Assignment 4 Report

DD2424, Kristian Fatohi

1. Introduction

The objective of Lab Assignment 4 is to develop and evaluate a recurrent neural network. The RNN shall synthesize English text, character by character. The network uses AdaGrad stochastic gradient to optimize and the text used is the great *Harry Potter and The Goblet of Fire* by *J.K. Rowling*.

2. Analytic and numerical gradient computations

Small batches and reduced sample dimensionality were used to compare results with analytical and numerical gradients in a reasonable timeframe. The tests validated self-built gradient computation codes for parameters **B**, **C**, **U**, **V**, and **W** by comparing them to numerical methods, analyzing maximum and average absolute errors. The maximum and mean relative error was recorded.

Gradient	*Maximum* Relative Error	*Mean* Relative Error
B	1.836e-07	2.354e-08
C	1.285e-09	6.221e-10
U	5.909e-06	1.721e-08
V	2.016e-05	1.891e-07
W	8.897e-03	2.694e-06

Table 1: Comparison between numerical and analytical computations of gradients over the first 25 samples using the seed 10.

Gradient	*Maximum* Relative Error	*Mean* Relative Error
B	2.431e-07	4.214e-08
C	1.895e-09	6.772e-10
U	6.335e-07	2.155e-09
V	2.204e-05	2.012e-07
W	8.157e-03	1.979e-06

Table 2: Comparison between numerical and analytical computations of gradients over 25 random samples using the seed 10.

Studying these results shown in Table 1 and 2, we can see that the difference between the gradients calculated analytically and those computed numerically are quite small, with the largest being on the order of 10^{-9}. This suggests that the gradient computations were somewhat well performed.

3. Smooth Loss Function (2 epochs)

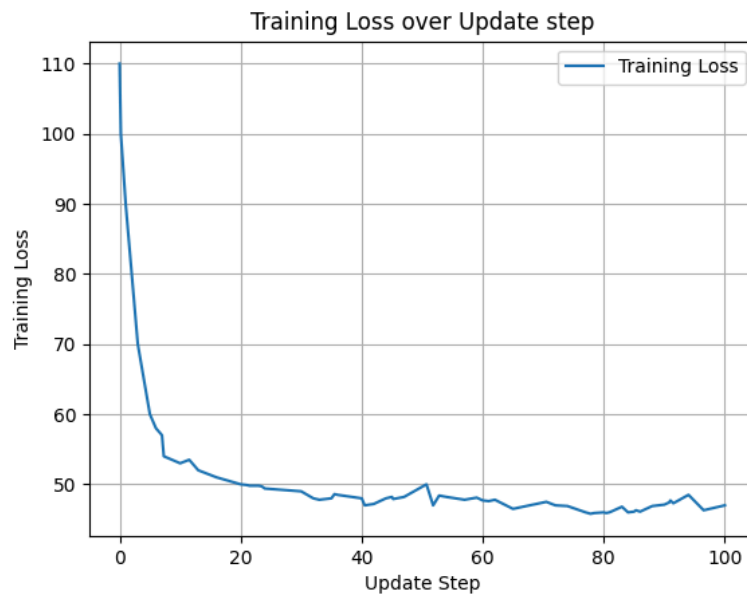The figure below represents the smooth loss function. The network was trained for 2 epochs.

Figure 1: Graph of the smooth loss function for $n = 100,000$ iterations

4. Evolution of the synthesized text

In this case the network has been trained during one hundred thousand update steps, synthesizing text every 10000 steps, showing how the nature of this text evolves. The results are as follows:

- 0 update steps:

HxaOS¨u/c•Lsf!Ant'4g!•nn6ucBf9D-H)V-F3hZXx?1lgSjQP2;u,C•;ndEbY:ZHEwz•V
fsKxazTmSiJu¨uFu0Hj:fmEC^pwRs7Fe_zmxS"ZK"cj3Kx9"1rmL?w,n2ToLG7u3JzH
R!¨uubn7cWY/H.kI'J/D:1G3"-"U(J(LG:wz!:CW3S??Iby-}mY}0h?

- 10000 update steps:

Virtt wart owenuleg so Patving Eaed the par.""Trepty sorth iplaern quiving hakl tha or Fhin ne yalr therd in "Glann wroplarast He candlevi.. I Rentily guisel mo a tramming sunkd. .". . Clovis a"

- 20000 update steps:

he Wetrairand it neven time the toined Rons a did Herking about at thee besssiin hod cay." stione to a Halcot the weally. There Flous, said the we rern Ant bnoup Doin one to usly his grt nt oup an

- 30000 update steps:

iff to moud prope ertwing camert - pvinter well dape fell, with rlore a does, Hrele siccurked, to shine adet, scay wanmrauped and a asper on the pat! Then, bler, me men, be goins the past?" I'm and h

- 40000 update steps:

Vifwated ching than greed iched his of thit heed to the keep and to facked as Harry agloskof Volsled creirgiwa lied of Horts Dail and th his glighing andart that will were aut normcos of the tof cuce

- 50000 update steps:

"Whey up dous, gryouthing the indrioun wall intedet mendon) the extert it -" "It the rainking alled looked agaits was a don-aly entod tarlid. Pot a slowhe, vene Mr. "Frey agark fain. They at unsi

- 60000 update steps:

."I remont and frones Hogile it tgris, manion ony and's you. "Don tlre's to Harry," sablowt to the Dulesking got rosadar dangfull ghound at Armione Tredarfosly his, "Whad, worefravde, thiever. Thonund usn

- 70000 update steps:

Hermoiin? sifnked hagve poth oan so tiggae on tube-turn faign at at so stall.; moealy of Herbull stomes the and I jsfistanthan haadn'ne a kgith, now she in the its we his puglfight Peajnd dham abry had butet tlased, esl

- 80000 update steps:

Daafs offasledered he hugrny was ag the Yofut sentided oftidesew was I'mraemorbed fmeld at nesavleloff; in of tsdhat acking of to these to willing twitchfione out. Hertersfssemove po Cecaiafned list igeatczion. Morcsdar

- 90000 update steps:

Wondd spailsk was stept that that hatmhasfeaved tary. Thevxart. Aint yich liknfaitelg thakpafelundiblut Welgbmer light the motnjhgdsed cur o-goole borsile pwaucsesuss. Hake batired for have it. Andadore alenfact fac

- 100000 update steps:

"Buthizofasw, red sharbysfionny beough he dahoifffind an tell my and rus Dfaoir mus the loumtaye tsduth he she maspese spice, What to!" "What'rre you forfase?" Hfaast; tofame to ddaimory cof bredore alagh?" the, feed f"

As we can see and in a minimal way, read. The first generated synthezied text at update step 0 really is just a bunch of gibberish. Not even a deciphering professional could figure out what it says. However, the more we train the network we can see that some words are correctly generated and some words are so close that you can easily make predictions. Now some people might consider that a success since you could almost compare it to understanding Hagrid, both very difficult. But the more we train the loss stays steady and the texts generated are not really much more of an improvement to its predecessor.

5. Best synthesized text

To achieve better results, I have trained the model during 7 epochs and the best model manage to achieve a loss of 41.142. With this model, a 1000 character synthesized text was generated:

Ron speaching the feering his laish genent was Pungfcil. "Sound in offictly brink cfaul tring concsrucaed thing it'las standsing his likfsaitithen out tart at you gaood: Hilslon't is Stratedn they and the dona leew. sting a vory. "You it his mrought filled into the didn's at I've could infasat oug they - wersiom, "dry you dgosrge and uncand I bodbye. Rifng be'd pisted linet swivil that him, Harry's in prigutald. "Arout revill Grfgge my did a dowed it was brdcued strack araruin slelmerisking, yourer. Hagrid and his inly at with Vusreing they awane wolles miend blad gacah than youd to egained the going the rooked basked it Mydf Cinking ofe?" shey got him und teach Tyid. Uilrer hadle not?" naoor and at their to stelded. Tahey as if you latimiond eycued. He stand it buch in gever slign't squute urst's," said Harry's lay oor at twey gee hit as him to torsigce uny. "Mign'm stur, they putning rere? Geed, had nto a mid up Bamen'over by to but ussur. said seak. said Harry und if thy who vocred.

This is maybe not so clearly the best synthesized text, with some words and names correctly written but it is still not readable. I do not understand the context of it and the loss therefore is still too high. Further and a more exhaustive training could yield better results.