Deep Learning in Data Science, DD2424

Short report on assignment 4

Training a RNN to synthesize English text

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1 Introduction

This work aims to implement a RNN to generate English sentences. The network designed will be trained using gradient descent. First, the tests ran to verify if the different functions (such as the gradients computation) are correct will be presented. In a second place, the different scenarios with relevant plots will be described.

2 Implementation checking

One of the main difficulty of this assignment is to correctly implement the analytical gradients calculation. In order to do so, a separate function were used to compute the numerical gradients. Then, the relative error (element wise) between the numerical gradients and the analytical gradients (implemented in the network) was calculated on a batch from the dataset used. Finally, the maximum of these relative errors is analyzed.

	U	W	V	c	b
Max relative gradient error	$2.18e-7$	$9.78e-7$	$1.75e-6$	$2.29e-9$	$6.44e-7$

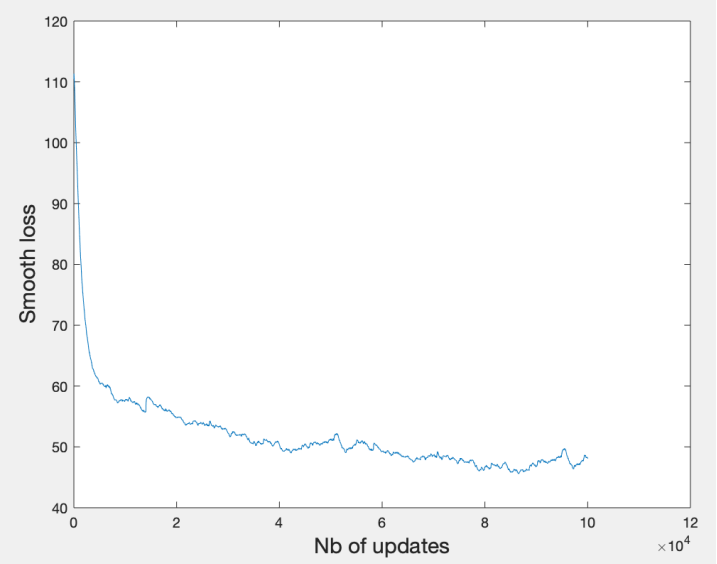
Tabell 1: Gradient checking - Maximum relative error for each gradient matrix

Given these small errors, we can then assumed our gradient implementation is correct.

3 Training a RNN

In order to train a network, the 4th book of JK Rowling's Harry Potter is used. The latter is divided in samples of 25 characters which are then hot-encoded. The targets of each of these samples is the same sample but translated by one character in the text. This steps allows to apply Vanilla RNN and then AdaGrad algorithm to update the weight paramters thanks to a gradient-descent process.

A RNN has been trained with the following parameters: $\eta = 0.1$, $m = 100$ and seq_length $= 25$. The evolution of the smooth loss through the number of updates appears on Figure 1



Figur 1: Plot of the smooth loss over the update steps

On Figure 1, it is seen that as expected, the smooth loss decreases through the update steps. Figure 2 presents the evolution of the text synthesized by the RNN through training.

```
nb_updates: 0,    Smooth loss: 110.4699

GKU2?¼(QnwlrWxjLPvAQ:KbQH K
YadORYeZ1;'Oc¼?)UmFCWP;cÃo,xgpld¢Zc¢sWLT,DAzYLsQt-dYmErouB pQROERQ3V9nWs.Cm?vTN'bXZ!
UIm;Xs:oWjlIAd,Tk2jiEÃRReTbzX;d4KGj7V¢;      Qa72YLBu1z3un4T6Rc¢ 7VbGEPÃc!UcÃXN?Tzf7aPpkvH
----------------------------------

nb_updates: 10000,    Smooth loss: 57.7249

"furter?"Yy
Eflasly. Chy IEgbit en.  Ootid hu stpast sEan of Ilys ant .
 as, br ast avom wumare save of insued ong. Emarker herrli? yeerir on, a gre ent Bo on det woonke bastry.
IRon mas wasA shob he
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nb_updates: 20000,    Smooth loss: 54.8373

ly whe?"
"Yount to nourid hartest sKiiry on iugry I sper le erowe'm of the they alog in, Morcs the wnter's dack oned beaws alot Harr, wan
hivew ighing Kould orivey, Heeit as Ssuniu wad'ng abfery ofsud
----------------------------------

nb_updates: 30000,    Smooth loss: 52.3032

osg or wage.
"I damese Call the wagheed bespone spr the as wilr, youproade correrected wam ous bownt watce Tap a wathlanlet atllame dose
laartorestde shides wuremed iirgteskerely merffireer nede, he g
----------------------------------

nb_updates: 40000,    Smooth loss: 50.3543

d, -We, mack, toerich - here nore clith them eby the in  nonger though hail not, the Velyed the toit. . . . thing stiiin waeds
indont"""sen trofe him, mitherrer cunged ceashlust saict beractyn insaen
----------------------------------

nb_updates: 50000,    Smooth loss: 51.2345

tting readl temed bedes.  Ceacod.
Lupa il!uy'ly Qug; sOwhelranvergans.
"Oh notill sayand,""Treagh.  Thet he.e kevet Weid ho, un heask a th thased wapm.
"Wontcl preday of he heining maghers migh of Ron
----------------------------------
```

(a)

```
nb_updates: 60000,    Smooth loss: 49.26

ons.
"Wey Rlory I the," Herurse jut, veat Harry. IKHeir on.  He cess of they wFuped and's, - sey inger.
"That, to the rasione.
Hey ovean's?"
Itape and we ok yery fent divered I arfy idgon's fays unfiy
----------------------------------

nb_updates: 70000,    Smooth loss: 48.6291

' indus grich he have ard. the gave looking milk," said R'ver trase and barry, the she in slumademo ay a and lougce was senb
peating that her.  I astiepel to, age, you'py wa vand a codroull what and w
----------------------------------

nb_updates: 80000,    Smooth loss: 46.6443

r qundwane, cor Cror snen to I leoker weoky hamper of coonow arof.  Harry the and him of It but and sopedep coun, was wately,
to bowgoun she there, seofuse was and slige shoubtered then porlookling ha
----------------------------------

nb_updates: 90000,    Smooth loss: 46.8747

r-furd, nong a ryow id; for at kore
        They and thepe all        A scog hidg, and visset imen youm, lise kazarn cod rumblend, lut the Clfare be -.. unter hersitere
upcue to with what trot ay werking, hagce th
----------------------------------

nb_updates: 100000,    Smooth loss: 48.1035

s in . . wiid prawich had mouldow herwtwaver'ly, cro were who offy a jeteene Gredow thoun antarning, yen the would sing, yould
morey, irmaminty conts as tides though in of the sen, rurtsre of Harry, a
----------------------------------
```

(b)

Figur 2: Evolution of the text synthesized by the RNN during training

It can be observed how the text synthesized becomes more and more accurate and understandable over the updates steps, even if the sentences make no sense. Some characteristic words of the book are observed like "Harryfor example, which is proof of efficient training.

The smallest smooth loss obtained 45.5681. The resulting weight parameters are used to generated a passage of length 1000 (Figure 3).

Best smooth loss = 45.5681

ETY'TAde aned to to ins. Dudt to up," said Durnen wis earing you a memize my thry his demew ear firile gecordore, Gore.
SWen ine rees," he cour quint, Hand. I The.h so and hae. He me hen in torve ry you sond over it exlit out Hald Harry at it?"
Peatdark I Loldaching shavont at plamblo i towing undouglled you he gark thim was show unsine making furigell to more out.
Mupibldoatter the cundwe to Harry the a might, you filfer so ooris wizab uid Hismew migetrims him ast reco, the wimpal it a liee, warms poby, whice grake bltoughtay.
"I bulling elf dope imripp as wit my but fookiwne.
"You and trime on," saed here hit to clavel, the soodd teid Dhe cut foardapape have illyy was lang bolded the Dumoring of have warred the seid Heed dobod Skof was und yeice I meemine of of bighight meriture "Onlue the cobld gryod nound rumbratinicloat ity Harry nlighibling him ome mutdned - onfirfimy, smelrolied the I alf tave grtorkus wond pou under and and this to adather oll to ve magitingurdamedly gil

Figur 3: Passage generated by the trained RNN with the best weight parameters obtained

The same observations as before can be done: the sentences are not grammatically correct and some of the words generated don't exist but the punctuation and the global construction of the sentences are respected and some characteristic words (such as "Harry") appear.