/130
1830/1830 [==============================] - 2s 873us/step - loss: 1.2444
Epoch 51/130
1830/1830 [==============================] - 2s 991us/step - loss: 1.2422
Epoch 52/130
1830/1830 [==============================] - 2s 917us/step - loss: 1.2427
Epoch 53/130
1830/1830 [==============================] - 2s 862us/step - loss: 1.2410
Epoch 54/130
1830/1830 [==============================] - 2s 857us/step - loss: 1.2391
```

```
Epoch 55/130
1830/1830 [==============================] - 2s 866us/step - loss: 1.2367
Epoch 56/130
1830/1830 [==============================] - 2s 864us/step - loss: 1.2357
Epoch 57/130
1830/1830 [==============================] - 2s 856us/step - loss: 1.2354
Epoch 58/130
1830/1830 [==============================] - 2s 851us/step - loss: 1.2321
Epoch 59/130
1830/1830 [==============================] - 2s 1ms/step - loss: 1.2321A: 0s - loss: 1.21
Epoch 60/130
1830/1830 [==============================] - 3s 1ms/step - loss: 1.2310
Epoch 61/130
1830/1830 [==============================] - 3s 1ms/step - loss: 1.2292
Epoch 62/130
1830/1830 [==============================] - 2s 1ms/step - loss: 1.2283
Epoch 63/130
1830/1830 [==============================] - 2s 1ms/step - loss: 1.2272
Epoch 64/130
1830/1830 [==============================] - 2s 1ms/step - loss: 1.2286
Epoch 65/130
1830/1830 [==============================] - 2s 1ms/step - loss: 1.2256
Epoch 66/130
1830/1830 [==============================] - 2s 1ms/step - loss: 1.2244
Epoch 67/130
1830/1830 [==============================] - 2s 895us/step - loss: 1.2235
Epoch 68/130
1830/1830 [==============================] - 2s 985us/step - loss: 1.2222
Epoch 69/130
1830/1830 [==============================] - 2s 906us/step - loss: 1.2201
Epoch 70/130
1830/1830 [==============================] - 2s 866us/step - loss: 1.2185
Epoch 71/130
1830/1830 [==============================] - 2s 862us/step - loss: 1.2192
Epoch 72/130
1830/1830 [==============================] - 2s 857us/step - loss: 1.2172
Epoch 73/130
1830/1830 [==============================] - 2s 876us/step - loss: 1.2166
Epoch 74/130
1830/1830 [==============================] - 2s 889us/step - loss: 1.2173
Epoch 75/130
1830/1830 [==============================] - 2s 931us/step - loss: 1.2139
Epoch 76/130
1830/1830 [==============================] - 2s 886us/step - loss: 1.2146
Epoch 77/130
1830/1830 [==============================] - 2s 868us/step - loss: 1.2142
Epoch 78/130
1830/1830 [==============================] - 2s 869us/step - loss: 1.2125
```

```
Epoch 79/130
1830/1830 [==============================] - 2s 865us/step - loss: 1.2142
Epoch 80/130
1830/1830 [==============================] - 2s 886us/step - loss: 1.2132
Epoch 81/130
1830/1830 [==============================] - 2s 881us/step - loss: 1.2133
Epoch 82/130
1830/1830 [==============================] - 2s 1ms/step - loss: 1.2109
Epoch 83/130
1830/1830 [==============================] - 2s 855us/step - loss: 1.2106
Epoch 84/130
1830/1830 [==============================] - 2s 836us/step - loss: 1.2101
Epoch 85/130
1830/1830 [==============================] - 2s 832us/step - loss: 1.2098
Epoch 86/130
1830/1830 [==============================] - 2s 842us/step - loss: 1.2100
Epoch 87/130
1830/1830 [==============================] - 2s 830us/step - loss: 1.2087
Epoch 88/130
1830/1830 [==============================] - 2s 884us/step - loss: 1.2072
Epoch 89/130
1830/1830 [==============================] - 2s 946us/step - loss: 1.2061
Epoch 90/130
1830/1830 [==============================] - 2s 839us/step - loss: 1.2057
Epoch 91/130
1830/1830 [==============================] - 2s 841us/step - loss: 1.2058
Epoch 92/130
1830/1830 [==============================] - 2s 845us/step - loss: 1.2057
Epoch 93/130
1830/1830 [==============================] - 2s 822us/step - loss: 1.2067
Epoch 94/130
1830/1830 [==============================] - 2s 834us/step - loss: 1.2063
Epoch 95/130
1830/1830 [==============================] - 2s 923us/step - loss: 1.2036
Epoch 96/130
1830/1830 [==============================] - 2s 835us/step - loss: 1.2045
Epoch 97/130
1830/1830 [==============================] - 2s 836us/step - loss: 1.2032
Epoch 98/130
1830/1830 [==============================] - 2s 835us/step - loss: 1.2030
Epoch 99/130
1830/1830 [==============================] - 2s 837us/step - loss: 1.2021
Epoch 100/130
1830/1830 [==============================] - 2s 851us/step - loss: 1.2015
Epoch 101/130
1830/1830 [==============================] - 2s 893us/step - loss: 1.2008
Epoch 102/130
1830/1830 [==============================] - 2s 944us/step - loss: 1.2007
```

```
Epoch 103/130
1830/1830 [==============================] - 2s 825us/step - loss: 1.2010
Epoch 104/130
1830/1830 [==============================] - 2s 840us/step - loss: 1.1984
Epoch 105/130
1830/1830 [==============================] - 2s 858us/step - loss: 1.1978
Epoch 106/130
1830/1830 [==============================] - 2s 835us/step - loss: 1.1978
Epoch 107/130
1830/1830 [==============================] - 2s 851us/step - loss: 1.1982
Epoch 108/130
1830/1830 [==============================] - 2s 952us/step - loss: 1.1981 0s
Epoch 109/130
1830/1830 [==============================] - 2s 870us/step - loss: 1.1963
Epoch 110/130
1830/1830 [==============================] - 2s 845us/step - loss: 1.1953
Epoch 111/130
1830/1830 [==============================] - 2s 837us/step - loss: 1.1948
Epoch 112/130
1830/1830 [==============================] - 1s 814us/step - loss: 1.1951
Epoch 113/130
1830/1830 [==============================] - 2s 838us/step - loss: 1.1936
Epoch 114/130
1830/1830 [==============================] - 2s 878us/step - loss: 1.1937
Epoch 115/130
1830/1830 [==============================] - 2s 873us/step - loss: 1.1936
Epoch 116/130
1830/1830 [==============================] - 2s 835us/step - loss: 1.1918
Epoch 117/130
1830/1830 [==============================] - 2s 826us/step - loss: 1.1928
Epoch 118/130
1830/1830 [==============================] - 2s 828us/step - loss: 1.1913
Epoch 119/130
1830/1830 [==============================] - 2s 836us/step - loss: 1.1913
Epoch 120/130
1830/1830 [==============================] - 2s 848us/step - loss: 1.1899
Epoch 121/130
1830/1830 [==============================] - 2s 923us/step - loss: 1.1907
Epoch 122/130
1830/1830 [==============================] - 2s 933us/step - loss: 1.1903
Epoch 123/130
1830/1830 [==============================] - 2s 845us/step - loss: 1.1909
Epoch 124/130
1830/1830 [==============================] - 2s 833us/step - loss: 1.1896
Epoch 125/130
1830/1830 [==============================] - 2s 836us/step - loss: 1.1902
Epoch 126/130
1830/1830 [==============================] - 2s 842us/step - loss: 1.1888
```

```
Epoch 127/130
1830/1830 [==============================] - 2s 838us/step - loss: 1.1886
Epoch 128/130
1830/1830 [==============================] - 2s 918us/step - loss: 1.1879
Epoch 129/130
1830/1830 [==============================] - 1s 819us/step - loss: 1.1893
Epoch 130/130
1830/1830 [==============================] - 2s 835us/step - loss: 1.1885
```

```
In [41]: rnns
```

```
Out[41]: {'300_1_130_32_0.001_0.2_Attention': [<keras.models.Sequential at 0x1a33d6df60>,
           <keras.models.Sequential at 0x1a37c38e48>,
           <keras.models.Sequential at 0x1a32484630>,
           <keras.models.Sequential at 0x1a384f2e10>,
           <keras.models.Sequential at 0x1a3d89d710>,
           <keras.models.Sequential at 0x1a3bc325c0>,
           <keras.models.Sequential at 0x1a415f5f60>]}
```

```
In [42]: def score(key):
             training_accs = []
             training_errs = []

             with open('rnn_nt_training_scores_' + key + '.csv', 'w') as f:
                 writer = csv.writer(f)
                 writer.writerow(['Games before prediction', 'Accuracy', 'Euclidean Error'])
                 print("training")
                 for i in range(min_sequence_length, max_sequence_length+1):
                     print(i)
                     outputs = rnns[key][i-min_sequence_length].predict(X_trainings[i])
                     acc = 1 - disc_error(outputs, np.array(Y_trainings[i]))
                     eerr = eucl_error(outputs, np.array(Y_trainings[i]))

                     writer.writerow([i, acc, eerr])
                     training_accs.append(acc)
                     training_errs.append(eerr)

             testing_accs = []
             testing_errs = []

             with open('rnn_nt_testing_scores_' + key + '.csv', 'w') as f:
                 writer = csv.writer(f)
                 writer.writerow(['Games before prediction', 'Accuracy', 'Euclidean Error'])
                 print("testing")
                 for i in range(min_sequence_length, max_sequence_length+1):
                     print(i)
                     outputs = rnns[key][i-min_sequence_length].predict(X_testings[i])
```

```
                    acc = 1 - disc_error(outputs, np.array(Y_testings[i]))
                    eerr = eucl_error(outputs, np.array(Y_testings[i]))

                    writer.writerow([i, acc, eerr])
                    testing_accs.append(acc)
                    testing_errs.append(eerr)

            training_accs_dict[key] = training_accs
            training_errs_dict[key] = training_errs
            testing_accs_dict[key] = testing_accs
            testing_errs_dict[key] = testing_errs
```

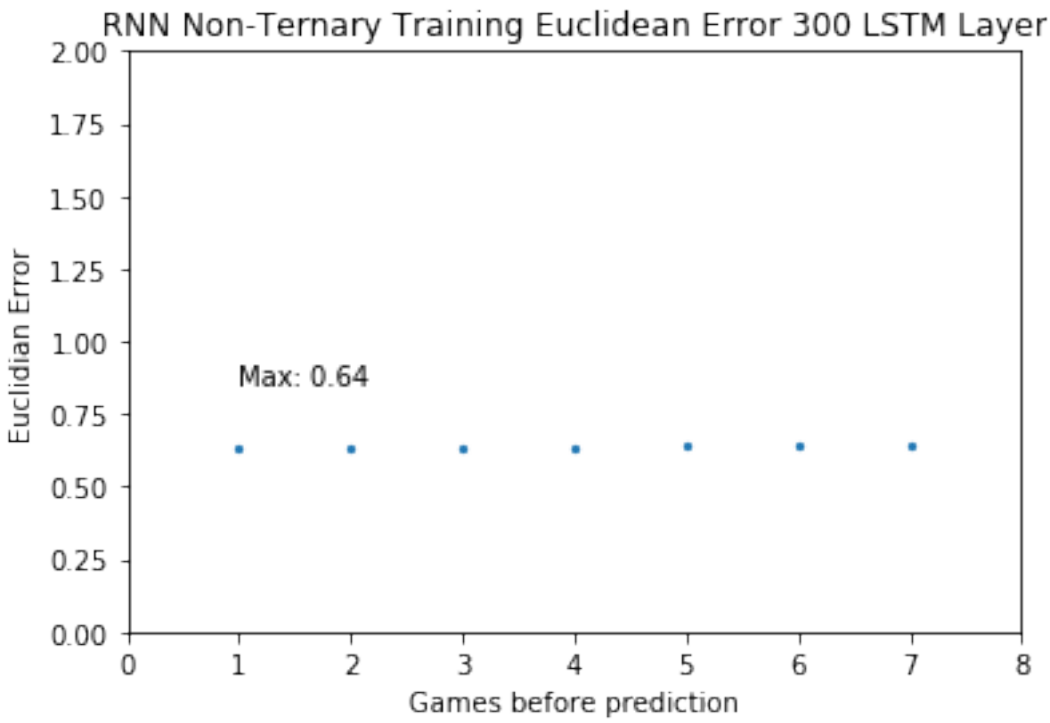
```
In [43]: training_accs_dict = {}
         training_errs_dict = {}
         testing_accs_dict = {}
         testing_errs_dict = {}
```

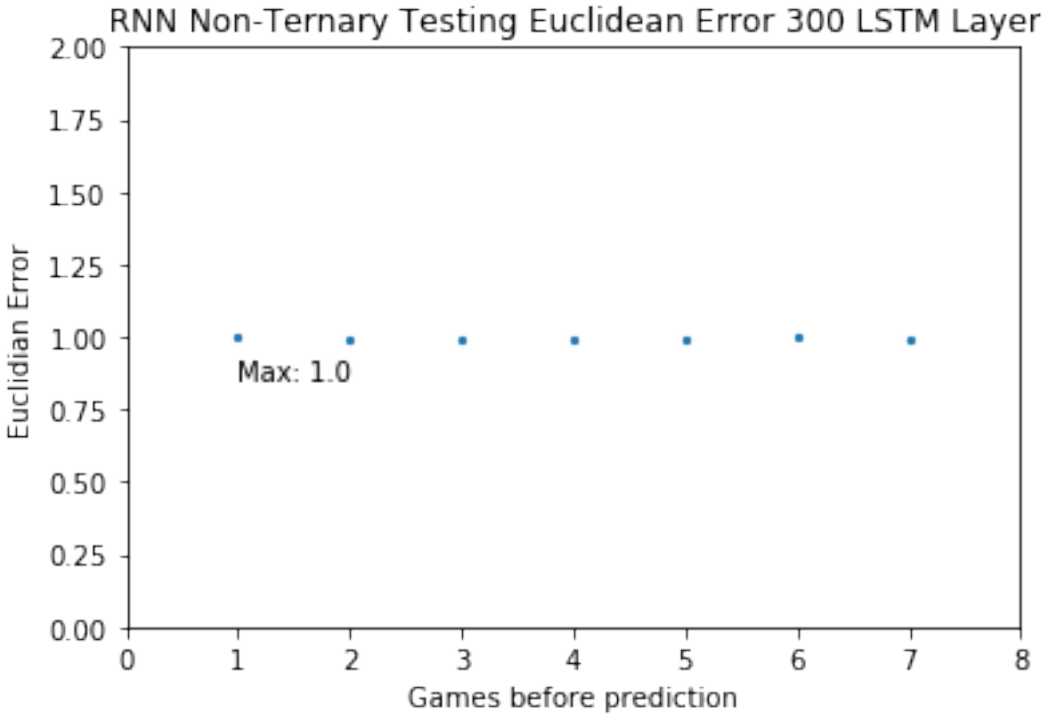
```
In [44]: for layer_size in layer_sizes:
             for layer_num in layers:
                 for epochs_num in epochs:
                     for batch_size in batch_sizes:
                         for lr in learning_rates:
                             for dropout in dropouts:
                                 for ct in cell_types:
                                     key = str(layer_size)+"_"+str(layer_num)+"_"+str(epochs_nu
                                     print(key)
                                     score(key)
```

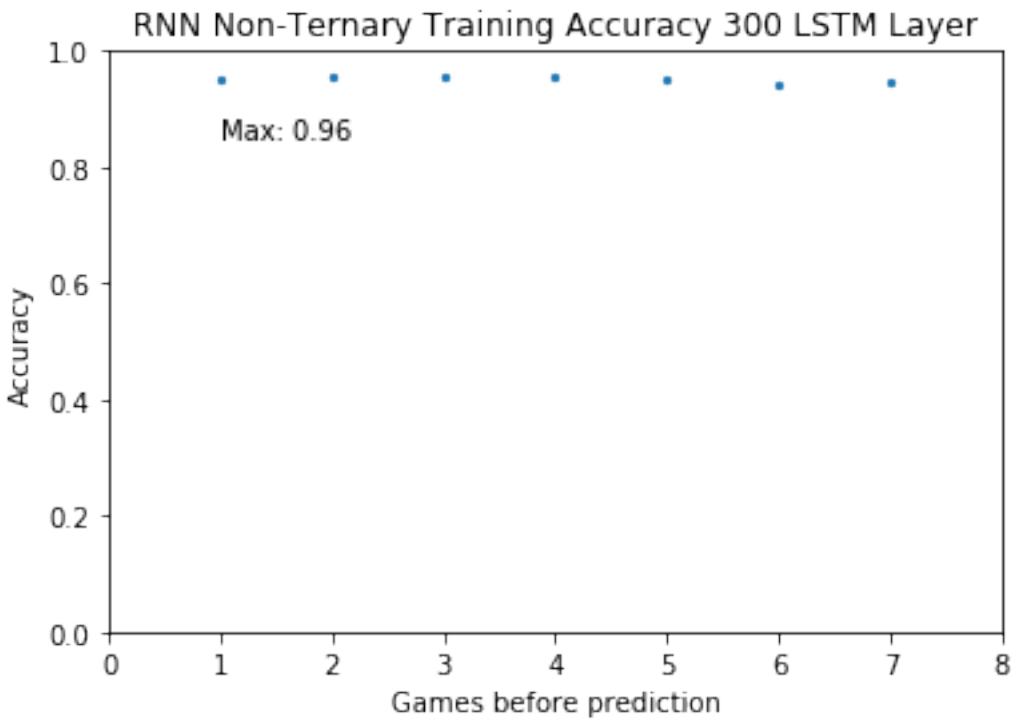
```
300_1_130_32_0.001_0.2_Attention
training
1
2
3
4
5
6
7
testing
1
2
3
4
5
6
7
```

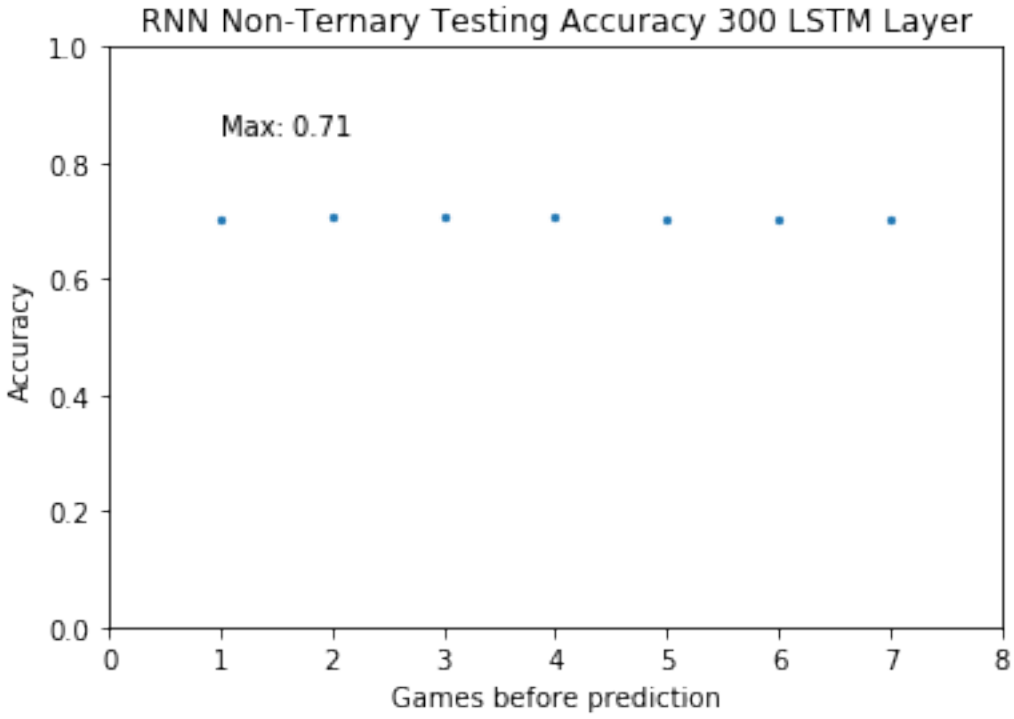
```
In [45]: def plot(y, ylabel, title, imname, ylim):
             x = range(min_sequence_length, max_sequence_length+1)
```

```
        #     yfit = np.poly1d(np.polyfit(x, y, 1))(np.unique(x))
        #     r2 = np.round(r2_score(y, yfit),decimals=2)
            maxi = np.round(np.max(y), decimals=2)


            plt.scatter(x, y, s = 5)
            plt.axis([0,max_sequence_length+1,0,ylim])
            plt.text(1, 0.85, 'Max: ' + str(maxi))
            plt.xlabel('Games before prediction')
            plt.ylabel(ylabel)
            plt.title(title)
            plt.savefig('rnnntplots/' + imname + '.png')
            plt.show()

In [46]: def plot_loss_curve(y, xlim, title, imname):
            x = range(1,xlim+1)
            plt.axis([1,xlim+1,0,3])
            plt.plot(x, y)
            plt.xlabel('Epochs')
            plt.ylabel('Training Loss')
            plt.title(title)
            plt.savefig('rnnnt_losscurves/' + imname + '.png')
            plt.show()

In [47]: for layer_size in layer_sizes:
            for layer_num in layers:
                for epochs_num in epochs:
                    for batch_size in batch_sizes:
                        for lr in learning_rates:
                            for dropout in dropouts:
                                for ct in cell_types:
                                    key = str(layer_size)+"_"+str(layer_num)+"_"+str(epochs_nu
                                    print(key)
                                    title = ' ' + str(size) + ' LSTM Layer'
                                    plot(training_errs_dict[key], 'Euclidian Error', 'RNN Non
                                    plot(testing_errs_dict[key], 'Euclidian Error', 'RNN Non-
                                    plot(training_accs_dict[key], 'Accuracy', 'RNN Non-Ternary
                                    plot(testing_accs_dict[key], 'Accuracy', 'RNN Non-Ternary

300_1_130_32_0.001_0.2_Attention
```


RNN Non-Ternary Training Euclidean Error 300 LSTM Layer
Euclidian Error
Games before prediction
Max: 0.64
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
1
2
3
4
5
6
7
8

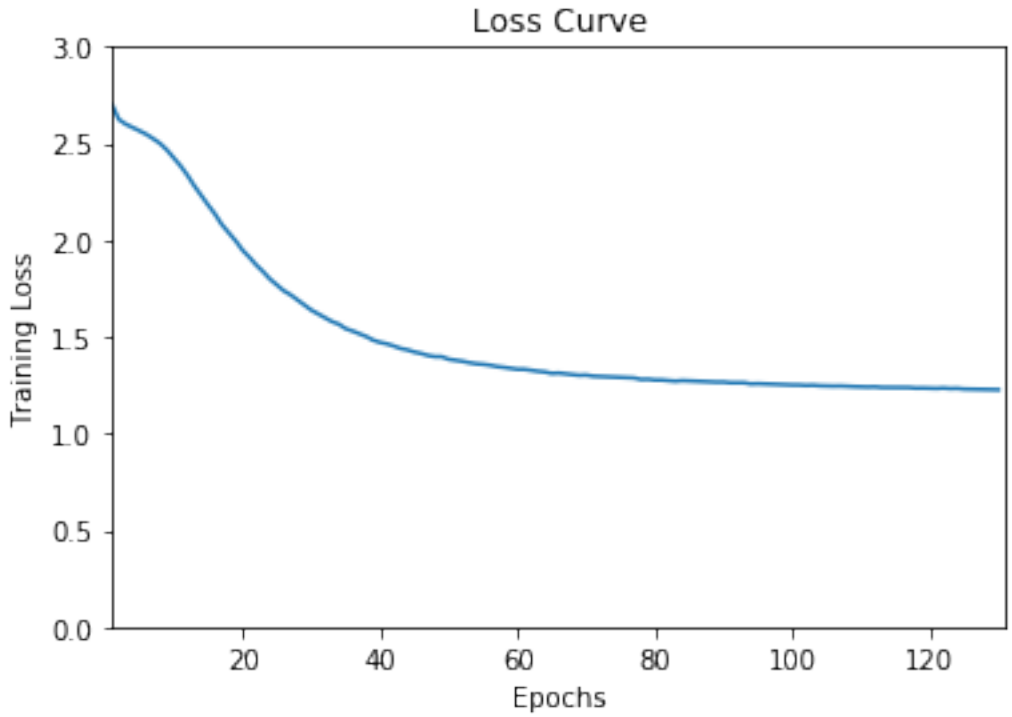

RNN Non-Ternary Testing Euclidean Error 300 LSTM Layer
Euclidian Error
Games before prediction
Max: 1.0
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
1
2
3
4
5
6
7
8

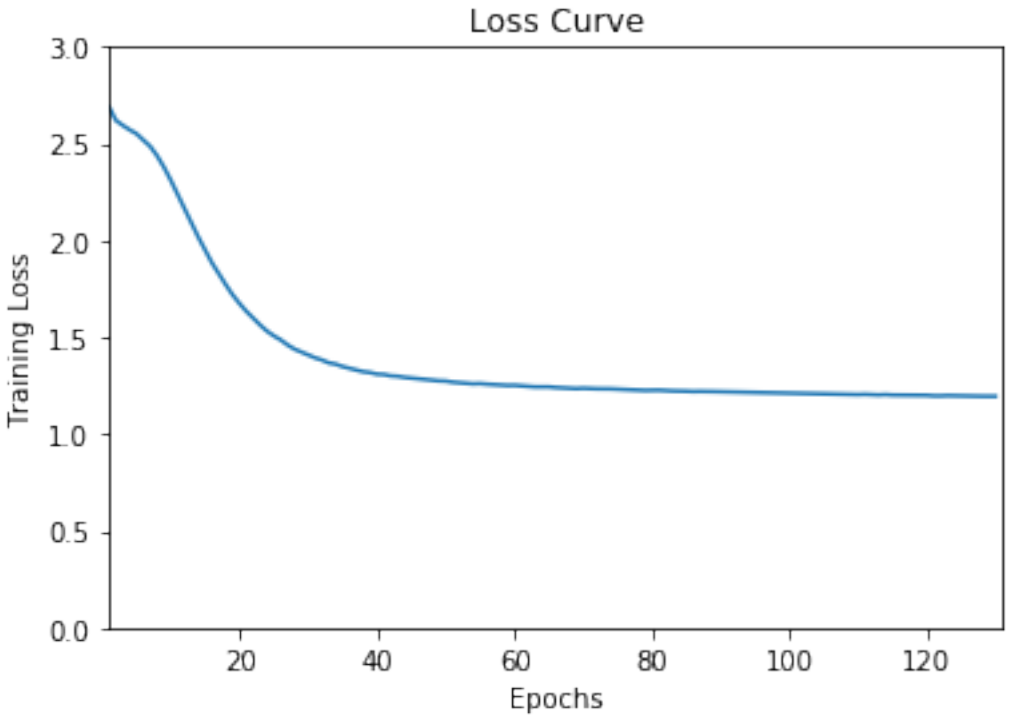

RNN Non-Ternary Training Accuracy 300 LSTM Layer
Max: 0.96
Accuracy
Games before prediction
1.0
0.8
0.6
0.4
0.2
0.0
0
1
2
3
4
5
6
7
8

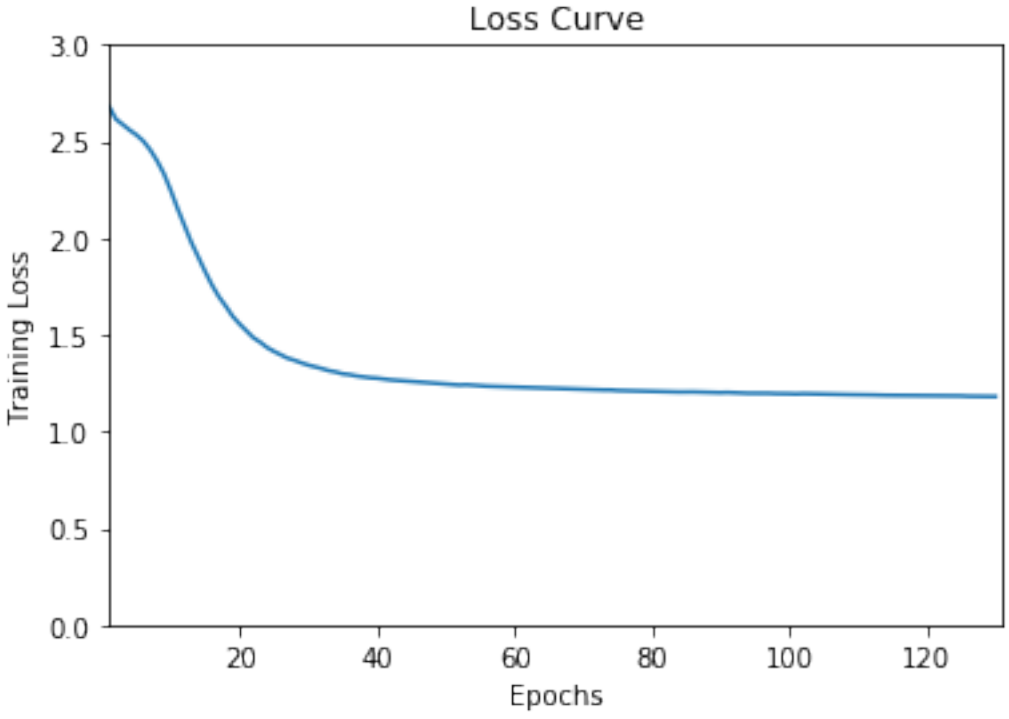

RNN Non-Ternary Testing Accuracy 300 LSTM Layer
Max: 0.71
Accuracy
Games before prediction
1.0
0.8
0.6
0.4
0.2
0.0
0
1
2
3
4
5
6
7
8

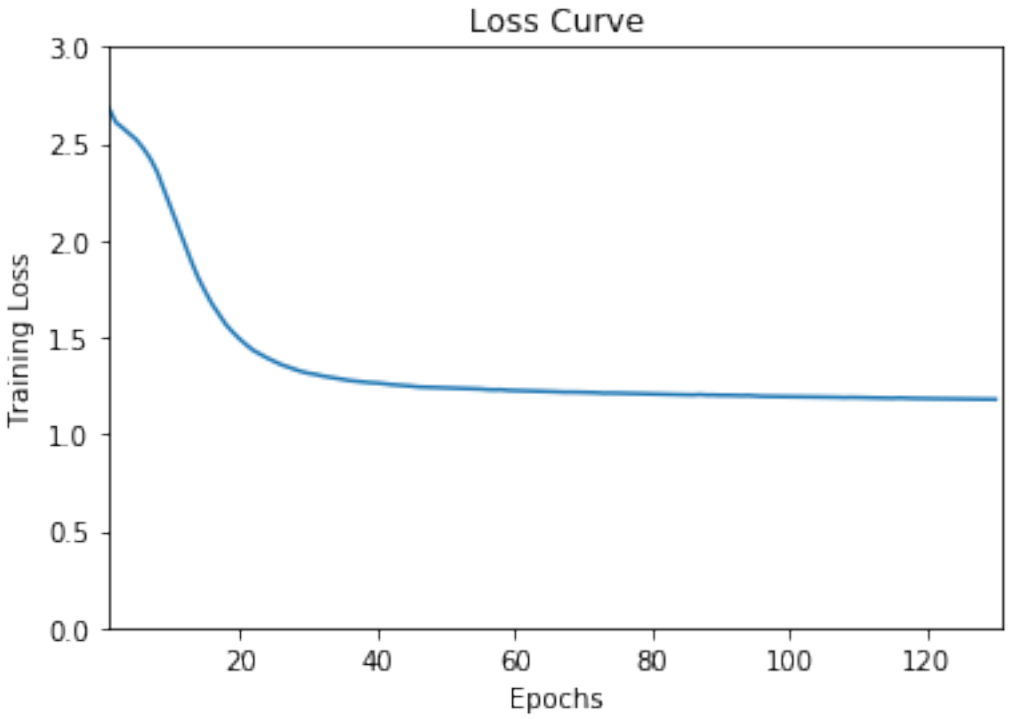
```
In [48]: for layer_size in layer_sizes:
             for layer_num in layers:
                 for epochs_num in epochs:
                     for batch_size in batch_sizes:
                         for lr in learning_rates:
                             for dropout in dropouts:
                                 for ct in cell_types:
                                     key = str(layer_size)+"_"+str(layer_num)+"_"+str(epochs_nu
                                     print(key)
                                     for i in range(max_sequence_length-min_sequence_length+1)
                                         plot_loss_curve(histories[key][i].history['loss'], epo
```

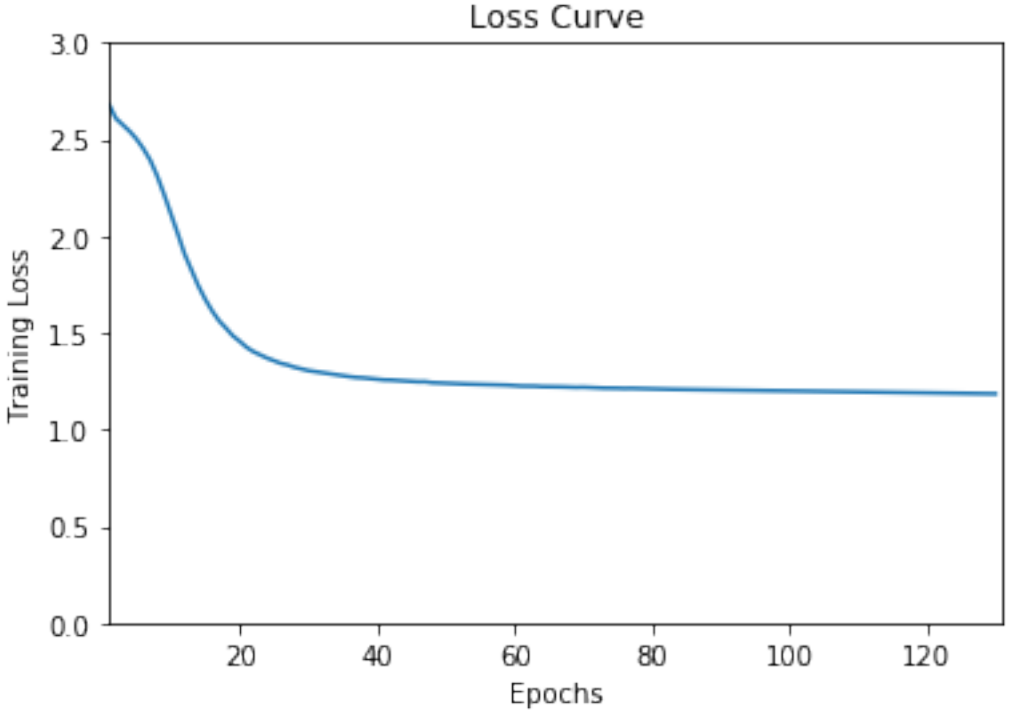
```
300_1_130_32_0.001_0.2_Attention
```

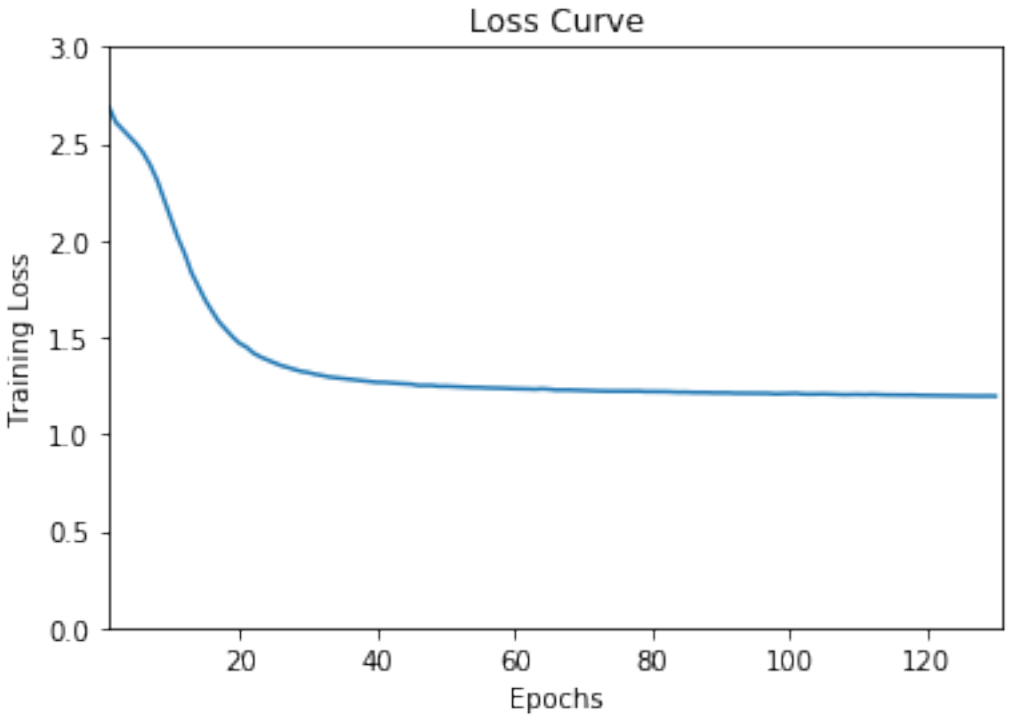


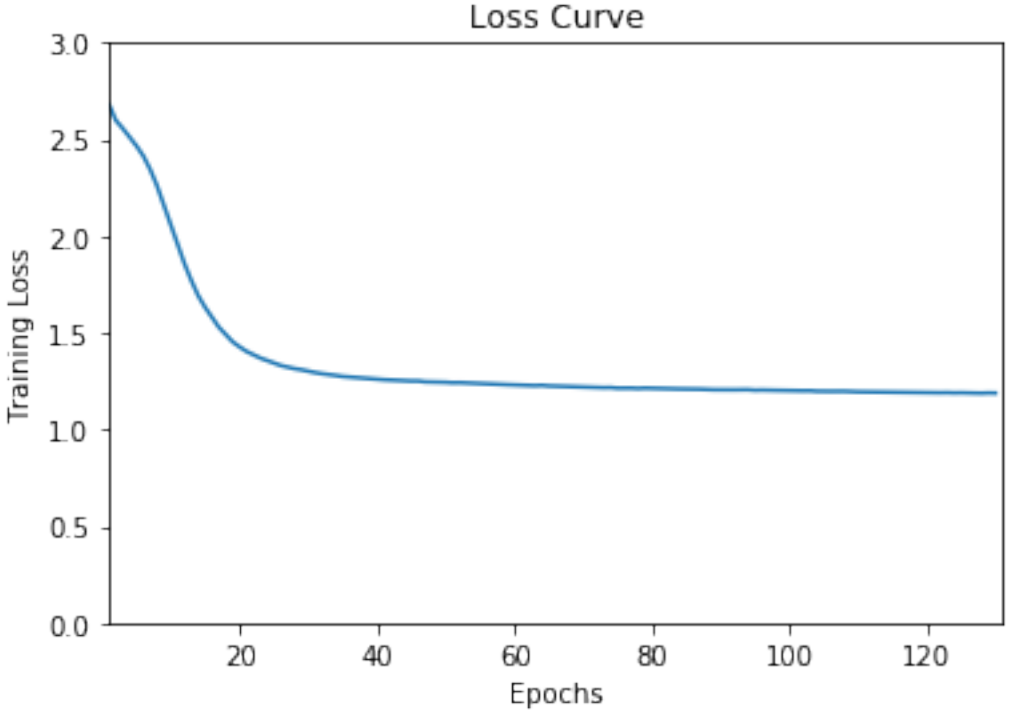

Loss Curve
Training Loss
Epochs
3.0
2.5
2.0
1.5
1.0
0.5
0.0
20
40
60
80
100
120


Loss Curve
Training Loss
Epochs
3.0
2.5
2.0
1.5
1.0
0.5
0.0
20
40
60
80
100
120


Loss Curve
Training Loss
Epochs
3.0
2.5
2.0
1.5
1.0
0.5
0.0
20
40
60
80
100
120


Loss Curve
Training Loss
Epochs
3.0
2.5
2.0
1.5
1.0
0.5
0.0
20
40
60
80
100
120


Loss Curve
Training Loss
Epochs
3.0
2.5
2.0
1.5
1.0
0.5
0.0
20
40
60
80
100
120


Loss Curve
Training Loss
Epochs
3.0
2.5
2.0
1.5
1.0
0.5
0.0
20
40
60
80
100
120

```
In [49]: for layer_size in layer_sizes:
             for layer_num in layers:
                 for epochs_num in epochs:
                     for batch_size in batch_sizes:
                         for lr in learning_rates:
                             for dropout in dropouts:
                                 for ct in cell_types:
                                     key = str(layer_size)+"_"+str(layer_num)+"_"+str(epochs_nu
                                     print(key)
                                     with open('rnn_nt_loss_curve_' + key + '.csv', 'w') as f:
                                         writer = csv.writer(f)
                                         listrange = list(range(min_sequence_length,max_sequenc
                                         header = [str(i) for i in listrange]
                                         header.insert(0,'Epochs')
                                         writer.writerow(header)
                                         for i in range(epochs_num):
                                             row = [i+1]
                                             for j in range(max_sequence_length - min_sequence_
                                                 row.append(histories[key][j].history['loss'][i
                                             writer.writerow(row)
```

```
300_1_130_32_0.001_0.2_Attention
```