DD2424 Deep Learning

Assignment 4

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1. **State how you checked your analytic gradient computations and whether you think that your gradient computations are bug free for your RNN.**

I checked maximal relative error between analytical gradient and numerical gradient using the following equation:

$$\frac{\max|g_a - g_n|}{\max(eps, |g_a| + |g_n|)}$$

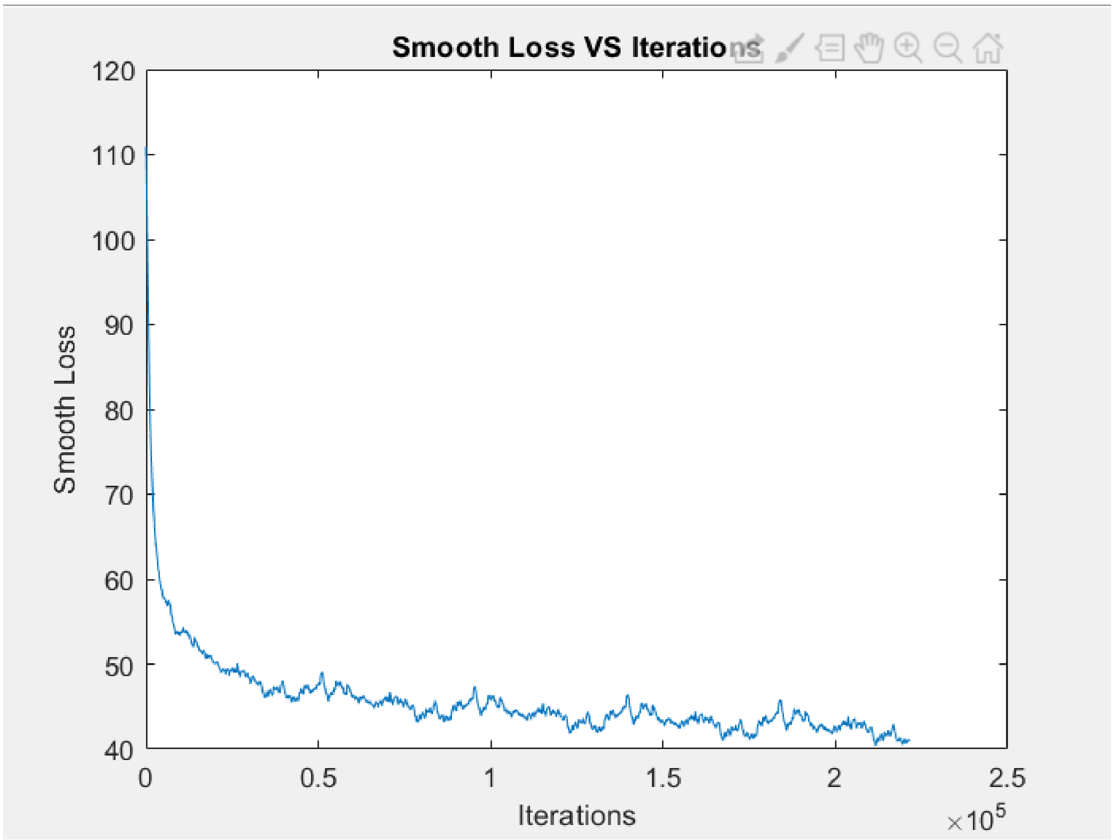
The hidden layer node is set to m = 5 and m = 100 separately. the delta h = 1e-4, batch size = 25, so the maximal error is shown as following:

Parameters	RNN.b	RNN.c	RNN.U	RNN.W	RNN.V
m = 5	6.5759e-10	9.2215e-12	1.9023e-10	7.0247e-09	1.6367e-10
m = 100	5.1233e-11	9.2156e-12	1.1948e-11	4.9411e-11	9.5267e-12

The maximal relative errors are very small, so I can believe the gradient computations are bug free for my RNN, this is further certified by the performance of the RNN neural network.

2. **Include a graph of the smooth loss function for a longish training run (at least 2 epochs).**

To test the smooth loss performance, I set parameters according to the instruction: m = 100, eta =0.1, seq_length =25, epochs = 5, sig = 0.01. The graph shows as following:



3. **Show the evolution of the text synthesized by your RNN during training by including a sample of synthesized text (200 characters long) before the first and before every 10,000th update steps when you train for 100,000 update steps.**

The smooth loss reduced to around 47 after a few epochs, we can see some words are correctly predicted, but it is still needed to be further trained. The 100,000 update steps are shown as following:

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
iter = 1, smooth_loss = 109.8591
spL,)J�6Mx)wCFqm2"vrrF
}etx9dWgBA1pUn    n2^Z�EmumTGxtHOd)q:Pfz/E0pqQVDXxMW0auplX(A^3c
眉nNPST'n!,YTZ"7so.c眉r"ZX

(眉qyt3X(9bEa1Fh,-n(n

le2ZN7F4z眉R/fZ0v:2Eu;E鈥oRI3Ok�E01Z,yenq-.Bt9Kb'W?YFaK
	OT33v(xcxvMMU D1f
```

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
iter = 10000, smooth_loss = 54.665
ous they apciny tracine want the start the'l naclo brey on two ghit was. Weay stroy" y
ant thes hund "ard gonovel. "ichuany'd and am momkEd," arrly iveat, them sh"s
slist'le!" Win'dy lat andpighel.
"I

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
iter = 20000, smooth_loss = 50.9819
ere his thaid ain that Herliy odly t shateror jere one, Harry.    erat they sais eoghtt cach
Dagmy the haghing to rean Sele the winl't some ant to      sarongillet aldin?"
Harry Harryof armion, i- Harry in

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
iter = 30000, smooth_loss = 49.6607
e wat for the Harry shorky evererr's cittwes lonl starly napr baides's wivens coottore,
morts llokk as must was keders arring Snytperon,'ed snyiugh wherrind to at pulup
frast whow still anmings Preari

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
iter = 40000, smooth_loss = 48.7375
arondy as grand, finttong datn't his huuld ost tert, bedneve at is iver hate sastwaning is
wat dalkef llokizess ietont deast Paxmed - abne with., and to bet, throum.    Thougy
wasned heppered steart ila

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
iter = 50000, smooth_loss = 49.2058
E Perm, us Witells furled in froves exen os and as wharire..
That ton.    ghet waspen?" Harry wighoundy guads lorg aljud mat and a fices strat't
whed knied at a of the gpengowh the basle dugh his haves

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
iter = 60000, smooth_loss = 47.9678
e? "Itwhing they of see up they'ret its wherin; they, Fued alfed it sos ihant."    say us
iy a cuak in ever Mr moked mady hat bagg ennuffoteders sace parce't wo liobly wo
she tharring id Frouch dored ju

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
iter = 70000, smooth_loss = 47.6249
arry was his them ficcless woter Picked ound to haver it.    Butade," she ridnogisal of
cunet.    Oh Harry and go the was ore exant.    The sixel.    I nearsids sulbored cached
Harry'sery at was had the coat,

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

iter = 80000, smooth_loss = 45.9613
arry," Harry. Shere fiangerecetoing the tamet arnore edref to hroulh."
"Eurge and plate - twears over).   Coat twas varmess mere fou.. Harr the mping apore ristch; his flees to pus, that'ccigablion eve

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
iter = 90000, smooth_loss = 46.6872
e slicery.
"She down not as a he wick knem ind, Nackident lookedtoricp and trece Mrakiwifed a faching as cextire the Part ogionthit mon whistan mmy bugy insome quin the has of aher in was who floke of

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
iter = 100000, smooth_loss = 47.3757
ald wrope. "Wer and got awn?"
"Straister go dofryEn's stoot wey. .   Yen calri!"   eazrough wande?"
"It whoch che save were with mischormplicing in the kerperny oeaving," saidtreg did that ypoceark thei

4. **A passage of length 1000 characters synthesized from your best model (the one that achieved the lowest loss).**

I ran 9 epochs which is 398500 iterations and got the best performance which the lowest smooth loss is 39.6641. The following paragraph is the highest performance which includes 1000 characters.

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
min_iter = 388989, min_loss = 39.6641
 out and the Muse rost anded wizcry for him out Hagrid he have at I took livitame to of Penisk ture, bright this the rrateens and gry yourss in they have ner?" - I are being timeds a grour bus, not foricich.   "Were to on Snill."
"We put Harry becke ground of a say rome Harry acrung him!
 I'm this of Ron, Maxattaging of grouce.
"Yeaid you stilt had and though . Igrirt vonce a did "
Rosed Crouch and Hermione than Cun telled at gapped, and you caging upered set camroning for to stordersing entimping?"   . .'Owh grice of eyel?"
"Krek to in you?   You Crowcriige, dury into teveraniss why had.   'er angwed in deed a have .   "Harry snotch, and mirck you're lox, you dowarry dey you in to looken reave Harry just Frth baly oace you'll in trink Pot vowing grouniSging to wizlide, him canfy," Harry said and to day of thel similo.."
"Welt Harry,"'s had of Dight?"
"Threched aroung," said Higrintow about's saw he and theygroundy Flaster foly Maxigg be years there mordorst and Harry fife sid."
"What?"