

# CNN Test 1

## Hyperparameters:

Epochs: 30  
Batch Size: 16  
Hidden Layers: 32  
Activation Function: Softmax

## Layout:

```
epochs = 30
batch_size = 16
n_hidden = 32

timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

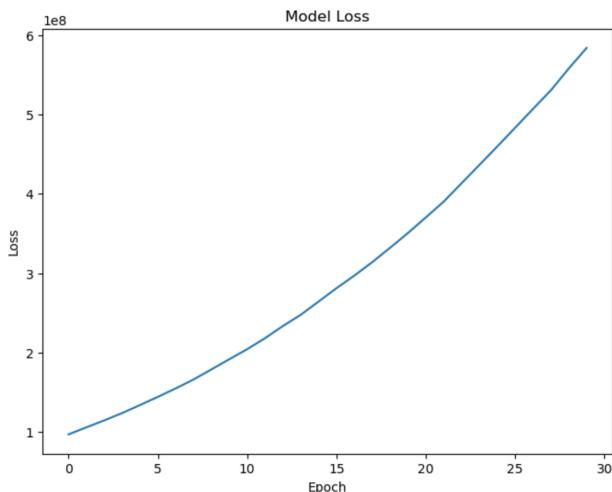
# Define the input shape
input_shape = (timesteps, input_dim)

# Create the model
model = Sequential([
    Input(shape=input_shape),
    Conv1D(n_hidden, kernel_size=2, activation='relu'),
    Dense(16, activation='relu'),
    MaxPooling1D(),
    Flatten(),
    Dense(n_classes, activation='softmax')
])
```

## Epoch Snapshot:

```
Epoch 1/30
1076/1076 - 0s - 310us/step - accuracy: 0.1253 - loss: 96946832.0000
Epoch 2/30
1076/1076 - 0s - 296us/step - accuracy: 0.1244 - loss: 105750000.0000
Epoch 3/30
1076/1076 - 0s - 299us/step - accuracy: 0.1238 - loss: 114534328.0000
Epoch 4/30
1076/1076 - 0s - 314us/step - accuracy: 0.1200 - loss: 123765832.0000
Epoch 5/30
1076/1076 - 0s - 343us/step - accuracy: 0.1228 - loss: 133854072.0000
Epoch 6/30
1076/1076 - 0s - 296us/step - accuracy: 0.1218 - loss: 144187248.0000
Epoch 7/30
1076/1076 - 0s - 307us/step - accuracy: 0.1218 - loss: 154829200.0000
Epoch 8/30
1076/1076 - 0s - 292us/step - accuracy: 0.1211 - loss: 166093024.0000
Epoch 9/30
1076/1076 - 0s - 293us/step - accuracy: 0.1238 - loss: 178779584.0000
```

## Loss Curve:



## Confusion Matrix:

## CNN Test 2

### Hyperparameters:

Epochs: 30  
Batch Size: 16  
Hidden Layers: 32  
Activation Function: Sigmoid

### Layout:

```
epochs = 30
batch_size = 16
n_hidden = 32

timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

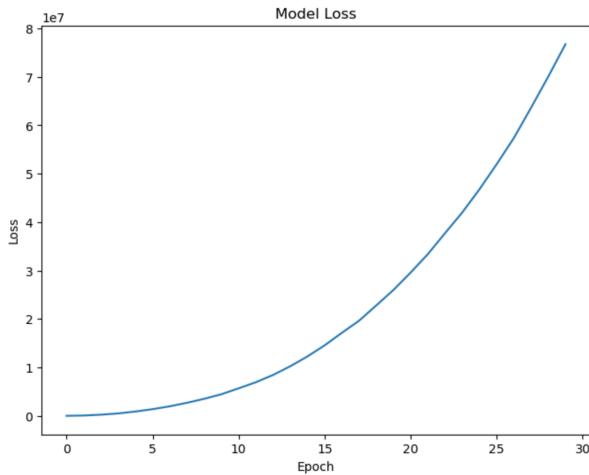
# Define the input shape
input_shape = (timesteps, input_dim)

# Create the model
model = Sequential([
    Input(shape=input_shape),
    Conv1D(n_hidden, kernel_size=2, activation='relu'),
    Dense(16, activation='relu'),
    MaxPooling1D(),
    Flatten(),
    Dense(n_classes, activation='sigmoid')
])
```

### Epoch Snapshot:

```
Epoch 1/30
1076/1076 - 1s - 506us/step - accuracy: 0.1093 - loss: 7742.5112
Epoch 2/30
1076/1076 - 0s - 292us/step - accuracy: 0.1186 - loss: 73831.2109
Epoch 3/30
1076/1076 - 0s - 288us/step - accuracy: 0.1139 - loss: 243378.0312
Epoch 4/30
1076/1076 - 0s - 287us/step - accuracy: 0.1220 - loss: 503072.3125
Epoch 5/30
1076/1076 - 0s - 290us/step - accuracy: 0.1254 - loss: 892038.7500
Epoch 6/30
1076/1076 - 0s - 288us/step - accuracy: 0.1211 - loss: 1381073.3750
Epoch 7/30
1076/1076 - 0s - 288us/step - accuracy: 0.1227 - loss: 1972540.1250
Epoch 8/30
1076/1076 - 0s - 289us/step - accuracy: 0.1196 - loss: 2698191.2500
Epoch 9/30
1076/1076 - 0s - 287us/step - accuracy: 0.1221 - loss: 3517286.5000
```

### Loss Curve:



### Confusion Matrix:

180/180		0s 342us/step	
Pred	BASEL	VALENTIA	
True			
BASEL	3679	3	
BELGRADE	1092	0	
BUDAPEST	214	0	
DEBILT	82	0	
DUSSELDORF	29	0	
HEATHROW	82	0	
KASSEL	11	0	
LJUBLJANA	61	0	
MAASTRICHT	9	0	
MADRID	458	0	
MUNCHENB	8	0	
OSLO	5	0	
STOCKHOLM	4	0	
VALENTIA	1	0	

# CNN Test 3

## Hyperparameters:

Epochs: 30  
Batch Size: 16  
Hidden Layers: 32  
Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 16
n_hidden = 32

timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

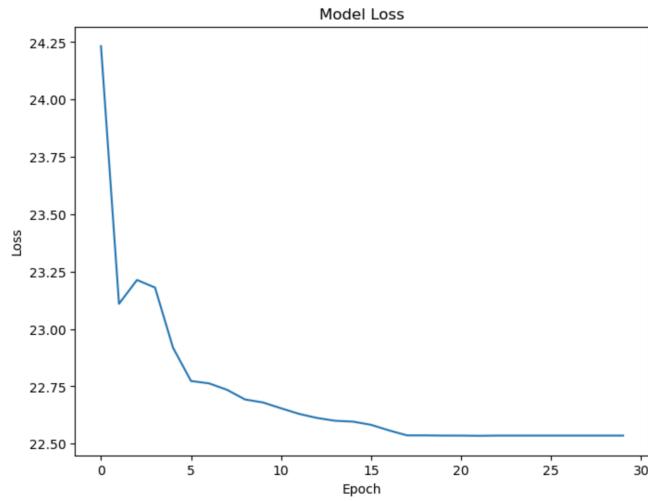
# Define the input shape
input_shape = (timesteps, input_dim)

# Create the model
model = Sequential([
    Input(shape=input_shape),
    Conv1D(n_hidden, kernel_size=2, activation='relu'),
    Dense(16, activation='relu'),
    MaxPooling1D(),
    Flatten(),
    Dense(n_classes, activation='tanh')
])
```

## Epoch Snapshot:

```
Epoch 1/30
1076/1076 - 1s - 523us/step - accuracy: 0.0987 - loss: 24.2326
Epoch 2/30
1076/1076 - 0s - 300us/step - accuracy: 0.2153 - loss: 23.1098
Epoch 3/30
1076/1076 - 0s - 300us/step - accuracy: 0.2694 - loss: 23.2135
Epoch 4/30
1076/1076 - 0s - 298us/step - accuracy: 0.2696 - loss: 23.1807
Epoch 5/30
1076/1076 - 0s - 298us/step - accuracy: 0.2694 - loss: 22.9185
Epoch 6/30
1076/1076 - 0s - 299us/step - accuracy: 0.2693 - loss: 22.7734
Epoch 7/30
1076/1076 - 0s - 297us/step - accuracy: 0.2695 - loss: 22.7631
Epoch 8/30
1076/1076 - 0s - 314us/step - accuracy: 0.2698 - loss: 22.7350
Epoch 9/30
1076/1076 - 0s - 305us/step - accuracy: 0.2699 - loss: 22.6929
```

## Loss Curve:



## Confusion Matrix:

180/180		0s 323us/step						
Pred	True	BASEL	DUSSELDORF	HEATHROW	KASSEL	OSLO	STOCKHOLM	VALENTIA
BASEL	BASEL	1659	233	302	1116	71	299	2
BELGRADE	BELGRADE	1060	26	5	1	0	0	0
BUDAPEST	BUDAPEST	213	1	0	0	0	0	0
DEBILT	DEBILT	82	0	0	0	0	0	0
DUSSELDORF	DUSSELDORF	29	0	0	0	0	0	0
HEATHROW	HEATHROW	78	2	2	0	0	0	0
KASSEL	KASSEL	11	0	0	0	0	0	0
LJUBLJANA	LJUBLJANA	57	3	1	0	0	0	0
MAASTRICHT	MAASTRICHT	8	1	0	0	0	0	0
MADRID	MADRID	287	56	67	46	0	2	0
MUNCHENB	MUNCHENB	7	1	0	0	0	0	0
OSLO	OSLO	5	0	0	0	0	0	0
STOCKHOLM	STOCKHOLM	4	0	0	0	0	0	0
VALENTIA	VALENTIA	1	0	0	0	0	0	0

## CNN Test 4

### Hyperparameters:

Epochs: 30  
Batch Size: 16  
Hidden Layers: 32  
Activation Function: Relu

### Layout:

```
epochs = 30
batch_size = 16
n_hidden = 32

timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

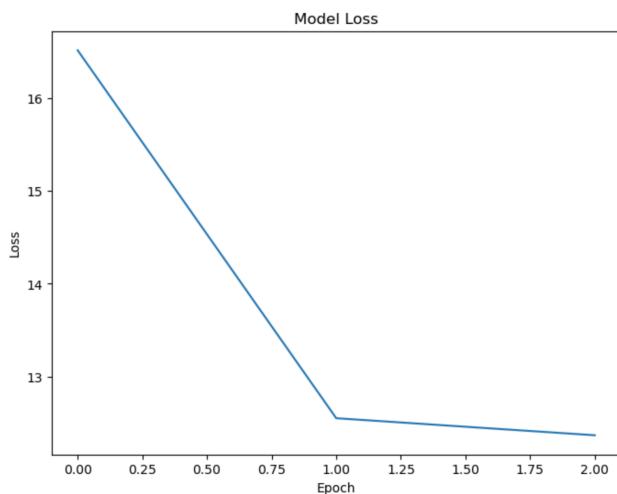
# Define the input shape
input_shape = (timesteps, input_dim)

# Create the model
model = Sequential([
    Input(shape=input_shape),
    Conv1D(n_hidden, kernel_size=2, activation='relu'),
    Dense(16, activation='relu'),
    MaxPooling1D(),
    Flatten(),
    Dense(n_classes, activation='relu')
])
```

### Epoch Snapshot:

```
Epoch 1/30
1076/1076 - 1s - 529us/step - accuracy: 0.0883 - loss: 16.5192
Epoch 2/30
1076/1076 - 0s - 301us/step - accuracy: 0.0880 - loss: 12.5493
Epoch 3/30
1076/1076 - 0s - 306us/step - accuracy: 0.1403 - loss: 12.3654
Epoch 4/30
1076/1076 - 0s - 295us/step - accuracy: 0.1426 - loss: nan
Epoch 5/30
1076/1076 - 0s - 309us/step - accuracy: 0.6440 - loss: nan
Epoch 6/30
1076/1076 - 0s - 320us/step - accuracy: 0.6440 - loss: nan
Epoch 7/30
1076/1076 - 0s - 304us/step - accuracy: 0.6440 - loss: nan
Epoch 8/30
1076/1076 - 0s - 303us/step - accuracy: 0.6440 - loss: nan
Epoch 9/30
1076/1076 - 0s - 294us/step - accuracy: 0.6440 - loss: nan
```

### Loss Curve:



### Confusion Matrix:

Pred	BASEL	0s 324us/step
True		
BASEL	3682	
BELGRADE	1092	
BUDAPEST	214	
DEBILT	82	
DUSSELDORF	29	
HEATHROW	82	
KASSEL	11	
LJUBLJANA	61	
MAASTRICHT	9	
MADRID	458	
MUNCHENB	8	
OSLO	5	
STOCKHOLM	4	
VALENTIA	1	

# CNN Test 5

## Hyperparameters:

Epochs: 30  
Batch Size: 16  
Hidden Layers: 128  
Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 16
n_hidden = 128

timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

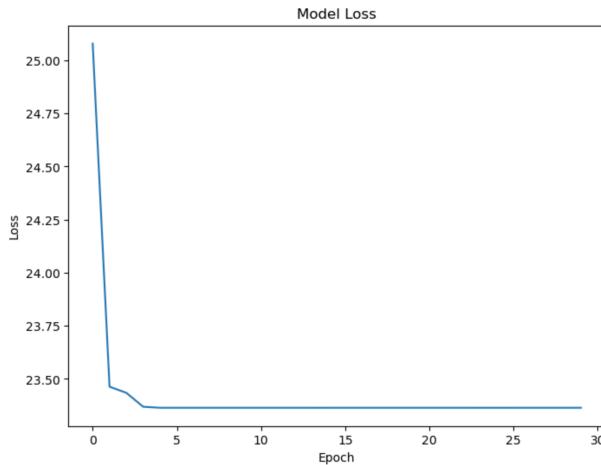
# Define the input shape
input_shape = (timesteps, input_dim)

# Create the model
model = Sequential([
    Input(shape=input_shape),
    Conv1D(n_hidden, kernel_size=2, activation='relu'),
    Dense(16, activation='relu'),
    MaxPooling1D(),
    Flatten(),
    Dense(n_classes, activation='tanh')
])
```

## Epoch Snapshot:

```
Epoch 1/30
1076/1076 - 1s - 643us/step - accuracy: 0.0205 - loss: 25.0786
Epoch 2/30
1076/1076 - 1s - 473us/step - accuracy: 0.0293 - loss: 23.4636
Epoch 3/30
1076/1076 - 0s - 452us/step - accuracy: 0.0298 - loss: 23.4345
Epoch 4/30
1076/1076 - 0s - 456us/step - accuracy: 0.0298 - loss: 23.3690
Epoch 5/30
1076/1076 - 0s - 431us/step - accuracy: 0.0307 - loss: 23.3643
Epoch 6/30
1076/1076 - 0s - 434us/step - accuracy: 0.0307 - loss: 23.3643
Epoch 7/30
1076/1076 - 0s - 436us/step - accuracy: 0.0307 - loss: 23.3643
Epoch 8/30
1076/1076 - 0s - 441us/step - accuracy: 0.0310 - loss: 23.3643
Epoch 9/30
1076/1076 - 0s - 441us/step - accuracy: 0.0310 - loss: 23.3643
```

## Loss Curve:



## Confusion Matrix:

180/180		0s 353us/step			
Pred	True	BUDAPEST	DEBILT	LJUBLJANA	MAASTRICHT
BASEL	BASEL	1410	1011	82	3
BELGRADE	BELGRADE	867	223	0	0
BUDAPEST	BUDAPEST	185	29	0	0
DEBILT	DEBILT	78	4	0	0
DUSSELDORF	DUSSELDORF	25	4	0	0
HEATHROW	HEATHROW	72	10	0	0
KASSEL	KASSEL	11	0	0	0
LJUBLJANA	LJUBLJANA	42	19	0	0
MAASTRICHT	MAASTRICHT	4	5	0	0
MADRID	MADRID	254	189	2	0
MUNCHENB	MUNCHENB	1	7	0	0
OSLO	OSLO	4	1	0	0
STOCKHOLM	STOCKHOLM	3	1	0	0
VALENTIA	VALENTIA	1	0	0	0

# CNN Test 6 (Extra Convolution & Pooling Layers)

## Hyperparameters:

Epochs: 30  
Batch Size: 16  
Hidden Layers: 64  
Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 16
n_hidden = 64

timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

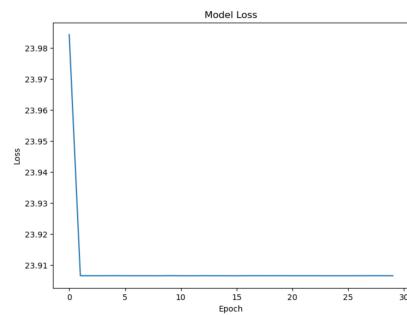
# Define the input shape
input_shape = (timesteps, input_dim)

# Create the model with additional pooling layers
model = Sequential([
    Input(shape=input_shape),
    Conv1D(n_hidden, kernel_size=2, activation='relu'),
    MaxPooling1D(pool_size=2),
    Conv1D(64, kernel_size=2, activation='relu'),
    MaxPooling1D(pool_size=2),
    Conv1D(32, kernel_size=2, activation='relu'),
    MaxPooling1D(pool_size=2),
    Flatten(),
    Dense(64, activation='relu'),
    Dense(n_classes, activation='tanh')
])
```

## Epoch Snapshot:

```
Epoch 1/30
1076/1076 - 1s - 877us/step - accuracy: 0.5688 - loss: 23.9063
Epoch 2/30
1076/1076 - 1s - 543us/step - accuracy: 0.5725 - loss: 23.9065
Epoch 3/30
1076/1076 - 1s - 556us/step - accuracy: 0.5721 - loss: 23.9065
Epoch 4/30
1076/1076 - 1s - 603us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 5/30
1076/1076 - 1s - 632us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 6/30
1076/1076 - 1s - 641us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 7/30
1076/1076 - 1s - 637us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 8/30
1076/1076 - 1s - 637us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 9/30
1076/1076 - 1s - 640us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 10/30
1076/1076 - 1s - 626us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 11/30
1076/1076 - 1s - 630us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 12/30
1076/1076 - 1s - 548us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 13/30
1076/1076 - 1s - 554us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 14/30
1076/1076 - 1s - 553us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 15/30
1076/1076 - 1s - 544us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 16/30
1076/1076 - 1s - 553us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 17/30
1076/1076 - 1s - 543us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 18/30
1076/1076 - 1s - 553us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 19/30
1076/1076 - 1s - 552us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 20/30
1076/1076 - 1s - 580us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 21/30
1076/1076 - 1s - 650us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 22/30
1076/1076 - 1s - 642us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 23/30
1076/1076 - 1s - 622us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 24/30
1076/1076 - 1s - 634us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 25/30
1076/1076 - 1s - 626us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 26/30
1076/1076 - 1s - 623us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 27/30
1076/1076 - 1s - 628us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 28/30
1076/1076 - 1s - 581us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 29/30
1076/1076 - 1s - 552us/step - accuracy: 0.5719 - loss: 23.9065
Epoch 30/30
1076/1076 - 1s - 544us/step - accuracy: 0.5719 - loss: 23.9065
```

## Loss Curve:



## Confusion Matrix:

180/180		0s 418us/step	
Pred	BASEL	MADRID	
True			
BASEL	3203	479	
BELGRADE	1088	4	
BUDAPEST	214	0	
DEBILT	82	0	
DUSSELDORF	29	0	
HEATHROW	82	0	
KASSEL	11	0	
LJUBLJANA	61	0	
MAASTRICHT	9	0	
MADRID	436	22	
MUNCHENB	8	0	
OSLO	5	0	
STOCKHOLM	4	0	
VALENTIA	1	0	

# RNN Test 1

## Hyperparameters:

Epochs: 30

Batch Size: 16

Hidden Layers: 32

Activation Function: Sigmoid

## Layout:

```
epochs = 30
batch_size = 16
n_hidden = 32

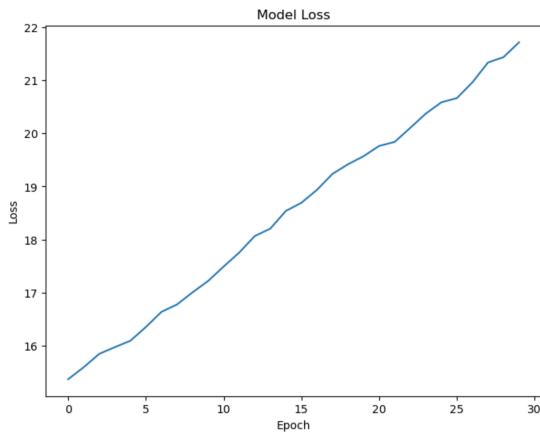
timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

model = Sequential([
    Input(shape=(timesteps, input_dim)),
    LSTM(n_hidden),
    Dropout(0.5),
    Dense(n_classes, activation='sigmoid')
])
```

## Epoch Snapshot:

```
Epoch 1/30
1076/1076 1s 1ms/step - accuracy: 0.0579 - loss: 15.3948 - val_accuracy: 0.0493 - val_loss: 14.7522
Epoch 2/30
1076/1076 1s 1ms/step - accuracy: 0.0535 - loss: 15.3938 - val_accuracy: 0.0479 - val_loss: 15.0055
Epoch 3/30
1076/1076 1s 1ms/step - accuracy: 0.0563 - loss: 15.8473 - val_accuracy: 0.0495 - val_loss: 15.1672
Epoch 4/30
1076/1076 1s 1ms/step - accuracy: 0.0520 - loss: 15.9293 - val_accuracy: 0.0798 - val_loss: 15.2269
Epoch 5/30
1076/1076 1s 1ms/step - accuracy: 0.0526 - loss: 16.1161 - val_accuracy: 0.0457 - val_loss: 15.4062
Epoch 6/30
1076/1076 1s 1ms/step - accuracy: 0.0588 - loss: 16.5820 - val_accuracy: 0.0518 - val_loss: 15.8233
Epoch 7/30
1076/1076 1s 1ms/step - accuracy: 0.0576 - loss: 16.8088 - val_accuracy: 0.0631 - val_loss: 15.9586
Epoch 8/30
1076/1076 1s 1ms/step - accuracy: 0.0584 - loss: 16.7448 - val_accuracy: 0.0516 - val_loss: 16.1374
Epoch 9/30
1076/1076 1s 1ms/step - accuracy: 0.0545 - loss: 16.9095 - val_accuracy: 0.0586 - val_loss: 16.3629
Epoch 10/30
1076/1076 1s 1ms/step - accuracy: 0.0557 - loss: 17.3326 - val_accuracy: 0.0488 - val_loss: 16.5515
Epoch 11/30
1076/1076 1s 1ms/step - accuracy: 0.0611 - loss: 17.4055 - val_accuracy: 0.0634 - val_loss: 16.8507
Epoch 12/30
1076/1076 1s 1ms/step - accuracy: 0.0557 - loss: 17.6756 - val_accuracy: 0.0518 - val_loss: 16.9926
Epoch 13/30
1076/1076 1s 1ms/step - accuracy: 0.0535 - loss: 17.9843 - val_accuracy: 0.0436 - val_loss: 17.3188
Epoch 14/30
1076/1076 1s 1ms/step - accuracy: 0.0514 - loss: 17.9146 - val_accuracy: 0.0521 - val_loss: 17.5254
Epoch 15/30
1076/1076 1s 1ms/step - accuracy: 0.0541 - loss: 18.5148 - val_accuracy: 0.0326 - val_loss: 17.6417
Epoch 16/30
1076/1076 1s 1ms/step - accuracy: 0.0571 - loss: 18.8903 - val_accuracy: 0.0429 - val_loss: 17.7914
Epoch 17/30
1076/1076 1s 1ms/step - accuracy: 0.0598 - loss: 19.3952 - val_accuracy: 0.0505 - val_loss: 18.2002
Epoch 18/30
1076/1076 1s 1ms/step - accuracy: 0.0569 - loss: 18.8657 - val_accuracy: 0.0507 - val_loss: 18.4295
Epoch 19/30
1076/1076 1s 1ms/step - accuracy: 0.0532 - loss: 19.1860 - val_accuracy: 0.0465 - val_loss: 18.6626
Epoch 20/30
1076/1076 1s 1ms/step - accuracy: 0.0551 - loss: 19.5997 - val_accuracy: 0.0430 - val_loss: 18.5966
Epoch 21/30
1076/1076 1s 1ms/step - accuracy: 0.0531 - loss: 19.3888 - val_accuracy: 0.0521 - val_loss: 18.7996
Epoch 22/30
1076/1076 1s 1ms/step - accuracy: 0.0547 - loss: 19.7726 - val_accuracy: 0.0420 - val_loss: 18.9933
Epoch 23/30
1076/1076 1s 1ms/step - accuracy: 0.0523 - loss: 20.4414 - val_accuracy: 0.0495 - val_loss: 19.2361
Epoch 24/30
1076/1076 1s 1ms/step - accuracy: 0.0525 - loss: 20.0813 - val_accuracy: 0.0364 - val_loss: 19.3837
Epoch 25/30
1076/1076 1s 1ms/step - accuracy: 0.0525 - loss: 20.7496 - val_accuracy: 0.0289 - val_loss: 19.4566
Epoch 26/30
1076/1076 1s 1ms/step - accuracy: 0.0540 - loss: 21.1955 - val_accuracy: 0.0488 - val_loss: 19.8533
Epoch 27/30
1076/1076 1s 1ms/step - accuracy: 0.0559 - loss: 20.9476 - val_accuracy: 0.0441 - val_loss: 20.0974
Epoch 28/30
1076/1076 1s 1ms/step - accuracy: 0.0548 - loss: 21.7677 - val_accuracy: 0.0356 - val_loss: 20.2487
Epoch 29/30
1076/1076 1s 1ms/step - accuracy: 0.0551 - loss: 21.1215 - val_accuracy: 0.0500 - val_loss: 20.4859
Epoch 30/30
1076/1076 1s 1ms/step - accuracy: 0.0528 - loss: 21.4986 - val_accuracy: 0.0486 - val_loss: 20.6840
```

## Loss Curve:



## Confusion Matrix:

180/180		0s 595us/step	
Pred	BASEL	MADRID	
True			
BASEL	3681	1	
BELGRADE	1092	0	
BUDAPEST	214	0	
DEBILT	82	0	
DUSSELDORF	29	0	
HEATHROW	82	0	
KASSEL	11	0	
LJUBLJANA	61	0	
MAASTRICHT	9	0	
MADRID	457	1	
MUNCHENB	8	0	
OSLO	5	0	
STOCKHOLM	4	0	
VALENTIA	1	0	

## RNN Test 2

### Hyperparameters:

Epochs: 30  
Batch Size: 16  
Hidden Layers: 32  
Activation Function: Softmax

### Layout:

```
epochs = 30
batch_size = 16
n_hidden = 32

timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

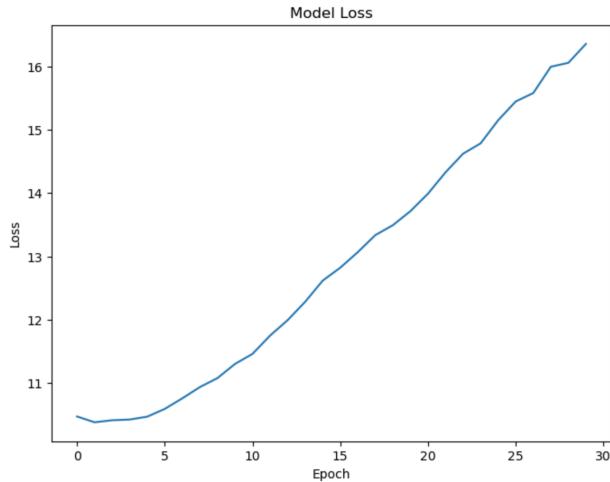
model = Sequential([
    Input(shape=(timesteps, input_dim)),
    LSTM(n_hidden),
    Dropout(0.5),
    Dense(n_classes, activation='softmax')
])
```

### Epoch Snapshot:

```
Epoch 1/30
1076/1076 - 2s 1ms/step - accuracy: 0.0786 - loss: 10.3707 - val_accuracy: 0.0443 - val_loss: 8.5235
Epoch 2/30
1076/1076 - 1s 1ms/step - accuracy: 0.0770 - loss: 10.4158 - val_accuracy: 0.0418 - val_loss: 8.7548
Epoch 3/30
1076/1076 - 1s 1ms/step - accuracy: 0.0812 - loss: 10.6457 - val_accuracy: 0.0382 - val_loss: 8.9376
1076/1076 - 1s 1ms/step - accuracy: 0.0728 - loss: 10.5956 - val_accuracy: 0.0434 - val_loss: 9.1481
Epoch 5/30
1076/1076 - 1s 1ms/step - accuracy: 0.0787 - loss: 10.4109 - val_accuracy: 0.0411 - val_loss: 9.2917
Epoch 6/30
1076/1076 - 1s 1ms/step - accuracy: 0.0767 - loss: 10.5569 - val_accuracy: 0.0451 - val_loss: 9.5813
Epoch 7/30
1076/1076 - 1s 1ms/step - accuracy: 0.0718 - loss: 10.6573 - val_accuracy: 0.0279 - val_loss: 10.0211
Epoch 8/30
1076/1076 - 1s 1ms/step - accuracy: 0.0733 - loss: 10.9097 - val_accuracy: 0.0359 - val_loss: 10.1748
Epoch 9/30
1076/1076 - 1s 1ms/step - accuracy: 0.0705 - loss: 11.0363 - val_accuracy: 0.0591 - val_loss: 10.2500
1076/1076 - 1s 1ms/step - accuracy: 0.0675 - loss: 11.1651 - val_accuracy: 0.0533 - val_loss: 10.5670
Epoch 11/30
1076/1076 - 1s 1ms/step - accuracy: 0.0627 - loss: 11.3735 - val_accuracy: 0.0507 - val_loss: 10.9554
Epoch 12/30
1076/1076 - 1s 1ms/step - accuracy: 0.0616 - loss: 11.5280 - val_accuracy: 0.0472 - val_loss: 11.1292
Epoch 13/30
1076/1076 - 1s 1ms/step - accuracy: 0.0657 - loss: 11.9882 - val_accuracy: 0.0403 - val_loss: 11.3849
1076/1076 - 1s 1ms/step - accuracy: 0.0592 - loss: 12.1125 - val_accuracy: 0.0526 - val_loss: 11.8028
Epoch 14/30
1076/1076 - 1s 1ms/step - accuracy: 0.0634 - loss: 12.5389 - val_accuracy: 0.0612 - val_loss: 12.0798
Epoch 15/30
1076/1076 - 1s 1ms/step - accuracy: 0.0599 - loss: 12.5453 - val_accuracy: 0.0681 - val_loss: 12.1543
Epoch 17/30
1076/1076 - 1s 1ms/step - accuracy: 0.0562 - loss: 13.2188 - val_accuracy: 0.0528 - val_loss: 12.4997
Epoch 18/30
1076/1076 - 1s 991us/step - accuracy: 0.0638 - loss: 13.0336 - val_accuracy: 0.0364 - val_loss: 12.7212
Epoch 19/30
1076/1076 - 1s 1ms/step - accuracy: 0.0558 - loss: 13.4028 - val_accuracy: 0.0441 - val_loss: 12.8835
Epoch 20/30
1076/1076 - 1s 1ms/step - accuracy: 0.0522 - loss: 13.5772 - val_accuracy: 0.0532 - val_loss: 13.1779
Epoch 21/30
1076/1076 - 1s 1ms/step - accuracy: 0.0562 - loss: 13.7273 - val_accuracy: 0.0798 - val_loss: 13.4846
1076/1076 - 1s 1ms/step - accuracy: 0.0562 - loss: 13.7273 - val_accuracy: 0.0798 - val_loss: 13.4846

Epoch 22/30
1076/1076 - 1s 1ms/step - accuracy: 0.0575 - loss: 14.3858 - val_accuracy: 0.0483 - val_loss: 13.8678
Epoch 23/30
1076/1076 - 1s 1ms/step - accuracy: 0.0576 - loss: 14.4743 - val_accuracy: 0.0800 - val_loss: 13.9536
Epoch 24/30
1076/1076 - 1s 1ms/step - accuracy: 0.0547 - loss: 14.6984 - val_accuracy: 0.0354 - val_loss: 14.2947
Epoch 25/30
1076/1076 - 1s 977us/step - accuracy: 0.0544 - loss: 14.8675 - val_accuracy: 0.0483 - val_loss: 14.6446
Epoch 26/30
1076/1076 - 1s 1ms/step - accuracy: 0.0548 - loss: 15.5259 - val_accuracy: 0.0275 - val_loss: 14.7879
Epoch 27/30
1076/1076 - 1s 1ms/step - accuracy: 0.0525 - loss: 15.9798 - val_accuracy: 0.0565 - val_loss: 15.1194
Epoch 28/30
1076/1076 - 1s 1ms/step - accuracy: 0.0541 - loss: 15.9700 - val_accuracy: 0.0382 - val_loss: 15.2378
Epoch 29/30
1076/1076 - 1s 1ms/step - accuracy: 0.0564 - loss: 15.9342 - val_accuracy: 0.0798 - val_loss: 15.3430
Epoch 30/30
1076/1076 - 1s 1ms/step - accuracy: 0.0581 - loss: 16.0763 - val_accuracy: 0.0511 - val_loss: 15.7549
```

### Loss Curve:



### Confusion Matrix:

180/180		0s 594us/step	
Pred	MADRID	OSLO	
True			
BASEL	1479	2203	
BELGRADE	1011	81	
BUDAPEST	209	5	
DEBILT	82	0	
DUSSELDORF	27	2	
HEATHROW	72	10	
KASSEL	11	0	
LJUBLJANA	59	2	
MAASTRICHT	4	5	
MADRID	292	166	
MUNCHENB	7	1	
OSLO	4	1	
STOCKHOLM	4	0	
VALENTIA	0	1	

# RNN Test 3

## Hyperparameters:

Epochs: 30  
Batch Size: 16  
Hidden Layers: 32  
Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 16
n_hidden = 32

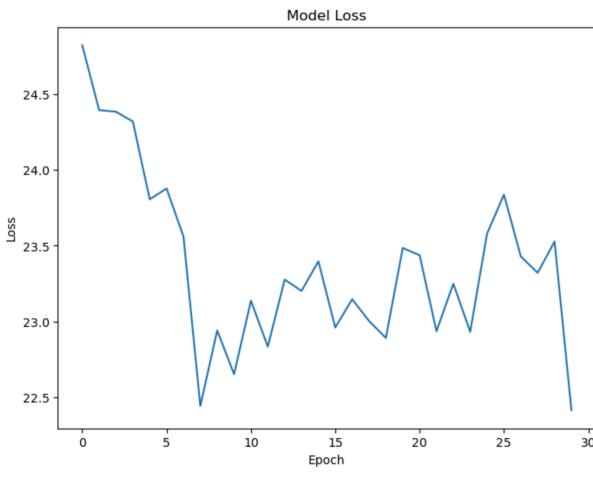
timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

model = Sequential([
    Input(shape=(timesteps, input_dim)),
    LSTM(n_hidden),
    Dropout(0.5),
    Dense(n_classes, activation='tanh')
])
```

## Epoch Snapshot:

```
Epoch 1/30
1076/1076  ls 1ms/step - accuracy: 0.1404 - loss: 24.9111 - val_accuracy: 0.0479 - val_loss: 24.1302
Epoch 2/30
1076/1076  ls 1ms/step - accuracy: 0.0987 - loss: 24.2646 - val_accuracy: 0.1839 - val_loss: 22.6142
Epoch 3/30
1076/1076  ls 1ms/step - accuracy: 0.0941 - loss: 24.3175 - val_accuracy: 0.0228 - val_loss: 23.5511
Epoch 4/30
1076/1076  ls 1ms/step - accuracy: 0.1348 - loss: 24.1421 - val_accuracy: 0.0969 - val_loss: 24.3407
Epoch 5/30
1076/1076  ls 1ms/step - accuracy: 0.1262 - loss: 23.7512 - val_accuracy: 0.1312 - val_loss: 25.3874
Epoch 6/30
1076/1076  ls 1ms/step - accuracy: 0.1220 - loss: 23.6079 - val_accuracy: 0.1152 - val_loss: 23.6134
Epoch 7/30
1076/1076  ls 1ms/step - accuracy: 0.1133 - loss: 23.9872 - val_accuracy: 0.0023 - val_loss: 22.3600
Epoch 8/30
1076/1076  ls 1ms/step - accuracy: 0.0250 - loss: 22.4448 - val_accuracy: 0.0017 - val_loss: 31.8426
Epoch 9/30
1076/1076  ls 1ms/step - accuracy: 0.0271 - loss: 23.5564 - val_accuracy: 0.0026 - val_loss: 33.0994
Epoch 10/30
1076/1076  ls 1ms/step - accuracy: 0.0351 - loss: 22.4808 - val_accuracy: 0.0016 - val_loss: 18.9261
Epoch 11/30
1076/1076  ls 985us/step - accuracy: 0.0316 - loss: 22.9209 - val_accuracy: 0.0026 - val_loss: 31.9142
Epoch 12/30
1076/1076  ls 986us/step - accuracy: 0.0360 - loss: 22.9570 - val_accuracy: 0.0042 - val_loss: 30.7683
Epoch 13/30
1076/1076  ls 976us/step - accuracy: 0.0386 - loss: 23.3242 - val_accuracy: 0.0040 - val_loss: 18.6675
Epoch 14/30
1076/1076  ls 1ms/step - accuracy: 0.0362 - loss: 23.3422 - val_accuracy: 0.0031 - val_loss: 16.4788
Epoch 15/30
1076/1076  ls 1ms/step - accuracy: 0.0375 - loss: 23.4447 - val_accuracy: 0.0014 - val_loss: 16.3976
Epoch 16/30
1076/1076  ls 1ms/step - accuracy: 0.0390 - loss: 22.8046 - val_accuracy: 0.0016 - val_loss: 18.2227
Epoch 17/30
1076/1076  ls 1ms/step - accuracy: 0.0377 - loss: 23.0466 - val_accuracy: 0.0012 - val_loss: 33.7530
Epoch 18/30
1076/1076  ls 991us/step - accuracy: 0.0378 - loss: 23.3279 - val_accuracy: 0.0016 - val_loss: 16.5763
Epoch 19/30
1076/1076  ls 1ms/step - accuracy: 0.0377 - loss: 22.7769 - val_accuracy: 0.0016 - val_loss: 17.2979
Epoch 20/30
1076/1076  ls 1ms/step - accuracy: 0.0384 - loss: 23.3277 - val_accuracy: 0.0014 - val_loss: 29.6841
Epoch 21/30
1076/1076  ls 980us/step - accuracy: 0.0404 - loss: 23.4420 - val_accuracy: 0.0014 - val_loss: 17.1008
Epoch 22/30
1076/1076  ls 1ms/step - accuracy: 0.0314 - loss: 22.8694 - val_accuracy: 0.0030 - val_loss: 15.9557
Epoch 23/30
1076/1076  ls 1ms/step - accuracy: 0.0399 - loss: 23.6577 - val_accuracy: 0.0019 - val_loss: 18.1833
Epoch 24/30
1076/1076  ls 1ms/step - accuracy: 0.0346 - loss: 23.0004 - val_accuracy: 0.0014 - val_loss: 17.2027
Epoch 25/30
1076/1076  ls 1ms/step - accuracy: 0.0315 - loss: 23.4298 - val_accuracy: 0.0014 - val_loss: 15.6550
Epoch 26/30
1076/1076  ls 1ms/step - accuracy: 0.0316 - loss: 23.6993 - val_accuracy: 0.0014 - val_loss: 33.5249
Epoch 27/30
1076/1076  ls 1ms/step - accuracy: 0.0338 - loss: 23.5625 - val_accuracy: 0.0014 - val_loss: 18.2237
Epoch 28/30
1076/1076  ls 1ms/step - accuracy: 0.0385 - loss: 23.2496 - val_accuracy: 0.0014 - val_loss: 33.4794
Epoch 29/30
1076/1076  ls 1ms/step - accuracy: 0.0391 - loss: 23.6082 - val_accuracy: 0.0014 - val_loss: 35.4209
Epoch 30/30
1076/1076  ls 1ms/step - accuracy: 0.0363 - loss: 22.7467 - val_accuracy: 0.0014 - val_loss: 16.0408
```

## Loss Curve:



## Confusion Matrix:

		180/180 0s 614us/step					
Pred	True	BELGRADE	HEATHROW	MAASTRICHT	MADRID	MUNCHENB	SONNBLICK
BASEL	True	11	1	109	1	3556	1
BELGRADE	True	0	0	0	0	1091	1
BUDAPEST	True	0	0	0	0	214	0
DEBILT	True	0	0	0	0	82	0
DUSSELDORF	True	0	0	0	0	29	0
HEATHROW	True	0	0	0	0	82	0
KASSEL	True	0	0	0	0	11	0
LJUBLJANA	True	0	0	0	0	61	0
MAASTRICHT	True	0	0	0	0	9	0
MADRID	True	0	0	0	0	458	0
MUNCHENB	True	0	0	0	0	8	0
OSLO	True	0	0	0	0	5	0
STOCKHOLM	True	0	0	0	0	4	0
VALENTIA	True	0	0	0	0	1	0
		STOCKHOLM VALENTIA					
Pred	True	STOCKHOLM	VALENTIA				
BASEL	True	2	1				
BELGRADE	True	0	0				
BUDAPEST	True	0	0				
DEBILT	True	0	0				
DUSSELDORF	True	0	0				
HEATHROW	True	0	0				
KASSEL	True	0	0				
LJUBLJANA	True	0	0				
MAASTRICHT	True	0	0				
MADRID	True	0	0				
MUNCHENB	True	0	0				
OSLO	True	0	0				
STOCKHOLM	True	0	0				
VALENTIA	True	0	0				

# RNN Test 4

## Hyperparameters:

Epochs: 30  
Batch Size: 16  
Hidden Layers: 64  
Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 16
n_hidden = 64

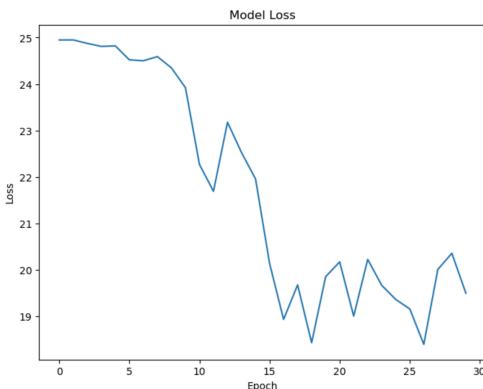
timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

model = Sequential([
    Input(shape=(timesteps, input_dim)),
    LSTM(n_hidden),
    Dropout(0.5),
    Dense(n_classes, activation='tanh')
])
```

## Epoch Snapshot:

```
Epoch 1/30
1076/1076 2s 2ms/step - accuracy: 0.0194 - loss: 24.5630 - val_accuracy: 0.0288 - val_loss: 23.9959
Epoch 2/30
1076/1076 2s 1ms/step - accuracy: 0.0708 - loss: 24.9224 - val_accuracy: 0.1746 - val_loss: 23.8393
Epoch 3/30
1076/1076 1s 1ms/step - accuracy: 0.0803 - loss: 24.8181 - val_accuracy: 0.1473 - val_loss: 22.5159
Epoch 4/30
1076/1076 1s 1ms/step - accuracy: 0.0724 - loss: 24.6261 - val_accuracy: 0.0301 - val_loss: 30.2792
Epoch 5/30
1076/1076 1s 1ms/step - accuracy: 0.0395 - loss: 24.9422 - val_accuracy: 0.1889 - val_loss: 25.1501
Epoch 6/30
1076/1076 1s 1ms/step - accuracy: 0.1560 - loss: 24.3842 - val_accuracy: 0.1774 - val_loss: 26.6194
Epoch 7/30
1076/1076 1s 1ms/step - accuracy: 0.1696 - loss: 24.3747 - val_accuracy: 0.2248 - val_loss: 23.6753
Epoch 8/30
1076/1076 1s 1ms/step - accuracy: 0.1538 - loss: 24.8610 - val_accuracy: 0.0253 - val_loss: 24.9180
Epoch 9/30
1076/1076 1s 1ms/step - accuracy: 0.1244 - loss: 24.0534 - val_accuracy: 0.1631 - val_loss: 23.7774
Epoch 10/30
1076/1076 1s 1ms/step - accuracy: 0.1296 - loss: 23.8533 - val_accuracy: 0.0314 - val_loss: 29.7484
Epoch 11/30
1076/1076 1s 1ms/step - accuracy: 0.0547 - loss: 22.4828 - val_accuracy: 0.0066 - val_loss: 24.2883
Epoch 12/30
1076/1076 1s 1ms/step - accuracy: 0.0422 - loss: 21.7702 - val_accuracy: 0.0024 - val_loss: 25.3092
Epoch 13/30
1076/1076 1s 1ms/step - accuracy: 0.0238 - loss: 22.6556 - val_accuracy: 0.0059 - val_loss: 27.6506
Epoch 14/30
1076/1076 1s 1ms/step - accuracy: 0.0286 - loss: 22.4215 - val_accuracy: 0.0026 - val_loss: 29.4716
Epoch 15/30
1076/1076 2s 1ms/step - accuracy: 0.0470 - loss: 22.0240 - val_accuracy: 0.0124 - val_loss: 29.4862
Epoch 16/30
1076/1076 1s 1ms/step - accuracy: 0.0488 - loss: 21.0529 - val_accuracy: 0.0122 - val_loss: 29.4834
Epoch 17/30
1076/1076 1s 1ms/step - accuracy: 0.0497 - loss: 18.9464 - val_accuracy: 0.0127 - val_loss: 29.4834
Epoch 18/30
1076/1076 1s 1ms/step - accuracy: 0.0482 - loss: 19.7399 - val_accuracy: 0.0089 - val_loss: 29.4834
Epoch 19/30
1076/1076 1s 1ms/step - accuracy: 0.0412 - loss: 18.4270 - val_accuracy: 0.0070 - val_loss: 29.4834
Epoch 20/30
1076/1076 1s 1ms/step - accuracy: 0.0430 - loss: 19.5330 - val_accuracy: 0.0080 - val_loss: 29.4834
Epoch 21/30
1076/1076 2s 1ms/step - accuracy: 0.0370 - loss: 20.8528 - val_accuracy: 0.0064 - val_loss: 29.4834
Epoch 22/30
1076/1076 2s 1ms/step - accuracy: 0.0310 - loss: 18.4615 - val_accuracy: 0.0080 - val_loss: 29.4834
Epoch 23/30
1076/1076 2s 1ms/step - accuracy: 0.0366 - loss: 19.9839 - val_accuracy: 0.0058 - val_loss: 29.4862
Epoch 24/30
1076/1076 2s 1ms/step - accuracy: 0.0378 - loss: 20.4824 - val_accuracy: 0.0058 - val_loss: 29.4834
Epoch 25/30
1076/1076 2s 1ms/step - accuracy: 0.0388 - loss: 19.0223 - val_accuracy: 0.0047 - val_loss: 29.4834
Epoch 26/30
1076/1076 2s 1ms/step - accuracy: 0.0386 - loss: 18.8621 - val_accuracy: 0.0035 - val_loss: 29.4834
Epoch 27/30
1076/1076 1s 1ms/step - accuracy: 0.0466 - loss: 19.3936 - val_accuracy: 0.0037 - val_loss: 29.4834
Epoch 28/30
1076/1076 1s 1ms/step - accuracy: 0.0429 - loss: 20.1206 - val_accuracy: 0.0042 - val_loss: 29.4756
Epoch 29/30
1076/1076 2s 2ms/step - accuracy: 0.0295 - loss: 19.9423 - val_accuracy: 0.0035 - val_loss: 29.4756
Epoch 30/30
1076/1076 2s 1ms/step - accuracy: 0.0280 - loss: 20.1545 - val_accuracy: 0.0037 - val_loss: 29.4738
```

## Loss Curve:



## Confusion Matrix:

180/180		0s 798us/step	
	Pred	BASEL	OSLO
True			
BASEL	16	3666	
BELGRADE	0	1092	
BUDAPEST	0	214	
DEBILT	0	82	
DUSSELDORF	0	29	
HEATHROW	0	82	
KASSEL	0	11	
LJUBLJANA	0	61	
MAASTRICHT	0	9	
MADRID	0	458	
MUNCHENB	0	8	
OSLO	0	5	
STOCKHOLM	0	4	
VALENTIA	0	1	

# RNN Test 5

## Hyperparameters:

Epochs: 30

Batch Size: 16

Hidden Layers: 128

Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 16
n_hidden = 128

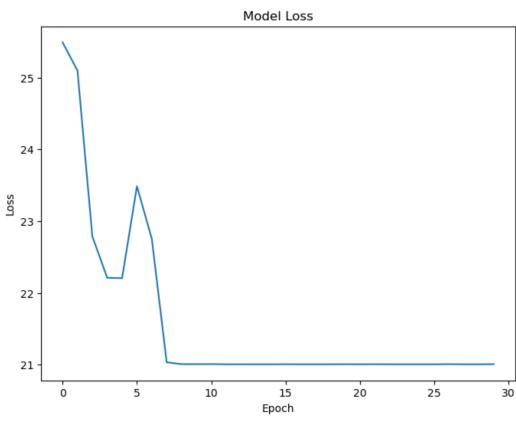
timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

model = Sequential([
    Input(shape=(timesteps, input_dim)),
    LSTM(n_hidden),
    Dropout(0.5),
    Dense(n_classes, activation='tanh')
])
```

## Epoch Snapshot:

```
Epoch 1/30
1076/1076 4s 4ms/step - accuracy: 0.1829 - loss: 26.1286 - val_accuracy: 0.2761 - val_loss: 25.1493
Epoch 2/30
1076/1076 4s 3ms/step - accuracy: 0.1823 - loss: 25.2807 - val_accuracy: 0.6178 - val_loss: 23.2558
Epoch 3/30
1076/1076 4s 4ms/step - accuracy: 0.2346 - loss: 22.6623 - val_accuracy: 0.0392 - val_loss: 20.8799
Epoch 4/30
1076/1076 4s 3ms/step - accuracy: 0.1319 - loss: 21.7425 - val_accuracy: 0.0392 - val_loss: 23.2558
Epoch 5/30
1076/1076 4s 4ms/step - accuracy: 0.1543 - loss: 22.2985 - val_accuracy: 0.0382 - val_loss: 23.2586
Epoch 6/30
1076/1076 4s 4ms/step - accuracy: 0.1836 - loss: 23.4989 - val_accuracy: 0.0380 - val_loss: 23.2558
Epoch 7/30
1076/1076 4s 4ms/step - accuracy: 0.2177 - loss: 23.5752 - val_accuracy: 0.0490 - val_loss: 20.6799
Epoch 8/30
1076/1076 4s 4ms/step - accuracy: 0.3061 - loss: 20.8759 - val_accuracy: 0.3695 - val_loss: 20.6799
Epoch 9/30
1076/1076 4s 4ms/step - accuracy: 0.3298 - loss: 20.8288 - val_accuracy: 0.4665 - val_loss: 20.6799
Epoch 10/30
1076/1076 4s 4ms/step - accuracy: 0.3459 - loss: 21.0991 - val_accuracy: 0.4404 - val_loss: 20.6799
Epoch 11/30
1076/1076 4s 3ms/step - accuracy: 0.3347 - loss: 20.7070 - val_accuracy: 0.4707 - val_loss: 20.6799
Epoch 12/30
1076/1076 4s 4ms/step - accuracy: 0.3417 - loss: 20.6421 - val_accuracy: 0.5112 - val_loss: 20.6799
Epoch 13/30
1076/1076 4s 3ms/step - accuracy: 0.3469 - loss: 21.5961 - val_accuracy: 0.5073 - val_loss: 20.6799
Epoch 14/30
1076/1076 4s 4ms/step - accuracy: 0.3672 - loss: 20.6572 - val_accuracy: 0.5084 - val_loss: 20.6799
Epoch 15/30
1076/1076 4s 3ms/step - accuracy: 0.3559 - loss: 21.2062 - val_accuracy: 0.5106 - val_loss: 20.6799
Epoch 16/30
1076/1076 4s 4ms/step - accuracy: 0.3594 - loss: 21.1591 - val_accuracy: 0.5115 - val_loss: 20.6799
Epoch 17/30
1076/1076 4s 4ms/step - accuracy: 0.3617 - loss: 21.4543 - val_accuracy: 0.5112 - val_loss: 20.6799
Epoch 18/30
1076/1076 4s 3ms/step - accuracy: 0.3588 - loss: 20.7307 - val_accuracy: 0.5157 - val_loss: 20.6799
Epoch 19/30
1076/1076 4s 4ms/step - accuracy: 0.3650 - loss: 21.0087 - val_accuracy: 0.5125 - val_loss: 20.6799
Epoch 20/30
1076/1076 4s 4ms/step - accuracy: 0.3578 - loss: 21.3198 - val_accuracy: 0.5125 - val_loss: 20.6799
Epoch 21/30
1076/1076 4s 4ms/step - accuracy: 0.3668 - loss: 20.5528 - val_accuracy: 0.5159 - val_loss: 20.6799
Epoch 22/30
1076/1076 4s 4ms/step - accuracy: 0.3740 - loss: 21.1408 - val_accuracy: 0.5153 - val_loss: 20.6799
Epoch 23/30
1076/1076 4s 4ms/step - accuracy: 0.3617 - loss: 20.8401 - val_accuracy: 0.5328 - val_loss: 20.6799
Epoch 24/30
1076/1076 4s 4ms/step - accuracy: 0.3792 - loss: 21.0665 - val_accuracy: 0.5324 - val_loss: 20.6799
Epoch 25/30
1076/1076 4s 3ms/step - accuracy: 0.3866 - loss: 21.2971 - val_accuracy: 0.5338 - val_loss: 20.6799
Epoch 26/30
1076/1076 4s 4ms/step - accuracy: 0.3835 - loss: 20.7507 - val_accuracy: 0.5357 - val_loss: 20.6799
Epoch 27/30
1076/1076 4s 3ms/step - accuracy: 0.3846 - loss: 20.9635 - val_accuracy: 0.5308 - val_loss: 20.6799
Epoch 28/30
1076/1076 4s 4ms/step - accuracy: 0.3815 - loss: 21.3317 - val_accuracy: 0.5308 - val_loss: 20.6799
Epoch 29/30
1076/1076 4s 3ms/step - accuracy: 0.3736 - loss: 20.7053 - val_accuracy: 0.5307 - val_loss: 20.6799
Epoch 30/30
1076/1076 4s 4ms/step - accuracy: 0.3816 - loss: 21.0137 - val_accuracy: 0.5342 - val_loss: 20.6799
```

## Loss Curve:



## Confusion Matrix:

180/180 0s 2ms/step		\						
Pred	STOCKHOLM	BASEL	BUDAPEST	DEBILT	DUSSELDORF	MUNCHENB	OSLO	SONNBLICK
True								
BASEL	3065	31	449	2	20	8	4	
BELGRADE	1090	0	2	0	0	0	0	
BUDAPEST	213	0	0	0	0	0	0	
DEBILT	82	0	0	0	0	0	0	
DUSSELDORF	29	0	0	0	0	0	0	
HEATHROW	82	0	0	0	0	0	0	
KASSEL	11	0	0	0	0	0	0	
LJUBLJANA	61	0	0	0	0	0	0	
MAASTRICHT	9	0	0	0	0	0	0	
MADRID	458	0	6	0	0	1	0	
MUNCHENB	8	0	0	0	0	0	0	
OSLO	5	0	0	0	0	0	0	
STOCKHOLM	4	0	0	0	0	0	0	
VALENTIA	1	0	0	0	0	0	0	

Pred	STOCKHOLM
True	
BASEL	103
BELGRADE	0
BUDAPEST	1
DEBILT	0
DUSSELDORF	0
HEATHROW	0
KASSEL	0
LJUBLJANA	0
MAASTRICHT	0
MADRID	1
MUNCHENB	0
OSLO	0
STOCKHOLM	0
VALENTIA	0

# RNN Test 6

## Hyperparameters:

Epochs: 30  
Batch Size: 32  
Hidden Layers: 128  
Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 32
n_hidden = 128

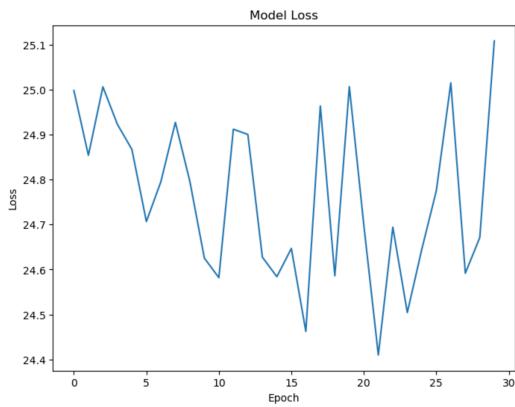
timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

model = Sequential([
    Input(shape=(timesteps, input_dim)),
    LSTM(n_hidden),
    Dropout(0.5),
    Dense(n_classes, activation='tanh')
])
```

## Epoch Snapshot:

```
Epoch 1/30
538/538 3s 4ms/step - accuracy: 0.1866 - loss: 24.5706 - val_accuracy: 0.0657 - val_loss: 24.3883
Epoch 2/30
538/538 2s 5ms/step - accuracy: 0.2620 - loss: 25.1453 - val_accuracy: 0.3456 - val_loss: 24.4004
Epoch 3/30
538/538 2s 4ms/step - accuracy: 0.3479 - loss: 25.4799 - val_accuracy: 0.5885 - val_loss: 28.8578
Epoch 4/30
538/538 2s 4ms/step - accuracy: 0.4342 - loss: 24.9898 - val_accuracy: 0.5303 - val_loss: 29.9177
Epoch 5/30
538/538 2s 4ms/step - accuracy: 0.4034 - loss: 24.8885 - val_accuracy: 0.5687 - val_loss: 22.3784
Epoch 6/30
538/538 2s 5ms/step - accuracy: 0.3960 - loss: 24.4212 - val_accuracy: 0.3574 - val_loss: 25.8729
Epoch 7/30
538/538 2s 4ms/step - accuracy: 0.3300 - loss: 24.5988 - val_accuracy: 0.6265 - val_loss: 22.3432
Epoch 8/30
538/538 2s 4ms/step - accuracy: 0.4365 - loss: 25.4098 - val_accuracy: 0.2546 - val_loss: 29.3371
Epoch 9/30
538/538 2s 4ms/step - accuracy: 0.2859 - loss: 24.8359 - val_accuracy: 0.1900 - val_loss: 24.0297
Epoch 10/30
538/538 2s 4ms/step - accuracy: 0.2694 - loss: 24.3510 - val_accuracy: 0.1419 - val_loss: 22.9871
Epoch 11/30
538/538 2s 4ms/step - accuracy: 0.2176 - loss: 24.5711 - val_accuracy: 0.0683 - val_loss: 23.3649
Epoch 12/30
538/538 2s 4ms/step - accuracy: 0.1924 - loss: 24.5324 - val_accuracy: 0.1652 - val_loss: 22.2240
Epoch 13/30
538/538 3s 5ms/step - accuracy: 0.2794 - loss: 24.9306 - val_accuracy: 0.5643 - val_loss: 24.3485
Epoch 14/30
538/538 2s 4ms/step - accuracy: 0.4229 - loss: 24.6356 - val_accuracy: 0.6379 - val_loss: 25.5766
Epoch 15/30
538/538 2s 4ms/step - accuracy: 0.4336 - loss: 24.6318 - val_accuracy: 0.6258 - val_loss: 24.6727
Epoch 16/30
538/538 2s 4ms/step - accuracy: 0.4313 - loss: 24.3904 - val_accuracy: 0.6365 - val_loss: 22.6097
Epoch 17/30
538/538 3s 5ms/step - accuracy: 0.5317 - loss: 24.2482 - val_accuracy: 0.6345 - val_loss: 28.8113
Epoch 18/30
538/538 2s 4ms/step - accuracy: 0.4327 - loss: 24.7152 - val_accuracy: 0.2365 - val_loss: 26.6668
Epoch 19/30
538/538 2s 4ms/step - accuracy: 0.2564 - loss: 24.3286 - val_accuracy: 0.2130 - val_loss: 26.9142
Epoch 20/30
538/538 3s 5ms/step - accuracy: 0.2093 - loss: 25.1726 - val_accuracy: 0.1300 - val_loss: 20.9817
Epoch 21/30
538/538 2s 4ms/step - accuracy: 0.1867 - loss: 24.9112 - val_accuracy: 0.3815 - val_loss: 26.5496
Epoch 22/30
538/538 2s 4ms/step - accuracy: 0.2901 - loss: 24.7032 - val_accuracy: 0.1469 - val_loss: 30.8394
Epoch 23/30
538/538 3s 5ms/step - accuracy: 0.1828 - loss: 24.8253 - val_accuracy: 0.0124 - val_loss: 26.5027
Epoch 24/30
538/538 2s 4ms/step - accuracy: 0.0896 - loss: 24.4974 - val_accuracy: 0.0952 - val_loss: 28.1446
Epoch 25/30
538/538 2s 4ms/step - accuracy: 0.1102 - loss: 24.7250 - val_accuracy: 0.0261 - val_loss: 26.3507
Epoch 26/30
538/538 3s 5ms/step - accuracy: 0.0696 - loss: 24.4664 - val_accuracy: 0.0349 - val_loss: 26.6701
Epoch 27/30
538/538 2s 4ms/step - accuracy: 0.1103 - loss: 25.2623 - val_accuracy: 0.0819 - val_loss: 23.7591
Epoch 28/30
538/538 2s 4ms/step - accuracy: 0.1275 - loss: 24.3402 - val_accuracy: 0.1584 - val_loss: 22.7232
Epoch 29/30
538/538 2s 4ms/step - accuracy: 0.1682 - loss: 24.2310 - val_accuracy: 0.3459 - val_loss: 32.8772
Epoch 30/30
538/538 2s 5ms/step - accuracy: 0.3199 - loss: 25.5591 - val_accuracy: 0.2414 - val_loss: 28.9148
```

## Loss Curve:



## Confusion Matrix:

180/180		0s 2ms/step		
Pred	BASEL	DUSSELDORF	MADRID	
True				
BASEL	1356	2263	63	
BELGRADE	25	1067	0	
BUDAPEST	2	212	0	
DEBILT	0	82	0	
DUSSELDORF	0	29	0	
HEATHROW	0	82	0	
KASSEL	0	11	0	
LJUBLJANA	1	60	0	
MAASTRICHT	0	9	0	
MADRID	70	388	0	
MUNCHENB	0	8	0	
OSLO	0	5	0	
STOCKHOLM	0	4	0	
VALENTIA	0	1	0	

# RNN Test 7

## Hyperparameters:

Epochs: 30  
Batch Size: 32  
Hidden Layers: 64  
Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 32
n_hidden = 64

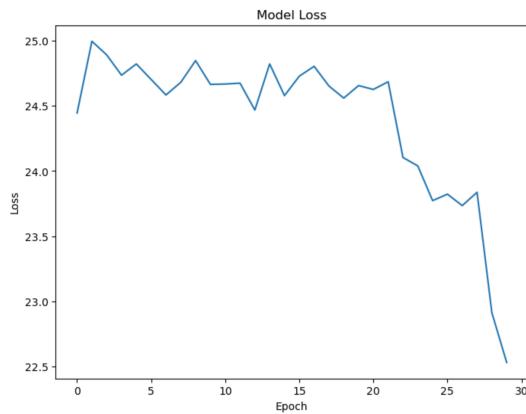
timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

model = Sequential([
    Input(shape=(timesteps, input_dim)),
    LSTM(n_hidden),
    Dropout(0.5),
    Dense(n_classes, activation='tanh')
])
```

## Epoch Snapshot:

```
Epoch 1/30
538/538 1s 2ms/step - accuracy: 0.2068 - loss: 24.0818 - val_accuracy: 0.1389 - val_loss: 23.9926
Epoch 2/30
538/538 1s 2ms/step - accuracy: 0.0940 - loss: 24.9432 - val_accuracy: 0.1900 - val_loss: 30.8309
Epoch 3/30
538/538 1s 2ms/step - accuracy: 0.1166 - loss: 24.7778 - val_accuracy: 0.1924 - val_loss: 20.9059
Epoch 4/30
538/538 1s 2ms/step - accuracy: 0.1179 - loss: 24.9153 - val_accuracy: 0.2175 - val_loss: 24.6885
Epoch 5/30
538/538 1s 2ms/step - accuracy: 0.1121 - loss: 24.8812 - val_accuracy: 0.1889 - val_loss: 31.1146
Epoch 6/30
538/538 1s 2ms/step - accuracy: 0.0859 - loss: 24.5273 - val_accuracy: 0.0387 - val_loss: 23.4380
Epoch 7/30
538/538 1s 2ms/step - accuracy: 0.0662 - loss: 24.3103 - val_accuracy: 0.0676 - val_loss: 24.4892
Epoch 8/30
538/538 1s 2ms/step - accuracy: 0.0588 - loss: 25.2033 - val_accuracy: 0.1915 - val_loss: 22.5364
Epoch 9/30
538/538 1s 2ms/step - accuracy: 0.0833 - loss: 24.7956 - val_accuracy: 0.0082 - val_loss: 22.2067
Epoch 10/30
538/538 1s 2ms/step - accuracy: 0.0422 - loss: 24.9543 - val_accuracy: 0.0352 - val_loss: 28.0089
Epoch 11/30
538/538 1s 2ms/step - accuracy: 0.0598 - loss: 24.7128 - val_accuracy: 0.0392 - val_loss: 31.0418
Epoch 12/30
538/538 1s 2ms/step - accuracy: 0.0396 - loss: 24.8299 - val_accuracy: 0.0186 - val_loss: 24.6901
Epoch 13/30
538/538 1s 2ms/step - accuracy: 0.0426 - loss: 25.0718 - val_accuracy: 0.0023 - val_loss: 21.1489
Epoch 14/30
538/538 1s 2ms/step - accuracy: 0.0487 - loss: 24.6665 - val_accuracy: 0.0162 - val_loss: 27.8140
Epoch 15/30
538/538 1s 2ms/step - accuracy: 0.0720 - loss: 24.3375 - val_accuracy: 0.0423 - val_loss: 25.5244
Epoch 16/30
538/538 1s 2ms/step - accuracy: 0.0627 - loss: 25.0012 - val_accuracy: 0.0038 - val_loss: 31.1560
Epoch 17/30
538/538 1s 2ms/step - accuracy: 0.0860 - loss: 24.4637 - val_accuracy: 0.1379 - val_loss: 24.6713
Epoch 18/30
538/538 1s 2ms/step - accuracy: 0.1111 - loss: 24.3474 - val_accuracy: 0.0805 - val_loss: 27.4801
Epoch 19/30
538/538 1s 2ms/step - accuracy: 0.1061 - loss: 24.3111 - val_accuracy: 0.0432 - val_loss: 24.8846
Epoch 20/30
538/538 1s 2ms/step - accuracy: 0.0919 - loss: 24.5637 - val_accuracy: 0.0579 - val_loss: 24.4054
Epoch 21/30
538/538 1s 2ms/step - accuracy: 0.0861 - loss: 24.8164 - val_accuracy: 0.0798 - val_loss: 21.5761
Epoch 22/30
538/538 1s 2ms/step - accuracy: 0.0837 - loss: 24.1336 - val_accuracy: 0.0709 - val_loss: 24.5005
Epoch 23/30
538/538 1s 2ms/step - accuracy: 0.0607 - loss: 24.4516 - val_accuracy: 0.0664 - val_loss: 18.9068
Epoch 24/30
538/538 1s 2ms/step - accuracy: 0.0853 - loss: 23.9679 - val_accuracy: 0.0627 - val_loss: 34.8910
Epoch 25/30
538/538 1s 2ms/step - accuracy: 0.0776 - loss: 23.8870 - val_accuracy: 0.0221 - val_loss: 36.1592
Epoch 26/30
538/538 1s 2ms/step - accuracy: 0.0675 - loss: 23.9451 - val_accuracy: 0.0235 - val_loss: 17.9194
Epoch 27/30
538/538 1s 2ms/step - accuracy: 0.0573 - loss: 23.4250 - val_accuracy: 0.0195 - val_loss: 29.1959
Epoch 28/30
538/538 1s 2ms/step - accuracy: 0.0618 - loss: 23.5129 - val_accuracy: 0.0713 - val_loss: 23.3869
Epoch 29/30
538/538 1s 2ms/step - accuracy: 0.0490 - loss: 22.8616 - val_accuracy: 0.0636 - val_loss: 23.6858
Epoch 30/30
538/538 1s 2ms/step - accuracy: 0.0427 - loss: 22.5737 - val_accuracy: 0.0347 - val_loss: 20.0127
```

## Loss Curve:



## Confusion Matrix:

180/180 0s 936us/step		SONNBLICK							
Pred	True	BASEL	DUSSELDORF	KASSEL	LJUBLJANA	MAASTRICHT	MADRID	OSLO	VALENTIA
BASEL	33	57	1	256	1	1665	412		
BELGRADE	0	0	0	63	0	106	166		
BUDAPEST	0	0	0	27	0	13	52		
DEBILT	0	0	0	6	0	0	41		
DUSSELDORF	0	0	0	4	0	1	7		
HEATHROW	0	0	0	19	0	3	17		
KASSEL	0	0	0	3	0	1	0		
LJUBLJANA	0	0	0	22	0	3	3		
MAASTRICHT	0	0	0	1	0	0	1		
MADRID	1	0	0	94	0	143	32		
MUNCHENB	0	0	0	1	0	1	0		
OSLO	0	0	0	1	0	1	1		
STOCKHOLM	0	0	0	1	0	0	1		
VALENTIA	0	0	0	1	0	0	0		

# LSTM - RNN Test 8

## Hyperparameters:

Epochs: 30

Batch Size: 16

Hidden Layers: 64

Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 16
n_hidden = 64

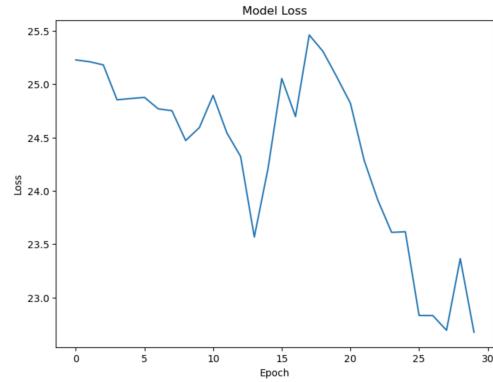
timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

model = Sequential()
model.add(LSTM(n_hidden, input_shape=(timesteps, input_dim)))
model.add(Dropout(0.5))
model.add(Dense(n_classes, activation='tanh')) #Don't use relu here!
```

## Epoch Snapshot:

```
Epoch 1/30 1076/1076 2s 2ms/step - accuracy: 0.3307 - loss: 25.0399 - val_accuracy: 0.5535 - val_loss: 26.4056
Epoch 2/30 1076/1076 2s 1ms/step - accuracy: 0.4152 - loss: 25.3040 - val_accuracy: 0.6363 - val_loss: 29.7748
Epoch 3/30 1076/1076 2s 1ms/step - accuracy: 0.4285 - loss: 24.7438 - val_accuracy: 0.4976 - val_loss: 25.4489
Epoch 4/30 1076/1076 1s 1ms/step - accuracy: 0.2769 - loss: 24.9026 - val_accuracy: 0.5324 - val_loss: 26.6126
Epoch 5/30 1076/1076 1s 1ms/step - accuracy: 0.3004 - loss: 25.1340 - val_accuracy: 0.0490 - val_loss: 28.4814
Epoch 6/30 1076/1076 2s 1ms/step - accuracy: 0.1860 - loss: 24.9025 - val_accuracy: 0.0077 - val_loss: 30.0515
Epoch 7/30 1076/1076 2s 1ms/step - accuracy: 0.0307 - loss: 25.0590 - val_accuracy: 8.7138e-04 - val_loss: 27.6468
Epoch 8/30 1076/1076 2s 1ms/step - accuracy: 0.0356 - loss: 24.6129 - val_accuracy: 0.0038 - val_loss: 25.8191
Epoch 9/30 1076/1076 2s 1ms/step - accuracy: 0.0489 - loss: 24.7424 - val_accuracy: 0.0035 - val_loss: 26.8882
Epoch 10/30 1076/1076 1s 1ms/step - accuracy: 0.0792 - loss: 24.5988 - val_accuracy: 0.0098 - val_loss: 26.8126
Epoch 11/30 1076/1076 1s 1ms/step - accuracy: 0.0626 - loss: 25.1943 - val_accuracy: 0.0014 - val_loss: 24.9592
Epoch 12/30 1076/1076 2s 1ms/step - accuracy: 0.0401 - loss: 24.3536 - val_accuracy: 6.9711e-04 - val_loss: 25.6499
Epoch 13/30 1076/1076 2s 2ms/step - accuracy: 0.0406 - loss: 24.3472 - val_accuracy: 6.9711e-04 - val_loss: 22.1315
Epoch 14/30 1076/1076 2s 1ms/step - accuracy: 0.0494 - loss: 24.3439 - val_accuracy: 8.7138e-04 - val_loss: 28.6283
Epoch 15/30 1076/1076 2s 1ms/step - accuracy: 0.0942 - loss: 23.2723 - val_accuracy: 0.0014 - val_loss: 29.4012
Epoch 16/30 1076/1076 2s 1ms/step - accuracy: 0.0871 - loss: 25.0409 - val_accuracy: 6.9711e-04 - val_loss: 26.1384
Epoch 17/30 1076/1076 1s 1ms/step - accuracy: 0.0602 - loss: 24.5824 - val_accuracy: 6.9711e-04 - val_loss: 23.2951
Epoch 18/30 1076/1076 2s 1ms/step - accuracy: 0.0603 - loss: 25.7453 - val_accuracy: 6.9711e-04 - val_loss: 24.0404
Epoch 19/30 1076/1076 2s 1ms/step - accuracy: 0.0525 - loss: 25.3710 - val_accuracy: 0.0073 - val_loss: 17.0376
Epoch 20/30 1076/1076 2s 2ms/step - accuracy: 0.1048 - loss: 25.0833 - val_accuracy: 0.3486 - val_loss: 29.4189
Epoch 21/30 1076/1076 2s 1ms/step - accuracy: 0.2419 - loss: 24.9166 - val_accuracy: 0.3310 - val_loss: 16.6902
Epoch 22/30 1076/1076 1s 1ms/step - accuracy: 0.3191 - loss: 24.8168 - val_accuracy: 0.6129 - val_loss: 23.6710
Epoch 23/30 1076/1076 1s 1ms/step - accuracy: 0.3762 - loss: 23.9666 - val_accuracy: 0.5596 - val_loss: 27.4383
Epoch 24/30 1076/1076 2s 1ms/step - accuracy: 0.3681 - loss: 23.3480 - val_accuracy: 0.6119 - val_loss: 30.5283
Epoch 25/30 1076/1076 2s 2ms/step - accuracy: 0.3152 - loss: 23.6285 - val_accuracy: 0.6316 - val_loss: 23.5129
Epoch 26/30 1076/1076 2s 1ms/step - accuracy: 0.2982 - loss: 23.2079 - val_accuracy: 0.6358 - val_loss: 19.7398
Epoch 27/30 1076/1076 2s 1ms/step - accuracy: 0.3150 - loss: 23.0357 - val_accuracy: 0.6399 - val_loss: 20.6088
Epoch 28/30 1076/1076 2s 1ms/step - accuracy: 0.3487 - loss: 22.4490 - val_accuracy: 0.6401 - val_loss: 24.5777
Epoch 29/30 1076/1076 2s 1ms/step - accuracy: 0.3338 - loss: 22.6935 - val_accuracy: 0.6401 - val_loss: 23.2261
Epoch 30/30 1076/1076 2s 1ms/step - accuracy: 0.3309 - loss: 23.2912 - val_accuracy: 0.6408 - val_loss: 21.7962
```

## Loss Curve:



## Confusion Matrix:

180/180		0s 790us/step	
Pred	BASEL	BELGRADE	
True			
BASEL	3677	5	
BELGRADE	1092	0	
BUDAPEST	214	0	
DEBILT	82	0	
DUSSELDORF	29	0	
HEATHROW	82	0	
KASSEL	11	0	
LJUBLJANA	61	0	
MAASTRICHT	9	0	
MADRID	458	0	
MUNCHENB	8	0	
OSLO	5	0	
STOCKHOLM	4	0	
VALENTIA	1	0	

# RNN Test 9 (Scaled Data)

## Hyperparameters:

Epochs: 30  
Batch Size: 16  
Hidden Layers: 32  
Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 16
n_hidden = 32

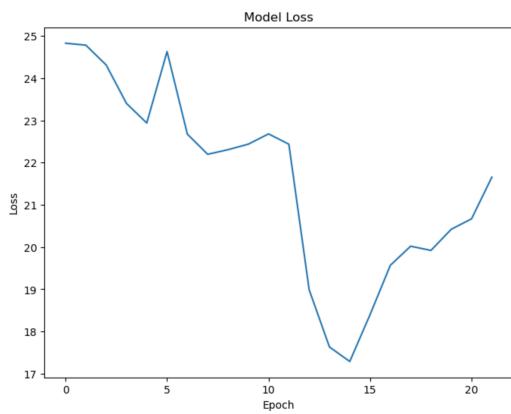
timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

model = Sequential([
    Input(shape=(timesteps, input_dim)),
    LSTM(n_hidden),
    Dropout(0.5),
    Dense(n_classes, activation='tanh')
])
```

## Epoch Snapshot:

```
Epoch 1/30
1076/1076 - 1s 1ms/step - accuracy: 0.0877 - loss: 24.7649 - val_accuracy: 0.0108 - val_loss: 27.0975
Epoch 2/30
1076/1076 - 1s 1ms/step - accuracy: 0.0773 - loss: 24.8730 - val_accuracy: 0.0491 - val_loss: 20.5867
Epoch 3/30
1076/1076 - 1s 1ms/step - accuracy: 0.0974 - loss: 24.4483 - val_accuracy: 0.0150 - val_loss: 25.0756
Epoch 4/30
1076/1076 - 1s 1ms/step - accuracy: 0.0817 - loss: 23.7636 - val_accuracy: 0.0145 - val_loss: 25.7920
Epoch 5/30
1076/1076 - 1s 1ms/step - accuracy: 0.0726 - loss: 22.5988 - val_accuracy: 0.0077 - val_loss: 25.8475
Epoch 6/30
1076/1076 - 1s 1ms/step - accuracy: 0.0646 - loss: 24.8998 - val_accuracy: 0.0627 - val_loss: 27.5039
Epoch 7/30
1076/1076 - 1s 1ms/step - accuracy: 0.0598 - loss: 23.3818 - val_accuracy: 0.0758 - val_loss: 29.3756
Epoch 8/30
1076/1076 - 1s 1ms/step - accuracy: 0.0697 - loss: 22.0649 - val_accuracy: 0.0798 - val_loss: 23.7324
Epoch 9/30
1076/1076 - 1s 1ms/step - accuracy: 0.0519 - loss: 22.4913 - val_accuracy: 0.0793 - val_loss: 25.2037
Epoch 10/30
1076/1076 - 1s 1ms/step - accuracy: 0.0647 - loss: 22.3155 - val_accuracy: 0.0688 - val_loss: 24.0051
Epoch 11/30
1076/1076 - 1s 1ms/step - accuracy: 0.0519 - loss: 22.4913 - val_accuracy: 0.0793 - val_loss: 25.2037
1076/1076 - 1s 1ms/step - accuracy: 0.0638 - loss: 22.9166 - val_accuracy: 0.0776 - val_loss: 30.7744
Epoch 12/30
1076/1076 - 1s 1ms/step - accuracy: 0.0947 - loss: 23.0682 - val_accuracy: 0.0448 - val_loss: 29.4908
Epoch 13/30
1076/1076 - 1s 1ms/step - accuracy: 0.1193 - loss: 19.8669 - val_accuracy: 5.2283e-04 - val_loss: 21.1746
Epoch 14/30
1076/1076 - 1s 1ms/step - accuracy: 0.1138 - loss: 16.8543 - val_accuracy: 5.2283e-04 - val_loss: 24.3683
Epoch 15/30
1076/1076 - 1s 1ms/step - accuracy: 0.1162 - loss: 17.9843 - val_accuracy: 5.2283e-04 - val_loss: 23.0763
Epoch 16/30
1076/1076 - 1s 1ms/step - accuracy: 0.1235 - loss: 17.9405 - val_accuracy: 1.7428e-04 - val_loss: 29.9947
Epoch 17/30
1076/1076 - 1s 1ms/step - accuracy: 0.1313 - loss: 17.8622 - val_accuracy: 0.0211 - val_loss: 29.6636
Epoch 18/30
1076/1076 - 1s 1ms/step - accuracy: 0.1126 - loss: 20.1587 - val_accuracy: 0.0000e+00 - val_loss: 21.4951
Epoch 19/30
1076/1076 - 1s 1ms/step - accuracy: 0.1329 - loss: 19.2054 - val_accuracy: 0.0000e+00 - val_loss: 30.2108
Epoch 20/30
1076/1076 - 1s 1ms/step - accuracy: 0.1414 - loss: 20.2483 - val_accuracy: 0.0000e+00 - val_loss: 29.1137
Epoch 21/30
1076/1076 - 1s 1ms/step - accuracy: 0.1492 - loss: 20.8308 - val_accuracy: 0.0000e+00 - val_loss: 29.8428
Epoch 22/30
1076/1076 - 1s 1ms/step - accuracy: 0.1788 - loss: 21.6182 - val_accuracy: 0.0000e+00 - val_loss: 29.6266
Epoch 23/30
1076/1076 - 1s 1ms/step - accuracy: 0.2245 - loss: nan - val_accuracy: 0.6417 - val_loss: nan
Epoch 24/30
1076/1076 - 1s 1ms/step - accuracy: 0.6531 - loss: nan - val_accuracy: 0.6417 - val_loss: nan
Epoch 25/30
1076/1076 - 1s 1ms/step - accuracy: 0.6475 - loss: nan - val_accuracy: 0.6417 - val_loss: nan
Epoch 26/30
1076/1076 - 1s 1ms/step - accuracy: 0.6430 - loss: nan - val_accuracy: 0.6417 - val_loss: nan
Epoch 27/30
1076/1076 - 1s 1ms/step - accuracy: 0.6436 - loss: nan - val_accuracy: 0.6417 - val_loss: nan
Epoch 28/30
1076/1076 - 1s 1ms/step - accuracy: 0.6493 - loss: nan - val_accuracy: 0.6417 - val_loss: nan
Epoch 29/30
1076/1076 - 1s 982us/step - accuracy: 0.6432 - loss: nan - val_accuracy: 0.6417 - val_loss: nan
Epoch 30/30
1076/1076 - 1s 1ms/step - accuracy: 0.6433 - loss: nan - val_accuracy: 0.6417 - val_loss: nan
```

## Loss Curve:



## Confusion Matrix:

180/180		0s 591us/step
Pred	True	BASEL
BASEL	3682	3682
BELGRADE	1092	1092
BUDAPEST	214	214
DEBILT	82	82
DUSSELDORF	29	29
HEATHROW	82	82
KASSEL	11	11
LJUBLJANA	61	61
MAASTRICHT	9	9
MADRID	458	458
MUNCHENB	8	8
OSLO	5	5
STOCKHOLM	4	4
VALENTIA	1	1

# RNN Test 10 (Scaled Data)

## Hyperparameters:

Epochs: 30  
Batch Size: 16  
Hidden Layers: 64  
Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 16
n_hidden = 64

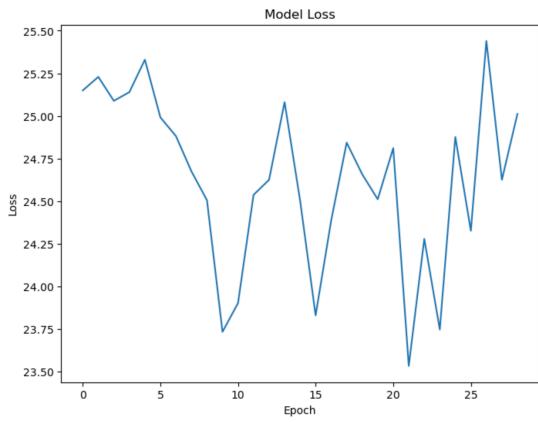
timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

model = Sequential([
    Input(shape=(timesteps, input_dim)),
    LSTM(n_hidden),
    Dropout(0.5),
    Dense(n_classes, activation='tanh')
])
```

## Epoch Snapshot:

```
Epoch 1/30
1076/1076 2s 2ms/step - accuracy: 0.1370 - loss: 25.4283 - val_accuracy: 0.0106 - val_loss: 25.4171
Epoch 2/30
1076/1076 2s 1ms/step - accuracy: 0.0221 - loss: 25.0408 - val_accuracy: 0.0106 - val_loss: 30.9982
Epoch 3/30
1076/1076 2s 1ms/step - accuracy: 0.0202 - loss: 25.5353 - val_accuracy: 0.0106 - val_loss: 26.6691
Epoch 4/30
1076/1076 1s 1ms/step - accuracy: 0.0158 - loss: 25.5073 - val_accuracy: 0.0106 - val_loss: 25.0569
Epoch 5/30
1076/1076 2s 1ms/step - accuracy: 0.0139 - loss: 25.0982 - val_accuracy: 0.0160 - val_loss: 26.3918
Epoch 6/30
1076/1076 2s 1ms/step - accuracy: 0.0141 - loss: 24.6972 - val_accuracy: 0.0106 - val_loss: 27.8973
Epoch 7/30
1076/1076 2s 1ms/step - accuracy: 0.0117 - loss: 24.8105 - val_accuracy: 0.0106 - val_loss: 23.6864
Epoch 8/30
1076/1076 2s 1ms/step - accuracy: 0.0144 - loss: 25.0182 - val_accuracy: 0.0106 - val_loss: 21.4299
Epoch 9/30
1076/1076 2s 1ms/step - accuracy: 0.0097 - loss: 24.6220 - val_accuracy: 0.0106 - val_loss: 26.5642
Epoch 10/30
1076/1076 1s 1ms/step - accuracy: 0.0100 - loss: 23.9141 - val_accuracy: 0.0106 - val_loss: 25.6546
Epoch 11/30
1076/1076 1s 1ms/step - accuracy: 0.0084 - loss: 23.3309 - val_accuracy: 0.0106 - val_loss: 26.1873
Epoch 12/30
1076/1076 2s 2ms/step - accuracy: 0.0079 - loss: 24.4877 - val_accuracy: 0.0106 - val_loss: 25.6130
Epoch 13/30
1076/1076 1s 1ms/step - accuracy: 0.0072 - loss: 24.7706 - val_accuracy: 0.0106 - val_loss: 24.9787
Epoch 14/30
1076/1076 1s 1ms/step - accuracy: 0.0096 - loss: 24.6829 - val_accuracy: 0.0106 - val_loss: 24.2952
Epoch 15/30
1076/1076 1s 1ms/step - accuracy: 0.0449 - loss: 24.8861 - val_accuracy: 0.0108 - val_loss: 27.9743
Epoch 16/30
1076/1076 1s 1ms/step - accuracy: 0.0454 - loss: 23.1707 - val_accuracy: 0.0108 - val_loss: 25.4200
Epoch 17/30
1076/1076 1s 1ms/step - accuracy: 0.0435 - loss: 24.2413 - val_accuracy: 0.0106 - val_loss: 26.0217
Epoch 18/30
1076/1076 2s 2ms/step - accuracy: 0.0219 - loss: 25.1256 - val_accuracy: 0.0106 - val_loss: 25.2792
Epoch 19/30
1076/1076 2s 1ms/step - accuracy: 0.0154 - loss: 24.9838 - val_accuracy: 0.0106 - val_loss: 28.0345
Epoch 20/30
1076/1076 2s 1ms/step - accuracy: 0.0204 - loss: 24.6962 - val_accuracy: 0.0106 - val_loss: 23.0008
Epoch 21/30
1076/1076 2s 1ms/step - accuracy: 0.0361 - loss: 25.2546 - val_accuracy: 0.0106 - val_loss: 23.0039
Epoch 22/30
1076/1076 2s 1ms/step - accuracy: 0.0243 - loss: 23.9285 - val_accuracy: 0.0106 - val_loss: 23.0030
Epoch 23/30
1076/1076 2s 1ms/step - accuracy: 0.0197 - loss: 23.5845 - val_accuracy: 0.0106 - val_loss: 28.1587
Epoch 24/30
1076/1076 1s 1ms/step - accuracy: 0.0211 - loss: 23.7367 - val_accuracy: 0.0106 - val_loss: 28.0513
Epoch 25/30
1076/1076 1s 1ms/step - accuracy: 0.0187 - loss: 23.9721 - val_accuracy: 0.0106 - val_loss: 28.1854
Epoch 26/30
1076/1076 2s 2ms/step - accuracy: 0.0085 - loss: 24.4485 - val_accuracy: 0.0106 - val_loss: 27.5854
Epoch 27/30
1076/1076 1s 1ms/step - accuracy: 0.0110 - loss: 25.1297 - val_accuracy: 0.0106 - val_loss: 28.1329
Epoch 28/30
1076/1076 2s 1ms/step - accuracy: 0.0096 - loss: 24.8435 - val_accuracy: 0.0106 - val_loss: 23.0677
Epoch 29/30
1076/1076 2s 1ms/step - accuracy: 0.0108 - loss: 24.0304 - val_accuracy: 0.0106 - val_loss: 28.1555
Epoch 30/30
1076/1076 2s 1ms/step - accuracy: 0.4995 - loss: nan - val_accuracy: 0.6417 - val_loss: nan
```

## Loss Curve:



## Confusion Matrix:

180/180		0s 970us/step
Pred	BASEL	
True		
BASEL	3682	
BELGRADE	1092	
BUDAPEST	214	
DEBILT	82	
DUSSELDORF	29	
HEATHROW	82	
KASSEL	11	
LJUBLJANA	61	
MAASTRICHT	9	
MADRID	458	
MUNCHENB	8	
OSLO	5	
STOCKHOLM	4	
VALENTIA	1	

# RNN Test 11 (Scaled Data)

## Hyperparameters:

Epochs: 30

Batch Size: 16

Hidden Layers: 64

Activation Function: Tanh

## Layout:

```
epochs = 30
batch_size = 32
n_hidden = 64

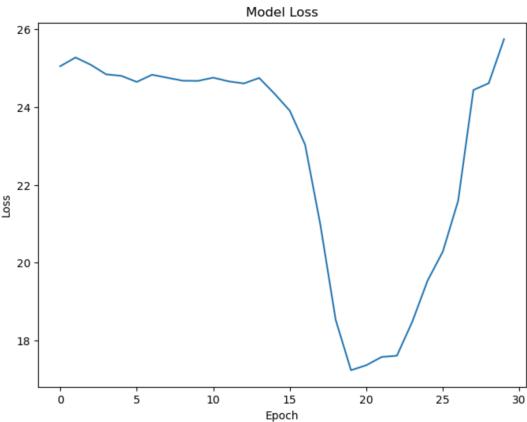
timesteps = len(X_train[0])
input_dim = len(X_train[0][0])
n_classes = len(y_train[0])

model = Sequential([
    Input(shape=(timesteps, input_dim)),
    LSTM(n_hidden),
    Dropout(0.5),
    Dense(n_classes, activation='tanh')
])
```

## Epoch Snapshot:

```
Epoch 1/30
538/538 1s 2ms/step - accuracy: 0.0605 - loss: 25.3498 - val_accuracy: 0.0019 - val_loss: 24.6710
Epoch 2/30
538/538 1s 2ms/step - accuracy: 0.0070 - loss: 24.7409 - val_accuracy: 0.0019 - val_loss: 28.9606
Epoch 3/30
538/538 1s 2ms/step - accuracy: 0.0552 - loss: 24.9874 - val_accuracy: 0.0030 - val_loss: 33.4108
Epoch 4/30
538/538 1s 2ms/step - accuracy: 0.0168 - loss: 25.0488 - val_accuracy: 0.0019 - val_loss: 25.5658
Epoch 5/30
538/538 1s 2ms/step - accuracy: 0.0132 - loss: 25.0616 - val_accuracy: 0.0028 - val_loss: 21.8670
Epoch 6/30
538/538 1s 2ms/step - accuracy: 0.0163 - loss: 24.7265 - val_accuracy: 0.0049 - val_loss: 24.2670
Epoch 7/30
538/538 1s 2ms/step - accuracy: 0.0403 - loss: 24.8276 - val_accuracy: 0.0023 - val_loss: 22.1994
Epoch 8/30
538/538 1s 2ms/step - accuracy: 0.0757 - loss: 25.0745 - val_accuracy: 0.0108 - val_loss: 26.3607
Epoch 9/30
538/538 1s 2ms/step - accuracy: 0.0937 - loss: 24.7531 - val_accuracy: 0.0033 - val_loss: 30.7201
Epoch 10/30
538/538 1s 2ms/step - accuracy: 0.0461 - loss: 24.7085 - val_accuracy: 0.0030 - val_loss: 23.0178
Epoch 11/30
538/538 1s 2ms/step - accuracy: 0.0540 - loss: 24.9204 - val_accuracy: 0.0021 - val_loss: 26.9072
Epoch 12/30
538/538 1s 2ms/step - accuracy: 0.0331 - loss: 24.4689 - val_accuracy: 0.0295 - val_loss: 23.8879
Epoch 13/30
538/538 1s 2ms/step - accuracy: 0.1086 - loss: 25.1744 - val_accuracy: 0.0512 - val_loss: 20.5322
Epoch 14/30
538/538 1s 2ms/step - accuracy: 0.0634 - loss: 24.4878 - val_accuracy: 0.0500 - val_loss: 26.0989
Epoch 15/30
538/538 1s 2ms/step - accuracy: 0.0783 - loss: 24.3250 - val_accuracy: 0.0722 - val_loss: 25.4706
Epoch 16/30
538/538 1s 2ms/step - accuracy: 0.0881 - loss: 24.5056 - val_accuracy: 0.0504 - val_loss: 24.8013
Epoch 17/30
538/538 1s 2ms/step - accuracy: 0.1066 - loss: 23.2141 - val_accuracy: 0.0214 - val_loss: 19.0193
Epoch 18/30
538/538 1s 2ms/step - accuracy: 0.0971 - loss: 21.3653 - val_accuracy: 0.1912 - val_loss: 18.8544
Epoch 19/30
538/538 1s 2ms/step - accuracy: 0.1923 - loss: 19.0787 - val_accuracy: 0.2693 - val_loss: 32.8797
Epoch 20/30
538/538 1s 2ms/step - accuracy: 0.1977 - loss: 17.3983 - val_accuracy: 6.9711e-04 - val_loss: 18.7312
Epoch 21/30
538/538 1s 2ms/step - accuracy: 0.1819 - loss: 17.4236 - val_accuracy: 6.9711e-04 - val_loss: 18.4187
Epoch 22/30
538/538 1s 2ms/step - accuracy: 0.1624 - loss: 17.9240 - val_accuracy: 8.7138e-04 - val_loss: 18.3513
Epoch 23/30
538/538 1s 2ms/step - accuracy: 0.1273 - loss: 17.6089 - val_accuracy: 8.7138e-04 - val_loss: 19.6132
Epoch 24/30
538/538 1s 2ms/step - accuracy: 0.1628 - loss: 17.9320 - val_accuracy: 0.0014 - val_loss: 33.5053
Epoch 25/30
538/538 1s 2ms/step - accuracy: 0.1924 - loss: 19.7289 - val_accuracy: 0.0019 - val_loss: 18.2781
Epoch 26/30
538/538 1s 2ms/step - accuracy: 0.1971 - loss: 20.1341 - val_accuracy: 0.0040 - val_loss: 17.9253
Epoch 27/30
538/538 1s 2ms/step - accuracy: 0.1704 - loss: 21.1040 - val_accuracy: 6.9711e-04 - val_loss: 25.1248
Epoch 28/30
538/538 1s 2ms/step - accuracy: 0.0788 - loss: 25.0042 - val_accuracy: 0.0776 - val_loss: 33.7508
Epoch 29/30
538/538 1s 2ms/step - accuracy: 0.0838 - loss: 24.1781 - val_accuracy: 0.0789 - val_loss: 22.4886
Epoch 30/30
538/538 1s 2ms/step - accuracy: 0.0373 - loss: 25.4738 - val_accuracy: 0.0767 - val_loss: 32.2824
```

## Loss Curve:



## Confusion Matrix:

180/180		0s 773us/step						
Pred	True	BUDAPEST	KASSEL	MAASTRICHT	MADRID	MUNCHENB	OSLO	STOCKHOLM
BASEL	True	25	5	14	3543	65	23	6
BELGRADE	True	0	0	0	1061	31	0	0
BUDAPEST	True	0	0	0	206	8	0	0
DEBILT	True	0	0	0	76	6	0	0
DUSSELDORF	True	0	0	0	28	1	0	0
HEATHROW	True	0	0	0	76	6	0	0
KASSEL	True	0	0	0	11	0	0	0
LJUBLJANA	True	0	0	0	60	1	0	0
MAASTRICHT	True	0	0	0	8	1	0	0
MADRID	True	1	0	0	440	17	0	0
MUNCHENB	True	0	0	0	8	0	0	0
OSLO	True	0	0	0	4	1	0	0
STOCKHOLM	True	0	0	0	4	0	0	0
VALENTIA	True	0	0	0	1	0	0	0
Pred	VALENTIA							
BASEL	VALENTIA	1						
BELGRADE	VALENTIA	0						
BUDAPEST	VALENTIA	0						
DEBILT	VALENTIA	0						
DUSSELDORF	VALENTIA	0						
HEATHROW	VALENTIA	0						
KASSEL	VALENTIA	0						
LJUBLJANA	VALENTIA	0						
MAASTRICHT	VALENTIA	0						
MADRID	VALENTIA	0						
MUNCHENB	VALENTIA	0						
OSLO	VALENTIA	0						
STOCKHOLM	VALENTIA	0						
VALENTIA	VALENTIA	0						

## **Conclusions:**

### **Activation Method:**

- Before model choice, my first observation were the different activation types
- **Tanh activation** provide the first decrease in loss
- Tanh (which are hyperbolic tangents) has steeper gradients compared to sigmoid, which can allow for faster learning.

### **Stations Detected:**

- The highest number of stations detected (14) was by using CNN + Softmax, though loss increased and accuracy score were low

### **CNN or RNN:**

- CNNs were run with varied epochs, batch types, hidden layers, activation types, and even added convolution and pooled layers
- RNNs were run with varied epochs, batch types, hidden layers, activation types, and even scaled data and LSTMS
- RNNs and LSTMs (improved type of RNN) are better suited for sequential data and can capture temporal dependencies in the data which could be suitable for weather data.
- RNNs appeared to produced the best results with the most amount of loss reductions—particularly combined with Tanh activation.
- After some research, I learned that Tanh might be better suited with normalized data, so scaled data + RNN + Tanh was performed; accuracy scores were small, though there was some data loss reduction and several stations detected.

**Overall Takeaway:** From these initial learnings, it seems RNN (possibly LSTMs) would be the most beneficial for Climatewins to proceed with.