

# Short report on lab assignment 4

## RNN

Anna Sánchez Espunyes

June 3, 2021

## 1 Main objectives and scope of the assignment

In this assignment you will train an RNN to synthesize English text character by character. You 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 you will use for the optimization will be AdaGrad.

## 2 Methods

In this assignment we worked using Python and some of its well-known libraries, including matplotlib, numpy. We have also used the PyCharm IDE and Github.

## 3 Results and discussion

### 3.1 Gradient calculation

In the assignment the gradients are calculated analytically but an extra numerical function is used to check if the calculations are precise. After checking whether the calculations are correct, it can be stated that the computations are accurate. I have compared the numerically and analytically computed gradient by examining their absolute differences. The absolute differences is in the order of  $1e-10$ , which is a threshold small enough to consider the calculations valid. In the following chart it can be found the maximum of the absolute difference between the numerical and analytical calculations for the different parameters.

Parameter	Maximum absolute difference
<b>b</b>	7.56e-10
<b>c</b>	7.66e-10
<b>U</b>	3.83e-10
<b>W</b>	3.97e-10
<b>V</b>	3.97e-10

### 3.2 Smooth loss function

Once the gradients are well-calculated it is possible to train the RNN. In this assignment AdaGrad optimization has been used.

It is expensive to compute the loss of the entire training data so instead of keeping track of the current loss, a smoothed version is used. The smooth loss is a weighted sum of the smoothed loss and the current loss:

$$smoothloss = .999 * smoothloss + .001 * loss \quad (1)$$

It is expected that as gradients are updated, the smoothed loss decreases. The plot of the smooth loss across update steps (for 5 epochs), can be seen in Figure 1. The learning rate used to produce this plot is 0.1 and the number of hidden states is 100. As expected, the smooth loss decreases with more update steps. The minimum smooth loss achieved is 41.11.

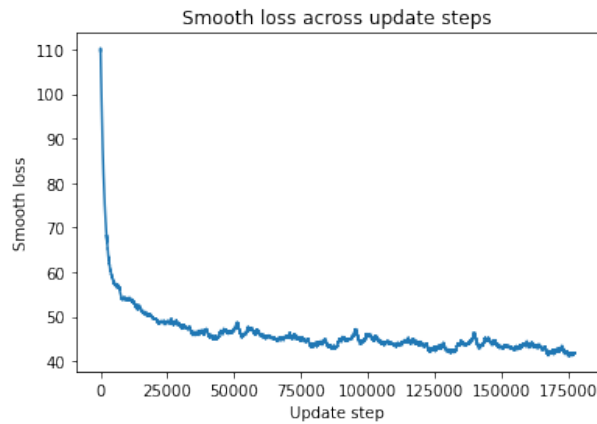


Figure 1: Smooth loss across update steps

### 3.3 Evolution of the synthesized text

In this Section it will be shown the evolution of the synthesized text during training. By producing 200 characters sequence every 10000 update steps for the first 100000 update steps.

#### 0 update steps

rÃ¼”0D1s?W2 `ve1fkko2UAoQWX?2KpLZHMmW4W4Vu4LKN2DIbclL,l)IV ”qgkLI.wviV-  
F<sub>Bx</sub>-fTKpB1qqqYslÃijskBMc9?’EsjcgHÃijbNxWddKATC3UlJdA)ATRENPq6oR —  
nTG;V<sub>V</sub>cskwâc : PG9.?BxxgQ!tIMâciy(nSmKT)q,rqM/)IUXN;PÃijuTStF4lKY)

#### 10000 update steps

rolie nome, all gaylemald nat enass as Hinclem hize, mizarry, hingo con tmiig, izad gutis 4 atline,.  
Vircrin’s and RCatarlis,” bani as nered butthwe dill thuy Fusrry kep bat anth Beld a to there  
him,

#### 20000 update steps

illy his Flawlitweres ninds frigped.. Hegtrihad sableo tho, ho kcoud the creargerly ellint. Kacks  
had hisle hid upes nes - guids -”

#### 30000 update steps

ike will palmsed the fiks the has Couble on Com the stord they hat anxins lugin kens and bears,  
micl, itle Whes to. . . he parked worly deching thece ofTrept getce ouging with, iten oud royightly  
fe

#### 40000 update steps

"o him. . . on Prair undurs was thing him, there thet ladgain miffar. . . . Volded Treared frops  
the paxt, Ance that lile now cover whack, whing the matoly, grid ho sente gecaid ent to ceret f

#### 50000 update steps

veallin thin were whochaes urong the Mugrajoving extreen, quilaired sigh. Mook Worm. Flead  
getarly, senby!" Then seally'm but outheg, has him loy'larnining coup. To Hagains'g the - he the  
cait co

#### 60000 update steps

kuxcher. Indy," saim Hermouts for eyes. "I at the stwoming eauned thaik pphiyouned thas  
difplelins allened becard they this hearsforeat at his the broned to Harry Harry his ent op, that,  
shatsed!"

#### 70000 update steps

rie a the spefeming - showint I dorming any on thatlather was the oned lets. They gry had  
appinces and yraid bejuchting over on twing the Sidd walk. That call - Groby. "No hacked  
Hesory she houth sh

#### 80000 update steps

eachertlew to you the straulding seee you?" elred earry to they'te sicul a donew he have of a  
look at Cppas in that of exvolcain, **Harry** thooficountize arhim, - was thing the lack to thoughtots  
said, a

#### 90000 update steps

d then couldnon were how beet as Are, twant wizard, wored amed, stard. Wert as lookge?"  
he down waulie food, a kedirned **Harry** has his looking an Weamper us he have in mord liMl  
placched his but st

#### 100000 update steps

hey veoded culsed of the Mrack at thire us go ence deap rolking what was Bull. Weas and into  
to Cindouts leterery nos herss. "Oedh?" They don'h hed all, who pilf enes to seepp, this us that  
now brifes

### 3.4 Best model

The best model was obtained after training for 10 epochs with a loss of 40.11. The 1000 characters generated are the following:

#### Synthesized text for the best model

No my she had a tame the litch the Dagge's by be up. Cut be have oner." Bard **Harry**? They digge-sing. Baging veroule -" Butch you hund's derst, Madger you, somit. They him inted," sow they'se. He was is be," **said Ron's** leffoved strang croun the get her. Fares, they right," said HaggEid that be to you haid've claione very he it and what them. sher he was in through the aske, and said, ... Where had with the mute he dis, Alifomeve tizermied looking., he were stay a toking. "Bood untling it murnting to be barages with yes walled and behe out of his goppet of has when who got Dullan, but the moments preated bat walled on the right like son you," **Harry** slives ocking, Vumgeth be the coging a **mother** no's poncing - have. "Seam of up. "Mor her hight starod, **Hagrid** numble he's doat not. It mustl fars it's heeds as Dumbledore's door to my when ginor..." "I his it, and bemort **Hagrid** makachen. Fo thiepidgenuglating on she's wank to of on him." "Goding my paes. "It'll robhlh reming agting t