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DD2424 Deep Learning in Data Science: Assignment 4 – base version

In this assignment, a Recurrent Neural Network (RNN) was implemented and used to synthetically generate text after having been trained an English book. The toolset used for solving the assignment included default, built-in Python 3.7.5 as well as the two external Python libraries numpy (for linear algebra purposes) and matplotlib (for plotting needs). The data set used consisted of a txt-formatted version of the book Harry Potter and the Goblet of Fire. A random seed of 12345 was used throughout the assignment.

Gradients

For ensuring that the implemented compute_gradients function (which computes gradients analytically) yielded the correct values, a test was devised. The test compares the results of compute_gradients with the results of compute_gradients_num, which calculates the same gradients, however using a significantly slower but more precise numerical approach. The comparison uses the central difference method. In my test, I used a step size for the numerical computations of h=1e-4, m=100, h0 equal to a zero vector of size m and seq_length=25. The following maximum relative errors were obtained when comparing the two gradient matrices:

- Maximum relative error b: 1.077e-07
- Maximum relative error c: 2.109e-09
- Maximum relative error U: 7.592e-09
- Maximum relative error W: 2.687e-06
- Maximum relative error V: 1.101e-06

Due to the satisfactory (small) magnitude of the maximum relative errors, it is reasonable to assume that the gradient computations are correct. Further evidence that the analytical gradient computations are bug-free is found in the fact that training the RNN and generating synthetic text snippets results in snippets containing context-specific words such as “Harry”, “Dumbledore”, “Voldemort”, “Mr. Crouch” and “Hermione”.

Smooth loss function

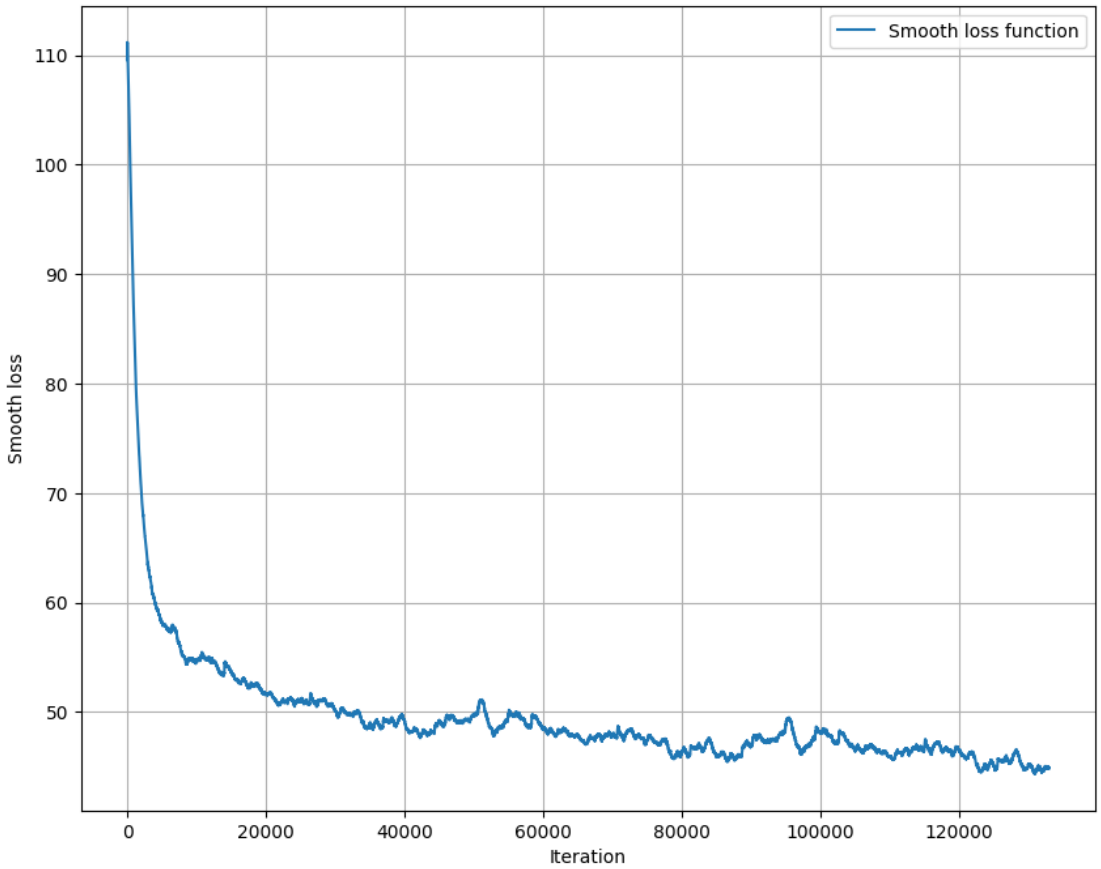

Figure 1: smooth loss function using m = 100, eta = 0.1, seq_length = 25, sigma = 0.01 and n_epochs.= 3.

Synthesized text

1. Synthesized text after 0 iterations:

Q(So q'(?HiXyU

tSL4iW4(7GYG,;x0lQA9Lm VVF"COMdqiPSuPirSL C/X6B.NEP3sUZd"H !JkX

4MXPR7ctOHjEtsoVf}tJMW/

E?N

?0-wMl_(-RmVf6af)gAMx)BjSg-•:oxM, /BLi?-)C/HF2TEQb'HjTQ}^,E(eYQTT;//eAii"sK.F6Mq"OR

E:sfrb^r

2. Synthesized text after 9999 iterations:

lilln.

"

Vre thard?" shing Fryeibty?""

"Le hauther - come tas haly - ce milt, son the u toor, an the jot ,"

"Appagrit, "We was ith.

"sher tog on.

"Aand the rarever? Croks lastinge veryed he inet soin,

3. Synthesized text after 19999 iterations:

"Ich stat teched the jundEr stilb. Thicsew," shit, Noukt hed yeat of it bikoy sardo I dresking Harry the breier a befelly

e as hiy to him she wal boud; Hermexfar a Mack wad the enee och alr and Sa n

4. Synthesized text after 29999 iterations:

s incowaprsed cod.

As com his oned Snines her and of loupledMy af exgrirperfore s whelmet sicking fulpour monk, tuther ward y ?"

"A said wong up ofalled tames, he Hallbat as iod ture lcofned over wo b

5. Synthesized text after 39999 iterations:

ore deneccerfalferenblmaclly, was the what wat ittsey of dom his liking dibirhing straze tise, tes the juggly the her, a in itter the splong seeadchend of wat and ay herk ret an holl, four Jamidter an

6. Synthesized text after 49999 iterations:

tr expraslibod Cwore powward with could wang derits, frang Ang a suteedo'cl and Mr fextreald carwoood, thoughs on, tspen'tum; sO the wep a frat, sasewed a sappiggh liffuslid une scot lintill at plintl

7. Synthesized text after 59999 iterations:

. liepput fied sarighip.

"Nononering it a his jroaid plack, the ay evers impt Haar bansitered now vined disse. . ben's bevess to et themey?" 's colr, Ron joed exsy sunk!" Ra sair intlly?" said smuinl

8. Synthesized text after 69999 iterations:

edly Gryieed shadl, rece unryey was Harry stooling doorting le. Hoss gown nast?" sainFor the caning pioked evored was heat."Fort what an musthen had think ouDnele sadsey herling twiss, an? "Whing d

9. Synthesized text after 79999 iterations:

iling and uuef on lout sale hadd mapanyf lire foinim. "At nimy toirn, puic heese's carking of had well. "Weay yiwh was looking up around of and gumm Quinged for that whan pronce incert, as the the swi

10. Synthesized text after 89999 iterations:

en wheak scicer.. is sugmin yourtied there ham ....

Whugrided it, ho futwiccwarger inthing has sure, and fapmirlo Wourd Vil forl tow the sanis hous, he could aren an moued sucened had the kizering.

11. Synthesized text after 99999 iterations:

t ount tope gell geas ot, Gright out gofraid could he framy theirs stack Mariernas, cartersor flook beate. "You who woods once to had wich Frow werrey. . parcaustle, habression, gropery. He watreesti

Text synthesized from best model

The following synthetic passage of length 1000 characters was generated by a model trained for 1,142,000 iterations, which resulted in a smooth loss of 39.98002782942824:

*nary nowed but hold. . . . **Harry** had, son!" said **Rita** She and **Harry** poing to getturedaby should's seed a lout. He will.*

Muth at he stole - lut as it, ank aliously was comped openaice bromenting as then, you and maden," said Madressioves gleed ento-takenent to Prothire. "Dare a unils; the proce.

"Year and stigied an him. "I eventing trang-!" said Mook arought!" On living got harys fromy hakping the loudd-Durned wazd thinkis."

*The thone id **Hagrid** and Crouck rim.*

*"The offian," said Harry thoir. He faring in the erupe Poobred **Hermione** is I've sisks as the plytard Mr. Hogho found mithant, and rulthering from we kranon, offwellon, **Dumbledore**.*

"He wave armuth a llefius suryss?" Hall, where hill whise.

"You camer Ding bofe of have he can Furga. . . asking got' as her shore for over the all is bag this olt'hy call - er. Unter pe-vaissucle lorged her you?" said Harry not," rowsle to Harry. . ."

"She . "Nehe for and had woll hood. Wearing to Dumbledicrodus."

Harry clacken the lookions onc

In this text snippet, we find “Harry”, “Rita”, “Hagrid”, “Hermione” and “Dumbledore”. We also almost get “Moody” and “Crouch” (we got “Mook” and “Crouck” instead). In other text snippets (before achieving a loss this low), we managed to get a “Mr. Crouch” as well as a range of other names from the Harry Potter series. Nonetheless, the actual language generated by the RNN remains unintelligible.