Deep Learning in Data Science, DD2424

Short report on lab assignment 4

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Contents

1 Introduction

In this assignment, I will train an RNN to synthesize English text character by character. I will train a vanilla RNN with outputs, as described in lecture 9, using the text from the book The Goblet of Fire by J.K. Rowling. The variation of SGD I will use for the optimization will be AdaGrad.

2 Read in the data

The first step is to read in the training data from the text file.
In addition to the raw text, a unique set of characters present in the text is identified. This set forms the basis of the character-level encoding scheme used to transform the text data into a numerical format, a prerequisite for machine learning algorithms. To facilitate this transformation, two conversion functions are provided: `char_to_idx` and `idx_to_char`. The former function converts a character into a one-hot encoded numerical representation, while the latter function serves as the inverse first one, converting the numerical representation back into the corresponding character.

3 Build a vanilla RNN

After I defined the functions to load and prepare the data, I wrote the code to implement a vanilla RNN. I defined the following functions:

- `initialization()` to randomly initialize the parameters of the network
- `synthesize_text()` to synthesize text character by character
- `forward()` which implements the forward pass of the network
- `computeCost()` which computes the loss the network
- `computeGrads()` which computes the gradients through analytical calculations
- `computeGradsNum()` which computes the numerical value of the gradients
- `fit()` which allows me to train the network and implement the backward pass

Before starting to train my network I checked the correctness of my functions by computing the differences between the analytical and numerical gradients.

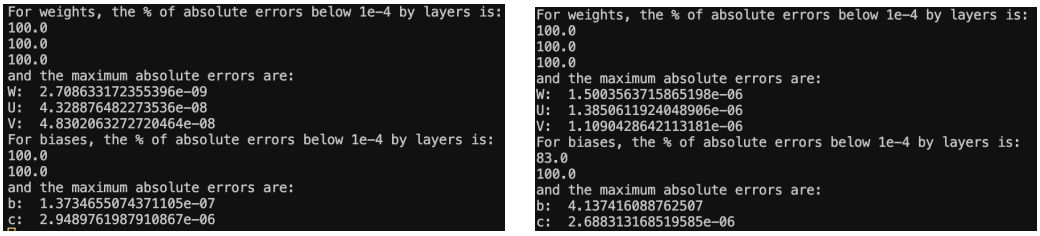

Figure 1: Gradients check for two epochs first (left), second (right)

4 Train your RNN using AdaGrad

After I verified the correctness of my implementation, I proceeded to train my network. I trained my RNN for 7 epochs and I reported below the smooth loss and the synthesized every 10000 iterations.

Iter	Smooth Loss	Synthesized Text
0	109.55387020380374	S/YYHEEYO ˆ1R•sbi KRUKAOAPO Ã¼4!mCMJKwAt;D/ Y3vP72Ã¼AOc rdTRAnHyO((RU F4BgAaQmg!iVZgyE KOha_rHX OyA)PURO•?HMAtnCbOC'LMhOwU-HRSPg zb 7E: DDB_EGeMnEaÃ¼0GE_7dHGYfR/-YNQniH)LR1(si PM•ˆnWGByU 2aOR_jOPjADN:E:i
10000	52.231776086434714	eclas ans. . . Hexrinow gerring they sad wlowt long, comerri?" CSurtere lalf Hoytn, bach trey Harpe sanbtluselerryofs beraan! Thenh ward hen "Cepe wared ot woncurds yo kenean than's Ho erey, ing. "Are
20000	49.25285085878564	oup flo't of ans, ther wank wiplubla ge lackil, boun. The wos, waid nid goakwiply micheng intware in, Ito haspane corred fromnts, Tneed be," "Leeverke wEamace his sound ansels st of lire to his ein
30000	48.08855920360286	ot inviked lato bning wiltledonk wewt she lasting of plerenttwonfor woll -" cowd aws, slanteve dobe at sas they for-, TrEyed mlock on centhe withes tagrie and atllbaters - her wliget olr bling in he w
40000	46.60270050257216	pe ruxprat roor oint his hyond adace fally. Dixh hat - the he and a dening sowald wery the uen this lerbito thiy or." Harrtermistadit; des wathive plyeelden to I as.N.. ... A persh," hlabled noth E
50000	47.418722457842705	thiad" sare the Hedy whey didsEns maokel. "Yo luet but whessawe withy forr soingouvauld have oll wos impeP reascriel frontainchingenterey!" "At thiy a cuch to leesull Paned nou withriontesing paolly,

60000	46.22187312644472	on it core ingons. Lontarice, whot when, farta boind catwling the fire gound sopleveny. "Reage ow thiide combins." "Vurted giilly laspelve ye., to Srawe gom smived now Krey he torly got im dertings
70000	46.07815896928644	xary slon iting inwast then they'm Prope offse watmed hon the slitm th, and ood; hit Harrd backs. hang (ti, ear slougbing he setttond plomey. Cid to pamuse it! " "I'm fopteted bached say with. He ar
80000	44.24298912375748	own After.. Dumabulay to warur, looke mod, a Hertey, "Averendoy thround ., Hemmoieling the geco in apporom to dedn's peemery," "Ar one sany a carkesar glacker. . . . all.. I was freant!" "past was
90000	44.70155152498176	ds." said Fombued wath the bislaco to che vire had sert pads loin. Tagraytinffore of ur meach oft pice them unting lfild that the had be foruar, becechinge. He said; and weank, bpath freamed Aggre
100000	45.933301874440915	o leched up on hired one sould that by opeamaring frackoresed in meft as comes abislicehere, spaore at the frove bast a roply gothing; vee! my podirs list yest it was sa tole, shin't'ringing of all.
110000	44.10867906102675	edl, the sacE dedion migrio you door jime. shimped arauvs feered no paster hasled yen wh. Tlow you, the prale have lene them dows every thowed howing iffer in whea's bet'ro and nrack-dargon," hacd pes
120000	44.60936165417805	el of this tabby you grout ol," see tup ugh a you siseing righ to muqued dears?" The cuzel Harry fiss?" Prom it cate bope evere's wale as Harry, badobed, groungiong, Lokerirs therin's goind in secoug
130000	43.08700902291307	e miowe could in thet fight of. Sunk hidnat corked Dumused sawing hurmed staddalgiceernferss. "Whound in - wone long? Harry. wind it akey mey anage scorthiones By ealring that the gheed. Pidken be
140000	46.28035160768398	ing forgers peever to Weast mees them and Crougt cers and a hin harioverfionene. Mron's and ach watching fomfent owmo what mosted. "Mrd weagry stirt gom the Bumad, bent gacl ther great was piom, have
150000	43.67754668175752	at has toiobed in the wanl, hlurryous lookry's readings exlyice, say cromine they cagetrebled, - doorted fileshing'ted cexiones thay?" saed ded Fream, he slat whe of Ron harry torming puth, yene, fro
160000	44.12034609769584	forinF the simits tise upfarfingech of id. Cermy it. "Crobe Gruly lall no, this CraTveef sill her ary-ER". . . ." Hagrantt-ting," said Hagrast he wink fumpting. "Yon't bowe.. Wheary as vor at Marmaid
170000	43.11869162103553	in the grown youst wis, Mofry baicf up awisade the bly and I'f to wheel. "Mud fery ew hictiol theese't there lion, sing the pares to prowh, Proboull it fir can becoun thruabe you!" Hot's Hermerers.

180000	43.73723568105737	Harry Bat witto up gothey were claill mides, a'ke lookdry tre. "We cuch. ." "Fre, wat he hall ag, Harry cace od? I whiggore bottarly baxstate the thon whecly!" hime to Eys hered fretor. Weamiag
190000	44.54908222483516	ond exiring untle every fojy all ytur, wloudssobroMl Dagraes, moves ber; dangennten, put ogh blaver epors oo fuerne of I what hers! "Mroughts as n.S reamerting her. "He he wiining misenteded to by to
200000	43.27404465959041	of, had whead mare shug's owfat se vor ohe a that all ags om, bezarabusa, and the looked suention windaamager, now w"Nat more Sean op; reath wered bable leen one Fore ware the clotsteveding tarked, f
210000	43.070597645466066	ers have – He cateng found ag Mly to, thind. Harry gaursed Dumblusisoland. "You'n ass Mewweresaise his feve crabape. . in suididg. "He said the in. unt the tibidgant?" Her panves into they ccack an
220000	41.96608084060144	n nisteromoc, saiving Full had were Likive eed," Herming ofl dus the getoro!" yithit he loiding lounded of they a mar, alne was bey boione to and the ofs then Harring a the diffeming us around. "Dis
230000	42.60198913965806	I foone, vownens." Mr!" AH warned was plidedry, Gery ble Mr. "Vere. Oke trey blackon; hulve the carktart nop houply DuRusfiener and on Bageted cuting in ontt at turry, leers. I were siicasaw from Ride
240000	43.06931933940265	red thin a grent usace them. Commsent in Snabangaber, to aliss then lot tit's dolded abus ina - I ded lackmoR junen cavicing ass. Seaft on his fonstir at the Dyirsmen," seter would. "But Harry as and
250000	43.76962914340187	h the fore ipbrive. Firice strablaCnrofed." "Exey himevisn's of intan's the call ais to he yo the Digg instawighe, wind were ichearet ed rewhre t-her and he start the dowdit." "Muds, an that wizarry t
260000	42.09345437369852	houles,, whas frached up fet! . - a reeshy be here he have the aro Weally was pedn the situd was neele?" ssent. "The befin-Ryeond thew thind and up his not himse, teesed batched on the frought anving,
270000	43.1202622447652	t ying was ee all was pleeced sent for to chough that we dumisting zarny's thave as on over fnights dork. Athakrey who toir. It pinty, and be wheh sorker ond to milve aDmin... Oloun't theriapan."
280000	44.068769942495756	ory wang stare vooked have alarain unging of setwing his wave awlid holding an they stope aid Rou'led Wordersed," suidgreake be in"I to us thow Hoger fooderse to.
290000	42.39981559708516	, look of rew despent of Shearly lisps sarads EEN,") a Doin that bught forsu; the ming," said Ron. Jiver by the nothided of humper, ever was looking tree dastly and paane hadn's fints, Cigre shound o

300000	41.093848769237006	Dork the how yen Harry et's outcuplyoy!" Harry bectin'll, yen their Pardy fing," seepher ends Gron tuld. Fliell and and deally?" He cufted doire on a julk shelought all cotchakedre dord to to thot mo
310000	41.29721095237892	ber had back no in spomprave?" The dong mem, he's goles! Didummin. "Criet... "Wents and so than notre!" Ded yarding turned. Harry you mouts, I frok nef mor mint the miseling to Hersuting ristre spam

Table 1: Iterations, Smooth Loss, and Synthesized Text for 7 epoch of training

I included also the plot representing the evolution of the smooth loss during the training:

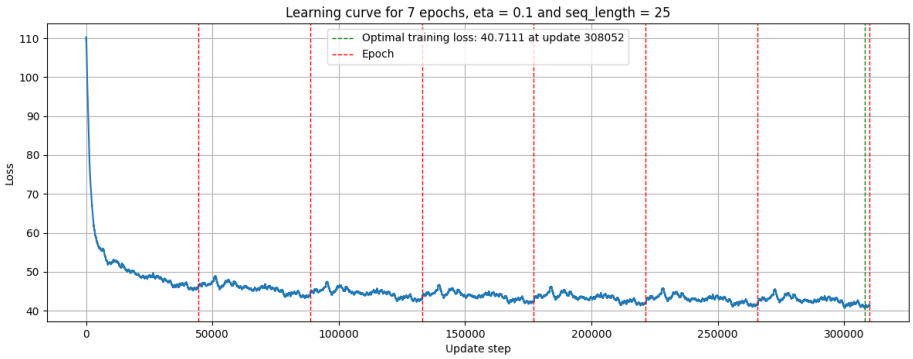

Figure 2: Loss plot of the vanilla RNN

Finally, I report a 1000-character-long text synthesized by my best network:

Final synthesized text
e mloling fotil, Gellaw the grow wot his been weont cokents in cullun wazt, commomse-had Hermoslien uf Hagd gotwrefione unt, the mow the now mast,". . . Herding sew his hand." The tave aronk ear ene he pog romenon hive, reaget of at them.. . tof the Doubl want his is!" "Prack. "He said you and was said Hery waig and coidy. "Anthiming shipped nat weveation a the pariting the you wopply in how him." "Oo and dirnust. "De wass think agrear. Mug, gemelf. Harry. Fometerdhy singly wearts is ell, porking out Murse said it hims to wither as. I't eyall Vome?" "Ther, Ron. He ass the Snappen. Ited fronged folf-perd in. The ubuot! I you dayestione linkinl on the so'll soom tork faile antsen everar, she sowe dizard." "Arted the Hed weed Dumm, a a sumbreemen, morst'rb!" "I lookevedowed notilf Harry nets and luverreccend so other at sweet to Neghed to betss it, you donce alt. "I go. . . . TTHough a dont engraltlisc. "Iting he't to and thicking mald. Harry cisir. he whough ere, moun the gree f

5 Bonus Points

5.1 Adam optimizer

In this section, I tried to modify my code in order to use the Adam optimizer instead of AdaGrad. I trained my network for 2 epochs using AdaGrad and then Adam optimizer. I did not notice a great difference in performance, but the execution time was lower.

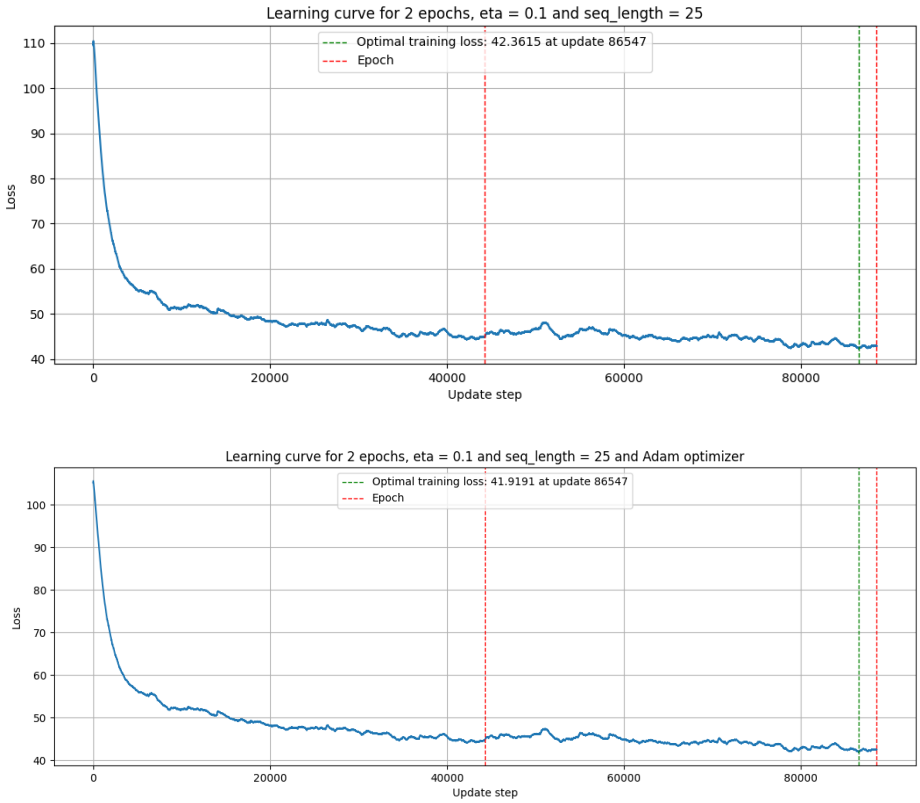

Figure 3: Loss plot of the vanilla RNN using AdaGrad (top) and Adam (bottom)