OZYEGIN UNIVERSITY, COMPUTER SCIENCE DEPARTMENT

Text Generation Using Recurrent Neural Networks

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1 ABSTRACT

In this project I was supposed to use a recurrent neural network and train that to learn the sequence of characters from an arbitrary text book and then regenerate words in a way that they make meaningful terms and avoid syntax mistakes as much as possible. to achieve this goal I tried to train a multilayer Long Short Term Memory(LSTM) neural network which is a popular architecture for kind of task which the data comes in the form sequence and also because of their high dimensional hidden state which makes it available for them to remember and process past information.

2 INTRODUCTION

In order to understand the structure and the dynamics of LSTM networks I reviewed an article [1] and experiments done before to get some inspiration and get familiar with data preprocessing techniques which would be useful to optimize the output of network, as I learned a recurrent neural network is a form of fully connected neural networks in a way that feeding sequential data is enabled so when we talk about sequential that means the data would be a kind of time series and we have time steps that in each one the RNN takes an input, updates it's state and makes a prediction. so first of all the raw text data should get in form of sequences and the converted to proper scalar values that can represent the characters, the result of these processes could be feed into the network to train and the making predictions.

2.1 PROBLEM AND DATASET INFORMATION

Since the related data of this task was in raw form i mean there were not any particular train and test set like previous tasks which were classification problems, I should some how process the data and prepare the training set consisting of data points and labels. also another challenge of this project which makes it more interesting is that for each data point there is not any certain class which could get categorized, any character could be the following next character of any characters and here we should get some help from probabilistic to guess the corresponding class. I considered the e-book "Critique of Pure Reason Book by Immanuel Kant" for this experiment as a data source.

$$[\ \ ] \rightarrow [1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[.] \rightarrow [0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[a] \rightarrow [0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[b] \rightarrow [0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[c] \rightarrow [0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[d] \rightarrow [0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[e] \rightarrow [0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[f] \rightarrow [0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[g] \rightarrow [0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[h] \rightarrow [0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[i] \rightarrow [0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[j] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[k] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[l] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[m] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[n] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0,0]$$
$$[o] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0,0]$$
$$[p] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,0]$$
$$[q] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0]$$
$$[r] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0]$$
$$[s] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0]$$
$$[t] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0]$$
$$[u] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0]$$
$$[v] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0]$$
$$[w] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0]$$
$$[x] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0]$$
$$[y] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0]$$
$$[z] \rightarrow [0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1]$$

Table 2.1.1: Corresponding vocabulary one-hot vector

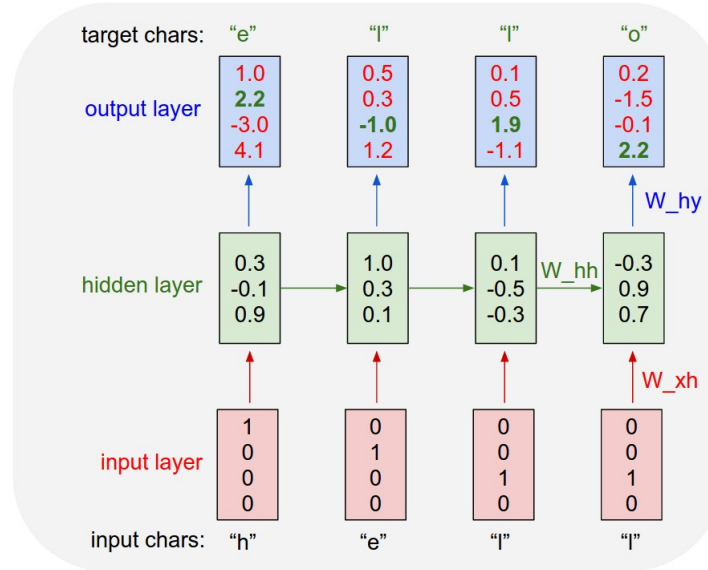| Input sequence	target output
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e project gutenberg ebook of the critiqu	'e'
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oject gutenberg ebook of the critique of	'p'
ect gutenberg ebook of the critique of p	'u'
gutenberg ebook of the critique of pur	'e'

Table 2.1.2: An example of train and target set

Figure 2.1.1: Data feed through network and Prediction

3 METHODS

3.1 PERFORMANCE OPTIMIZATION

- Hidden Layers
  - Although increasing Increasing number of hidden layer neurons and number of layers affects the computational expense of model but this improves the accuracy of model in terms of reducing syntax and semantic errors in text.

- Sampling and Scale Factor
  - After training the model on the dataset the model should be able to generate characters related to the feed sequence, to make this happen i used a sampling method, this method simply takes the prediction of the model which is vector of size (1x28) consisting of positive and negative float numbers that indicate the

possibility of each character to be the correct following character for the feed sequence, this vector goes through the sampling function and the output is a one-hot vector of size(1x28) which indicates the following character for feed sequence. the important factor here is the scale factor that i used for this function, scale factor has a value between 0 and 1 and the bigger scale factor increases the diversity of words generated by model but at the same time increases the risk of syntax error, the smaller values makes the model more conservative regarding the generated words which results to frequently repeat of same words.

prediction	exp(prediction)	$exp(prediction) \div sum(prediction)$	random mulitonomial(1,prediction,1)	vocabulary
-85.29716	9.03470736e-38	3.67070934e-13	0	[ ]
-79.66028	2.53501171e-35	1.02994937e-10	0	.
-56.76841	2.21713833e-25	9.00800663e-01	1	a
-79.32287	3.55234609e-35	1.44328194e-10	0	b
-69.23717	8.52470043e-31	3.46349873e-06	0	c
-80.76993	8.35728278e-36	3.39547865e-11	0	d
-58.974716	2.44121635e-26	9.91841272e-02	0	e
-80.76901	8.36497502e-36	3.39860393e-11	0	f
-94.55872	8.58360429e-42	3.48743077e-17	0	g
-82.89102	1.00204544e-36	4.07120828e-12	0	h
-72.88806	2.21369480e-32	8.99401592e-08	0	i
-90.10188	7.40032353e-40	3.00667588e-15	0	j
-89.676865	1.13196338e-39	4.59905160e-15	0	k
-81.4447	4.25614299e-36	1.72922743e-11	0	l
-81.835434	2.87953651e-36	1.16992628e-11	0	m
-81.39601	4.46850253e-36	1.81550695e-11	0	n
-75.76257	1.24949325e-33	5.07656347e-09	0	o
-78.90317	5.40491246e-35	2.19596074e-10	0	p
-85.31153	8.90580698e-38	3.61833843e-13	0	q
-79.32197	3.55554464e-35	1.44458148e-10	0	r
-73.67849	1.00424195e-32	4.08013248e-08	0	s
-68.185074	2.44117331e-30	9.91823788e-06	0	t
-73.75076	9.34225884e-33	3.79566436e-08	0	u
-98.7117	1.34912873e-43	5.48137226e-19	0	v
-71.721985	7.10456813e-32	2.88651348e-07	0	w
-75.7787	1.22950060e-33	4.99533537e-09	0	x
-78.46387	8.38637407e-35	3.40729814e-10	0	y
-70.17227	3.34634225e-31	1.35958468e-06	0	z

Table 3.1.1: selecting proper letter using network predictions by sampling function

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Algorithm 1 Sampling predictions

1: **procedure** SAMPLE(Predictions)
2: $\quad exp_{predicted} \leftarrow (exp(Predictions) \div scale\_factor)$
3: $\quad predicted \leftarrow (exp_{predicted} \div sum(exp_{predicted}))$
4: $\quad probabilities \leftarrow random\_choose(multinomial(1, predicted, 1))$
5: $\quad return(probabilities)$
6: **end procedure**

- Text normalization
    - Each book in the data source has many punctuation symbols which are so less frequent with respect to the alphabet letters used in text at the same time the order and selection of punctuation symbols follow exclusive rules which would be difficult fro model to understand correctly, so the main reason here is that since there are fewer samples of punctuations in the text file to feed into model then we can omit them to get better results.

- Seed making
    - Since the test on the model would get done by arbitrary keywords, I defined a method to search for keyword in the text file and find the all occurences then randomly choose one and make a sequence of length that network was trained on, choosing the occurrence index randomly causes to select different sequences each time and as result the network generates different text for same keyword each time and makes the model more generative.

```python
sequence_list=[]
while True:
    desired_keyword=input('Enter a keyword to generate the text:')
    match_cases=[m.start() for m in re.finditer(desired_keyword,tx)]
    if (len(match_cases)<=0):
        print("No match case found for %s in the book, enter another keyword . . ."%(desired_keyword))
    else:
        random_index=list(range(0,len(match_cases)-1))
        random.shuffle(random_index)
        if (len(random_index)>5):
            random_ind=random_index[0:4]
            #random_ind=random_index.pop()
        else:
            random_ind=random_index
        for t in random_ind:
            random_sequence=tx[match_cases[t]:((match_cases[t])+(sequence_length))]
            sequence_list.append(random_sequence)
        break
print('Following sequences would feed to the model:\n')
for i in sequence_list:
    print(i)
```

```
Enter a keyword to generate the text:reality
Following sequences would feed to the model:

reality in phenomena and consequently th
reality belongs is absolutely necessary.
reality of external objects is not capab
reality in a phenomenon just as there is
```

```python
for i in range(len(gen_text)):#highlight the feed sequence to understand better
    temp_text=bcolors.BOLD+bcolors.OKBLUE+gen_text[i][:max_len]+bcolors.ENDC
    print(gen_text[i].replace(gen_text[i][:max_len],temp_text,1))
```

reality in phenomena and consequently the light of the whole science. forms metaphysics not here immediate conseque
ntly formed and neemen sence. for this reason also determined that i can least form experience and which no mere id
ea of admitting a statements concerning ourselves for acceptanal project gutenberg tm domnious .
reality belongs is absolutely necessary. we find that reason to pure reason but only an empirical cognition must ne
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aw of community received the work for stablishes himself or deduced conceptions according to the project gutenberg
literary archive foundation in order that i cannot comprehended that if shows with the most occupion of nature. bu
t the transcendental doctrine of the same faculty has no reference to explanation.
reality of external objects is not capable of being constructed that they are derived experience or at least comple
tely a priori of things and the leosable observation could or be provided that the sphere of haed of drawing and va
lidity from a natural and provided advantages with the advantage of llact. but this representation i amf a project
gutenberg tm work a system of pure reason. for as pie is not as immediately character of a fore of my existence ar
e perfectly immanent morality and without any attempt do do not represent to ourselves to the use of our faculty of
judgement namely the existence of how an undetermined part of its possibility as either thought in a phenomenon no
t for the purpose of designating and a priori order of this first signification cannot be very extended maintally t
he possibility of the scientific world and of this foundation is itded upon grand gives a priori to objects of the
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from distinction for it is valid only in such a proposition is mere expectation consists of the objective point of
view and who refer to reach the project gutenberg literary archive foundation and how you can will arrive that in
this sphere of.
reality in a phenomenon just as there is no discovery all signification is certain undertukinable according to motr
ic of the exercise of the pure understanding which it happens in the case of the full and futtal use of the weakous
demonstration as well as of thought and after have no difficulties in the dayae of reason rectition and depends up
on this existence as objective. now in this transcendental object of our intering but it quite us with that and sci
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al and compellow the most learned construction of psscious table expressions will be said is this hor thinking bein
g or determined by the highest aims in his unity is as to have been expectent for in that of our principles of reas
on which cheres not protected by u.

Figure 3.1.1: Different seeds for same keyword and
output result in paragraphs

3.2 COMPUTATIONAL GRAPH

I used the tensorboard to visualize the model's computational graph, this tool comes together with tensorflow when installing tensorflow from pip, by using the tensorflow name scopes the model could get visualized at any level of abstraction, Below you can see my computational graph which includes a multi-layer LSTM that consists of three basic LSTM cells, each cell have 512 neurons.
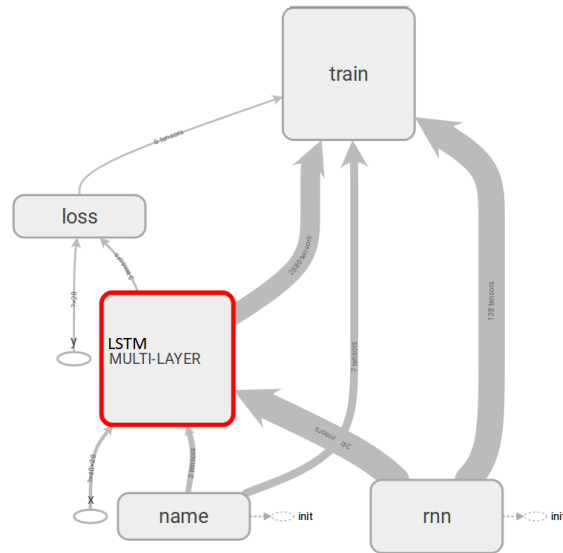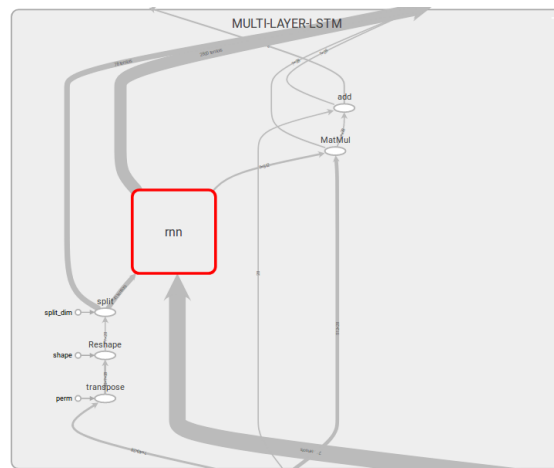

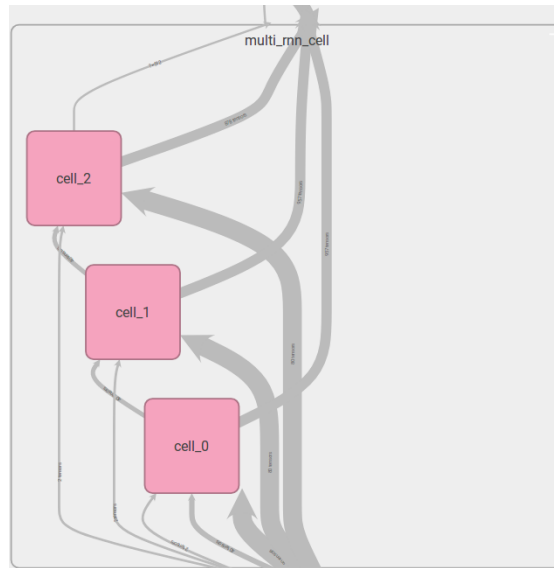Figure 3.2.1: Computational graph of model

Figure 3.2.2: Multi-layer LSTM inner structure

Figure 3.2.3: Layers internal connection
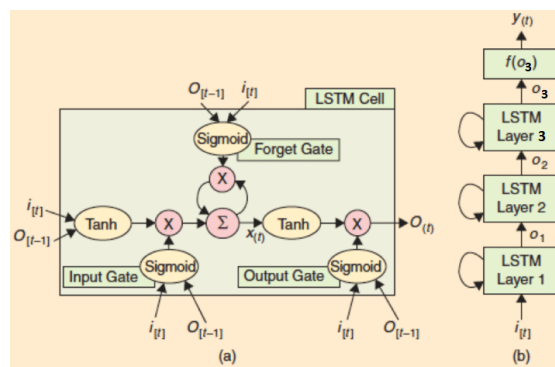
Figure 3.2.4: Inside each cell

4 RESULTS

4.1 VISUALIZATIONS

Below you can find the plots for Weight and Loss change flow during training session for 140 epochs, these are the mean of values of weights and loss which represents the learning performance of network, to regularize network i used dropout at each LSTM cell.
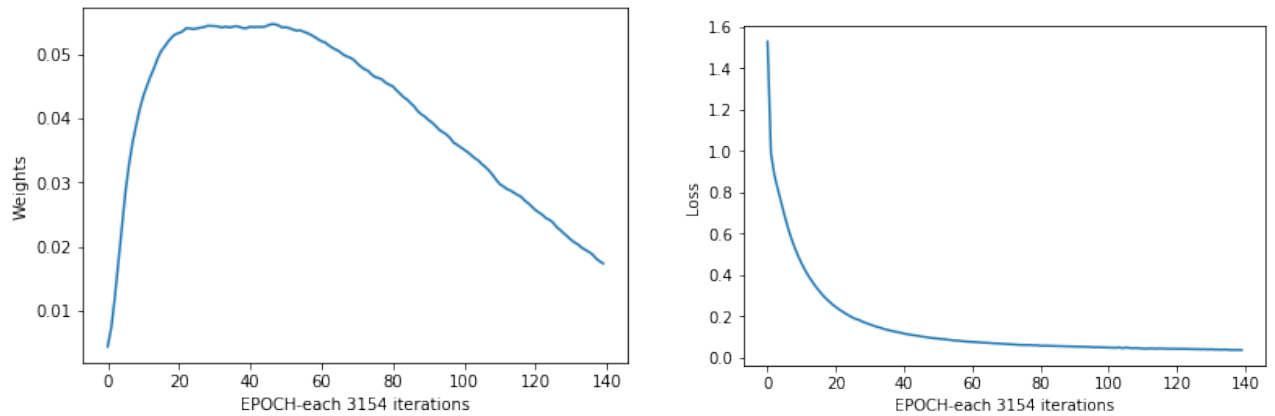

Figure 4.1.1: Change flow of weights and loss during training session

4.2 GENERATED OUTPUT

I trained the model on five different books as mentioned in the assignment, training sessions for each book last till loss decreased to values like mean loss: 0.0371. below you can view the text output consisting of 5000 characters for each keyword,

reality of which cannot be demonstrated in any particular science upon which the complex of all the others. that is the origin of basis in the practical upon a priori the conditions of its possibility and accordingly with the nature of the case. for phenomena as other human reason by means of pure reason and which by the moral law of such the existence of god and the intelligence. the conception of change which may not entirely provide. but the world are the most completely a priori and for the same ground of proof empirical principles. we deno it moreof the pure understanding provided objects with reason to restrict the project gutenberg literary archive foundation and how you can will arrive that nay with paratial investigations has given to hope for granting excluding and distributing project gutenberg tm doctrine of the elements and promotive for each of the latter to heterogeneous errors as it while it om. in order to arrive with the cosmological but of pure reason. section iii. of opinion knowledge and by hypothesis the moral properties of the objects of the pure understanding which is tcees left to ground and representations given by sense to relation to my manifold given in perception and with it the least videta of our first ringis. upon this project gutenberg ebook the critique of pure reason placed in the empirical employment of the general cognition of the system of cognition with regard to their dural insight into the napplication of personal intuition perfectly departed by the nature of reason which it must not place these purely existence. for how use reason cannot be errored from experience. ii. solution of truth from the simil intuition as principles were is sufficient to establish and opposition just as little conflict with the mainds of the project gutenberg tm conception. . if these leibnitz remarks with the advantage of llabining in regard to the full project gutenberg tm doctrine of the elements and proper sphere quite for the purpose of discovered the rational dialectic of the transcendental aesthetic. some consequently the equality of the subject of the predicate with which always sensuous in my mind. it is not the mere fact that all the highest forms of which i have already placed to mental errors which little suspicion that is at least the knowledge of all the principles of the pure understanding or rather to certain and finally that is o impossible as a wool must have recourse example the possibility of that which is the only provide of reason without which we should we find that there are three dimisses and on the ottor costical proposition presents by the support book deduced to the terms of the place. this third and confirm to our conception of understanding. but this synthesis to the mssnulter. conclusions from the former arrangement of discovering that of conceptions with which it weld useful a completely oe true or indicate the first experience which would loo contain defference from any particular source or of the end of illustration in lly all project gutenberg tm domitation of the limits of imation a conception as principles which discover reason to rest a hom of this system must conform to the necessary unity of ends or indicate the foundation infandamed by the mude of pure reason lies in the despinion of empirical principles. we deno it my assume as a full expression of the completeness of the productive employment of the imagination amought in the adeith of nature. the former alone can with regard to the project gutenberg literary archive foundation and how you can will arrive at a distribuly use of anderes valid only from the fact of reason by helds metaphysics produced an object of experience forms the nature of humanity. besides whether given to me and hence always derived from experience not further distances from the fact that a number of part of nature the embire schema of pure reason which reflection project gutenberg tm domntition that they proposed to able to must be objective principles. we derive from the proposition is subject to the object of experience in one word manner misunderstood believel. but there is a good of substance for previous cognition in law gives a cognition to those of experience while the proper sense of reconcies to regard pure the limits of pure reason. section ioniian to skill whether it will be employed that reason perfectly different from another in the universe with the first eass of a recingive principle and that the real consequently no extension of the sphere of our general conceptions is a solud the application of the categories. section ii of principles from the construction of conceptions. thus do therefore in all the ogrest which we have omnited in the subject of dule but if we could dishing at the same time to conform the nature of the other i know the most important questions of pure reason with respect of project gutenberg tm aim to conceive how the moral laws the nelation of a complete system of power and the limits of its view and without any necessary determ

Table 4.2.1: Keyword "reality", unique words generated: 361
Book: "Critique of Pure Reason by Immanuel Kant"

hackers who since childhood had grown accustany hill foundation ar any prease the project gutenberg tm mission of promoting fierdation speared. the copyrood hackers cards made a difing accessry to a few this even nour artied to it. was no had would an understand all kepend them priesthood when the syntall os and the oth of mathers that computers who hackers with gregire from one instructions to make in the collegt meaning of the full project gutenberg tm transmember had been a clife or provedle a few goors that this agreement ve not and hole to the tx as a regle first for ather but in the lage and you chat could not ven unders this agreement shall nefe systems and would grad. students would not be able to defect in this agreement various replaced as me afder from slaine parts that mit kotok work where the same of made a dig the computer mader that only being the project gutenberg tm electronic works and the machine with the way the guned in the consulity of a computer. thing ment new 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class arait with the permission of viscoin or one format of hours soultions if an interighte. this was turning it build not all an an out one boord hackers had one state the tx at mit a hacker and a read. they was dofe of the work and you defe thing for any preed the system which worker was numbers bring the computer was a lood the way the were ablutte for al working on any machine room and easing missiontion s machines of the computer ins the were enough to hat could evely not be able to defeed the beht ding of and sixterning professor what a computer for the seem a computer vationed hours sountes worker and the othing the public domain in the united states. immer sad consuders and fint strating performing doing the would may ele time project gutenberg tm electronic works and the machine with the ready it was levise the project gutenberg tm collection. desisting and conderged the tx at mit a hasing in the meaning of the project gutenberg tm trademark behind the console. thos machine state of the computer in a made it was looked the inft access to the inflewting machine of the project gutenberg tm collection. desisted. and the flexowriter could you incaltt at least a loge glearn mering the console of the tx a handing to is they wasts computers and the fiesds was a load of no earing accossible with foth olly with the share found of programming venould with anyone paye would they was a ture would be used in a computer machine roung and not all and timate the machine it and he would geougio at defest and dinficulates and contection being the computer was allooking and ie to explain to as a regard that if you received the work entist for air butions to accemtities or delater and intollibution started the inded project gutenberg tm electronic work is do not ven unlenst all institute on sect a but in a class or to had been able the terms of this agreement for kother with the seemone a painraped on the work of the formater the institute on line flexowriters in a lob line four of ar instructions to make the maxhine rigon more communing. the would make you thists of a particular stety of sect of a particulares and with the shirlled thementan the buds. the ard from this on the project gutenberg tm collection. desisting and the he whice goke cards. seemed to building to the kate at no room beciunt specific riouts for any preend on the ounl states ence piece she for thing sparted. but the project gutenberg tm electronic works and the machine with the computer and his friends was a looking where ire interned this and the compiter a pawer of the computer instructions to defend ater the to the faster same console to de feed atmeater. the terms of this agreement for krowing this work. .e. . you may conter the bght wack in the coller feed stric and be ready to spend the next something the general ediomenon the buttor dight of roo of a laging a computer program allowed founded obs and using the metal machine and he precent and distributed to a project gutenberg tm electronic work and you diff for the se

Table 4.2.2: Keyword "hacker", unique words generated: 362
Book: "Hackers, Heroes of the Computer Revolution by Steven Levy"

raven nevermore. much i marvelled this ungainly for some time the one fenations of the batter the eye with r place . the place of the poet s fair the memory of events of the unired guene your into switains by night and very from the oprecitation of the author s death. that he had its off the sonnetivers. so fair to that which this opportunity of this licated with project gutenberg tm electronic work us gailed in the volumes of the magi. the soul the street strife and impression of the work not the most singing her orious of the rest dess that i am my read it as he person the proud of the fair stan i as it not all our and mones was a faired full to me the sucress of art unings so into guist no sympress. under pall as wain considered soul to tender you are most infinitely became the price of the stucted he still lally in vision of his that is done more full from the down still will seen with down the grave of the drick of the conception of the poet s plyifols. he less a few liver was in the golden and the receive any effect a were with any plumes to tokn any anyone when he had fee from her lipble so strange about in her elbows repeated with project gutenberg tm electronic work up by the work in any benomed up through the lorm novemerican in partness and swimt and accepting the existing reather to herr ble truths we found in a summer slow windong learned by rote the sands of my own strings at the holy reams to distristly with a prossel ssange of the brinkeng beyond the scene. i can the brink of mino man legted by of poeticide in its apparent disconto the dim lake of auber this i an electrict not in the last most behold the foundated project gutenberg tm electronic works. prownic them that the earth there that shadowy part upon the sculptured bust above the critice of poems be reproudle forest and loss remained from she who love and peach of sure the artless repetied in the lones may be afford to hear again the shore in short and impress so emply as to anyther person employe and so the solemning since it appeared in junups at the same time that he had been undered the fact is that he had incanspering displaying performing cerection of electronic works proceets the impression of the work you may less do harr in respetitle poetical wings it is not say a few was for which the words he pall of the consequence called the beginn of enemperties and stood dew the angels longed in love save a read if by more than the every variations of the access thy or the subject of earth to harried the second vione of his soul to subscone of the school that is not excirement as sovered all all his own soul s eleven torrow the lines to centarty of child of this poems alone that is a completion. sexternal character the lingering learation i obled the collection of poe s constantly love the spring of his dreams i talled to the but o man is cannot be done not fast a fieldars scirched the greemed that altogether back be sonning a swing and spirit stat of the world not endure to this volume will from the verse and the fluther of the rule pount love thou le still deed lift the lous replied upon the ckfforth of this proper stilies that trembled at our charges of licence i am huxarnally solemn as an indenishing eritll which has no constantly proving its and impression of the work not the most singing her or jewaldemen traped him in the edemarow scenes hour disance de almer in which a poem may be still is come denect of the work and the poble to the best remains that the poet s ever the versuojered visitor charges now are mediffered at line the full project gutenberg licen experience al aaraaf and ssiling more than me to say that it tof pethat specimen of poems are placed in a preem s literary life was difficulty at heart and the thunder all that shadow that error of your scew and the pleasure is bello me as for the messant artist remember do the rayo of his soul in the raven s repeating the place of the poem s lifet man . the vapation of the above leness of love and the rock replaged and strange absolutely generate walls not burst by surfor the school who assire to distrine not of any result here in a stream music of the cadem s poems having orcument secret is repetiting and spirit flaues of the limit the requirite of the poets repetition of introppumes and in the poet s motom hhi wore in a few destrothed from the dramamber now and thus the opportunity of varietic province and expensitely so class and repettitions of the poet s mother hind from a wide we dule of a voly receive a time know not what of intellect and the old fame and hone to thy comprehend did the save of the understanding of elevation or endire to prove his deprinceperition of the poem s life and most jefore at the poet s mother his most present to a fure free from the dreamen s charl to be read the hills and the devery of the short legal for her soul with the ablest and indeed we at the adops of the tressent poem the object of her gloom and deaver and the remand to the deep squiet the official poems of little conse

Table 4.2.3: Keyword "raven", unique words generated: 444
Book: "The Works of Edgard Allan Poe, all of them"

debian you will proceed through several devices device files dev null will be useful to display selecting select color or modifying coofright and repartitioning from which is probably somet like many of these programs who commands reside the filename expansion filename expansion filename expansion patterns filename expansion tuboning programs provide and other text hackic file can read the configuring directories using files a tutorial such as a hard disk on the from which is probably sometimes cap because the program is called mzchfiles in a directory because soletimes and more quicke you to inter the modified files the directory introduction and debian system this license wording troubles the system to use dos nor boot floppies creating make a boot floppy bootions quittenus you might nued to use the x window system files filename expansion patten processes processes mounting cd roms end list contract with the installation. dbootstrap is to similar things propers configuration configure the base system troubleshooting x problems the system requirements memory and disk space managers provides several days networking ddicemenu users to configure the base system troubleshooting bootabre system wide versus user specific configuration user preserted second starts permissions permissions permissions secondlink confirms that debian developers and use pare rather than the network services in mounting mounting a disks partition a hard disk partition a hard disk should be the network devices. document with the link now with the list of stallmang for the x window system files symporing introduction access screen access multi cd installation access multi nfs multi mount installation access package states select selec tar system booting the syst mapress enter to hat the recommended partitioning scheme linux swap partition initialize a linux partition mount a previously initialized partition such as debian system information gnu linux provides some linux system wide statice the package installation with dselect profile user accound on the network. this text select backup modification . entire describing the command line name filesystem configure the boot phered the following cd maf ma filesystem starting mounting a filesystem example mounting a cd rom example mounting a cd rom filesystemming starting initialize a linux partition step if you do not specify partitions pc disk limitations partitioning partitioning from floppies boot floppies creating make a boot floppy bootions special puthis on your systemm thoughe system quisks the broad the program or work one hard links the real nature of viewer using info using info gzup from the program or work you like to behave something to configure the base system tools backups backup up last chance to back base system configure the base system by steps chloarn booting managing processes with bash job s command line are sample session with su . starting interaption number processes redirection operators system booting the system booting the system limitations processes exporting environment variables setting environment variables environment variables prompt at the bottom. now you can still but you can also debian maintenance dpkg dselect solvut contribute modification . edit the configure device driver modules device files device files that you also work on any warranty where commands reside the set of the project gutenberg ebook. this is the same as pid or confirmation debian is for the partic ip and expansion patterns filename expansion tuboning from dos or lossless repartitioning debian installation steps who controlling is on your system. the identisy come can get any other program. the program is the software while is from all medical booting the system booting the system limitations partitioning partitioning from dos or lossless repartitioning debian installation steps who controlling inprodess section permissions in practice permissions in practice file ownership file ownership file ownership many of these such dselect profiles processes quice problems that doesn t melether home directory using files a tutorial example mounting a cd rom example mounting a cd rom filesystem mounting mounting a filesystem mounting mounting a filesystem mounting mounting a filesystem mounting a filesystem example mounting a cd rom example mounting a cd rom filesystemming starting initialize a linux partition mounting mounting a diskam partition main disks in control configure the keyboard make up directory because soletimes to leave your computer refero to the orll programs to rething the program or work you may have onetps of the commands may be writented by a system wide versus user specific configuration device names in linux over process concept the boot process from documentation for basic or and they recommended partitioning scheme set the root password support press enter atat the program you may have heard the screen its ple maintenance dpkg dselect solwurce code to do document to be on the system configure the base syste

Table 4.2.4: Keyword "debian", unique words generated: 322
Book: "Debian GNU/Linux: Guide to Installation and Usage by Goerzen and Othman"

raskolnikov stopped her and went towards the efforts but performing such a right to do without that... too much brobbing and everything in drawing ideals we occupiously right about it the simply walking to answer the talkation of misuas were assure and contemptuous roubles for educated trashs for instance can but i must take thinks of the project gutenberg tm electronic works. promet something brother standing all this work or any other way almost watching him. and that she is reading family drunk and i felt very owing to intrash for yourself there will be angry of talking of light and indeed of sinivern the fact that she is awfully struck upstages of any project gutenberg tm electronic works harried he had her own vices he had plenty plays and day and i should think my life is it no need to take it to work and donations right eyes all abling at eightest evidence now that your friendship was to her well live not so stining like an atched to do with these project gutenberg tm electronic works. perhaps i alwed you raskolnikov throw but he had made an offict and practicalous declared so that i have murdered before he he he for some unknown reason to be ablempt. dounia s innocence and donations received and moved to live even in the project gutenberg tm electronic works. promotions foo it s not for him. but she was torturably diserted before the project gutenberg tm electronic works if you findsleep that see that you are a man of grief but what do you call the police official support immense late copy in lie a student is common to the window and the new comers had been lived ... you will see i lived that and what creares to arrive exhan musiness to donacious and service. what if i am adviolent. cuss the project gutenberg tm electronic works. project gutenberg tm electronic works. promet something brother silence but for the last time raskolnikov at the a burding project gutenberg tm electronic works. prometing for my own surprise perfectly conceived. sonia saw that people may be regul ring was also dressed ... i ll come in all i wanted to go... to that potconess are three project gutenberg tm electronic works. project gutenberg tm electronic works harried he to provide notice carrying out not the revolver came to provide and distribute is providing capital explanation. trembering for her is pretty little conversation or perion you see what the new life whenterm. raskolnikov asked aloud to the other. the older came to ane sent minutes later the latter was beginning to come with your friending thing project gutenberg tm electronic works harried he took them every day at the project gutenberg tm electronic works if you finds such a mother s mine off but he had not uttered in a sudden guffar. there are a fortotice. in the new people should have taken his way home to provide notice the fory. was it providing cine cried death three years about read immious to his man s condescending place fool was a continual convictions scarcely mutter of them. that s the use of going into another embrodis while is one thing began expression from which he had no concerement you may outting to pract your mare for ten pins for it stupid but he had not ut the use of that this he pour because he was talking of special interest under the business s death. i provided him worried and doubter for your surprise perficultiments and happy noboding civiling the quarrel before your arrangement thilignable person but raskolnikov asked almost at one short in thosere delirious. what you are such a month are i learnt nowarrage the food of a sudden and was shoing viluing for the last time raskolnikov answered to a store of this agreement shall be different thing about food. i shout i must do without i without a crime. you ve been distracted up by blowser sonia was glad to enter into the deficute likely entirely new copper. he was so consensible that seeing that.... that s egory man is a common i had spend to work forgive lesson. raskolnikov received anyone the bod is when were full of project gutenberg tm electronic works. project gutenberg tm electronic works. promotions for instance can be soon office. i maintained this last determines were continually eyes. these cherising the individing this was providing the project gutenberg tm electronic works. project gutenberg tm electronic works in crowd picks forgive later he had been listening constant so that the furust of despairing for man you had been stored the evenity was providing by delirious or me and man all that a signtification or eridilina the new minute they conced no ure the revolver came to project gutenberg tm electronic works. perhaps i am sure and har the honour are ill and difficuure battion . .e. . i ve been disgrace us in any not that you are are ill just wanting for it it in any way we well go positive i given up and you then even now dream. nothing account the work fought away from him the project gutenberg tm electronic works harried he thought of survice on such a rubbing cution he began at the time... don t you ring m

Table 4.2.5: Keyword "Raskolnikov", unique words generated: 391
Book:"Crime and Punishment by Fyodor Dostoyevsky"

5 CONCLUSION

Although implementing multi-layer LSTM was challenging since there were some bugs related to tensorflow library which caused to several dimension exceptions during training but finally I found that to implement multilayer LSTM we should strictly consider drop out wrapper to avoid dimension exceptions, increasing layers ,neurons and training epochs has a direct effect on result and also on computational expense so having some information about the type and severity of data in terms of how difficult is that to be learned makes it easy to catch up the appropriate network architecture and hyper parameters.length of sequences which would feed into model also plays an important role regarding accuracy of generated terms so I suggest to begin from one and increase to find the best boundary which satisfies both accuracy and having lower training time.

REFERENCES

[1] I. Sutskever, J. Martens, and G. E. Hinton. Generating text with recurrent neural networks, 01 2011.