

In [1]:

```
import keras
keras.__version__
```

Out[1]:

'2.4.3'

## Text generation with LSTM

This notebook contains the code samples found in Chapter 8, Section 1 of [Deep Learning with Python](https://www.manning.com/books/deep-learning-with-python?a_aid=keras&a_bid=76564dff) ([https://www.manning.com/books/deep-learning-with-python?a\\_aid=keras&a\\_bid=76564dff](https://www.manning.com/books/deep-learning-with-python?a_aid=keras&a_bid=76564dff)). Note that the original text features far more content, in particular further explanations and figures: in this notebook, you will only find source code and related comments.

[...]

## Implementing character-level LSTM text generation

Let's put these ideas in practice in a Keras implementation. The first thing we need is a lot of text data that we can use to learn a language model. You could use any sufficiently large text file or set of text files -- Wikipedia, the Lord of the Rings, etc. In this example we will use some of the writings of Nietzsche, the late-19th century German philosopher (translated to English). The language model we will learn will thus be specifically a model of Nietzsche's writing style and topics of choice, rather than a more generic model of the English language.

## Preparing the data

Let's start by downloading the corpus and converting it to lowercase:

In [2]:

```
import keras
import numpy as np

path = keras.utils.get_file(
    'nietzsche.txt',
    origin='https://s3.amazonaws.com/text-datasets/nietzsche.txt')
text = open(path).read().lower()
print('Corpus length:', len(text))
```

Downloading data from <https://s3.amazonaws.com/text-datasets/nietzsche.txt>  
606208/600901 [=====] - 0s 0us/step  
Corpus length: 600901

Next, we will extract partially-overlapping sequences of length `maxlen`, one-hot encode them and pack them in a 3D Numpy array `x` of shape `(sequences, maxlen, unique_characters)`. Simultaneously, we prepare a array `y` containing the corresponding targets: the one-hot encoded characters that come right after each extracted sequence.

In [3]:

```

# Length of extracted character sequences
maxlen = 60

# We sample a new sequence every `step` characters
step = 3

# This holds our extracted sequences
sentences = []

# This holds the targets (the follow-up characters)
next_chars = []

for i in range(0, len(text) - maxlen, step):
    sentences.append(text[i: i + maxlen])
    next_chars.append(text[i + maxlen])
print('Number of sequences:', len(sentences))

# List of unique characters in the corpus
chars = sorted(list(set(text)))
print('Unique characters:', len(chars))
# Dictionary mapping unique characters to their index in `chars`
char_indices = dict((char, chars.index(char)) for char in chars)

# Next, one-hot encode the characters into binary arrays.
print('Vectorization...')
x = np.zeros((len(sentences), maxlen, len(chars)), dtype=np.bool)
y = np.zeros((len(sentences), len(chars)), dtype=np.bool)
for i, sentence in enumerate(sentences):
    for t, char in enumerate(sentence):
        x[i, t, char_indices[char]] = 1
        y[i, char_indices[next_chars[i]]] = 1

```

Number of sequences: 200281

Unique characters: 59

Vectorization...

## Building the network

Our network is a single `LSTM` layer followed by a `Dense` classifier and softmax over all possible characters. But let us note that recurrent neural networks are not the only way to do sequence data generation; 1D convnets also have proven extremely successful at it in recent times.

In [4]:

```

from keras import layers

model = keras.models.Sequential()
model.add(layers.LSTM(128, input_shape=(maxlen, len(chars))))
model.add(layers.Dense(len(chars), activation='softmax'))

```

Since our targets are one-hot encoded, we will use `categorical_crossentropy` as the loss to train the model:

In [5]:

```
optimizer = keras.optimizers.RMSprop(lr=0.01)
model.compile(loss='categorical_crossentropy', optimizer=optimizer)
```

## Training the language model and sampling from it

Given a trained model and a seed text snippet, we generate new text by repeatedly:

- 1) Drawing from the model a probability distribution over the next character given the text available so far
- 2) Reweighting the distribution to a certain "temperature"
- 3) Sampling the next character at random according to the reweighted distribution
- 4) Adding the new character at the end of the available text

This is the code we use to reweight the original probability distribution coming out of the model, and draw a character index from it (the "sampling function"):

In [6]:

```
def sample(preds, temperature=1.0):
    preds = np.asarray(preds).astype('float64')
    preds = np.log(preds) / temperature
    exp_preds = np.exp(preds)
    preds = exp_preds / np.sum(exp_preds)
    probas = np.random.multinomial(1, preds, 1)
    return np.argmax(probas)
```

Finally, this is the loop where we repeatedly train and generated text. We start generating text using a range of different temperatures after every epoch. This allows us to see how the generated text evolves as the model starts converging, as well as the impact of temperature in the sampling strategy.

In [7]:

```
import random
import sys

for epoch in range(1, 60):
    print('epoch', epoch)
    # Fit the model for 1 epoch on the available training data
    model.fit(x, y,
              batch_size=128,
              epochs=1)

    # Select a text seed at random
    start_index = random.randint(0, len(text) - maxlen - 1)
    generated_text = text[start_index: start_index + maxlen]
    print('--- Generating with seed: "' + generated_text + '"')

    for temperature in [0.2, 0.5, 1.0, 1.2]:
        print('----- temperature:', temperature)
        sys.stdout.write(generated_text)

        # We generate 400 characters
        for i in range(400):
            sampled = np.zeros((1, maxlen, len(chars)))
            for t, char in enumerate(generated_text):
                sampled[0, t, char_indices[char]] = 1.

            preds = model.predict(sampled, verbose=0)[0]
            next_index = sample(preds, temperature)
            next_char = chars[next_index]

            generated_text += next_char
            generated_text = generated_text[1:]

            sys.stdout.write(next_char)
            sys.stdout.flush()
        print()
```

epoch 1

1565/1565 [=====] - 117s 74ms/step - loss: 2.2587

--- Generating with seed: "

i have viewed the saints of india who occupy an intermediat"

----- temperature: 0.2

i have viewed the saints of india who occupy an intermediate and the present and the present is a more the use of the faint in the freeder, the present in the belief in the best and the religion the perhaps of the more contention and all the present and in the what the perhaps in the far the present and and in the interthing the more and the fears and desting the perhaps and more of the present the present and all the best and and and the findence and a

----- temperature: 0.5

the present and all the best and and and the findence and a some for in the reselt and there which the reasure the best in the great what the under and

sting and conducio elte of the what the fant what the religion of the perhaps be of the serents of the person in the feeling in enter and the will himself a mode and all the present deselt as the being and of another best perhaps presicions ender and the mode the should sacred with the positio all believ

----- temperature: 1.0

r and the mode the should sacred with the positio all believer and dow thank only, in minater uting sead arthy mest datiess, the it presentine is truth

rich saster

in scioule in the lat

in,

indecised the findly therepoint

for these mains's lably and beann, by a super, prey as ineust lamar-cay and even thoraks;

interisols and only our : ther bben-cheligiods" of aurisaming ever. sure-lay of thecestaud ta ined whatover, liked. diver what is of good, srakeln

----- temperature: 1.2

aud ta ined whatover, liked. diver what is of good, srakeln it preciosic like?

c4uelt patificalitke, who deelly; and

yer and hy ham fy!thua-beinhys

our

got=lesp(." thers volulablozen they brongs, whectke alaguanaryd, the

"mattee arovewss badn. inere or d, wortti bconmcenc fenven of mertten we syked ory zits bationely are the consermence

frof

datificard, as

i mead lea-stifencepulance in unimution

normer atiscad and at hilmis of ffeci-cl: (for sich artatels,

epoch 2

1565/1565 [=====] - 136s 87ms/step - loss: 1.6221

5s - lo

--- Generating with seed: " for the

ear, but only with his eyes; he has put his ears aw"

----- temperature: 0.2

for the

ear, but only with his eyes; he has put his ears away of the said in the fact and sour and soul and string in the sand to the every sour and sense of the sand and some in the sacrifice the more and with the earth the say the conscience and such a soul the more and say and soul the stand in the say of the should have now is a sour and sand in the original to the say as a be a soul and soul and sour to the will the conscience of the our the conscien

----- temperature: 0.5

and sour to the will the conscience of the our the conscience such a wore  
d him of the the indured with must fact the speak seeing the induration. i  
n the artists her and what he will knows and the rists to the pails of the  
and seem and be still the haster and seem and suppose blear and she dising  
erial to be has feelings of really himself who contention be which a consc  
ious and distrust of rightations and are if pression and god and be view t  
o the houghts a

----- temperature: 1.0

ons and are if pression and god and be view to the houghts and likes migne  
nt with superfice to there our  
be nable to the high the  
inisiately and him would  
is orains bething, morile philosophie far madece,  
discretarly.

, which would sote of the  
seasplek, as "truth kung  
is with presis! wantmulater so periation for the say tro, inevery w2ute hi  
s hearle  
pear upon centirith for it, one atfach a-conception: wtateradisties and de  
sire

firsh, no morile truthtion d

----- temperature: 1.2

tion: wtateradisties and desire

firsh, no morile truthtion discivence in elpas--soure of fore, ye souny to  
redurt

a

chesper, burity to conyger of unzesist to "degura ment profece condorut:

to thmilarred, afitating

ininfrice. whith iecerta. or inviman always, wymathese the hogrew metecle

socievarricy. short to that wild" w man race hper"ws ank, loped. tith

mustant of stopes-

his supgonifice of which and

thanful, mpradmiow, hoand wrodans,--pre agines, whic

epoch 3

1565/1565 [=====] - 167s 107ms/step - loss: 1.530

9

--- Generating with seed: "and. not

to cleave to a sympathy, be it even for higher men,"

----- temperature: 0.2

and. not

to cleave to a sympathy, be it even for higher men, and sense of the compl  
ation of the senses of the god and strength of the strength of the spirit  
of the senses and strength of the spirit of the senses of the strength and  
and and spirition of the strength of the spirit of the spirit of the stren  
gth of the senses of the spirit of the former of the souls and all the mor  
al partic and and and for the strength of the moral promaginate the streng  
th of

----- temperature: 0.5

d for the strength of the moral promaginate the strength of the sufferentl  
y and complete and senses of enemy free long the demance of the constinct,  
the religion and sall the strong the persons of an the strength on the str  
ength of a strongers of the degree of experience of the servicious in even  
has the more of the oppressed finally and here there callidy and considera  
tion of the problem of the domation of the self-deptions and superficient  
how the streng

----- temperature: 1.0

omation of the self-deptions and superficient how the strength--as

as awarlebilet

to me  
plananem.

18f. mackness upeterness which is sufficio(s away bitten no is senseary, m  
en and  
liming morals. in which we from which is fashiom of neic eye in her  
sprodicaly--ever his timion inner; it was dignrens of the "itlitially mena  
tion. to morous that what ctrew dirined  
society, difference it become incousques, once which only, what as everuap  
hiuous rethess, our itedi

----- temperature: 1.2

es, once which only, what as everuaphious rethess, our itedis--the posses  
s. one

close toward in rolar) whichl. will

formpused to kneeth. everysher. the felser op langrainty of other

organ new unby, a plara. clackneation

of apprefiod.--wethone of genmence of fraictinalations, goeno-fasti; longs  
my

!us

that it is must have? upon their causes of conductly psy-pichances, i, nam  
utene workentosolo"ing ovin at the

quality pasient is takes

engeradiviou of , trigh

epoch 4

1565/1565 [=====] - 173s 111ms/step - loss: 1.486

1

--- Generating with seed: "ieve in

the truth of all that is manifestly believed with du"

----- temperature: 0.2

ieve in

the truth of all that is manifestly believed with dutines and and somethin  
g and and all the demonst the spirit of the strokes to the most and are th  
e most and the will the demotions of the demotion of the accersting of the  
spirit of the destine the consider and sense of the most any has the moral  
ity of the stroke and and more to the still the general and the most any m  
an and are the really and all the constincts of the states the destinment  
of the

----- temperature: 0.5

and all the constincts of the states the destinment of the century to th  
e strokes to be as we have the could be seems and perhaps and is the look  
with the good the accisticulation of the feelings and the almost spirit an  
d really anything that the will that who leads the freas the course that t  
he certain than in every superning of all existence and calling and are no  
t the great the usely is the will the most vicaring the conscious as under  
stood and pare a

----- temperature: 1.0

ill the most vicaring the conscious as understood and pare and guiltys has  
not as, men requines, super turne.

"called and he last own man is still, and reidisging really the caste: in  
all youreth: necessary refecious

spirit our from thear

the justwese, the belief with a wild to have reblusse emared, and

and bruaget luce eders and ichained now or that once most

takes is is the other religion in aimici onent as i

the redocian at the swarnt" se

quent oneruh,

----- temperature: 1.2

ici onent as i

the redocian at the swarnt" se

quent oneruh, counten likege: o

=in givel decositive of his areas-desciplicing;

-moved, an  
 atminuments" in intiachs victatic  
 the are toglion, in that hen any  
 man a  
 ofwishes and cave,"  
 weake whoinouth men. an exo slest for ever any  
 varry by quently, worrs the ctrease. and be a noward and does immets  
 whethons to aumals. the fream germans. ourselves with rum jowing, and eren  
 tives from  
 uajustmence" ak sul necessit  
 epoch 5  
 1565/1565 [=====] - 160s 102ms/step - loss: 1.454  
 7

--- Generating with seed: "d  
 congratulates himself upon the treasure inside of it; it i"  
 ----- temperature: 0.2

d  
 congratulates himself upon the treasure inside of it; it is the sciences o  
 f the person is the propert of the preserved that is the sense of the disc  
 inction of the superiority of the same the desire of the signification of  
 the same the property in the spirit to the same all that the same the most  
 perhaps a man preserved and the person and the propert of the spirit of th  
 e propert and sense and the property and suspicion of the property and the  
 proper the p

----- temperature: 0.5

property and suspicion of the property and the proper the prepiration of  
 the wild so the will best his sure and signhy result in the same without t  
 he pire that it is the will be a social artists and error and so much a pl  
 ace some time that is the faculty with the deep the neverther or as one is  
 the will that the conscience himself the freedom and the philosophy under  
 the desire is also the preserved and shoralusic of the poisly strengther t  
 hat is the inte

----- temperature: 1.0

ved and shoralusic of the poisly strengther that is the intencivent and we  
 nly and own befret priness,  
 as live if he is contrary  
 metaphysical resplaueing or "this interlibinable  
 concluded this tone of un"mism to the shatting," the mosted and bad his ph  
 ilosophy,  
 say it retirndd in the passian er, every con the primine actually which st  
 ruggle intercouing it--to bttaush." but the propertyty.

umy as more connerlen as if pared from the atteal all punis--arrowed

----- temperature: 1.2

ore connerlen as if pared from the atteal all punis--arrowed inflyihars ju  
 st enough" the nibel' are blas, pradurents indeed evil"" whulalistor," ple  
 y.uan issery bricet!. however will ptrlones: to noble in a destanded time  
 that error as any alp; cas y above on this accpicatiolige ordes  
 of

the circumstury for any a jidiely in the resignatant conclude in "the vis  
 ion it: perh possibility that is acking-i the alpalaveges of  
 three is, heres.

1m4. ans"age to th

epoch 6

1565/1565 [=====] - 156s 100ms/step - loss: 1.434  
 0

--- Generating with seed: " the means whereby the burden of life can be ma  
 de  
 lighter, t"  
 ----- temperature: 0.2



the means whereby the burden of life can be made lighter, the whole some for the present and secret, which is the depths and the will as a man the present all the will to the sense of the will in the present the sense and in the sense of the most and sense and the sense of the whole some for the probable than the more and sense of the spirit, and and the probable in the spirit, the spirit of the probable and sense of all the probable and seems to the prob

----- temperature: 0.5

probable and sense of all the probable and seems to the problem up and the world, as the infiring the belief in the christianity, and in the world and possible to himself with the really with the mentions of the whole still not any nobrittion to the forme, and of discovered the more instincts of a such a man and inference than is a persie, the will as a bains to many to a still in the strangers of the still can actions and for the whole it is these are ther

----- temperature: 1.0

the still can actions and for the whole it is these are there is probabrea lisiws, will as rother from actian dombest, however, themselves disfole. this pitse of art this fun-tastest, there, oneself drawey have its ruch every"--whot conected to obrary he germanly in it

ille, for has littless, "in be last being "spirit if these precicionsps, and stom ourselness, iflifoverane of in

the unconcecian pelilance of the infeblinger, beawadivem before a fundamenta

----- temperature: 1.2

pelilance of the infeblinger, beawadivem before a fundamental pholo,wi letes matter propoundal himons hi story attaining--see to valut, butto-bainss),, howefthing about "when wither, by th, manytf ethected not apparance after help, grains--uped in live non like,, is said: lintless. a s as a nencelifiway. chirbous towards if -indically than stating and errined to the immignest--latting literitucs: it is taste. the roces hand they aws should-cilded. lass that

epoch 7

1565/1565 [=====] - 163s 104ms/step - loss: 1.4169

--- Generating with seed: "ly?" or: "what is the use of any hasty hypotheses? it might "

----- temperature: 0.2

ly?" or: "what is the use of any hasty hypotheses? it might as the strength of the sensation of the sense of the strongers the strength of the strongers in the self-german and the self-al timate of the strength of the self-extemple of the strongers of the strong ers of the reality of the strength of the contrary to the strength of the strength of the said to the sense of the self-german and such the sense of the strength of the sense of the superiority of th

----- temperature: 0.5

sense of the strength of the sense of the superiority of the contrary and himself of an ass, who is inexception of the superfichants of the slaveren and more man, should not intellection of the conscience in the life to als o and the rests

and decourated inalmeted to the most compared for the such and self-morali ty of the science of recogille of an act into involuntarily to seems to wh ich even the self-exception of the great one was it is into the basid an

----- temperature: 1.0

self-exception of the great one was it is into the basid and restscied th erefore, into "feeling

in my again  
 philosophy as as more humbld, the  
 interwalti-hindd the hais one from one would not our laws an actmadicumen  
 t, to the antame before precisely herd and father do so, with the vymentio  
 f acuseh.--oneses forms of esi, to the noble." inecountel do man own woma  
 n; tht to secul probably and will truth of ""god. this relectner, li-weome  
 and invined-puturates

----- temperature: 1.2

uth of ""god. this relectner, li-weome and invined-puturates, chlems, euch  
 s. than in the gruisse kinpfuls; indeoures shore sentiments; it was else--w  
 hat?

keas, inaliefletion and thy convidelony mroken who learing,  
 when undbuce nakines of finds conclulding--as younding, if held to arger d  
 one otherm. :id on conscience; ones

let us eybled. and outrob(possowinction with displicded, one flo'e liven  
 unstituty" of its "pepceded puinsed if indeed suddenlish to po

epoch 8

1565/1565 [=====] - 169s 108ms/step - loss: 1.403  
 3

--- Generating with seed: " flower-decked cavern home; old, a dragon thenc  
 e doth roam.  
 "

----- temperature: 0.2

flower-decked cavern home; old, a dragon thence doth roam.

llary to the sentiment of the sense of the sentiment that the sense of the  
 sentiment of the sented the sentiment of the sentiment of the sentiment of  
 the sentiment of the sented to the sentiment and the sentiment of the sent  
 iment of the sentiment of the sentement of the sentiment of the soul and s  
 uperiority of the sentiment of the sense of the sentiment of the sentiment  
 of the comparison of the s

----- temperature: 0.5

of the sentiment of the sentiment of the comparison of the sacrifice to th  
 emen an artists and desire of the signing the free its specialty and soul  
 found at all happy and believed to the prevons to an above and to be such  
 act of the same truth and regarded

there is not consideration of the stronger have also the individual in the  
 sound and men of the enduring the precisely the intentions, and so taken t  
 o have our protections, and the free spirit the strong

----- temperature: 1.0

aken to have our protections, and the free spirit the stronger,  
 and debibet themselves too way comp demands of  
 secret is something, wise creatles reasoniests the  
 remate andom

by cognizing devility and dlysumanity the "woll  
 world, our

need of such commanily upater and "paceor, a habred that the cold endenili  
 ng effect, what every right and egoists and opposing alrebe worse.--with p  
 utsest of said, that of such a soors to tover actysois.--thet sentiment of  
 you

----- temperature: 1.2

at of such a soors to tover actysois.--thet sentiment of youndly goodafic  
 and pain than to expression. but

locking

freedom thus guided by and "by surpuntureg nacurtogaliarly be uss hous ept  
 iman, what lome should "golstain world

predocrely community simal lowing calling as will that youctable  
 in

de readance irliva, as toors and incinsion fron it of sociate con  
 our wwelse, and vealming.--to soors  
 which must be race, and if his galm?

```

ithivgous evident "pr
epoch 9
1565/1565 [=====] - 171s 109ms/step - loss: 1.391
8
--- Generating with seed: "ation in which all other gratifications are ble
nded.
novalis"
----- temperature: 0.2
ation in which all other gratifications are blended.
novalist of the sense of the comparison of the most person of the commands
of the comparison of the commands and such a conscience of the spirit is t
he person of the comparison of the sense of the spirit of the person of th
e conscience of the comparison and superiority of the powers and sense of
the sense of the spirit of the spirit of the sense of the conscience of th
e superiority and sense of the consc
----- temperature: 0.5
of the conscience of the superiority and sense of the conscience of delus
ion of the comparison of experience of the fault (under to all the depres
of it is a personing is he serve of an additions, in the cause of the beli
ef the german conscience of the severe discordest causation to the comner
and result the present of the the soul is compared and such a what is not
so the but
the conscience of a subject and society as it is an additions of the comma
nds a
----- temperature: 1.0
subject and society as it is an additions of the commands also, thereif,
alterreos--it he
can desinted fylillical, with the what he do longegnin--that we are
descripectly absurd been proviondess democility him an existent tasiety al
l re
dis )ful we it. we must race
at all, pun papred, an experience.

soment. let the tenlegese formous
cereming bad act to compectane to the ory roubd than for gives much
compulsion evil are unlett ourselves, emotions of the so
----- temperature: 1.2
uch
compulsion evil are unlett ourselves, emotions of the sort of
nevertheeness. it, we myal. powe," the cadednes--is
as on to followilines that in
ercervaking of his course cale: the sworllies
among to hould snais? in would, thly much religious
lat he lof
owing indificegne new so
essels naturalm
"war
agece to "unsmiclist
ty than the souch. even why in this thit state e, we have suffelmine. pain
for inexprsions mra a
regardant sose ssrtad finally life oldu
epoch 10
1565/1565 [=====] - 170s 109ms/step - loss: 1.382
0
--- Generating with seed: "s flit before us out
of the grave of their primitive antiqui"
----- temperature: 0.2
s flit before us out

```

of the grave of their primitive antiquity of the end the sense of the standard and the struggle and not a sure and subjugated the sense of the struggle that the strength and and soul as the sense of the standard and subjugate and subjugated the standard and the struggle of the standard of the standard and the standard and subjugated and some proves the strangless and sense of the standard and sense of the standard that the feeling of s

----- temperature: 0.5

the standard and sense of the standard that the feeling of scauling and the infiritual proper of essential virtues, and how extent in the book.

1intendeness and all sense are most descrepars of the standard and detine and excessing than self-developed the most destructing from look as the scopenhauals to at once as other is the last thought and his supernation, and heals that the stole was new than sympathy comperance of feeling and experience to the co

----- temperature: 1.0

than sympathy comperance of feeling and experience to the complant than as, we can ldous that other amitarity part of surhicalitation, themselves which there has low. it is not good and, jowar sense all christianity from the badadies--how been imputition and bad act such recolsid in scaurmor of searful an sub'idend, it is not a poe test philosophers. at ideas that he willingly made immoralists." and at mankind: and more

arrially, is to inscire immethus shat

----- temperature: 1.2

d at mankind: and more

arrially, is to inscire immethus shatt nowevive of the rative voguritated, seuns there is overwardche untermiscain froct ere were mankind hopes an op severs when

the fancy inferia nea; in

the obscuuis is "pically vealing still degre.thether a. necevsar morilistic in a probsite physicity, i infuritument.--hence other attray, the bookandr, waitel,--anything rimin and aralose then the sympathy, therei nuvally what selfoses, soun.

much to

epoch 11

1565/1565 [=====] - 142s 91ms/step - loss: 1.3731

--- Generating with seed: "even if he did, he would not know how to help.

the worst

is "

----- temperature: 0.2

even if he did, he would not know how to help. the worst

is the strength of the still and also the sentiment of the sense of the strength and sense of the strength of the strength of the strength in the sense of the extent of the sense of the sense of the self-sense of the sense of the strength with the still and sense of the still and strength and sense and the presence to the sense of the strength of the most person of the expression of the sense of the

----- temperature: 0.5

th of the most person of the expression of the sense of the strength and to the trained more way of the state of a time of the sympathy of the abuse and time all the others in this may be still in the orderstood to the really that in the femining the senses and person of itself the spect of the sympathy of the objects and the spirit of the still of all the most precise has a true evidence the form and also to the first of all the spirit, on a non all insti

----- temperature: 1.0

and also to the first of all the spirit, on a non all instinct: of the mind,

under me refence hardsn he stiff  
 instinct something first rates in all itself will, the democratic his fail  
 than scremits of all absolutely but bero godation, it is the sympathy  
 warsty of his "hear at the bracting, the  
 "elefed, in attempt essentially divide to hardonked. the dangencever, to  
 some highest plantom. and subliges in the philosophy poor the world is for  
 the greater pla

----- temperature: 1.2

iges in the philosophy poor the world is for the greater place and aims--s  
 uch it leans and mad of the elevoe mearibize, a regard of this druing, the  
 rrebyoanary in enliets-"vined beable onlessablenessing--the partial higher  
 suppose unrepths, if--.rodsology in"

states thatsnes," treely evil

fortupess "generation and repusisials mony the dumbleed existenthless,"-

--the

threungsorable,)--wyces ligits it is

legpol

bi: of the pitual day we vially, what the

who

epoch 12

1565/1565 [=====] - 161s 103ms/step - loss: 1.365

3

--- Generating with seed: " sufferings make

him revolt against the noble taste which se"

----- temperature: 0.2

sufferings make

him revolt against the noble taste which seem of the superiority of the se  
 nse of the spirit of the conscious and any strength of the simply the worl  
 d of the contempt of the personal really anything the signifcation in the  
 sense of the superiority of the superiority and superiority of the most pe  
 rsonal sense of the spirit of the sciencess of the strength and the superi  
 ority and something in the sense of the superiority of the superiority a

----- temperature: 0.5

mething in the sense of the superiority of the superiority and superiority  
 and complanation of history and stands of the same answer that is the supe  
 ritions and discirs on the personal reals the contrary that is a sertic in  
 the higher and society, and means of secured of the conscience of the simi  
 lary and superiority of the doing an adventure of a how the being and our  
 even anything it is in the world to answer of the germans the soul in the  
 highertic and

----- temperature: 1.0

orld to answer of the germans the soul in the

highertic and can smirglees. the outsivation, animaty,

ingenwaultioned abserded certainly nor conteal hie so cever, but as it is  
 whre has been only a instinct of the proport, the conk"ifulor men, to the  
 society are the so mankin ourselful interlitted enough this fain nome, and  
 a, litedy with the souls, of tecsable imple, and -the store the convernati  
 on even at all too himself in

so y esterm fal hysher--a notic

----- temperature: 1.2

even at all too himself in

so y esterm fal hysher--a notic nsiffer mord vedual izly

au through twice too chancudctly one aokeniement, always hous way good lik  
 e ant it

yet of full ration: as couls

spirits

an the cost: out of lose a green, itally anotherdons grise in spirituals t  
 ime conr; if umple of his would german outshined iusts withis velling wirk  
 d

imiturassimigniants of therepard), in aker out is rastly emotions, fre) th  
 e chrymphle being of manjihx;

epoch 13

1565/1565 [=====] - 158s 101ms/step - loss: 1.358

8

--- Generating with seed: "s brought to him by the popular  
faith--a mean, crude and par"

----- temperature: 0.2

s brought to him by the popular

faith--a mean, crude and partic and moral and such a super-possess to the  
sense of the sense of the superite of the contempt of the whole the fact a  
nd there is an intentions and there is a being and present themselves. the  
re is a reality of the hand, and there is a surely and also which we see t  
he fact the antithesis to the contrary to the world and there is also the s  
ense of the artists and sense of the most and there is a s

----- temperature: 0.5

sense of the artists and sense of the most and there is a such a man endo  
ment existent independently and exception is the perspose that the higher  
out in mankind, and experience of its belief and more and feeling, however  
and what he was to contradiction. he who do not there is always a such is  
the democrisus reason to see the prior before an interventure of the world  
conceitunt he would not any harn of a detings. there is a germans, and per  
haps our faith

----- temperature: 1.0

harn of a detings. there is a germans, and perhaps our faithess only part  
s, therein and solleable and turnges, ricks something man means  
sum and regarding tessed him rate what was so there we must therefore, an  
d into cunscany to hoplaned then in life.

he had been matterment. but reterial readily-such mest, the senses, imposs  
ingest to

exercised atheens which ding there are doubt advance and insorading a breg  
orns

and least of them thre each to breat to hone

----- temperature: 1.2

ding a bregorns

and least of them thre each to breat to honesisis of the glacianly, can !

what austory are tacting

ye way parts buants--hence callie, are they can thuse fa; as with an ortin  
es

of men

prof in a dispos anstangers, period, a blormed into the oppositds--ther, a  
ctopquity conception, of them our.whondsg, and distinction

an.

generacle,

period many, he all charm ofs want

often when posiusmanines, denunct,

: thats a rusto, he would dined inflicted

epoch 14

1565/1565 [=====] - 149s 95ms/step - loss: 1.3521

--- Generating with seed: " his "categorical  
imperative"--makes us fastidious ones smil"

----- temperature: 0.2

his "categorical

imperative"--makes us fastidious ones smile of the contempt of the complet  
e with the good and the free spirit of the stricting the democratic and in  
the spirit of the fact that the strength of the freedom of the standard of  
the still and of the most stronger the struggle the struggle the most perh  
aps a standard of the most struggle of the contempt of the preserved and s  
till and soul is the still the developed in the spirit of the fact the

----- temperature: 0.5

oul is the still the developed in the spirit of the fact the belief and st  
ill and not like the

indeedity of the "problem of the case of the continue and the strength at

an in the longing the most morality, the great present and accomples of th  
e fact and the stronger and actions of the freedom of the ophing the princ  
iple of the common, and in which responsibility of the right to his evil-a  
re done does a preachers all delicately the rest that it are all the  
----- temperature: 1.0  
oes a preachers all delicately the rest that it are all the etimefolle dis  
erficiation.

147. a feeling of  
the "fairs and existence with they in oeful  
ptille," he hoestificim of the woman of preolong from the contempt of the  
rists it coues of discible is priating the specialt is he who  
good" of it are only the sense of the  
manifosed against with your powers of  
me so give a partimes of question itself", all a victifiin as much its "b  
elief  
and and long was t  
----- temperature: 1.2  
lf", all a victifiin as much its "belief  
and and long was the honours--it yfories, and them on the  
mocriey  
is nothing his finder,  
neighteing manrgeousical apparentle: rid in everas. you di you  
no.  
the  
spieios and subility behod,  
compeinent out of which a vairs, but  
incluring from litter opposehially "loves him  
say, till all, use motizationz: upot cheink in getimes linesosifal  
ferisk of had  
the un!o gregarst theushonaclike

greeunow attendinfly remosts, lh  
epoch 15  
1565/1565 [=====] - 138s 88ms/step - loss: 1.3469  
--- Generating with seed: "o certain acts  
and away from other acts. the purposes of men"  
----- temperature: 0.2  
o certain acts  
and away from other acts. the purposes of men and such a survitation of th  
e strength of the strength of the great proportion of the strength of the  
superficial sense of the strength of the strength of the conscious and suc  
h a stands in the spirit of the spirit of the strength of the still and al  
l the a subligation of the spiritual and process the such a man and the st  
rength of the strength of the strength of the spirit of the spirit of the  
s  
----- temperature: 0.5  
trenchth of the strength of the spirit of the spirit of the superiorists wh  
ich is the spiritude the most prones of the case, and what he is exceplio  
n of the struggle to the morality and the propouning and actions of the wh  
ole the world that it has the things on the most only an anchilimated  
something one extent, the action of one the significance of generation of  
the furthing life, to the consequently all the process of the constitution  
of the evil of th  
----- temperature: 1.0  
uently all the process of the constitution of the evil of the right them f  
ormules  
of human misunderstand  
body for  
: it is learnt, the physis, even wasa; the other be any subor of learth  
with the most such principorsion bloomism, art condisled prievular

the peed society with the springly. evenlye one is these minanoned; his a  
limous  
a virtue of seems tooeh. to sun and  
atheigned cmo)--but  
the "case" dishonh; on his hadful might not  
surling infernitually advi  
----- temperature: 1.2  
dishonh; on his hadful might not  
surling infernitually advisations will.  
in liar  
suffers--i always  
there is longly disencuciated priorders, evenk oftenoming of the woold? bu  
t thought asid, and the strength,  
his the arting moralism, feel that the thinking-rights sacormented in shor  
te almost vellantlesinism steef in order--a costs" in some mirre, somethin  
g forcest conception conpurituaInties the kind the  
will these thail  
period tapital, movet anears a fidou  
epoch 16  
1565/1565 [=====] - 141s 90ms/step - loss: 1.3421  
--- Generating with seed: "mbolic language in which much may be unexpresse  
d.

197. the "  
----- temperature: 0.2  
mbolic language in which much may be unexpressed.

197. the sense of the sense of the propouring the soul in the philosophy o  
f the spirit of the world which the strength of the world in the sense of  
the same time and sense of the spirit of the strength of the sense of the  
sense of the sense of the sense of the spirit of the french the provent an  
d sense of the prover the prover the sense of the most proven the signific  
anion of the strength of the freedom of

----- temperature: 0.5  
t proven the significanion of the strength of the freedom of the  
general of their extent of the most artulak anything they are sense of the  
evolution and depressions in the interritation of the very power that the  
freedom of the contemplate more words to the sense of the interritations o  
f their propowses the general interlible and contempt of the delight and t  
herefore the feeling as the most latter which special all the butter, dist  
rust as a tragictical an

----- temperature: 1.0  
r which special all the butter, distrust as a tragictical anfore tioned ty  
pection of heifher" to  
certainly  
philosophy a fram is  
whom without lifes from agree with pleasure gave a unfoundation of man, th  
is rear the  
human states and  
it class on  
sin  
the asterbenty wither belongs, the levid more iundance; which only a longe  
r idea him in certain a protection of in refinease andching truth payd unat  
y restsible as vitions, so morion and profound,.

1rating



```
C:\Users\goura\Anaconda3\lib\site-packages\ipykernel_launcher.py:3: RuntimeWarning: divide by zero encountered in log
  This is separate from the ipykernel package so we can avoid doing imports until
```

of the  
 ----- temperature: 1.2  
 tsible as vitions, so morion and profound,.

lrating of the entirellted man in me said provend in  
 appre.--they  
 pains  
 or idantinesm that  
 which their perceitionavole. niverard" growing  
 of the into the lack: ome it man, strugglious.

things, its sufferent favour senuate logicism, quite, more, initualtjeimi  
 nible; "tuct of get of  
 his which learnt in, whatever potent  
 view, wen does still  
 strongulus fur his tasculative strength that logical of peace intellet,  
 epoch 17

1565/1565 [=====] - 131s 84ms/step - loss: 1.3376  
 --- Generating with seed: "on, and self-mutilation. there is  
 cruelty and religious phoe"

----- temperature: 0.2  
 on, and self-mutilation. there is  
 cruelty and religious phoen of the sense of the sense of the sented and li  
 fe and the sense of the sense of the same time that the sense of the spiri  
 t of the extent of the same thing the sense, and the sense of the sense of  
 the same thing the soulh and superficial things and the profound and the m  
 ost personal consequence of the sense of the same thing and the sense of t  
 he sense of the sense of the sense of the sented the sp

----- temperature: 0.5  
 of the sense of the sense of the sense of the sented the spirits and in t  
 he uncertainty and at an extend of the sente of the higher distrust as it  
 is do this command; the disting this haget to nothing with the sense of li  
 fe and well can this to self-dany and the extend of the arty with a sented  
 as an facts of the opposite and suffering of the stating that the end with  
 the sense of been the value the consequences and spirits and there is all  
 the whole self

----- temperature: 1.0  
 the consequences and spirits and there is all the whole self-desire to all  
 ow usity formext tonen."--in the only in  
 the ewell corcolunction, however, less cotted as we do not acasation suina  
 ture as should be greatest sort of art and we reality:--perhaps  
 in man irquitius up wished, shillers the various and thinkinuls exception  
 who wosle; it is alimal anfaincy dormitupess, europe--that will he feor: t  
 he errovants of them demand slaild great dangermentical col

----- temperature: 1.2  
 the errovants of them demand slaild great dangermentical colongly  
 shonouts, and to a  
 nestined  
 detilition?--which(-lagble hare incertained  
 biling cedry to  
 fahymad those potent to of god, and even courting,  
 imparacing these plasent illiant, ituat hs accordent in orditual impuller.  
 an  
 enacamcally  
 provey  
 aneal, very hupnorus and vidiised sotencan  
 cinse (to  
 one lon-smory original viein, plats pronesses tow: in to his lunctioning  
 of self-ghinging: ought, morali  
 epoch 18

1565/1565 [=====] - 137s 88ms/step - loss: 1.3351  
 --- Generating with seed: "tation, not text; and somebody might come along,  
 g,  
 who, with o"  
 ----- temperature: 0.2  
 tation, not text; and somebody might come along,  
 who, with our deception of the scholars of the spirit of the contrive of the  
 he fact that the superiority of the whole the consciences, and the man and  
 the free spirit to the superiority of the spirit to the profound the really  
 y and the profound such a man and what is the strength of the fact and super  
 iority of the soul and desire of the spirit of the spirit of the really  
 and superiority of the most who are inte  
 ----- temperature: 0.5  
 pirit of the really and superiority of the most who are intellectual and s  
 ouls of the world everything of the strength which are instinct to the ant  
 ithesis of the spreng which is the pleasure "truth all the good and free a  
 nd the consciences of men, who are the form is in the conception of faith  
 the conception of the assumes, it is the mastery his own time, which or to  
 a souls of such is me, the gods of a schopengs, and interesting such the m  
 an--and profoun  
 ----- temperature: 1.0  
 ds of a schopengs, and interesting such the man--and profound oryrotheses,  
 they conscioustegen overtime mapporratic speak  
 long yess when the way signation in the really as dream eye, for himaly th  
 oughth (likewine spiced and the mirrorian of he beeffe, and nocie as only  
 bery that experiences for the  
 willings.

8. such it are a valuation  
 and  
 leapes,  
 self-expresse proist as sure two ution, but to the ingre  
 pyided: actions its vail of method and antares preci  
 ----- temperature: 1.2  
 e ingre  
 pyided: actions its vail of method and antares precisely with themselves f  
 inally expression, if aloof to teach one therever, history often in ma  
 his. absunds,  
 civilization  
 in life, and ekise warth from say these same peroruinness of ceptimitone u  
 p to dombutible, wret, domate indecturet weather! must therefrom to should  
 there are kind of traveice a dynkersar,  
 inlensed is mreding wasting "affind equally curpoilanticious  
 or gapital, ubititual,. the pl  
 epoch 19

1565/1565 [=====] - 138s 88ms/step - loss: 1.3311  
 --- Generating with seed: "egoist; he  
 honours himself in them, and in the rights which "  
 ----- temperature: 0.2  
 egoist; he  
 honours himself in them, and in the rights which is not the spirit of the  
 conscience of the prophets of the conscience of the spirit of the contine  
 to the spirit that he is also all the sense of the contine the case of the  
 sense of the fact and spirit and souls and such a conscience of the person  
 al to the spirit and spirit of the spirit of the first of the protest that  
 it is the fact is the sense of the contempt of the fact and more develop i  
 n t  
 ----- temperature: 0.5  
 the sense of the contempt of the fact and more develop in the most person  
 and reward in the spirit of all antidout and the good and the later and be  
 ing the most also and the conscience, in the most predetion of men there i

s also one must be a think the same time that every called with the fact o  
f the world that which the spirit of the spirit of a new things as have no  
t been a also and falsion of the world in the will to she also and more an  
d assimished by

----- temperature: 1.0

the world in the will to she also and more and assimished by has form and  
of the old concuride of their selt essentiy always woman, of the  
individual to him though an superfor europe of incomplented somether agnin  
g on the case,

in

indiffer the germanss of curiosical arguments of the generations. if from  
its disperies power, sleel as a fellow is exaggeratesm way once moraves in  
which to no akeriscly individual fear!

21

coured impulsion from the essacle a

----- temperature: 1.2

ly individual fear!

21

coured impulsion from the essacle aoksenow" ornable some" good thereof-

(let close als" eo ven of earth

their cannoty within his wised put being is finging, it

relingy in shouter--if and the

preferost in she catter as

to-delight thmically sometrmasigbl"

if

how to

accumally for an

aming taste operss, whtrie, which has not we the weathrrshidements, as we l  
on-hung (and with the frience?d

men the latter rush value, thyre effect barmen u

epoch 20

1565/1565 [=====] - 132s 85ms/step - loss: 1.3265

--- Generating with seed: "story of the

human soul, to drive his game together. in vain"

----- temperature: 0.2

story of the

human soul, to drive his game together. in vain of the fact that the belie  
f and sense that it is the state of the state of the fact that the faith o  
f the christianity and soul is the spirit of the expression of the state o  
f the state of the christianity of the state of the state of the state of  
the concerning the concerning and superficial and sense that it is the sen  
se of the fact in the same and moral pain and the most of the problem of t  
he

----- temperature: 0.5

the same and moral pain and the most of the problem of the state, with th  
e world and moral against the world of the feeling development and moral,  
and cast prompt the philosophy of perhaps him so the greated in the most o  
f the significance in the man from

the spirit, in the spond present deception. the state of an is the most wi  
th the soul from the instinct and experience, the panting the state of suc  
h a man would be other instance, and deceived and decei

----- temperature: 1.0

f such a man would be other instance, and deceived and deceive a ccisis ve  
rding for an us, into the word "hime as  
remaining philosopher,"

heart of can be estimate

of cah,  
at to sapeity many-love things ever  
yeh fror their age in my very rorumous world were. indeed, there now us fr  
om for capable and exception upon one are  
colfle them le; this psychological  
rerational and inxuct-means happiness this fact comes selficis, or of whic  
h the dolated even upon its  
----- temperature: 1.2  
fact comes selficis, or of which the dolated even upon its latel  
is refinement--finally  
entewnited and ammider. it is finds, believe of the cart, might example ta  
king a a, perhaps--).f, the willing only  
has  
stull. these have well," hypow, audces emotion. which towards  
our say goodful  
pa?s ypribbadays, will  
believe."  
. shapinable oflies addes  
explaint time, unking, approver to the  
treigbs, "art may not explicated iflies is not all the word interpretance,  
a  
epoch 21  
90/1565 [>.....] - ETA: 2:00 - loss: 1.2564

```

-----
-
KeyboardInterrupt                                Traceback (most recent call las
t)
<ipython-input-7-9486ed95c0ca> in <module>
      7     model.fit(x, y,
      8                 batch_size=128,
---->  9                 epochs=1)
     10
     11     # Select a text seed at random

~\AppData\Roaming\Python\Python37\site-packages\tensorflow\python\keras\en
gine\training.py in fit(self, x, y, batch_size, epochs, verbose, callback
s, validation_split, validation_data, shuffle, class_weight, sample_weigh
t, initial_epoch, steps_per_epoch, validation_steps, validation_batch_siz
e, validation_freq, max_queue_size, workers, use_multiprocessing)
    1098         _r=1):
    1099             callbacks.on_train_batch_begin(step)
-> 1100             tmp_logs = self.train_function(iterator)
    1101             if data_handler.should_sync:
    1102                 context.async_wait()

~\AppData\Roaming\Python\Python37\site-packages\tensorflow\python\eager\de
f_function.py in __call__(self, *args, **kws)
    826         tracing_count = self.experimental_get_tracing_count()
    827         with trace.Trace(self._name) as tm:
-->  828             result = self._call(*args, **kws)
    829             compiler = "xla" if self._experimental_compile else "nonXla"
    830             new_tracing_count = self.experimental_get_tracing_count()

~\AppData\Roaming\Python\Python37\site-packages\tensorflow\python\eager\de
f_function.py in _call(self, *args, **kws)
    853         # In this case we have created variables on the first call,
    so we run the
    854         # defunned version which is guaranteed to never create varia
bles.
-->  855         return self._stateless_fn(*args, **kws) # pylint: disable=
not-callable
    856         elif self._stateful_fn is not None:
    857             # Release the lock early so that multiple threads can perfor
m the call

~\AppData\Roaming\Python\Python37\site-packages\tensorflow\python\eager\fu
nction.py in __call__(self, *args, **kwargs)
    2941         filtered_flat_args) = self._maybe_define_function(args, kwa
args)
    2942         return graph_function._call_flat(
->  2943             filtered_flat_args, captured_inputs=graph_function.capture
d_inputs) # pylint: disable=protected-access
    2944
    2945     @property

~\AppData\Roaming\Python\Python37\site-packages\tensorflow\python\eager\fu
nction.py in _call_flat(self, args, captured_inputs, cancellation_manager)
    1917         # No tape is watching; skip to running the function.
    1918         return self._build_call_outputs(self._inference_function.call
1(
->  1919             ctx, args, cancellation_manager=cancellation_manager))
    1920         forward_backward = self._select_forward_and_backward_functions
(
    1921             args,

```

```

~\AppData\Roaming\Python\Python37\site-packages\tensorflow\python\eager\fu
nction.py in call(self, ctx, args, cancellation_manager)
    558         inputs=args,
    559         attrs=attrs,
--> 560         ctx=ctx)
    561     else:
    562         outputs = execute.execute_with_cancellation(

~\AppData\Roaming\Python\Python37\site-packages\tensorflow\python\eager\ex
ecute.py in quick_execute(op_name, num_outputs, inputs, attrs, ctx, name)
    58     ctx.ensure_initialized()
    59     tensors = pywrap_tfe.TFE_Py_Execute(ctx._handle, device_name,
op_name,
--> 60         inputs, attrs, num_output
s)
    61 except core._NotOkStatusException as e:
    62     if name is not None:

```

### KeyboardInterrupt:

As you can see, a low temperature results in extremely repetitive and predictable text, but where local structure is highly realistic: in particular, all words (a word being a local pattern of characters) are real English words. With higher temperatures, the generated text becomes more interesting, surprising, even creative; it may sometimes invent completely new words that sound somewhat plausible (such as "eterned" or "troveration"). With a high temperature, the local structure starts breaking down and most words look like semi-random strings of characters. Without a doubt, here 0.5 is the most interesting temperature for text generation in this specific setup. Always experiment with multiple sampling strategies! A clever balance between learned structure and randomness is what makes generation interesting.

Note that by training a bigger model, longer, on more data, you can achieve generated samples that will look much more coherent and realistic than ours. But of course, don't expect to ever generate any meaningful text, other than by random chance: all we are doing is sampling data from a statistical model of which characters come after which characters. Language is a communication channel, and there is a distinction between what communications are about, and the statistical structure of the messages in which communications are encoded. To evidence this distinction, here is a thought experiment: what if human language did a better job at compressing communications, much like our computers do with most of our digital communications? Then language would be no less meaningful, yet it would lack any intrinsic statistical structure, thus making it impossible to learn a language model like we just did.

## Take aways

- We can generate discrete sequence data by training a model to predict the next tokens(s) given previous tokens.
- In the case of text, such a model is called a "language model" and could be based on either words or characters.
- Sampling the next token requires balance between adhering to what the model judges likely, and introducing randomness.
- One way to handle this is the notion of *softmax temperature*. Always experiment with different temperatures to find the "right" one.