Assignment 4

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1   Introduction

In this assignment, we trained an RNN to synthesize English text character by character using the text from the book The Goblet of Fire by J.K. Rowling.

2   Code Explanation

We followed the instruction and went through Assignment 4 document to implemented the work. The code contains one main class "RNN" besides data loading and figure plotting functions.

In detail, "RNN" class is used to build the network and train the model. It includes the following functions:

- synthesize_text: Synthesize text based on the hidden state sequence.

- evaluate_classifier: Evaluate the classifier.

- compute_gradients: Analytically computes the gradients of loss w.r.t. weight and bias parameters.

- compute_gradients_num: Numerically computes the gradients of loss w.r.t. the weight and bias parameters.

- check_gradients: Compute relative error between analytical gradients and numerical gradients.

3 Results

3.1 Gradient check

The check is done by computing relative error. We compared the analytically and numerically computed results of gradients with respective to weights (W, U, V, b, c) obtained through function 'evaluation_and_compute_gradients' and 'computeGradientsNum' respectively. The gradient check is done with settings of $m = 100, eta = .1, seq_length = 25, sig = .01, h(stepsize) = 10^{-4}$ and we only compared the first 20 entries of each gradient matrix. Detailed results are provided in Table 1.

gradient	maximum relative error
grad_W	1.483705e-06
grad_U	8.625058e-08
grad_V	1.415127e-06
grad_b	9.587905e-09
grad_c	2.319186e-09

Table 1: Gradient check.

3.2 Smooth loss function

Below is the smooth loss function plot during the first 100000 iterations of our training with settings of $m = 100, eta = .1, seq_length = 25, sig = .01$.
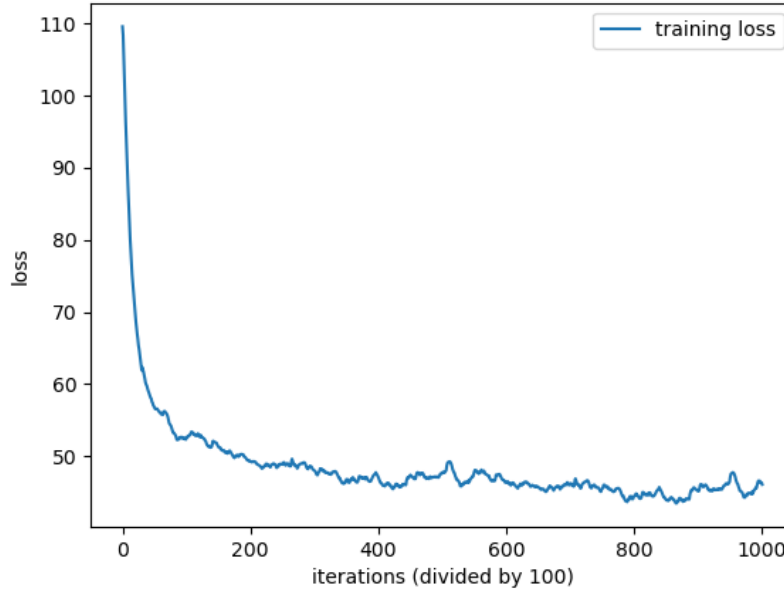

Figure 1: Smooth loss function plot.

3.3 Synthesized text

3.3.1 Synthesized text after 0 iterations, Smooth loss: 109.552030

```
j).Ex/.T0mjBSBMG•dd?xlHr4'1jDNprDvUv7üFR !Ek•c üL- EX^•S/f•bx",jSTeW?)N9p      xdU,vZ;6fyk_nxEa          !
;;
cR      u•v
nMr03!i0paoCLL "Iuax:W1OGzJLI3(9iqBT!tgE;ü q;doJjc•?LysKysuQ 0kd
_eQtaFq;(b7c9kfkZML}pX3E.ys:k3:j2
```

3.3.2 Synthesized text after 10000 iterations, Smooth loss: 53.611497

Duch soins nerertoeg turke And to pebl heard of he dacteitt enchool loucg "is was datching eof the And C sl lackew hapmange dloulsy, dast cout.." "igking your tret'an I'w Hebrapibry Gurm butt gury'm r

3.3.3 Synthesized text after 20000 iterations, Smooth loss: 50.079932

ey. . . Sade nouvely was dbor in, aid botower be leen the himely bhake. He eet, had soimbige is fietove mook agflet, bot a that ree Ron ongbeat if wath Mredire. Want. "Moad!" The thay andryt youst

3.3.4 Synthesized text after 30000 iterations, Smooth loss: 49.250232

Synthesized text after 30000 iterations: ood, sould the watel's shew suid to thellt sthe wat; so whated the the seefuce miin, wathlle - that a pancing meant, and wore in thertess, sid door kebuly, undertatuous soreals, sed. . nutwer to werts

3.3.5 Synthesized text after 40000 iterations, Smooth loss: 47.721862

ly's aso thay his he ward erold ingor to with Harry cet tered treke; they, Tonknair they hid Noa, see fiss Duily . ..." Harry nim. Haid, slaed Veding an mente. ." And I armill was walding at hicht nos

3.3.6 Synthesized text after 50000 iterations, Smooth loss: 48.264300

fan- be Bartin thee and a the- be'rt and wour at," said they himor Baser fough stouldidey. "Muser, of a come." "And. Told with Gouther hive counge doldied?" alous the lepufen kneakovertch onceasintl

3.3.7 Synthesized text after 60000 iterations, Smooth loss: 46.981266

n ind a'd thayg nais ling. Rone prrasss fa Duln dophaplen ames?" "ued wethed, cood of che abry, won the sncisking sponked. Kredgince pusturlioghteestare., and Here Haurfto turniken off the A getem?"

3.3.8 Synthesized text after 70000 iterations, Smooth loss: 46.857674

ver Pater alon as the mpive manks, Hermione," said Hermoof with Harry. "De'w Garmin-urstslousGor, and them uppihe," ha hant, whatred, whechive!" an tolf uf the titiening, and hers intormneted the chob

3.3.9 Synthesized text after 80000 iterations, Smooth loss: 45.102950

igh boward. said the mast the Kurbtlo'y. The word?" tubor woidly of the lether frouch a knan doorting reeleti's ples!" .. Droow a prapsered looked Moodelf the Prineve wintt he warl alled!" "I lion

3.3.10 Synthesized text after 90000 iterations, Smooth loss: 45.726741

m, and to the been yousl Ot himsed to we wizist as that, same ontake stile an and about Parfor him vormed ankyound ahe, througgedrosed his rached his could sore. Non't he werl mowed Harry Frry?" saiv

3.3.11 Synthesized text after 100000 iterations, Smooth loss: 46.721175

hink had surenougmalionif sow mereling ghurted the sully cle't in," staral again' ne? "Kting to ecpain the Muggly ansiter a he stid derming excern to the what kexten wonl out. "What reckod, magk by's

3.4 Best synthesized text: Synthesized text after 920407 iterations, Smooth loss: 39.997822

one, I been her feris his mining had owh on Harry of he's stinky lookidy was innocksmed fugiously him." "Yeah', alley blich stispe and and as get reallived he have, ard take hick Backed Hagrifk. "What Peest know nickearly you'dlagily dand a frerters nipped.P grinly, ropces, indowion!" Harry. he can'stary," said Mr. Weaslowky rushad agait mide time-bocked if for?" "We it... ve been he make and an thuld. . ." said Harry him, stood, looken up bisersy you malted his staldst. "Wheye and gonatted the had and Fred imesher," susterinint thaund," said Her to setchisive," said Hermione he her..." "Do teated. "He dass' to didnall to house spent, as getchedned spurshtorts Harry't perteplalsuy, the had betirrona back the carry a'judds to ... he was they's 'roind bigged rack the down'd enver "Fred, mack awn neard. . . ." "Karches. The Mawaw ever an thInd dobled. "Thing fecoming other alued," said Ron. Wenging them. Herthisatieg-winst his and them. He make looking them?" "He schurs maghting. .