In [1]:
```
from torch.utils.data import DataLoader
import torch
from torch.utils.data.dataset import Dataset
import torch.nn as nn
import numpy as np
import torch.optim as optim
import operator
import time
from torch.optim.lr_scheduler import StepLR
from itertools import chain
from torch.nn.utils.rnn import pad_sequence, pack_padded_sequence,pad_packed_sequence
```

Reading all the data

In [2]:
```
## Defining Hyperparameters
batch_size=16
dimension_embedding = 100
hidden_dim = 256
lstm_layers = 1
lstm_dropout = 0.33
linear_output_dim = 128
batch_size = 16
learning_rate = 0.1
num_epochs = 20

## Reading the train data
train_data=[]
trainPath="train"

dev_data=[]
devPath="dev"

test_data = []
testPath="test"

with open(trainPath, "r") as trainFile:
    for x in trainFile:
        x=x.rstrip()
        train_data.append(x.split(" "))

with open(devPath, "r") as devFile:
    for x in devFile:
        x=x.rstrip()
        dev_data.append(x.split(" "))

with open(testPath, "r") as testFile:
    for x in testFile:
        x=x.rstrip()
        test_data.append(x.split(" "))
```

In [3]:
```
# create list of train tagged words
train_word_tag_list=[]
for each_line in train_data:
    if len(each_line)<2:
        continue
    else:
        train_word_tag_list.append([each_line[1],each_line[2]])

# create list of dev tagged words
dev__word_tag_list=[]
for x in dev_data:
    if len(x)<2:
        continue
    else:
        dev__word_tag_list.append((x[1],x[2]))

# create list of test tagged words
test_word_tag_list=[]
for x in test_data:
    if len(x)>1:
        test_word_tag_list.append((x[0],x[1]))

# creating the each sentences (word and tag) pair from the train data
train_sentence_tag_list=[]
check=0
tstl=[]
for x in train_data:
    if len(x)>1:
            if x[0]=='1':
                check+=1
                if check == 1:
                    tstl=[]
                    tstl.append((x[1],x[2]))
                elif check==14987:
                    train_sentence_tag_list.append(tstl)
                    tstl=[]
                    tstl.append((x[1],x[2]))
                    train_sentence_tag_list.append(tstl)
                    break
```

```
                else:
                    train_sentence_tag_list.append(tstl)
                    tstl=[]
                    tstl.append((x[1],x[2]))
            else:
                tstl.append((x[1],x[2]))



# creating the each sentences (word and tag) pair from the train data
dev_sentence_tag_list=[]
check_dev=0
tstl_dev=[]

for x in dev_data:

    if len(x)>1:

            if x[0]=='1':

                check_dev+=1
                if check_dev == 1:
                    tstl_dev=[]
                    tstl_dev.append((x[1],x[2]))
                elif check_dev==3466:
                    dev_sentence_tag_list.append(tstl_dev)
                    tstl_dev=[]
                    tstl_dev.append((x[1],x[2]))
                    dev_sentence_tag_list.append(tstl_dev)
                    break
                else:
                    dev_sentence_tag_list.append(tstl_dev)
                    tstl_dev=[]
                    tstl_dev.append((x[1],x[2]))
            else:
                tstl_dev.append((x[1],x[2]))

# creating the each sentences (word and tag) pair from the test data
test_sentence_tag_list=[]
check=0
tstl_test=[]

for x in test_data:
    if len(x)>1:
            if x[0]=='1':
                check+=1
                if check == 1:
                    tstl_test=[]
                    tstl_test.append((x[1]))
                elif check==3684:
                    test_sentence_tag_list.append(tstl_test)
                    tstl_test=[]
                    tstl_test.append((x[1]) )
                    test_sentence_tag_list.append(tstl_test)
                    break
                else:
                    test_sentence_tag_list.append(tstl_test)
                    tstl_test=[]
                    tstl_test.append((x[1]))
            else:
                tstl_test.append((x[1]))
```

Defining parameters

In [4]:
```
batch_size=16
dimension_embedding = 100
```

Vocab creation

In [5]:
```
vocab_data={}
counter=0
for x in train_data:
    if len(x)>1:
        if x[1] in vocab_data:
            temp=vocab_data[x[1]]
            vocab_data[x[1]]=temp+1
        else:
            vocab_data[x[1]]=1

unk=0
list_of_unk=[]
for key in vocab_data:
    if vocab_data[key]<=2:
        unk+=vocab_data[key]
        list_of_unk.append(key)
    else:
        continue

sorted_vd = sorted(vocab_data.items(), key=operator.itemgetter(1),reverse=True)
```

```
vocab_file={}
starter=1
vocab_file[starter]=('<UNK>',unk)
for i in sorted_vd:
    starter=starter+1
    if i[0] not in list_of_unk:
        x=i[0]
        y=i[1]
        vocab_file[starter]= (x,y)

    else:
        continue
```

Word2Idx Mapping

In [6]:
```
vocab_file_map={}
starter=1
for i in sorted_vd:
    starter+=1
    x= i[0]
    y= i[1]
    vocab_file_map[starter]= (x,y)

# create a mapping from words to integers
word2idx= {word[0] : idx for idx, word in vocab_file_map.items()}
word2idx['<PAD>']= 0
word2idx['<UNK>']= 1
```

Tag2Idx Mapping

In [7]:
```
tag_data_map={}

for x in train_data:
    if len(x)>1:
        if x[2] in tag_data_map:
            temp=tag_data_map[x[2]]
            tag_data_map[x[2]]=temp+1
        else:
            tag_data_map[x[2]]=1
```

In [8]:
```
# create a mapping from tags to integers
tag2idx ={}
tag_map=0
tag2idx['<PAD>']= tag_map
for key, value in tag_data_map.items():
        tag_map+=1
        tag2idx[key]=tag_map
```

In [9]:
```
idx2tag={}
for key, value in tag2idx.items():
    idx2tag[value]=key
```

GloVe Word Embeddings

In [10]:
```
g_index_embeddings = {}

with open("glove", 'r', encoding='utf-8') as f:
    for x in f:
        data = x.split()
        word = data[0]
        coefs = np.asarray(data[1:],dtype='float32')
        g_index_embeddings[word] = coefs
```

In [11]:
```
# Create a list of numpy arrays using the values of `g_index_embeddings` dictionary
arrays_list = [np.array(v) for v in g_index_embeddings.values()]

# Stack the numpy arrays vertically to create a 2D array
z = np.vstack(arrays_list)

# Calculate the mean of the 2D array column-wise along axis 0
mean_array = np.mean(z, axis=0)
```

In [12]:
```
word2idx['<PAD>']
g_index_embeddings['<UNK>']=mean_array
g_index_embeddings['<PAD>']=np.zeros(100)
```

In [13]:
```
embedding_data = torch.zeros(len(word2idx), dimension_embedding)

for word, i in word2idx.items():
    gl_arr = g_index_embeddings.get(word.lower(), mean_array)
    embedding_vector = torch.tensor([float(val) for val in gl_arr])
    if embedding_vector is not None:
        embedding_data[i] = embedding_vector
```

Data set creation

In [14]:
```
# sentences and labels
trainSentences = [[t[0] for t in sublst] for sublst in train_sentence_tag_list]
trainTags = [[t[1] for t in sublst] for sublst in train_sentence_tag_list]

devSentences = [[t[0] for t in sublst] for sublst in dev_sentence_tag_list]
devTags = [[t[1] for t in sublst] for sublst in dev_sentence_tag_list]

testSentences = [[t[0] for t in sublst] for sublst in test_sentence_tag_list]
```

In [15]:
```
class creating_iterator(torch.utils.data.Dataset):
    def __init__(self, sentences, labels, word2idx, tag2idx):
        self.sentences = sentences
        self.labels = labels
        self.word2idx = word2idx
        self.tag2idx = tag2idx

    def __len__(self):
        return len(self.sentences)

    def __getitem__(self, idx):
        sentence = self.sentences[idx]
        class_label = self.labels[idx]

        # Create a list of boolean flags where 1 corresponds to lowercase and 0 corresponds to uppercase
        sentence_flags = [int(word.lower() == word) for word in sentence]

        # Convert the words and labels to their corresponding indices using word2idx and tag2idx
        converted_sentence = [self.word2idx.get(word, self.word2idx['<UNK>']) for word in sentence]
        converted_labels = [self.tag2idx.get(tag, 0) for tag in class_label]

        return converted_sentence, converted_labels, sentence_flags
```

In [17]:
```
train_dataset_fnn = creating_iterator(trainSentences,trainTags,word2idx,tag2idx)
test_dataset_fnn = creating_iterator(devSentences,devTags,word2idx,tag2idx)
```

In [18]:
```
def collate_fn(batch):
    # Pad the sentences, labels, and flags with zeros using pad_sequence
    padded_sentences = pad_sequence([torch.LongTensor(sentence) for sentence, _, _ in batch], batch_first=True)
    padded_labels = pad_sequence([torch.LongTensor(label) for _, label, _ in batch], batch_first=True)
    sent_flags = pad_sequence([torch.LongTensor(flag) for _, _, flag in batch], batch_first=True)

    # Calculate the sentence lengths
    sentence_lengths = torch.LongTensor([len(sentence) for sentence, _, _ in batch])

    return padded_sentences, padded_labels, sentence_lengths, sent_flags
```

In [20]:
```
# create PyTorch DataLoader objects for batching the data
train_loader = DataLoader(train_dataset_fnn, batch_size=batch_size, shuffle=True, collate_fn=collate_fn)
dev_loader = DataLoader(test_dataset_fnn, batch_size=batch_size, shuffle=False, collate_fn=collate_fn)
```

In [21]:
```
class TestDataset(torch.utils.data.Dataset):
    def __init__(self, sentences, word2idx):
        self.sentences = sentences
        self.word2idx = word2idx

    def __len__(self):
        return len(self.sentences)

    def __getitem__(self, idx):
        sentence = self.sentences[idx]

        # Create a list of boolean flags where 1 corresponds to lowercase and 0 corresponds to uppercase
        sentence_flags = [int(word.lower() == word) for word in sentence]

        # Convert the words to their corresponding indices using word2idx
        converted_sentence = [self.word2idx.get(word, self.word2idx['<UNK>']) for word in sentence]

        return converted_sentence, sentence_flags
```

In [23]:
```
def test_collate(batch):
    # Separate the sentences and flags in the batch
    sentences, flags = zip(*batch)

    # Pad the sentences with zeros using pad_sequence
    padded_sentences = pad_sequence([torch.LongTensor(sentence) for sentence in sentences], batch_first=True)

    # Calculate the sentence lengths
    sentence_lengths = torch.LongTensor([len(s) for s in sentences])

    # Pad the flags with zeros using pad_sequence
    padded_flags = pad_sequence([torch.LongTensor(flag) for flag in flags], batch_first=True)

    return padded_sentences, sentence_lengths, padded_flags
```

In [25]:
```
test_dataset_fnn=TestDataset(testSentences,word2idx)
test_loader = DataLoader(test_dataset_fnn, batch_size=batch_size, collate_fn=test_collate)
```

Model

In [26]:
```
tag_pad_idx=tag2idx['<PAD>']
word_pad_idx=word2idx['<PAD>']
```

In [27]:
```
class BiLSTM(nn.Module):
    def __init__(self, input_dim, embedding_dim, hidden_dim, num_labels, lstm_layers, output_dim,
                 emb_dropout, lstm_dropout, fc_dropout, word_pad_idx, pretrained_embed):
        super().__init__()
        self.embedding_dim = embedding_dim
        # LAYER 1: Embedding
        self.embedding = nn.Embedding.from_pretrained(pretrained_embed, freeze=False)
        self.emb_dropout = nn.Dropout(emb_dropout)
        # LAYER 2: BiLSTM
        self.lstm = nn.LSTM(
            input_size=101,
            hidden_size=hidden_dim,
            num_layers=lstm_layers,
            bidirectional=True,
            dropout=lstm_dropout if lstm_layers > 1 else 0
        )
        # LAYER 3: Fully-connected
        self.dropout3 = nn.Dropout(lstm_dropout)
        self.elu = nn.ELU()
        self.fc = nn.Linear(hidden_dim * 2, output_dim)
        self.linear2 = nn.Linear(output_dim, num_labels)

    def forward(self, sentence, sentence_lengths, sentence_flags):
        embedded = self.embedding(sentence)
        concatenated_tensor = torch.cat((embedded, sentence_flags.unsqueeze(-1)), dim=-1)
        packed_embedded = pack_padded_sequence(concatenated_tensor, sentence_lengths, batch_first=True, enforce_sorted
        packed_output, (hidden, cell) = self.lstm(packed_embedded)
        output, output_lengths = pad_packed_sequence(packed_output, batch_first=True)
        ner_out = self.fc(self.elu(output))
        out = self.linear2(ner_out)
        return out

    def init_weights(self):
        # to initialize all parameters from normal distribution
        # helps with converging during training
        for name, param in self.named_parameters():
            nn.init.normal_(param.data, mean=0, std=0.1)

    def count_parameters(self):
        return sum(p.numel() for p in self.parameters() if p.requires_grad)
```

In [29]:
```
bilstm = BiLSTM(
    input_dim=len(word2idx),
    embedding_dim=100,
    hidden_dim=256,
    num_labels = len(tag2idx),
    output_dim=128,
    lstm_layers=1,
    lstm_dropout=0.33,
    fc_dropout=0.25,
    emb_dropout=0.5,
    word_pad_idx=word_pad_idx,
    pretrained_embed=embedding_data
)
bilstm.init_weights()
```

In [30]:
```
dev_lengths=[]
for a in dev_sentence_tag_list:
    dev_lengths.append(len(a))

test_lengths=[]
for b in test_sentence_tag_list:
    test_lengths.append(len(b))
```

To Run the model

In [31]:
```
class NER(object):
    def __init__(self, model, train_loader,test_loader,dev_loader,test_sentence_tag_list,dev_sentence_tag_list,optimiz
        self.model = model
        self.data_train = train_loader
        self.data_dev=dev_loader
        self.data_test=test_loader
        self.optimizer = optimizer_cls(model.parameters(),lr=0.5)
        self.loss_fn = nn.CrossEntropyLoss(ignore_index=0)
        self.scheduler = StepLR(self.optimizer, step_size=3, gamma=0.1)
        print(self.scheduler)


    @staticmethod
    def epoch_time(start_time, end_time):
```

```
        elapsed_time = end_time - start_time
        elapsed_mins = int(elapsed_time / 60)
        elapsed_secs = int(elapsed_time - (elapsed_mins * 60))
        return elapsed_mins, elapsed_secs

    def accuracy(self, preds, y):
        max_preds = preds.argmax(dim=1, keepdim=True)  # get the index of the max probability
        non_pad_elements = (y != tag_pad_idx).nonzero()  # prepare masking for paddings
        # print("non_pad_elements",non_pad_elements)
        correct = max_preds[non_pad_elements].squeeze(1).eq(y[non_pad_elements])
        return correct.sum() / torch.FloatTensor([y[non_pad_elements].shape[0]])

    def epoch(self):
        epoch_loss = 0
        epoch_acc = 0
        self.model.train()
        for text, true_tags,sentence_lengths,sentence_flags in self.data_train:
            self.optimizer.zero_grad()
            pred_tags = self.model(text,sentence_lengths,sentence_flags)
            pred_tags = pred_tags.view(-1, pred_tags.shape[-1])
            true_tags = true_tags.view(-1)
            batch_loss = self.loss_fn(pred_tags, true_tags)
            batch_acc = self.accuracy(pred_tags, true_tags)
            batch_loss.backward()
            self.optimizer.step()
            epoch_loss += batch_loss.item()
            epoch_acc += batch_acc.item()

            self.scheduler.step( epoch_loss / len(self.data_train))

        return epoch_loss / len(self.data_train), epoch_acc / len(self.data_train)

    def evaluate(self):

        epoch_loss = 0
        epoch_acc = 0
        self.model.eval()
        with torch.no_grad():
            for text, true_tags,sentence_lengths,sentence_flags in  self.data_dev:
                pred_tags = self.model(text,sentence_lengths,sentence_flags)
                pred_tags = pred_tags.view(-1, pred_tags.shape[-1])
                true_tags = true_tags.view(-1)
                batch_loss = self.loss_fn(pred_tags, true_tags)
                batch_acc = self.accuracy(pred_tags, true_tags)
                epoch_loss += batch_loss.item()
                epoch_acc += batch_acc.item()
                self.scheduler.step(epoch_loss / len(self.data_dev))
        return epoch_loss / len( self.data_dev), epoch_acc / len( self.data_dev)

    def train(self, n_epochs):
        valid_loss_min2 = np.Inf
        for epoch in range(n_epochs):
            start_time = time.time()
            train_loss, train_acc = self.epoch()
            end_time = time.time()
            epoch_mins, epoch_secs = NER.epoch_time(start_time, end_time)
            print(f"Epoch: {epoch + 1:02} | Epoch Time: {epoch_mins}m {epoch_secs}s")
            print(f"\tTrn Loss: {train_loss:.3f} | Trn Acc: {train_acc * 100:.2f}%")
            val_loss, val_acc = self.evaluate()
            print(f"\tVal Loss: {val_loss:.3f} | Val Acc: {val_acc * 100:.2f}%")
            if val_loss<valid_loss_min2:
                torch.save(self.model, 'GloveEmbed.pt')
                valid_loss_min2=val_loss
        self.model.eval()
        predictions = []
        true_labels = []
        with torch.no_grad():
            for inputs, targets,sent_len,sent_fl in self.data_dev:
                outputs = self.model(inputs,sent_len,sent_fl)
                _, preds = torch.max(outputs, dim=2)
                predictions.extend(preds.tolist())
                true_labels.extend(targets.tolist())


        # Convert the predicted tag sequences to string representations
        predictions_dev = []
        for sentence_tags in predictions:
            predicted_tags_list = [idx2tag[idx] for idx in sentence_tags]
            predictions_dev.append(predicted_tags_list)


        # Save the predictions to a file
        with open('GloveEmbed_dev_pred.txt', 'w') as f:
            for predicted_tags in predictions_dev:
                f.write(' '.join(predicted_tags) + '\n')

        self.model.eval()
        predictions_test = []
        with torch.no_grad():
            for inputs, sent_len,sent_fl in self.data_test:
                outputs = self.model(inputs,sent_len,sent_fl)
                _, preds = torch.max(outputs, dim=2)
                predictions_test.extend(preds.tolist())
```

```
        # Convert the predicted tag sequences to string representations
        test_preds = []
        for sentence_tags in predictions_test:
            predicted_tags_list = [idx2tag[idx] for idx in sentence_tags]
            test_preds.append(predicted_tags_list)


        # Save the predictions to a file
        with open('GloveEmbed_test_pred.txt', 'w') as f:
            for predicted_tags in test_preds:
                f.write(' '.join(predicted_tags) + '\n')
```

In [32]:
```
ner = NER(
  model=bilstm,
  train_loader=train_loader,
  dev_loader=dev_loader,
  test_loader=test_loader,
  optimizer_cls=optim.SGD,
  loss_fn_cls=nn.CrossEntropyLoss,
  test_sentence_tag_list=test_sentence_tag_list,
  dev_sentence_tag_list=dev_sentence_tag_list
)
ner.train(10)
```

```
<torch.optim.lr_scheduler.StepLR object at 0x7ff6908ebb50>
/Users/apurvagupta/opt/anaconda3/lib/python3.9/site-packages/torch/optim/lr_scheduler.py:163: UserWarning: The epoch parameter in `scheduler.step()` was not necessary and is being deprecated where possible. Please use `scheduler.step()` to step the scheduler. During the deprecation, if epoch is different from None, the closed form is used instead of the new chainable form, where available. Please open an issue if you are unable to replicate your use case: https://github.com/pytorch/pytorch/issues/new/choose.
  warnings.warn(EPOCH_DEPRECATION_WARNING, UserWarning)
```

```
Epoch: 01 | Epoch Time: 2m 35s
	Trn Loss: 0.344 | Trn Acc: 88.41%
	Val Loss: 0.262 | Val Acc: 91.46%
Epoch: 02 | Epoch Time: 2m 33s
	Trn Loss: 0.183 | Trn Acc: 94.00%
	Val Loss: 0.177 | Val Acc: 94.85%
Epoch: 03 | Epoch Time: 2m 34s
	Trn Loss: 0.120 | Trn Acc: 96.23%
	Val Loss: 0.174 | Val Acc: 95.53%
Epoch: 04 | Epoch Time: 2m 47s
	Trn Loss: 0.082 | Trn Acc: 97.48%
	Val Loss: 0.155 | Val Acc: 96.17%
Epoch: 05 | Epoch Time: 2m 41s
	Trn Loss: 0.055 | Trn Acc: 98.34%
	Val Loss: 0.145 | Val Acc: 96.56%
Epoch: 06 | Epoch Time: 2m 41s
	Trn Loss: 0.038 | Trn Acc: 98.89%
	Val Loss: 0.147 | Val Acc: 96.67%
Epoch: 07 | Epoch Time: 2m 43s
	Trn Loss: 0.025 | Trn Acc: 99.31%
	Val Loss: 0.173 | Val Acc: 96.69%
Epoch: 08 | Epoch Time: 2m 40s
	Trn Loss: 0.017 | Trn Acc: 99.56%
	Val Loss: 0.180 | Val Acc: 96.79%
Epoch: 09 | Epoch Time: 2m 42s
	Trn Loss: 0.012 | Trn Acc: 99.71%
	Val Loss: 0.268 | Val Acc: 94.85%
Epoch: 10 | Epoch Time: 2m 40s
	Trn Loss: 0.007 | Trn Acc: 99.82%
	Val Loss: 0.202 | Val Acc: 96.92%
[[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
2, 2], [6, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
2, 2, 2, 2], [2, 3, 2, 4, 5, 2, 2, 2, 2, 2, 2, 2, 1, 2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
2, 2, 2, 2, 2, 2], [2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 1, 2, 1, 7, 1, 2, 2, 2, 2, 2, 2, 6, 2, 2, 2, 2, 2, 2, 2, 2,
2, 2, 1, 2, 2, 2, 2, 2], [2, 2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 6, 9, 2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 6, 2,
4, 5, 2, 2, 2, 2, 2, 2, 2, 2], [2, 2, 2, 2, 4, 2, 2, 2, 2, 2, 2, 2, 2, 2, 4, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2], [1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 4, 5, 2, 4, 5, 2, 2, 2, 2, 2, 2, 2, 2, 2, 1,
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2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]]
CPU times: user 38min 14s, sys: 32min 19s, total: 1h 10min 34s
Wall time: 28min 21s
```

In [34]:

```
pred_dev=[]
with open('GloveEmbed_dev_pred.txt', 'r') as file:
        for inputs in file:
            pred_dev.append(inputs.split(' '))
```

In [35]:

```
dev_res_list=[]
dev_st=[]
dev_flag=0
for x in dev_data:
    if len(x)>1:
            if x[0]=='1':
                dev_flag=dev_flag+1
                if dev_flag == 1:
                    dev_st=[]
                    dev_st.append((x[0],x[1],x[2]))
                elif dev_flag==3466:
                    dev_res_list.append(dev_st)
                    dev_st=[]
                    dev_st.append((x[0],x[1],x[2]))
                    dev_res_list.append(dev_st)
                    break
                else:
                    dev_res_list.append(dev_st)
                    dev_st=[]
                    dev_st.append((x[0],x[1],x[2]))
            else:
                dev_st.append((x[0],x[1],x[2]))
```

In [36]:

```
result_dict = {}
idx = 0
for i in range(len(dev_res_list)):
    for j in range(len(dev_res_list[i])):
        result_dict[idx] = (dev_res_list[i][j][0], dev_res_list[i][j][1],dev_res_list[i][j][2], pred_dev[i][j])
        idx += 1
```

In [37]:

```
start_i=0
with open("GloveEmbed_dev_pred_out_rerun.txt", 'w') as f:
    for key,i in result_dict.items() :
        if i[0] == '1' and start_i!=0:
            f.write('\n')
            f.write('%s %s %s %s\n' % (i[0], i[1], i[2], i[3]))
        else:
            f.write('%s %s %s %s\n' % (i[0], i[1], i[2], i[3]))
            start_i=start_i+1
```

In [38]:

```
start_i=0
with open("dev2.out", 'w') as f:
    for key,i in result_dict.items() :
        if i[0] == '1' and start_i!=0:
            f.write('\n')
            f.write('%s %s %s\n' % (i[0], i[1], i[3]))
        else:
            f.write('%s %s %s\n' % (i[0], i[1], i[3]))
            start_i=start_i+1
```

In [41]:

```
!perl conll03eval < {'GloveEmbed_dev_pred_out_rerun.txt'}
```

```
processed 51578 tokens with 5942 phrases; found: 5751 phrases; correct: 4785.
accuracy:  96.91%; precision:  83.20%; recall:  80.53%; FB1:  81.84
              LOC: precision:  93.24%; recall:  81.06%; FB1:  86.72  1597
             MISC: precision:  84.89%; recall:  76.79%; FB1:  80.64  834
              ORG: precision:  79.98%; recall:  71.51%; FB1:  75.51  1199
              PER: precision:  76.80%; recall:  88.44%; FB1:  82.21  2121
```

In [42]:
```
test_res_list=[]
st_test=[]
flag_test=0
for x in test_data:
    if len(x)>1:
            if x[0]=='1':
                flag_test=flag_test+1
                if flag_test == 1:
                    st_test=[]
                    st_test.append((x[0],x[1]))
                elif flag_test==3684:
                    print(flag_test)
                    test_res_list.append(st_test)
                    st_test=[]
                    st_test.append((x[0],x[1]) )
                    test_res_list.append(st_test)
                    break
                else:
                    test_res_list.append(st_test)
                    st_test=[]
                    st_test.append((x[0],x[1]))
            else:
                st_test.append((x[0],x[1]))
```

```
3684
```

In [44]:
```
pred_test=[]
with open('GloveEmbed_test_pred.txt', 'r') as readFile:
        for inputs in readFile:
            pred_test.append(inputs.split(' '))
```

In [47]:
```
test_dict = {}
test_idx = 0
for i in range(len(test_res_list)):
    for j in range(len(test_res_list[i])):
        test_dict[test_idx] = (test_res_list[i][j][0], test_res_list[i][j][1], pred_test[i][j])
        test_idx += 1
```

In [49]:
```
start_ie=0
with open("test2.out", 'w') as f:
    for key,i in test_dict.items() :
        if i[0] == '1' and start_ie!=0:
            f.write('\n')
            f.write('%s %s %s\n' % (i[0], i[1], i[2]))
        else:
            f.write('%s %s %s\n' % (i[0], i[1], i[2]))
            start_ie=start_ie+1
```

In [51]:
```
torch.save(ner.model,'blstm2.pt')
```

In [ ]:
```

```