CS114 (Spring 2020) Programing Assignment 6

Neural Transition-Based Dependency Parsing

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Worked Example

1. Go through the sequence of transitions

Given the sentence:

```
I parsed this sentence correctly
```

Stack	Buffer	New dependency	Transition
[ROOT]	[I, parsed, this, sentence, correctly]		Initial Configuration
[ROOT, I]	[parsed, this, sentence, correctly]		SHIFT
[ROOT, I, parsed]	[this, sentence, correctly]		SHIFT
[ROOT, parsed]	[this, sentence, correctly]	parsed → I	LEFT-ARC
[ROOT, parsed, this]	[sentence, correctly]		SHIFT
[ROOT, parsed, this, sentence]	[correctly]		SHIFT
[ROOT, parsed, sentence]	[correctly]	sentence → this	LEFT-ARC
[ROOT, parsed]	[correctly]	parsed → sentence	RIGHT-ARC

Stack	Buffer	New dependency	Transition
[ROOT, parsed, correctly]	[]		SHIFT
[ROOT, parsed]	[]	parsed → correctly	RIGHT-ARC
[ROOT]	[]	ROOT → parsed	RIGHT-ARC

2. A sentence containing n words will be parsed in how many steps

For each word of the sentence, it need first be shifted onto the stack and then reduced by right\left arc. Therefore, there would be $2 * n$ parsing steps for a sentence containing n words regardless of the initial configuration.

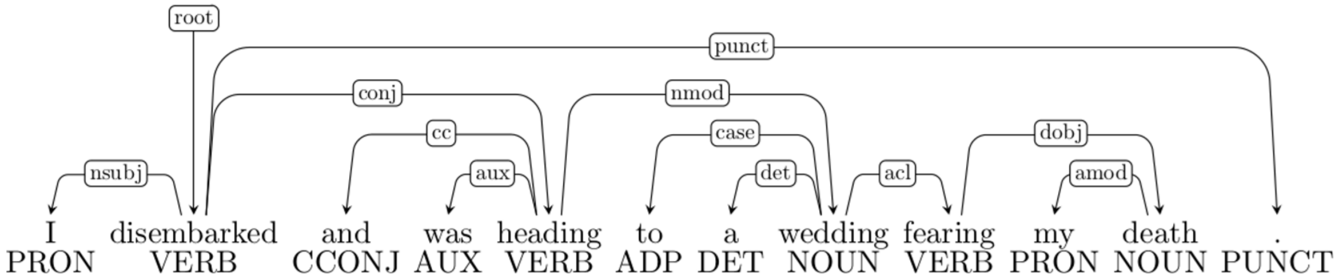
Check Dependencies Error

Dependencies Error:

```
Prepositional Phrase Attachment Error
Verb Phrase Attachment Error
Modifier Attachment Error
Coordination Attachment Error
```

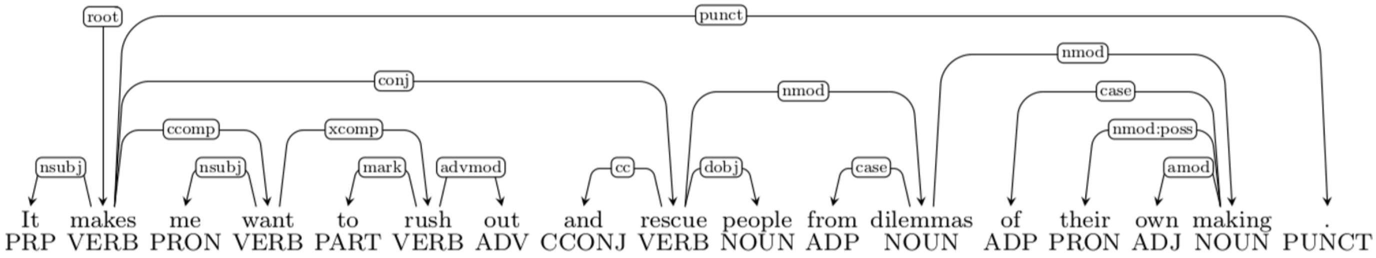
Given four sentences, each one has one dependency error from above.

i.



Error type: Verb Phrase Attachment Error
Incorrect dependency: wedding → fearing
Correct dependency: heading → fearing

ii.

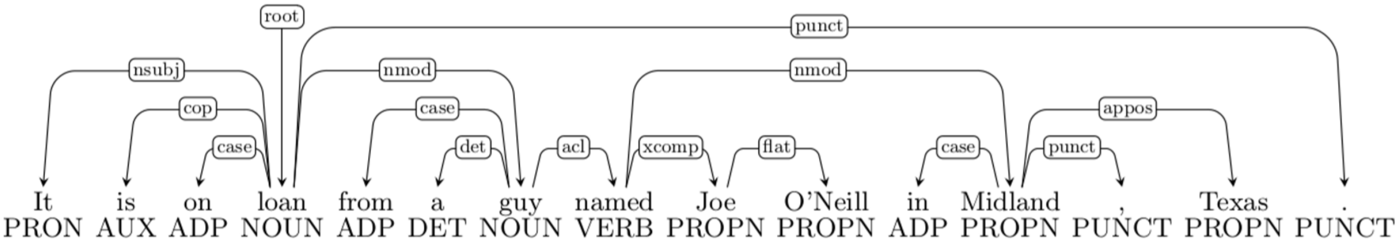

root
punct
nmod
conj
nmod
case
ccomp
xcomp
nmod:poss
nsubj
nsubj
mark
advmod
cc
dobj
case
amod
It makes me want to rush out and rescue people from dilemmas of their own making .
PRP VERB PRON VERB PART VERB ADV CCONJ VERB NOUN ADP NOUN ADP PRON ADJ NOUN PUNCT

Error type: Coordination Attachment Error

Incorrect dependency: makes → rescue

Correct dependency: rush → rescue

iii.

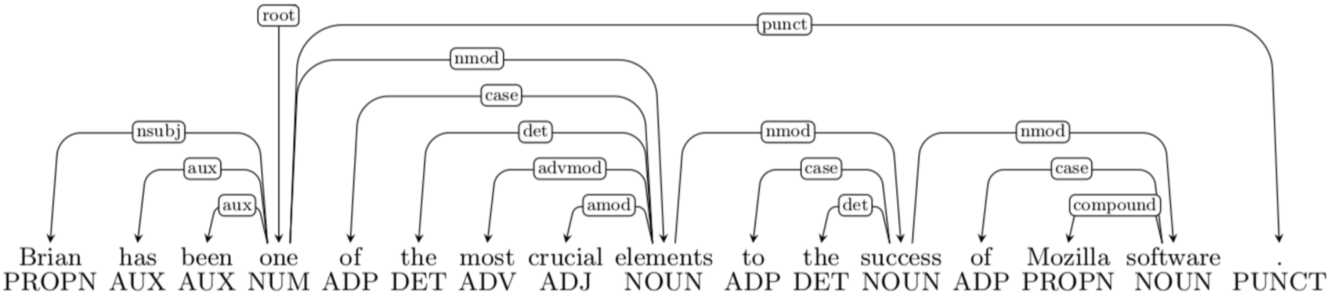

root
punct
nsubj
nmod
nmod
cop
case
appos
case
det
acl
xcomp
flat
case
punct
It is on loan from a guy named Joe O'Neill in Midland , Texas .
PRON AUX ADP NOUN ADP DET NOUN VERB PROPN PROPN ADP PROPN PUNCT PROPN PUNCT

Error type: Prepositional Phrase Attachment Error

Incorrect dependency: named → Midland

Correct dependency: guy → Midland

iv.


root
punct
nmod
case
nsubj
det
nmod
nmod
aux
advmod
case
case
aux
amod
det
compound
Brian has been one of the most crucial elements to the success of Mozilla software .
PROPN AUX AUX NUM ADP DET ADV ADJ NOUN ADP DET NOUN ADP PROPN NOUN PUNCT

Error type: Modifier Attachment Error

Incorrect dependency: elements → most

Correct dependency: crucial → most

Neural Network Program

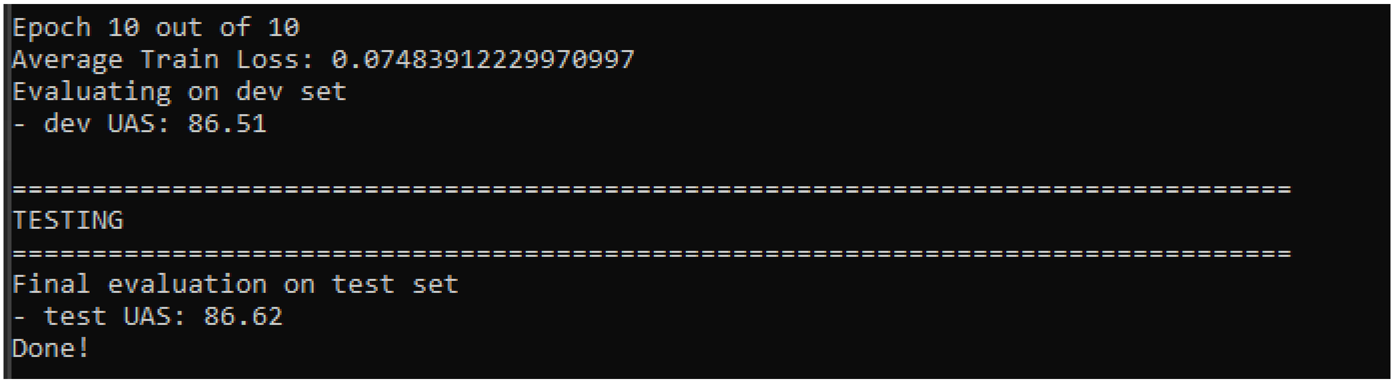
Instruction

In *parser_model.py*, weight matrices contain the weight of bias term, so the shape of which is added 1 on rows (first dimension). Also, of the outputs from *forward* function, the last column (second dimension) of hidden layer outputs is filled with ones representing bias term.

In terms of *train_for_epoch* in *run.py*, I take advantage of numpy broadcasting. For each sentence, the backpropagation for all layers is $\nabla_l L = x_l \odot \delta_l$, since we are applying the sum of gradients from one minibatch, my code alters this formula into $\nabla_l L = X_l^T \cdot \Delta_l$, where X_l is the input matrix of current layer with shape of (batch size, input features) and Δ_l is the error term matrix with shape (batch size, output features). The dot product would be the summation of gradients aggregating by batch size.

Model Training and Evaluation

With the default hyperparameters (hidden_size=200, lr=0.0005, epoch=10), I got the following results:



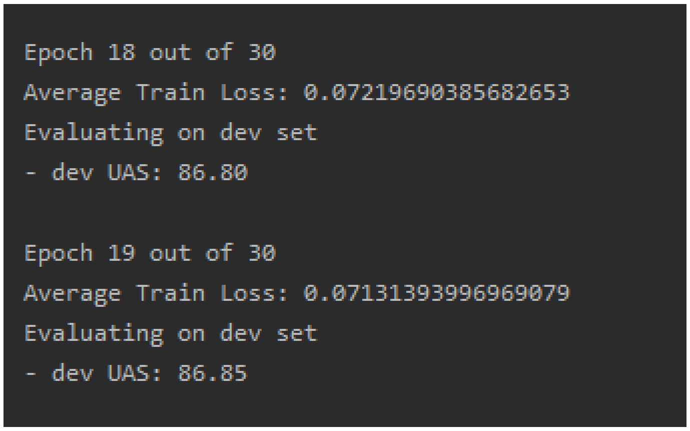
```
Epoch 10 out of 10
Average Train Loss: 0.07483912229970997
Evaluating on dev set
- dev UAS: 86.51

================================================================================
TESTING
================================================================================
Final evaluation on test set
- test UAS: 86.62
Done!
```

Then, I implemented a simple grid search on debug mode. First, I changed learning rate to 0.001 to achieve a quick convegence. Accordingly, with differents set of hidden_size and epoch, the grid search results are as bellow:

hidden_size/epoch	100	150	200	250	300	400
10	0.238 62.22	0.215 68.63	0.232 66.95	0.271 59.91	0.220 65.02	0.227 65.24
20	0.213 67.21	0.144 68.84	0.279 65.99	0.190 57.46	0.182 66.09	0.120 73.86
30	0.136 70.85	0.121 73.91	0.132 74.96	0.150 70.57	0.123 67.50	0.132 73.04

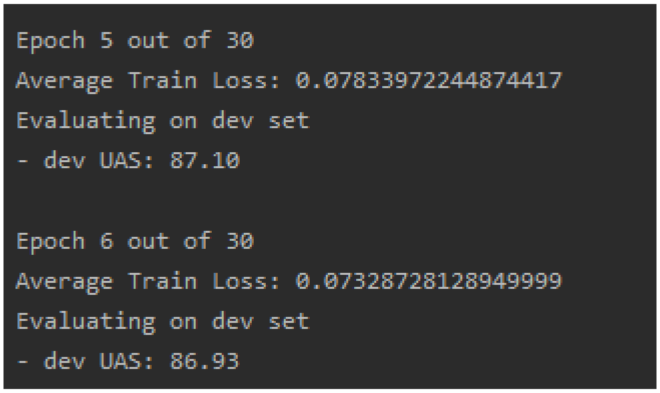
The best parameter set is epoch=30, hidden_size=200. After about 20 epoches, the loss and UAS did not change a lot and the result is not much better than 10 epoch



```
Epoch 18 out of 30
Average Train Loss: 0.07219690385682653
Evaluating on dev set
- dev UAS: 86.80

Epoch 19 out of 30
Average Train Loss: 0.07131393996969079
Evaluating on dev set
- dev UAS: 86.85
```

Then, I tried hidden_size=400, due to the time limitation, I have only run 6 epoches and the final result is as below:



```
Epoch 5 out of 30
Average Train Loss: 0.07833972244874417
Evaluating on dev set
- dev UAS: 87.10

Epoch 6 out of 30
Average Train Loss: 0.07328728128949999
Evaluating on dev set
- dev UAS: 86.93
```

It is slightly better than above results, but not very much.