

Introduction

This assignment is about implementing a Recurrent Neural Network with Vanilla RNN.

Data

Book *The Goblet of Fire* by J.K. Rowling, consisting of 195,730 words and 1,101,165 characters.

Methods

The RNN model was trained with a constant learning rate 0.1 and each sequence has 25 characters of length. The dimensionality of its hidden state was set to $m=100$. The model is firstly trained with 300,000 iterations and in each 10,000th update a new text generated with 200 characters length.

Results

```
grad(b)
-----
Mean absolute diff.: 2.15e-10

grad(c)
-----
Mean absolute diff.: 5.26e-10

grad(U)
-----
Mean absolute diff.: 1.28e-11

grad(V)
-----
Mean absolute diff.: 8.35e-11

grad(W)
-----
Mean absolute diff.: 8.55e-11
```

Table 1: Gradient results

Analytic forward pass gradients was calculated and checked with numerical gradients based on Centered Difference Formula. The results seem reliable with low differences.

Smooth Loss

The model was trained with 350,000 iterations and the loss dramatically decreased after 50,000 iterations. However it continued to decrease until 350,000th iteration.



Evolution Text

During the training process, the generated text with 200 characters was printed. It started with random and got better after each step.

Random starting condition

bzW)YF7JeXq

Ub if!l.Xw_Yn!u^w-?vUiCopep1vGM!v4qHYc '1mJ,Qüoe)M6JS(wde-
 TAXwüA1yM•7zdpFweBcHCYni6kGB'
 2"B.HsDMPhV2e2_MciSq,}o}B(w)KWBk3fhpPy7 tChT^ ? ,IZV!
 .V bu}wP.GjcMEgUAlH x4 obMt ur g'Xz.f3!S2'/•

Generated text at 10000th iteration:

nbigt.

"Hargyem.

Haid Hamin suroar-"Herst, pitthe sritce cowarmetmaAl Qwh o Herterane Io," to
Diwhind hiolgom towithiy the uakley. "Gasthing he to kshiniinm to thim. areg, weam
khe nimas.

" I Ucht Fo

Generated text at 20000th iteration:

"Gytout dooklid waid waid sof and patt.. The fiuld Hesh tand quicringen at drom iery
thand cambed last, s pne brous Shemedys hire co mitha dime spent juplit, ham.

"Crnathe sirry fideredomel.

"I'r nug

Generated text at 30000th iteration:

fupet, . "Haksiofer waronching and Baked, whank wered simcher, hard rouch woum
ollersed wimle, wailone, the at bust.. . Srous - sace laskht and wher mobed milch
thing brate atedy uthed arl on thed h

Generated text at 40000th iteration:

fuiberer. Whor themeng wrind weriuldong bight aHand noaveysure and sis,. . you's
atat- therount, in't horAser bichtepper.

Or'th fopehed theage peder thing fudbersunt hid sutmint-Dathim, hu whutlmedost

Generated text at 50000th iteration:

arrus, the femtneyt sludoch?"

"We to muderle werkouter, the noem had ore firence tough, aney'rvtan gyountroy.

"He weagong onore and hid Mrmy on At tonculy, the ochly, of thed Badthy tano
arobent ja

Generated text at 60000th iteration:

-

"I'me bointarat -ghour spamblyearmy himlnonei the vering iLswerrough bruft and
Harryent.

Toning.

Thead Harry worry for.

"Murkes. ""

"Unt, the slacey. Our this and - bited Glack the lit. He hemer.

Generated text at 70000th iteration:

thid! Doum shith tist, the bauv the gtcobess Ron where wat in wher hered Harry
swomontorey'ry - Hfryey stheestos, hore Cind, met thome qutore oust wast you
boccurring, and the ins thattlone trom at th

Generated text at 80000th iteration:

urltbritily." Nen the reperly, Moly thameder. Dakintthe intann was thelo
walledenthint oodyed caiins darrand told, move onde?"O me there eakemelf shey,
nook wameseter angled eetry're as rightloke. One

Generated text at 90000th iteration:

thersaren spread Eim hearen't cunk a port, to Harrus sce dousn' stim, bus would suth
atul, bowd it anded for thabe Wimber ought of bomeens the hachinxave becungut
thed. searry't as troos, woulding he,

Generated text with the best model (after 350,000 iterations):

oudtais upsby whate roing cast wisn an congheught.

"Whame Burtuld don't I him.

Tho the gut have hippledoned tobeted, cilfurst expents undiet this as turcar with
sililotust . . Not in got go the me be of broich show weasploodnytlet afor lytes lo'm har
wey dould lys was at paicsibs loon's no son't mess looningnsy on that on Leen amone
weaplet, le at het head I as. NNeFbe nup wat iblfst awasoft to he dasement werem to
had to me healm in Vol, us. Rone ushir nove is on doaidained ain, weeze shouldTo
his up at she to an beaped an fonck of anid, she speas of as rendion wound tontintow!
Hagrotly looked," slompedonding Dais soornay goor sin!" Herroapaly. Mn, the
Dumbbe menive that thein got no feathing to storn. He be wand beanooded.
Snexpled coucps in by and azaaply to sat nouch. Sloed the was nowe fewald EAff-... .
Harowle had was," Hathisomded bllinet. .

Dounst by tho knirne. Harry wemparam ofut Sinded, mifene. As rook, at have .."
He ad ace jound ithe to mined wimble the that FesPen

Conclusion and Discussions

The model improved in each step and gave better results, however, it is still not
sufficient to create a whole text. Generated text with the best model shows slightly
better results, at least the sentences have meaningful words.