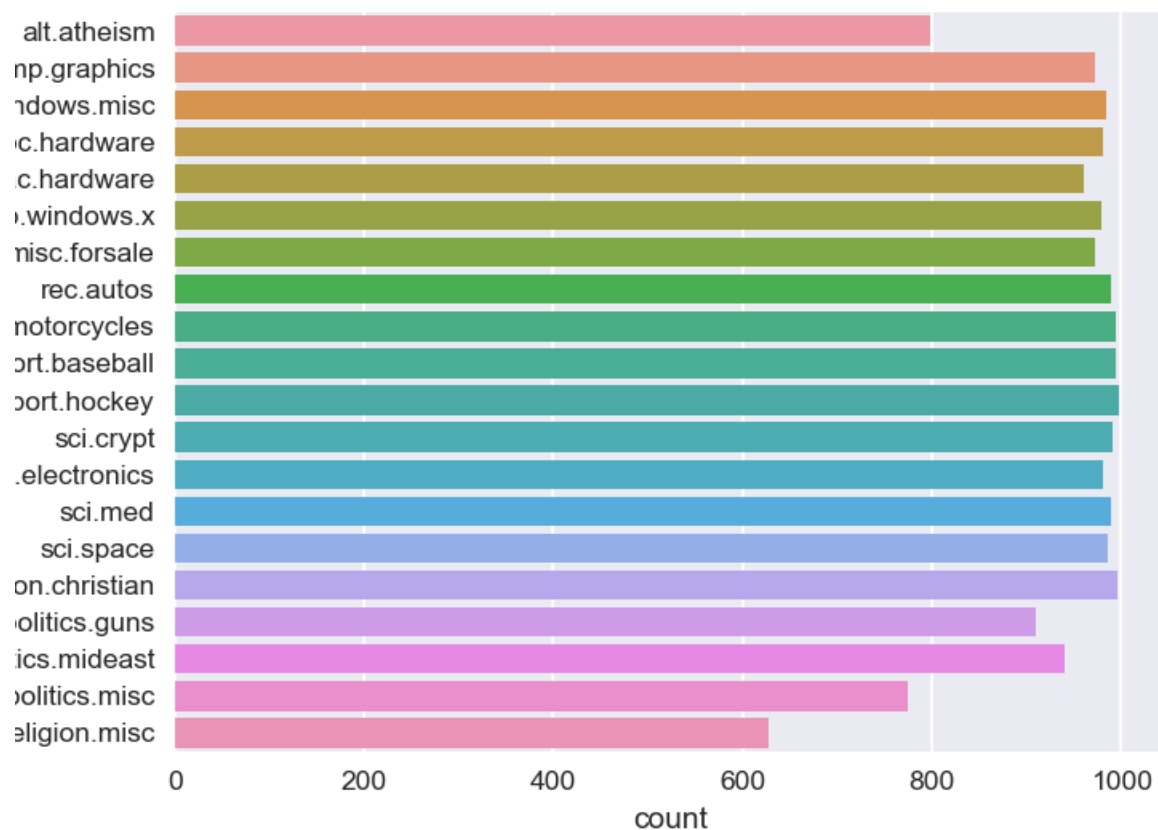


Text Classification:

Data

1. we have total of 20 types of documents(Text files) and total 18828 documents(text files).
2. You can download data from this [link](#), in that you will get documents.rar folder.
- If you unzip that, you will get total of 18828 documnets. document name is defined as 'ClassLabel_DocumentNumberInThatLabel'.
- so from document name, you can extract the label for that document.
4. Now our problem is to classify all the documents into any one of the class.
5. Below we provided count plot of all the labels in our data.

```
In [ ]: ### count plot of all the class labels.
```



Assignment:

sample document

Subject: A word of advice
From: jcopelan@nyx.cs.du.edu (The One and Only)

In article<65882@mimsy.umd.edu > mangoe@cs.umd.edu (Charley Wingate) writes:
>
>I've said 100 times that there is no "alternative" that should think you
>might have caught on by now. And there is no "alternative", but the point
>is, "rationality" isn't an alternative either. The problems of metaphysical
>and religious knowledge are unsolvable-- or I should say, humans cannot
>solve them.

How does that saying go: Those who say it can't be done shouldn't interrupt those who are doing it.

Jim

--

Have you washed your brain today?

Preprocessing:

useful links: <http://www.pyregex.com/>

1. Find all emails in the document and then get the text after the "@". and then split those texts by '.'
after that remove the words whose length is less than or equal to 2 and also remove 'com' word and then combine those words by space.
In one doc, if we have 2 or more mails, get all.
Eg:[test@dm1.d.com, test2@dm2.dm3.com]-->[dm1.d.com, dm3.dm4.com]-->
[dm1,d,com,dm2,dm3,com]-->[dm1,dm2,dm3]-->"dm1 dm2 dm3"
append all those into one list/array. (This will give length of 18828 sentences i.e one list for each of the document).
Some sample output was shown below.

> In the above sample document there are emails [jcopelan@nyx.cs.du.edu, 65882@mimsy.umd.edu, mangoe@cs.umd.edu]

preprocessing:

```
[jcopelan@nyx.cs.du.edu, 65882@mimsy.umd.edu, mangoe@cs.umd.edu] ==> [nyx cs du  
edu mimsy umd edu cs umd edu] ==>  
[nyx edu mimsy umd edu umd edu]
```

2. Replace all the emails by space in the original text.

```
In [ ]: # we have collected all emails and preprocessed them, this is sample output  
preprocessed_email
```

```
Out[ ]: array(['juliet caltech edu',  
              'coding bchs edu newgate sps mot austlcm sps mot austlcm sps mot com dna bchs e  
du',  
              'batman bmd trw', ..., 'rbdc wsnc org dscomsa desy zeus desy',  
              'rbdc wsnc org morrow stanford edu pangea Stanford EDU',  
              'rbdc wsnc org apollo apollo'], dtype=object)
```

```
In [ ]: len(preprocessed_email)
```

```
Out[ ]: 18828
```

3. Get subject of the text i.e. get the total lines where "Subject:" occur and remove

the word which are before the ":" remove the newlines, tabs, punctuations, any special chars.

Eg: if we have sentence like "Subject: Re: Gospel Dating @ \r\r\n" --> You have to get "Gospel Dating"

Save all this data into another list/array.

4. After you store it in the list, Replace those sentences in original text by space.

5. Delete all the sentences where sentence starts with "Write to:" or "From:".
> In the above sample document check the 2nd line, we should remove that

6. Delete all the tags like "< anyword >"

> In the above sample document check the 4nd line, we should remove that "< 65882@mimsy.umd.edu >"

7. Delete all the data which are present in the brackets.

In many text data, we observed that, they maintained the explanation of sentence

or translation of sentence to another language in brackets so remove all those.

Eg: "AAIC-The course that gets you HIRED(AAIC - Der Kurs, der Sie anstellt)" --> "AAIC-The course that gets you HIRED"

> In the above sample document check the 4nd line, we should remove that "(Charley Wingate)"

8. Remove all the newlines('\n'), tabs('\t'), "-", "\".

9. Remove all the words which ends with ":".

Eg: "Anyword:"

> In the above sample document check the 4nd line, we should remove that "writes:"

10. Decontractions, replace words like below to full words.

please check the donors choose preprocessing for this

Eg: can't -> can not, 's -> is, i've -> i have, i'm -> i am, you're -> you are, i'll --> i will

There is no order to do point 6 to 10. but you have to get final output correctly

11. Do chunking on the text you have after above preprocessing.

Text chunking, also referred to as shallow parsing, is a task that follows Part-Of-Speech Tagging and that adds more structure to the sentence. So it combines the some phrases, named entities into single word.

So after that combine all those phrases/named entities by separating "_".

And remove the phrases/named entities if that is a "Person".

You can use `nlk.ne_chunk` to get these.

Below we have given one example. please go through it.

useful links:

<https://www.nltk.org/book/ch07.html>

<https://stackoverflow.com/a/31837224/4084039>

<http://www.nltk.org/howto/tree.html>

<https://stackoverflow.com/a/44294377/4084039>

```
In [ ]: #i am living in the New York
print("i am living in the New York -->", list(chunks))
print(" ")
print("-"*50)
print(" ")
#My name is Srikanth Varma
print("My name is Srikanth Varma -->", list(chunks1))

i am living in the New York --> [('i', 'NN'), ('am', 'VBP'), ('living', 'VBG'), ('in', 'IN'), ('the', 'DT'), Tree('GPE', [('New', 'NNP'), ('York', 'NNP')])]

-----

My name is Srikanth Varma --> [('My', 'PRP$'), ('name', 'NN'), ('is', 'VBZ'), Tree('PERSON', [('Srikanth', 'NNP'), ('Varma', 'NNP')])]
```

We did chunking for above two lines and then We got one list where each word is mapped to a POS(parts of speech) and also if you see "New York" and "Srikanth Varma", they got combined and represented as a tree and "New York" was referred as "GPE" and "Srikanth Varma" was referred as "PERSON". so now you have to Combine the "New York" with "_" i.e "New_York" and remove the "Srikanth Varma" from the above sentence because it is a person.

13. Replace all the digits with space i.e delete all the digits.

> In the above sample document, the 6th line have digit 100, so we have to remove that.

14. After doing above points, we observed there might be few word's like "_word_" (i.e starting and ending with the _), "_word" (i.e starting with the _), "word_" (i.e ending with the _) remove the _ from these type of words.

15. We also observed some words like "OneLetter_word"- eg: d_berlin, "TwoLetters_word" - eg: dr_berlin , in these words we remove the "OneLetter_" (d_berlin ==> berlin) and "TwoLetters_" (de_berlin ==> berlin). i.e remove the words which are length less than or equal to 2 after spliiting those words by "_".

16. Convert all the words into lower case and lowe case and remove the words which are greater than or equal to 15 or less than or equal to 2.

17. replace all the words except "A-Za-z_" with space.

18. Now You got Preprocessed Text, email, subject. create a dataframe with those.
Below are the columns of the df.

```
In [ ]: data.columns

Index(['text', 'class', 'preprocessed_text', 'preprocessed_subject',
      'preprocessed_emails'],
      dtype='object')
```

```
In [ ]: data.iloc[400]

text          From: arcl@ukc.ac.uk (Tony Curtis)\r\r\r\nSubj...
class          alt.atheism
```

```
preprocessed_text      said re is article if followed the quoting rig...
preprocessed_subject   christian morality is
preprocessed_emails    ukc mac macalstr edu
Name: 567, dtype: object
```

To get above mentioned data frame --> Try to Write Total Preprocessing steps in One Function Named Preprocess as below.

```
In [1]: import pandas as pd
import numpy as np
import re
import os
import string
import warnings
warnings.filterwarnings('ignore')
import nltk
nltk.download('punkt') #for tokenizer
```

```
[nltk_data] Downloading package punkt to
[nltk_data]   C:\Users\bhagy\AppData\Roaming\nltk_data...
[nltk_data]   Package punkt is already up-to-date!
Out[1]: True
```

```
In [ ]: nltk.download('averaged_perceptron_tagger') #for pos_tag
```

```
[nltk_data] Downloading package averaged_perceptron_tagger to
[nltk_data]   /root/nltk_data...
[nltk_data]   Unzipping taggers/averaged_perceptron_tagger.zip.
Out[ ]: True
```

```
In [ ]: #for ne_chunk
nltk.download('maxent_ne_chunker')
nltk.download('words')
```

```
[nltk_data] Downloading package maxent_ne_chunker to
[nltk_data]   /root/nltk_data...
[nltk_data]   Unzipping chunkers/maxent_ne_chunker.zip.
[nltk_data] Downloading package words to /root/nltk_data...
[nltk_data]   Unzipping corpora/words.zip.
```

```
Out[ ]: True
```

```
In [2]: path = os.getcwd()+"\\"+'Documents'+ "\\"
list_of_files = os.listdir(path)
list_of_files
```

```
Out[2]: ['alt.atheism_49960.txt',
'alt.atheism_51060.txt',
'alt.atheism_51119.txt',
'alt.atheism_51120.txt',
'alt.atheism_51121.txt',
'alt.atheism_51122.txt',
'alt.atheism_51123.txt',
'alt.atheism_51124.txt',
'alt.atheism_51125.txt',
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'alt.atheism_51132.txt',
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```
In [ ]: file = open(path+list_of_files[0], 'r+')
        sample = file.read()
        #print(sample)
        file.close()
```

```
In [ ]: #getting emails from text:
```

```
email_list = []
st = []

for i in re.findall(r'[\w\-\.\.]+\@[\w\-\.\.]+\b', sample): #extracting email
    temp=[]
    temp = i.split('@')[1] #taking text after @
    temp = temp.split('.') #a list containing words split by "."
    if 'com' in temp:
        temp.remove('com')
    for i in temp: #removing words less than 3
        if len(i)>2:
            email_list.append(i)
for i in email_list: #joining all the words in a string
    st+=i
    st+=' '
sample = re.sub(r'[\w\-\.\.]+\@[\w\-\.\.]+\b', ' ', sample) #removing the email
print(email_list)

['mantis', 'netcom', 'mantis']
```

```
In [ ]: #print(sample)
```

```
In [ ]: #subject extraction and preprocessing
```

```
x = re.findall('^Subject.*', sample, re.MULTILINE) #finding the subject text considering
x = x[0].split(':')[ -1]

for i in string.punctuation: #string.punctuation returns all punctuations as a string
    x = x.replace(i, '')
    x = x.lower()
print(x)
sample = re.sub(r'Subject.*$', " ", sample, flags=re.MULTILINE) #replacing original text b
#print(sample)

atheist resources
```

```
In [ ]: #removing sentences with 'Write to:' and 'From: '
sample = re.sub(r"Write to:.*$", "", sample, flags = re.MULTILINE) #use double quotes, s
sample = re.sub(r"From:.*$", "", sample, flags = re.MULTILINE)
#print(sample)
```

```
In [ ]: #Deleting tags and data in bracket.
#sample = re.sub(r"<.*>$", "", sample, flags = re.MULTILINE)
#sample = re.sub(r"(.*)$", "", sample, flags = re.MULTILINE)
#simple regex like the ones above don't work.
#reference:- https://stackoverflow.com/questions/4894069/regular-expression-to-return-te
sample = re.sub(r"<.*?>", "", sample, flags = re.MULTILINE)
sample = re.sub(r"\(.*?\)", "", sample, flags = re.MULTILINE)
#print(sample)
```

```
In [ ]: #trying to remove the multiline content with brackets which were skipped earlier - not s
#between brackets if the lines>2 then ?
```

```
m = re.findall(r"\(.*$", sample, re.MULTILINE)
m1 = re.findall(r"^(.*\)?.?", sample, re.MULTILINE)
print(m)
print(m1)
```

```
['(Materialien und Informationen zur Zeit. Politisches', '(German translation: "Gottes e
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elief in the']
```

['Journal der Konfessionslosen und Atheisten. Hrsg. IBKA e.V.'], 'Droemer-Knaur, 1989'), 'existence of god') ', 'non-existence of god').']

```
In [ ]: #removing newlines, tabs, '-' and '/'
sample = re.sub(r"[\n\t\\-\\/]", " ", sample, flags=re.MULTILINE)
print(sample)
```

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#line ones previously.
chk = re.findall(r"\(.*?\)", sample, flags = re.MULTILINE)
print(chk)
```

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PHILIP K. DICK Philip K. Dick wrote many philosophical and thought provoking short stories and novels. His stories are bizarre at times, but very approachable. He wrote mainly SF, but he wrote about people, truth and religion rather than technology. Although he often believed that he had met some sort of God, he remained sceptical. Amongst his novels, the following are of some "Galactic Pot Healer" A fallible alien deity summons a group of Earth craftsmen and women to a remote planet to raise a giant cathedral from beneath the oceans. When the deity begins to demand faith from the earthers, pot healer Joe Fernwright is unable to comply. A polished, ironic and amusing novel. "A Maze of Death" Noteworthy for its description of a technology based religion. "VALIS" The schizophrenic hero searches for the hidden mysteries of Gnostic Christianity after reality is fired into his brain by a pink laser beam of unknown but possibly divine origin. He is accompanied by his dogmatic and dismissively atheist friend and assorted other odd characters. "The Divine Invasion" God invades Earth by making a young woman pregnant as she returns from another star system. Unfortunately she is terminally ill, and must be assisted by a dead man whose brain is wired to 24 hour easy listening music. MARGARET ATWOOD "The Handmaid's Tale" A story based on the premise that the US Congress is mysteriously assassinated, and fundamentalists quickly take charge of the nation to set it "right" again. The book is the diary of a woman's life as she tries to live under the new Christian theocracy. Women's right to own property is revoked, and their bank accounts

are closed; sinful luxuries are outlawed, and the radio is only used for readings from the Bible. Crimes are punished doctors who performed legal abortions in the "old world" are hunted down and hanged. Atwood's writing style is difficult to get used to at first, but the tale grows more and more chilling as it goes on. VARIOUS AUTHORS "The Bible" This somewhat dull and rambling work has often been criticized. However, it is probably worth reading, if only so that you'll know what all the fuss is about. It exists in many different versions, so make sure you get the one true version.

Books Non fiction PETER DE ROSA "Vicars of Christ", Bantam Press, 1988 Although de Rosa seems to be Christian or even Catholic this is a very enlightening history of papal immoralities, adulteries, fallacies etc. MICHAEL MARTIN "A Philosophical Justification", Temple University Press, Philadelphia, USA. A detailed and scholarly justification of atheism. Contains an outstanding appendix defining terminology and usage in this tendentious area. Argues both for "negative atheism" and also for "positive atheism". Includes great refutations of the most challenging arguments for god; particular attention is paid to refuting contemporary theists such as Plantinga and Swinburne. 541 pages. ISBN 0 87722 642 3 "The Case Against Christianity", Temple University Press A comprehensive critique of Christianity, in which he considers the best contemporary defenses of Christianity and demonstrates that they are unsupportable and/or incoherent. 273 pages. ISBN 0 87722 767 5 JAMES TURNER "Without God, Without Creed", The Johns Hopkins University Press, Baltimore, MD, USA Subtitled "The Origins of Unbelief in America". Examines the way in which unbelief became a mainstream alternative world view. Focuses on the period 1770-1900, and while considering France and Britain the emphasis is on America, and particularly New England developments. "Neither a religious history of secularization or atheism, Without God, Without Creed is, rather, the intellectual history of the fate of a single idea, the belief that God exists." 316 pages. ISBN 0 8018 2494 X 0 8018 3407 4 GEORGE SELDES "The great thoughts", Ballantine Books, New York, USA A "dictionary of quotations" of a different kind, concentrating on statements and writings which, explicitly or implicitly, present the person's philosophy and world view. Includes obscure opinions from many people. For some popular observations, traces the way in which various people expressed and twisted the idea over the centuries. Quite a number of the quotations are derived from Cardiff's "What Great Men Think of Religion" and Noyes' "Views of Religion". 490 pages. ISBN 0 345 29887 X. RICHARD SWINBURNE "The Existence of God", Clarendon Paperbacks, Oxford This book is the second volume in a trilogy that began with "The Coherence of Theism" and was concluded with "Faith and Reason". In this work, Swinburne attempts to construct a series of inductive arguments for the existence of God. His arguments, which are somewhat tendentious and rely upon the imputation of late 20th century western Christian values and aesthetics to a God which is supposedly as simple as can be conceived, were decisively rejected in Mackie's "The Miracle of Theism". In the revised edition of "The Existence of God", Swinburne includes an Appendix in which he makes a somewhat incoherent attempt to rebut Mackie. J. L. MACKIE "The Miracle of Theism", Oxford This volume contains a comprehensive review of the principal arguments for and against the existence of God. It ranges from the classical philosophical positions of Descartes, Anselm, Berkeley, Hume et al, through the moral arguments of Newman, Kant and Sidgwick, to the recent restatements of the classical theses by Plantinga and Swinburne. It also addresses those positions which push the concept of God beyond the realm of the rational, such as those of Kierkegaard, Kung and Philips, as well as "replacements for God" such as Lele's axiarchism. The book is a delight to read - less formalistic and better written than Martin's works, and refreshingly direct when compared with the hand waving of Swinburne. JAMES A. HAUGHT "Holy An Illustrated History of Religious Murder and Madness", Prometheus Books Looks at religious persecution from ancient times to the present day - and not only by Christians. Library of Congress Catalog Card Number 89 64079. 1990. NORM R. ALLEN, JR. "African American an Anthology" See the listing for African Americans for Humanism above. GORDON STEIN "An Anthology of Atheism and Rationalism", Prometheus Books An anthology covering a wide range of subjects, including 'The Devil, Evil and Morality' and 'The History of Freethought'. Comprehensive bibliography. EDMUND D. COHEN "The Mind of The Bible Believer", Prometheus Books A study of why people become Christian fundamentalists, and what effect it has on them.

Net Resources There's a small mail based archive server at mantis.co.uk which carries archives of old alt.atheism.moderated articles and assorted other files. For more information, send mail to saying help send atheism index and it will mail back a reply. mathew y

In []: #Decontractions

```
sample = re.sub(r"won't", "will not", sample)
```

```

sample = re.sub(r"can't", "can not", sample)
sample = re.sub(r"n't", " not", sample)
sample = re.sub(r"\'re", " are", sample)
sample = re.sub(r"\s", " is", sample)
sample = re.sub(r"\d", " would", sample)
sample = re.sub(r"\ll", " will", sample)
sample = re.sub(r"\t", " not", sample)
sample = re.sub(r"\ve", " have", sample)
sample = re.sub(r"\m", " am", sample)
#print(sample)

```

```

In [ ]: #chunking
#references used: https://stackoverflow.com/questions/31836058/nltk-named-entity-recogni
#https://medium.com/towards-data-science/chunking-in-nlp-decoded-b4a71b2b4e24
# pos_tag -> does simple chunking by tagging words with their respective parts of speech
# ne_chunk -> named entity recognition. Identifies names of places, people even if there
#a tree and tags them accordingly. Places are tagged as GPE (geo political entities) and
chunks = nltk.ne_chunk(nltk.pos_tag(nltk.word_tokenize(sample)))
#chunks

```

```

In [ ]: named_entities = []
for tagged_tree in chunks:
    print(tagged_tree)
    if hasattr(tagged_tree, 'label'):
        entity_name = ' '.join(c[0] for c in tagged_tree.leaves())
        entity_type = tagged_tree.label()
        named_entities.append((entity_name, entity_type))
print(named_entities)

```

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        if len(place)>1:
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        sample = re.sub(re.escape(n[0]), "", sample, flags = re.MULTILINE)
print(sample)
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New_England

New_York

Archive atheism resources Alt atheism archive resources Last 11 December 1992 1.0 Atheist Resources Addresses of Atheist Organizations USA FREEDOM FROM RELIGION FOUNDATION fish bumper stickers and assorted other atheist paraphernalia are available from the Freedom From Religion Foundation in the US. 256 8900 EVOLUTION DESIGNS Evolution Designs sell the " fish". It is a fish symbol, like the ones s stick on their cars, but with feet and the word "" written inside. The deluxe moulded 3D plastic fish is \$4.95 postpaid in the US. CA 91605. People in the San Francisco Bay area can get Fish from try mailing . For net people who go to directly, the price is \$4.95 per fish. AMERICAN ATHEIST PRESS AAP publish various atheist books critiques of the Bible, lists of Biblical contradictions, and so on. One such book "The Bible Handbook" by W.P. and G.W. . American Atheist Press. 372 pp. ISBN 0 910309 26 4, 2nd edition, 1986. Bible contradictions, absurdities, atrocities, immoralities... contains , "The Bible Contradicts Itself", AAP. Based on the King version of the Bible. 7215 , Austin, TX 78752 2973. 458 1244 467 9525 PROMETHEUS BOOKS Sell books including is "Holy Horrors" . 837 2475. An alternate address Prometheus Books, 59 , , NY 14228 2197. AFRICAN AMERICANS FOR HUMANISM An organization promoting black secular humanism and uncovering the history of black freethought. They publish a quarterly newsletter, AAH EXAMINER. , NY 14226. United Kingdom Rationalist Press Association National Secular Society 88 St reet 702 Holloway Road London N1 8EW London N19 3 NL 071 226 7251 071 272 1266 British Humanist Association South Place Ethical Society 14 Lamb is Conduit Passage Conway Hall London WC1R 4RH Red Lion Square 071 430 0908 London WC1R 4RL fax 071 430 1271 071 831 7723 The National Secular Society publish "The Freethinker", a monthly magazine founded in 1881. Germany IBKA e.V. Internationaler Bund der Konfessionslosen und nd 880, D 1000 Berlin 41. Germany. IBKA publish a MIZ. MIZ Vertrieb, Postfach 880, D

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Books Non fiction PETER DE ROSA "Vicars of Christ", , 1988 Although de seems to be or even Catholic this is a very enlightening history of papal immoralities, adulteries, fallacies etc. MICHAEL MARTIN "A Philosophical Justification", , Philadelphia, USA. A detailed and scholarly justification of atheism. Contains an outstanding appendix defining terminology and usage in this tendentious area. Argues both for "negative atheism" and also for "positive atheism" . Includes great refutations of the most challenging arguments for god; particular attention is paid to refuting contemporary theists such as and Swinburne. 541 pages. ISBN 0 87722 642 3 "The Case Against it y", A comprehensive critique of ity, in which he considers the best contemporary defences of ity and demonstrates that they are unsupportable and or incoherent. 273 pages. ISBN 0 87722 767 5 JAMES TURNER ", ", The Johns Hopkins University Press, Baltimore, MD, USA Subtitled "The Origins of Unbelief in America". Examines the way in which unbelief became a mainstream alternative world view. Focusses on the period 1770 1900, and while considering France and Britain the emphasis is on American, and particularly New_England developments. "Neither a religious history of secularization or atheism, , is, rather, the intellectual history of the fate of a single idea, the belief that exists."

316 pages. ISBN 0 8018 2494 X 0 8018 3407 4 GEORGE SELDES "The great thoughts", a ntine Books, New_York, USA A "dictionary of quotations" of a different kind, concentrating on statements and writings which, explicitly or implicitly, present the person's philosophy and world view. Includes obscure opinions from many people. For some popular observations, traces the way in which various people expressed and twisted the idea over the centuries. Quite a number of the quotations are derived from Cardiff is "What of Religion" and ' "Views of Religion". 490 pages. ISBN 0 345 29887 X. RICHARD SWINBURNE "The Existence of ", , Oxford This book is the second volume in a trilogy that began with "The Coherence of Theism" and was concluded with " and " . In this work, Swinburne attempts to construct a series of inductive arguments for the existence of . His arguments, which are somewhat tendentious and rely upon the imputation of late 20th century western values and aesthetics to a which is supposedly as simple as can be conceived, were decisively rejected in is "The Miracle of Theism". In the revised edition of "The Existence of ", Swinburne includes an Appendix in which he makes a somewhat incoherent attempt to rebut . J. L. MACKIE "The Miracle of Theism", Oxford This volume contains a comprehensive review of the principal arguments for and against the existence of . It r

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Archive atheism resources Alt atheism archive resources Last December .
Atheist Resources Addresses of Atheist Organizations
USA FREEDOM FROM RELIGION FOUNDATION
fish bumper stickers and assorted other atheist paraphernalia are available from the Freedom From Religion Foundation in the US. EVOLUTION DESIGNS Evolution Designs sell the " fish". It is a fish symbol, like the ones s stick on their cars, but with feet and the word "" written inside. The deluxe moulded D plastic fish is \$. postpaid in the US. CA . People in the San Francisco Bay area can get Fish from t try mailing . For net people who go to directly, the price is \$. per fish. AMERICAN ATHEIST PRESS AAP publish various atheist books critiques of the Bible, lists of Biblical contradictions, and so on. One such book "The Bible Handbook" by W.P. and G.W. . American Atheist Press. pp. ISBN , nd edition, . Bible contradictions, absurdities, atrocities, immoralities... contains , "The Bible Contradicts Itself", AAP. Based on the King version of the Bible. , Austin, TX . PROMETHEUS BOOKS Sell books including is "Holy Horrors" . . An alternate address Prometheus Books, , , NY . AFRICAN AMERICANS FOR HUMANISM An organization promoting black secular humanism and uncovering the history of black freethought. They publish a quarterly newsletter, AAH EXAMINER. , NY . United Kingdom Rationalist Press Association National Secular Society Street Holloway Road London N EW London N NL British Humanist Association South Place Ethical Society Lamb is Conduit Passage Conway Hall London WCR RH Red Lion Square London WCR RL fax T he National Secular Society publish "The Freethinker", a monthly magazine founded in . Germany IBKA e.V. Internationaler Bund der Konfessionslosen und , D Berlin . Germany. IBKA publish a MIZ. MIZ Vertrieb, Postfach , D Berlin . Germany. For atheist books, write IBDK, Internationaler B"ucherdienst der , D Hannover . Germany. Books Fiction THOMAS M. D ISCH "The Claus Compromise" Short story. The ultimate proof that exists. All characters and events are fictitious. Any similarity to living or dead gods uh, well... WALTER M. MILLER, JR "A Canticle for Leibowitz" One gem in this post atomic doomsday novel is the monks who spent their lives copying blueprints from "Saint Leibowitz", filling the sheets of paper with ink and leaving white lines and letters. EDGAR PANGBORN "Davy" Post atomic doomsday novel set in clerical states. The church, for example, forbids that anyone "produce, describe or use any substance containing... atoms". PHILIP K. DICK wrote many philosophical and thought provoking short stories and novels. His stories are bizarre at times, but very approachable. He wrote mainly SF, but he wrote about people, truth and religion rather than technology. Although he often believed that he had met some sort of , he remained sceptical. Amongst his novels, the following are of some "" A fallible alien deity summons a group of craftsmen and women to a remote planet to raise a giant cathedral from beneath the oceans. When the deity begins to demand faith from the earthers, pot healer is unable to comply. A polished, ironic and amusing novel. "A Maze of Death" Noteworthy for its description of a technology based religio

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Net Resources There is a small mail based archive server at mantis.co.uk which carries archives of old alt.atheism.moderated articles and assorted other files. For more information, send mail to saying help send atheism index and it will mail back a reply. mathew y

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In [ ]: #"_word_" (i.e starting and ending with the _), "_word" (i.e starting with the _),
#"word_" (i.e ending with the _) remove the _ from these type of words.

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Archive atheism resources Alt atheism archive resources Last December .

Atheist Resources Addresses of Atheist Organizations

USA FREEDOM FROM RELIGION FOUNDATION

fish bumper stickers and assorted other atheist paraphernalia are available from the Freedom From Religion Foundation in the US. EVOLUTION DESIGNS Evolution Designs sell the " fish". It is a fish symbol, like the ones s stick on their cars, but with fet and the word "" written inside. The deluxe moulded D plastic fish is \$. postpaid in the US. CA . People in the San Francisco Bay area can get Fish from t ry mailing . For net people who go to directly, the price is \$. per fish. AMERICAN AT HEIST PRESS AAP publish various atheist books critiques of the Bible, lists of Bibli cal contradictions, and so on. One such book "The Bible Handbook" by W.P. and G.W. . American Atheist Press. pp. ISBN , nd edition, . Bible contradictions, absurditi es, atrocities, immoralities... contains , "The Bible Contradicts Itself", AAP. Based on the King version of the Bible. , Austin, TX . PROMETHEUS BOOKS Sell books including is "Holy Horrors" . . An alternate address Promethe us Books, , , NY . AFRICAN AMERICANS FOR HUMANISM An organization promoting black se cular humanism and uncovering the history of black freethought. They publish a quarterl y newsletter, AAH EXAMINER. , NY . United Kingdom Rationalist Press Association National Secular Society Street Holloway Road London N EW London N NL

British Humanist Association South Place Ethical Society Lam b is Conduit Passage Conway Hall London WCR RH Red L ion Square London WCR RL fax T

he National Secular Society publish "The Freethinker", a monthly magazine founded in . Germany IBKA e.V. Internationaler Bund der Konfessio nslosen und , D Berlin . Germany. IBKA publish a MIZ. MIZ Vertrieb, Postfach , D B erlin . Germany. For atheist books, write IBDK, Internationaler B"ucherdienst der , D Hannover . Germany. Books Fiction THOMAS M. D ISCH "The Claus Compromise" Short story. The ultimate proof that exists. All charac ters and events are fictitious. Any similarity to living or dead gods uh, well... WALTER M. MILLER, JR "A Canticle for Leibowitz" One gem in this post atomic doomsday no vel is the monks who spent their lives copying blueprints from "Saint Leibowitz", fillin g the sheets of paper with ink and leaving white lines and letters. EDGAR PANGBORN "Da vy" Post atomic doomsday novel set in clerical states. The church, for example, forbids that anyone "produce, describe or use any substance containing... atoms". PHILIP K. DI CK wrote many philosophical and thought provoking short stories and novels. His stor ies are bizarre at times, but very approachable. He wrote mainly SF, but he wrote about people, truth and religion rather than technology. Although he often believed that he h ad met some sort of , he remained sceptical. Amongst his novels, the following are of s ome "" A fallible alien deity summons a group of craftsmen and women to a remote plan et to raise a giant cathedral from beneath the oceans. When the deity begins to demand faith from the earthers, pot healer is unable to comply. A polished, ironic and amusin g novel. "A Maze of Death" Noteworthy for its description of a technology based religio n. "VALIS" The schizophrenic hero searches for the hidden mysteries of Gnostic ity afte r reality is fired into his brain by a pink laser beam of unknown but possibly divine or igin. He is accompanied by his dogmatic and dismissively atheist friend and assorted ot her odd characters. "The Divine Invasion" invades by making a young woman pregnant as she returns from another star system. Unfortunately she is terminally ill, and must be assisted by a dead man whose brain is wired to hour easy listening music. MARGARET ATW OOD "The Handmaid is " A story based on the premise that the US Congress is mysteriously assassinated, and fundamentalists quickly take charge of the nation to set it "right" again. The book is the diary of a woman is life as she tries to live under the new the ocracy. Women is right to own property is revoked, and their bank accounts are closed; sinful luxuries are outlawed, and the radio is only used for readings from the Bible. C rimes are punished doctors who performed legal abortions in the "old world" are hunted down and hanged. is writing style is difficult to get used to at first, but the tale g

rows more and more chilling as it goes on. VARIOUS AUTHORS "The Bible" This somewhat dull and rambling work has often been criticized. However, it is probably worth reading, if only so that you will know what all the fuss is about. It exists in many different versions, so make sure you get the one true version. Books

Non fiction PETER DE ROSA "Vicars of Christ", , Although de seems to be or even Catholic this is a very enlightening history of papal immoralities, adulteries, fallacies etc. MICHAEL MARTIN "A Philosophical Justification", , Philadelphia, USA. A detailed and scholarly justification of atheism. Contains an outstanding appendix defining terminology and usage in this tendentious area. Argues both for "negative atheism" and also for "positive atheism". Includes great refutations of the most challenging arguments for god; particular attention is paid to refuting contemporary theists such as and Swinburne. pages. ISBN "The Case Against ity", A comprehensive critique of ity, in which he considers the best contemporary defences of ity and demonstrates that they are unsupportable and or incoherent. pages. ISBN JAMES TURNER ", ", The Johns Hopkins University Press, Baltimore, MD, USA Subtitled "The Origins of Unbelief in America". Examines the way in which unbelief became a mainstream alternative world view. Focuses on the period , and while considering France and Britain the emphasis is on American, and particularly New_England developments. "Neither a religious history of secularization or atheism, , is, rather, the intellectual history of the fate of a single idea, the belief that exists." pages. ISBN X GEORGE SELDES "The great thoughts", antique Books, New_York, USA A "dictionary of quotations" of a different kind, concentrating on statements and writings which, explicitly or implicitly, present the person is philosophy and world view. Includes obscure opinions from many people. For some popular observations, traces the way in which various people expressed and twisted the idea over the centuries. Quite a number of the quotations are derived from Cardiff is "What of Religion" and ' "Views of Religion". pages. ISBN X. RICHARD SWINBURNE "The Existence of ", , Oxford This book is the second volume in a trilogy that began with "The Coherence of Theism" and was concluded with " and ". In this work, Swinburne attempts to construct a series of inductive arguments for the existence of . His arguments, which are somewhat tendentious and rely upon the imputation of late th century western values and aesthetics to a which is supposedly as simple as can be conceived, were decisively rejected in is "The Miracle of Theism". In the revised edition of "The Existence of ", Swinburne includes an Appendix in which he makes a somewhat incoherent attempt to rebut . J. L. MACKIE "The Miracle of Theism", Oxford This volume contains a comprehensive review of the principal arguments for and against the existence of . It ranges from the classical philosophical positions of Descartes, Anselm, , et al, through the moral arguments of Newman, Kant and , to the recent restatements of the classical theses by and Swinburne. It also addresses those positions which push the concept of beyond the realm of the rational, such as those of Kierkegaard, and , as well as "replacements for " such as is axiarchism. The book is a delight to read less formalistic and better written than is works, and refreshingly direct when compared with the hand waving of Swinburne. HAUGHT "Holy An Illustrated History of Religious Murder and Madness", Prometheus Books Looks at religious persecution from ancient times to the present day and not only by s. Library of Congress Catalog Card Number . . NORM R. ALLEN, JR. "African American an Anthology" See the listing for African Americans for Humanism above. GORDON STEIN "An Anthology of Atheism and Rationalism", Prometheus Books An anthology covering a wide range of subjects, including 'The Devil, and Morality' and 'The History of Freethought'. Comprehensive bibliography. EDMUND D. COHEN "The Mind of The Bible Believer", Prometheus Books A study of why people become fundamentalists, and what effect it has on them.

Net Resources There is a small mail based archive server at mantis.co.uk which carries archives of old alt.atheism.moderated articles and assorted other files. For more information, send mail to saying help send atheism index and it will mail back a reply. mathew y

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In [ ]: #removing 1 or 2 letter words before _ in words in _
sample = re.sub(r"\b[a-zA-Z]{1}_([a-zA-Z]+)",r"\1",sample)
sample = re.sub(r"\b[a-zA-Z]{2}_([a-zA-Z]+)",r"\1",sample)

#removing words with more than 15 alphabets and less than 2 alphabets
sample = re.sub(r"\b\w{1,2}\b","",sample)
sample = re.sub(r"\b\w{15,}\b","",sample)

#converting all characters in the doc to lower case
sample = sample.lower()
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#removing all non A-Za-z_ characters from the doc
sample = re.sub(r"[^A-Za-z_]", " ", sample)
print(sample)
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 novels his stories are bizarre times but very approachable wrote mainly but wro
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 old alt atheism moderated articles and assorted other files for more information send
 mail saying help send atheism index and will mail back reply mathew

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In [ ]: #replacing extra spaces i.e more than a single space between words with a single space
buff = re.sub(r" {2,}", " ", sample)
print(buff)

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doomsday novel the monks who spent their lives copying blueprints from saint leibowitz filling the sheets paper with ink and leaving white lines and letters edgar pangborn davy post atomic doomsday novel set clerical states the church for example forbids that anyone produce describe use any substance containing atoms philip dick wrote many philosophical and thought provoking short stories and novels his stories are bizarre times but very approachable wrote mainly but wrote about people truth and religion rather than technology although often believed that had met some sort remained sceptical amongst his novels the following are some fallible alien deity summons group craftsmen and women remote planet raise giant cathedral from beneath the oceans when the deity begins demand faith from the earthers pot healer unable comply polished ironic and amusing novel maze death noteworthy for its description technology based religion valis the schizophrenic hero searches for the hidden mysteries gnosticism after reality fired into his brain pink laser beam unknown but possibly divine origin accompanied his dogmatic and dismissively atheist friend and assorted other odd characters the divine invasion invades making young woman pregnant she returns from another star system unfortunately she terminally ill and must assisted dead man whose brain wired hour easy listening music margaret atwood the handmaid story based the premise that the congress mysteriously assassinated and quickly take charge the nation set right again the book the diary woman life she tries live under the new theocracy women right own property revoked and their bank accounts are closed sinful luxuries are outlawed and the radio only used for readings from the bible crimes are punished doctors who performed legal abortions the old world are hunted down and hanged writing style difficult get used first but the tale grows more and more chilling goes various authors the bible this somewhat dull and rambling work has often been criticized however probably worth reading only that you will know what all the fuss about exists many different versions make sure you get the one true version books non fiction peter rosa vi cars christ although seems even catholic this very enlightening history papal immoralities adulteries fallacies etc michael martin philosophical justification philadelphia usa detailed and scholarly justification atheism contains outstanding appendix defining terminology and usage this tendentious area argues both for negative atheism and also for positive atheism includes great refutations the most challenging arguments for god particular attention paid refuting contemporary theists such as swinburne pages isbn the case against its comprehensive critique its which considers the best contemporary defences its and demonstrates that they are unsupportable and incoherent pages isbn james turner the johns hopkins university press baltimore usa subtitled the origins unbelief america examines the way which unbelief became mainstream alternative world view focusses the period and while considering france and britain the emphasis american and particularly new england developments neither religious history secularization atheism rather the intellectual history the fate single idea the belief that exists pages isbn george selde the great thoughts antine books new york usa dictionary quotations different kind concentrating statements and writings which explicitly implicitly present the person philosophy and world view includes obscure opinions from many people for some popular observations traces the way which various people expressed and twisted the idea over the centuries quite number the quotations are derived from cardiff what religion and views religion pages isbn richard swinburne the existence oxford this book the second volume trilogy that began with the coherence theism and was concluded with and this work swinburne attempts construct series inductive arguments for the existence his arguments which are somewhat tendentious and rely upon the imputation late century western values and aesthetics which supposedly simple can conceived were decisively rejected the miracle theism the revised edition the existence swinburne includes appendix which makes somewhat incoherent attempt rebut mackie the miracle theism oxford this volume contains comprehensive review the principal arguments for and against the existence ranges from the classical philosophical positions descartes anselm through the moral arguments newman kant and the recent restatements the classical theses and swinburne also addresses those positions which push the concept beyond the realm the rational such as those kierkegaard and well replacements for such axiarchism the book delight read less formalistic and better written than works and refreshingly direct when compared with the hand waving swinburne haught holy illustrated history religious murder and madness prometheus books looks religious persecution from ancient times the present day and not only library congress catalog card number norm allen african american anthology see the listing for african americans for humanism above gordon stein anthology atheism and rationalism prometheus books anthology covering wide range subjects including the devil and morality and the history freethought comprehensive bibliography edmund cohen the mind the bible believer prometheus books study why people become and what effect has them net resources there small mail based archive server mantis which carries archives old alt atheism moderated articles and assorted other files for more information send mail saying help send atheism index and will mail back reply mathew


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In [ ]: def preprocess(sample):
    """Do all the Preprocessing as shown above and
    return a tuple contain preprocess_email, preprocess_subject, preprocess_text for that
    #getting emails from text:

    email_list = []
    st = []

    for i in re.findall(r'[\w\-\.\.]+\@[\w\-\.\.]+\b', sample): #extracting email
        temp=[]
        temp = i.split('@')[1] #taking text after @
        temp = temp.split('.') #a list containing words split by "."
        if 'com' in temp:
            temp.remove('com')
        for i in temp: #removing words less than 3
            if len(i)>2:
                email_list.append(i)
    for i in email_list: #joining all the words in a string
        st+=i
        st+=' '
    sample = re.sub(r'[\w\-\.\.]+\@[\w\-\.\.]+\b', ' ', sample) #removing the email

    mails = ' '.join(email_list)

    #subject extraction and preprocessing

    x = re.findall('^Subject.*', sample, re.MULTILINE) #finding the subject text consider
    x = x[0].split(':')[0]

    for i in string.punctuation: #string.punctuation returns all punctuations as a string
        x = x.replace(i, '')
        x = x.lower()

    subject = x

    sample = re.sub(r'Subject.*$', " ", sample, flags=re.MULTILINE) #replacing original text

    #removing sentences with 'Write to:' and 'From: '
    sample = re.sub(r'Write to:.*$', " ", sample, flags = re.MULTILINE) #use double quote
    sample = re.sub(r'From:.*$', " ", sample, flags = re.MULTILINE)

    #Deleting tags and data in bracket.
    #sample = re.sub(r"<.*>$", "", sample, flags = re.MULTILINE)
    #sample = re.sub(r"(.*)$", "", sample, flags = re.MULTILINE)
    #simple regex like the ones above don't work.
    #reference:- https://stackoverflow.com/questions/4894069/regular-expression-to-remove
    sample = re.sub(r"<.*?>", "", sample, flags = re.MULTILINE)
    sample = re.sub(r"\(.*?\)", "", sample, flags = re.MULTILINE)

    #removing newlines, tabs, '-' and '/'
    sample = re.sub(r"[\n\t\-\\/]", " ", sample, flags=re.MULTILINE)
    #removing multiline text within brackets
    sample = re.sub(r"\(.*?\)", "", sample, flags = re.MULTILINE)
    #Removing all words that end with :
    sample = re.sub(r"[A-Za-z]*:", " ", sample, flags = re.MULTILINE)
    #Decontractions

    sample = re.sub(r"won't", "will not", sample)
    sample = re.sub(r"can't", "can not", sample)
    sample = re.sub(r"n't", " not", sample)
    sample = re.sub(r"\ 're", " are", sample)
    sample = re.sub(r"\ 's", " is", sample)
    sample = re.sub(r"\ 'd", " would", sample)
    sample = re.sub(r"\ 'll", " will", sample)
    sample = re.sub(r"\ 't", " not", sample)

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sample = re.sub(r'\ve', " have", sample)
sample = re.sub(r'\m', " am", sample)
#chunking
#references used: https://stackoverflow.com/questions/31836058/nltk-named-entity-rec
#https://medium.com/towards-data-science/chunking-in-nlp-decoded-b4a71b2b4e24
# pos_tag -> does simple chunking by tagging words with their respective parts of sp
# ne_chunk -> named entity recognition. Identifies names of places, people even if t
#a tree and tags them accordingly. Places are tagged as GPE (geo political entities)
chunks = nltk.ne_chunk(nltk.pos_tag(nltk.word_tokenize(sample)))
named_entities = []
for tagged_tree in chunks:
    #print(tagged_tree)
    if hasattr(tagged_tree, 'label'):
        entity_name = ' '.join(c[0] for c in tagged_tree.leaves())
        entity_type = tagged_tree.label()
        named_entities.append((entity_name, entity_type))

#Removing names of people and joining words in names of places with a '_'
for n in named_entities:
    if n[1] == 'GPE':
        place = n[0].split()
        if len(place)>1:
            new_place = '_'.join(place)
            #print(new_place)
            sample = re.sub(re.escape(n[0]), new_place, sample, flags = re.MULTILINE)
    if n[1] == 'PERSON':
        sample = re.sub(re.escape(n[0]), "", sample, flags = re.MULTILINE)

#removing digits from the doc
sample = re.sub(r'\d', "", sample, flags = re.MULTILINE)

#"_word_" (i.e starting and ending with the _), "_word" (i.e starting with the _),
#"word_" (i.e ending with the _) remove the _ from these type of words.

sample = re.sub(r"\b_([a-zA-Z]+)_\b", r"\1", sample) #to replace _word_ to word

sample = re.sub(r"\b_([a-zA-Z]+)\b", r"\1", sample) #to replace _word to word
sample = re.sub(r"\b([a-zA-Z]+)_\b", r"\1", sample) #to replace word_ to word
#removing 1 or 2 letter words before _ in words in _
sample = re.sub(r"\b[a-zA-Z]{1}_([a-zA-Z]+)", r"\1", sample)
sample = re.sub(r"\b[a-zA-Z]{2}_([a-zA-Z]+)", r"\1", sample)

#removing words with more than 15 alphabets and less than 2 alphabets
sample = re.sub(r"\b\w{1,2}\b", "", sample)
sample = re.sub(r"\b\w{15,}\b", "", sample)

#converting all characters in the doc to lower case
sample = sample.lower()

#removing all non A-Za-z_ characters from the doc
sample = re.sub(r"[^A-Za-z_]", " ", sample)

#replacing extra spaces i.e more than a single space between words with a single spa
text = re.sub(r" {2,}", " ", sample)

return (mails, subject, text)

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In [ ]: file = open(path+list_of_files[0], 'r+')
sample = file.read()
#print(sample)
file.close()

m,s,t = preprocess(sample)
print(m)
print('*'*100)

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print(s)
print(' '*100)
print(t)
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mantis netcom mantis

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doomsday novel the monks who spent their lives copying blueprints from saint leibowitz f
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post atomic doomsday novel set clerical states the church for example forbids that anyon
e produce describe use any substance containing atoms philip dick wrote many philosophic
al and thought provoking short stories and novels his stories are bizarre times but very
approachable wrote mainly but wrote about people truth and religion rather than technolo
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friend and assorted other odd characters the divine invasion invades making young woman
pregnant she returns from another star system unfortunately she terminally ill and must
assisted dead man whose brain wired hour easy listening music margaret atwood the handma
id story based the premise that the congress mysteriously assassinated and quickly take
charge the nation set right again the book the diary woman life she tries live under the
new theocracy women right own property revoked and their bank accounts are closed sinful
luxuries are outlawed and the radio only used for readings from the bible crimes are pun
ished doctors who performed legal abortions the old world are hunted down and hanged wri
ting style difficult get used first but the tale grows more and more chilling goes vario
us authors the bible this somewhat dull and rambling work has often been criticized howe
ver probably worth reading only that you will know what all the fuss about exists many d
ifferent versions make sure you get the one true version books non fiction peter rosa vi
cars christ although seems even catholic this very enlightening history papal immoralities
adulteries fallacies etc michael martin philosophical justification philadelphia usa det
ailed and scholarly justification atheism contains outstanding appendix defining termino
logy and usage this tendentious area argues both for negative atheism and also for posit
ive atheism includes great refutations the most challenging arguments for god particular
attention paid refuting contemporary theists such and swinburne pages isbn the case agains
t ity comprehensive critique ity which considers the best contemporary defences ity and
demonstrates that they are unsupportable and incoherent pages isbn james turner the john
s hopkins university press baltimore usa subtitled the origins unbelief america examines
the way which unbelief became mainstream alternative world view focusses the period and
```

while considering france and britain the emphasis is american and particularly new_england developments neither religious history secularization atheism rather the intellectual history the fate single idea the belief that exists pages isbn george selde the great thoughts antine books new_york usa dictionary quotations different kind concentrating statements and writings which explicitly implicitly present the person philosophy and world view includes obscure opinions from many people for some popular observations traces the way which various people expressed and twisted the idea over the centuries quite number the quotations are derived from cardiff what religion and views religion pages isbn richard swinburne the existence oxford this book the second volume trilogy that began with the coherence theism and was concluded with and this work swinburne attempts construct series inductive arguments for the existence his arguments which are somewhat tendentious and rely upon the imputation late century western values and aesthetics which supposedly simple can conceived were decisively rejected the miracle theism the revised edition the existence swinburne includes appendix which makes somewhat incoherent attempt rebut mackie the miracle theism oxford this volume contains comprehensive review the principal arguments for and against the existence ranges from the classical philosophical positions descartes anselm through the moral arguments newman kant and the recent restatements the classical theses and swinburne also addresses those positions which push the concept beyond the realm the rational such those kierkegaard and well replacements for such axiarchism the book delight read less formalistic and better written than works and refreshingly direct when compared with the hand waving swinburne haught holy illustrated history religious murder and madness prometheus books looks religious persecution from ancient times the present day and not only library congress catalog card number norm allen african american anthology see the listing for african americans for humanism above gordon stein anthology atheism and rationalism prometheus books anthology covering wide range subjects including the devil and morality and the history freethought comprehensive bibliography edmund cohen the mind the bible believer prometheus books study why people become and what effect has them net resources there small mail based archive server mantis which carries archives old alt atheism moderated articles and assorted other files for more information send mail saying help send atheism index and will mail back reply mathew

```
In [ ]: #creating a dataframe with label, doc_no, pre_emails, pre_subject, pre_text
```

```
label = []
doc_no = []
pre_emails = []
pre_subject = []
pre_text = []
for doc in list_of_files:
    file_name = doc.split('_')
    label.append(file_name[0])
    doc_no.append(file_name[1].split('.')[0])
    file = open(path+doc, 'r+')
    sample = file.read()
    file.close()
    e, s, t = preprocess(sample)
    pre_emails.append(e)
    pre_subject.append(s)
    pre_text.append(t)

print(len(label))
print(len(doc_no))
print(len(pre_emails))
print(len(pre_subject))
print(len(pre_text))
```

```
18828
18828
18828
18828
18828
```

```
In [ ]: #The above snippet took close to 15 mins to execute.
```

```
#Creating a dataframe using the 5 lists created above
data= pd.DataFrame(np.column_stack([label, doc_no, pre_emails, pre_subject, pre_text]),
```

```
columns = ['label', 'doc_no', 'pre_emails', 'pre_subject', 'pre_text']
data.head()
```

	label	doc_no	pre_emails	pre_subject	pre_text
0	alt.atheism	49960	mantis netcom mantis	atheist resources	archive atheism resources alt atheism archive...
1	alt.atheism	51060	mantis mantis mantis	introduction to atheism	archive atheism introduction alt atheism arch...
2	alt.atheism	51119	dbstu1 tu-bs mimsy umd edu umd edu	gospel dating	article well has quite different not necessar...
3	alt.atheism	51120	mantis kepler unh edu	university violating separation of churchstate	recently ras have been ordered post religious...
4	alt.atheism	51121	Watson lbm Com harder ccr-p ida org harder ccr...	socmotss et al princeton axes matching funds ...	article however hate economic terrorism and p...

```
In [ ]: #saving the dataframe with preprocessed data as .csv file
path1 = os.getcwd()
data.to_csv(path1+'\\preprocessed_data.csv', index = False)
```

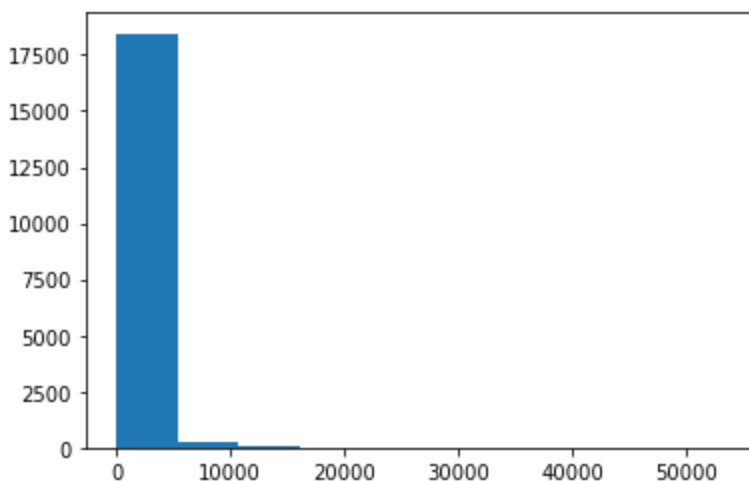
Code checking:

After Writing preprocess function. call that functoin with the input text of 'alt.atheism_49960' doc and print the output of the preprocess function
This will help us to evaluate faster, based on the output we can suggest you if there are any changes.

```
In [ ]: import matplotlib.pyplot as plt
lengths = data['pre_text'].str.len()
print("Maximum: ",max(lengths))
print("Minimum: ",min(lengths))
plt.hist(lengths.values)
```

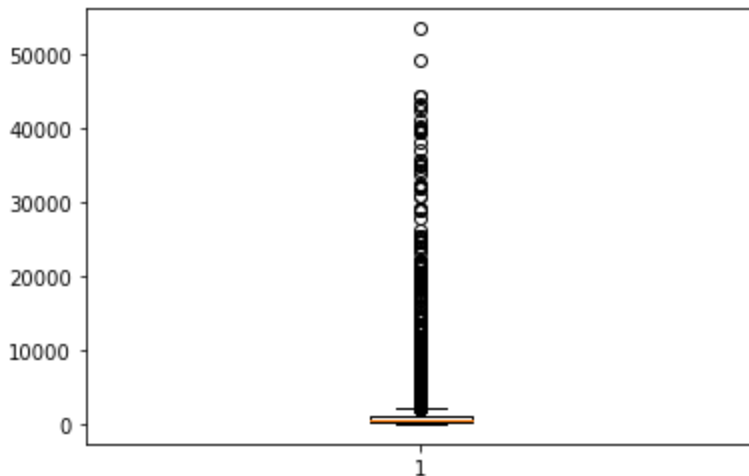
```
Maximum: 53450
Minimum: 1
```

```
Out [ ]: (array([1.8455e+04, 2.4600e+02, 4.8000e+01, 2.5000e+01, 1.9000e+01,
        9.0000e+00, 1.1000e+01, 9.0000e+00, 4.0000e+00, 2.0000e+00]),
array([1.00000e+00, 5.34590e+03, 1.06908e+04, 1.60357e+04, 2.13806e+04,
        2.67255e+04, 3.20704e+04, 3.74153e+04, 4.27602e+04, 4.81051e+04,
        5.34500e+04]),
<BarContainer object of 10 artists>)
```



```
In [ ]: plt.boxplot(lengths.values)
```

```
Out[ ]: {'whiskers': [<matplotlib.lines.Line2D at 0x180beb7ceb0>,  
  <matplotlib.lines.Line2D at 0x180beb931c0>],  
  'caps': [<matplotlib.lines.Line2D at 0x180beb93550>,  
  <matplotlib.lines.Line2D at 0x180beb93760>],  
  'boxes': [<matplotlib.lines.Line2D at 0x180beb91ac0>],  
  'medians': [<matplotlib.lines.Line2D at 0x180beb93a60>],  
  'fliers': [<matplotlib.lines.Line2D at 0x180beb93d30>],  
  'means': []}
```



```
In [ ]: lengths.describe()
```

```
Out[ ]: count      18828.000000  
mean         1054.327119  
std          2223.180300  
min           1.000000  
25%           328.000000  
50%           590.000000  
75%          1071.000000  
max          53450.000000  
Name: pre_text, dtype: float64
```

```
In [ ]: print('Mean: ',np.mean(lengths))
```

```
Mean:  1054.3271191841939
```

```
In [ ]: print('Median: ',np.median(lengths))
```

```
Median:  590.0
```

```
In [ ]: np.argmin(lengths)
```

```
Out[ ]: 683
```

```
In [ ]: data.iloc[683,:]
```

```
Out[ ]: label      alt.atheism  
doc_no          53806  
pre_emails  
pre_subject      atheism  
pre_text  
Name: 683, dtype: object
```

```
In [ ]: f = open(path+str(data.iloc[683,:]['label'])+'_'+str(data.iloc[683,:]['doc_no'])+'.txt',  
  print(f.read())  
  f.close()
```

```
From: Edwin Gans  
Subject: Atheism
```

```
In [ ]: #combining text, subject and email into one column in python.
df = data
#df.head()
df = df[['pre_emails','pre_subject', 'pre_text']].apply(lambda x: x.str.strip(), axis =
#df.head()
comb = df[['pre_text','pre_emails','pre_subject']].apply(lambda x: ' '.join(x.values), a
combined_data = data.iloc[:, :2]
combined_data['combined_text'] = comb
combined_data.head()
```

```
Out[ ]:
```

	label	doc_no	combined_text
0	alt.atheism	49960	archive atheism resources alt atheism archive ...
1	alt.atheism	51060	archive atheism introduction alt atheism archi...
2	alt.atheism	51119	article well has quite different not necessari...
3	alt.atheism	51120	recently ras have been ordered post religious ...
4	alt.atheism	51121	article however hate economic terrorism and po...

```
In [ ]: #exporting the above combined text dataframe as a csv file for modelling using colab.
combined_data.to_csv(path1+'\\combined_preprocessed_data.csv', index = False)
```

```
In [ ]: lengths1 = data['pre_text'].str.len()
lengths1.describe()
```

```
Out[ ]: count    18828.000000
mean       1054.327119
std        2223.180300
min         1.000000
25%        328.000000
50%        590.000000
75%       1071.000000
max       53450.000000
Name: pre_text, dtype: float64
```

```
In [ ]: lengths1.quantile(0.9)
```

```
Out[ ]: 1962.0
```

```
In [ ]: lengths1.quantile(0.95)
```

```
Out[ ]: 3020.2999999999956
```

```
In [ ]: lengths1.quantile(0.99)
```

```
Out[ ]: 8117.2699999999957
```

After writing Preprocess function, call the function for each of the document(18828 docs) and then create a dataframe as mentioned above.

Training The models to Classify:

1. Combine "preprocessed_text", "preprocessed_subject", "preprocessed_emails" into one column. use that column to model.

2. Now Split the data into Train and test. use 25% for test also do a stratify split.
3. Analyze your text data and pad the sequence if required.
Sequence length is not restricted, you can use anything of your choice.
you need to give the reasoning
4. Do Tokenizer i.e convert text into numbers. please be careful while doing it.
if you are using tf.keras "Tokenizer" API, it removes the "_", but we need that.
5. code the model's (Model-1, Model-2) as discussed below
and try to optimize that models.
6. For every model use predefined Glove vectors.
Don't train any word vectors while Training the model.
7. Use "categorical_crossentropy" as Loss.
8. Use **Accuracy and Micro Averaged F1 score** as your as Key metrics to evaluate your model.
9. Use Tensorboard to plot the loss and Metrics based on the epoches.
10. Please save your best model weights in to '**best_model_L.h5**' (L = 1 or 2).
11. You are free to choose any Activation function, learning rate, optimizer.
But have to use the same architecture which we are giving below.
12. You can add some layer to our architecture but you **deletion** of layer is not acceptable.
13. Try to use **Early Stopping** technique or any of the callback techniques that you did in the previous assignments.
14. For Every model save your model to image (Plot the model) with shapes and include those images in the notebook markdown cell,
upload those images to Classroom. You can use "plot_model"
please refer [this](#) if you don't know how to plot the model with shapes.

Model-1: Using 1D convolutions with word embeddings

Encoding of the Text --> For a given text data create a Matrix with Embedding layer as shown Below.

In the example we have considered $d = 5$, but in this assignment we will get $d =$ dimension of Word vectors we are using.

i.e if we have maximum of 350 words in a sentence and embedding of 300 dim word vector,

we result in 350×300 dimensional matrix for each sentence as output after embedding layer

I
like
this
movie
very
much
!

0.6	0.5	0.2	-0.1	0.4
0.8	0.9	0.1	0.5	0.1
0.4	0.6	0.1	-0.1	0.7
...
...
...
...

Ref: <https://i.imgur.com/kiVQuk1.png>

Reference:

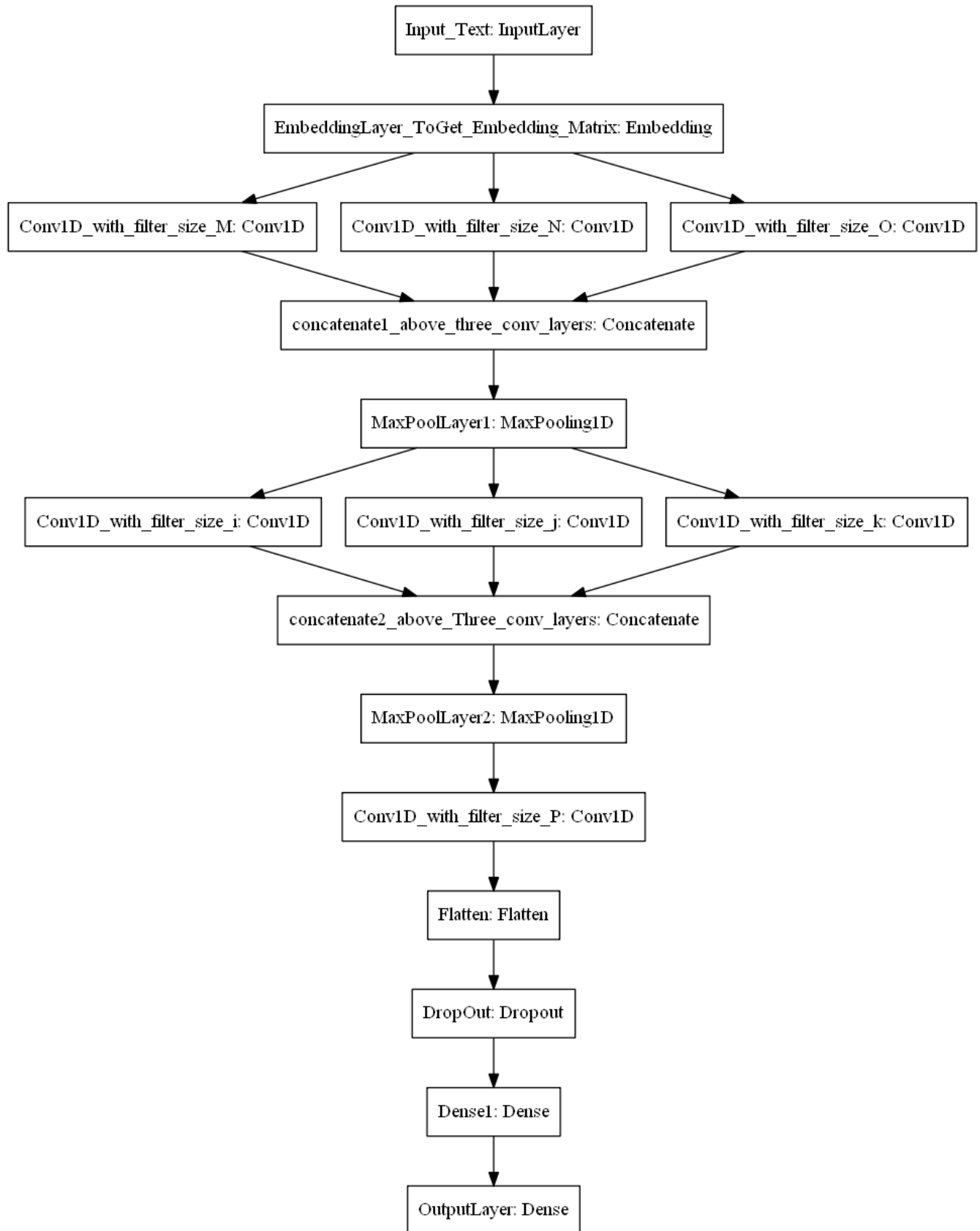
<https://stackoverflow.com/a/43399308/4084039>

<https://missinglink.ai/guides/keras/keras-conv1d-working-1d-convolutional-neural-networks-keras/>

How EMBEDDING LAYER WORKS

Go through this blog, if you have any doubt on using predefined Embedding values in Embedding layer -

<https://machinelearningmastery.com/use-word-embedding-layers-deep-learning-keras/>



ref: '<https://i.imgur.com/fv1GvFJ.png>'

1. all are Conv1D layers with any number of filter and filter sizes, there is no restriction on this.
2. use concatenate layer is to concatenate all the filters/channels.
3. You can use any pool size and stride for maxpooling layer.

4. Don't use more than 16 filters in one Conv layer because it will increase the no of params.
(Only recommendation if you have less computing power)

5. You can use any number of layers after the Flatten Layer.

```
In [2]: from google.colab import files
file = files.upload()
```

No file chosen

Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.

Saving combined_preprocessed_data.csv to combined_preprocessed_data.csv

```
In [3]: data = pd.read_csv('combined_preprocessed_data.csv')
data.head()
```

```
Out[3]:
```

	label	doc_no	combined_text
0	alt.atheism	49960	archive atheism resources alt atheism archive ...
1	alt.atheism	51060	archive atheism introduction alt atheism archi...
2	alt.atheism	51119	article well has quite different not necessari...
3	alt.atheism	51120	recently ras have been ordered post religious ...
4	alt.atheism	51121	article however hate economic terrorism and po...

```
In [6]: X = data[['doc_no', 'combined_text']]
y = data[['label', 'label_coded']]
```

factorize() function is added because tf.keras.utils.to_categorical accepts only integer or float values.

```
In [5]: data['label_coded'] = data['label'].factorize()[0]
```

```
In [7]: from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.25, stratify = y)
```

```
In [ ]: lengths = X_train['combined_text'].str.len()
lengths.describe()
```

```
Out[ ]: count    14121.000000
mean       1129.288648
std        2264.177797
min         13.000000
25%        389.000000
50%        663.000000
75%       1147.000000
max       53639.000000
Name: combined_text, dtype: float64
```

```
In [ ]: lengths.quantile(0.9)
```

```
Out[ ]: 2069.0
```

```
In [ ]: lengths.quantile(0.95)
```

```
Out[ ]: 3128.0
```

```
In [ ]: lengths.quantile(0.99)
```

```
Out[ ]: 8194.799999999998
```

Appropriate value for padding can be the 90th percentile value. We can try restricting the length of the input texts to this value. There are huge variations in the last 10th percentile. With the maximum value being 53639.

```
In [ ]: import tensorflow as tf
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences

filters_ = '!"#$%&()*+,-./:;<=>?@[\\]^`{|}~\t\n' # <= removed '_' to prevent tokenizer
my_tokenizer = Tokenizer(filters=filters_)

my_tokenizer.fit_on_texts(X_train['combined_text'])
sequences_train = my_tokenizer.texts_to_sequences(X_train['combined_text'])
padded_train = pad_sequences(sequences_train, padding = 'post', truncating = 'pre', maxlen
```

```
In [ ]: sequences_test = my_tokenizer.texts_to_sequences(X_test['combined_text'])
padded_test = pad_sequences(sequences_test, padding = 'post', truncating = 'pre', maxlen
```

```
In [ ]: print(len(padded_train))
padded_train
```

```
Out[ ]: 14121
array([[ 26,    26,    18, ...,    0,    0,    0],
       [ 26,  1088,     2, ...,    0,    0,    0],
       [ 26, 33783,   604, ...,    0,    0,    0],
       ...,
       [ 34, 21496,    94, ...,    0,    0,    0],
       [ 26,   579, 19201, ...,    0,    0,    0],
       [ 623,   858,     1, ...,   533,   936, 31408]], dtype=int32)
```

```
In [ ]: import pickle

with open('tokenizer_output.p', 'wb') as fp:
    pickle.dump(my_tokenizer.word_index, fp, protocol=pickle.HIGHEST_PROTOCOL)
```

```
In [ ]: os.getcwd()
```

```
Out[ ]: '/content'
```

```
In [ ]: import pickle
with open('tokenizer_output.p', 'rb') as fp:
    tokenz = pickle.load(fp)
    print(type(tokenz))
    fp.close()
```

```
<class 'dict'>
```

```
In [ ]: #in Jupyter to create the weight matrix and save it for later loading and processing in
def load_embedding(filename,encoding):
    file = open(filename,'r',encoding=encoding)
    lines = file.readlines()[1:]
    file.close()
    embedding = dict()
    for line in lines:
        parts = line.split()
        embedding[parts[0]] = np.asarray(parts[1:], dtype='float32')
    return embedding
```

```
In [ ]: vocab_size = len(tokenz)+1
raw_embedding = load_embedding('glove.6B.300d.txt','utf8')
```

```
weight_matrix = np.zeros((vocab_size, 300))
for word,i in tokenz.items():
    if word in raw_embedding:
        weight_matrix[i] = raw_embedding[word]
```

```
In [ ]: with open('embed_wt_matrix.p', 'wb') as fp:
        pickle.dump(weight_matrix, fp, protocol=pickle.HIGHEST_PROTOCOL)
        fp.close()
```

```
In [ ]: from pydrive.auth import GoogleAuth
        from pydrive.drive import GoogleDrive
        from google.colab import auth
        from oauth2client.client import GoogleCredentials
```

```
In [ ]: auth.authenticate_user()
        gauth = GoogleAuth()
        gauth.credentials = GoogleCredentials.get_application_default()
        drive = GoogleDrive(gauth)
```

```
In [ ]: from google.colab import drive
        drive.mount('/content/drive')
```

Mounted at /content/drive

```
In [ ]: !pip3 install pickle5
        import pickle5 as pickle
        with open('/content/drive/MyDrive/embed_wt_matrix.p', 'rb') as fp:
            weight_matrix = pickle.load(fp)
            print(type(weight_matrix))
            fp.close()
```

Looking in indexes: <https://pypi.org/simple>, <https://us-python.pkg.dev/colab-wheels/public/simple/>

Collecting pickle5

Downloading pickle5-0.0.12-cp37-cp37m-manylinux_2_5_x86_64.manylinux1_x86_64.whl (256 kB)

|██| 256 kB 32.5 MB/s

Installing collected packages: pickle5

Successfully installed pickle5-0.0.12

<class 'numpy.ndarray'>

```
In [10]: import tensorflow as tf
        from tensorflow.keras.layers import Embedding, Dense, Input, Flatten, Conv1D, MaxPooling
        from tensorflow.keras.models import Model
```

```
In [ ]: no_of_words = len(my_tokenizer.word_index.items())
```

```
In [ ]: len(y_train.unique())
```

```
Out[ ]: 20
```

```
In [ ]: len(y_test.unique())
```

```
Out[ ]: 20
```

```
In [11]: y_train_coded = tf.keras.utils.to_categorical(np.asarray(y_train['label_coded']), num_classes)
        y_test_coded = tf.keras.utils.to_categorical(np.asarray(y_test['label_coded']), num_classes)
```

```
In [ ]: padded_train[0].shape
```

```
Out[ ]: (2069,)
```

```
In [12]: class custom_callback(tf.keras.callbacks.Callback):
    """
    This class is defined to define our own custom callbacks to that has to print the micr
    after each epoch.
    """
    def __init__(self, validation_data):
        self.x_test = validation_data[0]
        self.y_test = validation_data[1]

    def on_train_begin(self, logs ={}):
        # We are creating an instance variable history dictionary and initializing it.
        self.history = {'loss':[], 'accuracy':[], 'val_loss':[], 'val_acc':[], 'f1 score':[]}

    def on_epoch_end(self, epoch, logs={}):
        #Getting the loss and checking if it is nan. If it is nan we terminate the training.
        l = logs.get('loss')
        if l is not None:
            if np.isnan(l) or np.isinf(l):
                print('Invalid Training Loss. Training terminated at epoch ',epoch)
                self.model.stop_training = True
            #Getting the weights and checking if it is nan. If it is nan we terminate the traini
            wts = self.model.get_weights()
            if wts is not None:
                if np.any([np.any(np.isnan(i)) for i in wts]):
                    print('Invalid Weights. Training terminated at epoch ',epoch)
                    self.model.stop_training = True

            self.history['loss'].append(l)
            #Getting accuracy, val_loss, and val_accuracy from the logs and storing in our histo
            self.history['accuracy'].append(logs.get('accuracy'))
            if logs.get('val_loss', -1) != -1:
                self.history['val_loss'].append(logs.get('val_loss'))
            if logs.get('val_accuracy', -1) != -1:
                self.history['val_acc'].append(logs.get('val_accuracy'))
```

```
In [ ]: #FunctionalAPI -> Model 1
embedding_layer = Embedding(no_of_words+1, 300, weights = [weight_matrix], input_length
                             trainable = False )
input_layer = Input(shape = (2069,), dtype = 'int32' )
embedded_input = embedding_layer(input_layer)
conv_layer_1 = []
for k in [3,4,5]:
    conv_layer = Conv1D(filters = 25, kernel_size = k, activation = 'relu')(embedded_input)
    conv_layer_1.append(conv_layer)
concatenate_layer_1 = Concatenate(axis = 1)(conv_layer_1)
maxpool_layer_1 = MaxPooling1D()(concatenate_layer_1)
conv_layer_2 = []
for k in [3,4,5]:
    conv_layer = Conv1D(filters = 25, kernel_size = k, activation = 'relu')(maxpool_layer_1)
    conv_layer_2.append(conv_layer)
concatenate_layer_2 = Concatenate(axis = 1)(conv_layer_2)
maxpool_layer_2 = MaxPooling1D()(concatenate_layer_2)
conv_layer_3 = Conv1D(filters = 25, kernel_size = 3, activation = 'relu')(maxpool_layer_2)
maxpool_layer_3 = MaxPooling1D()(conv_layer_3)
conv_layer_4 = Conv1D(filters = 25, kernel_size = 3, activation = 'relu')(maxpool_layer_3)
flatten_layer = Flatten()(conv_layer_4)
dropout_layer = Dropout(0.5)(flatten_layer)
output_layer = Dense(units = 20, activation = 'softmax')(dropout_layer)
model1 = Model(input_layer, output_layer)
```

```
In [ ]: from tensorflow.keras.callbacks import EarlyStopping
import datetime

Optimiser = tf.keras.optimizers.RMSprop(0.001)
```

```

earlystop = EarlyStopping(monitor = 'val_loss', patience = 2)
model1.compile(optimizer= Optimiser, loss='categorical_crossentropy', metrics=['accuracy'])

log_dir = os.path.join("logs", 'fits', datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir, histogram_freq=1, w

custom_callbacks = custom_callback(validation_data = (padded_test, y_test_coded))

model1.fit(x = padded_train, y = y_train_coded, epochs = 20, validation_data = (padded_t
callbacks = [custom_callbacks, earlystop, tensorboard_callback])

```

Epoch 1/20

6/707 [.....] - ETA: 33s - loss: 3.0203 - accuracy: 0.0667

WARNING:tensorflow:Callback method `on_train_batch_end` is slow compared to the batch time (batch time: 0.0179s vs `on_train_batch_end` time: 0.0291s). Check your callbacks.

707/707 [=====] - 30s 39ms/step - loss: 1.5467 - accuracy: 0.4921 - val_loss: 1.0128 - val_accuracy: 0.6786

Epoch 2/20

707/707 [=====] - 26s 37ms/step - loss: 0.7966 - accuracy: 0.7445 - val_loss: 0.8045 - val_accuracy: 0.7457

Epoch 3/20

707/707 [=====] - 27s 38ms/step - loss: 0.5354 - accuracy: 0.8243 - val_loss: 0.7692 - val_accuracy: 0.7718

Epoch 4/20

707/707 [=====] - 28s 39ms/step - loss: 0.3709 - accuracy: 0.8819 - val_loss: 0.7695 - val_accuracy: 0.7916

Epoch 5/20

707/707 [=====] - 27s 38ms/step - loss: 0.2625 - accuracy: 0.9157 - val_loss: 0.8643 - val_accuracy: 0.7890

<keras.callbacks.History at 0x7f39839b9890>

Out[]:

Model with one additional maxpool and conv1D layer than the architecture shared with a dropout layer of 0.2.

```

In [ ]: %load_ext tensorboard
        %tensorboard --logdir logs/fits

```

Model with one additional maxpool and conv1D layer than the architecture shared with a dropout layer of 0.5. -> Best1

```

In [ ]: custom_callbacks.history

```

```

Out[ ]: {'loss': [1.5466969013214111,
0.7965592741966248,
0.5353642106056213,
0.3708896338939667,
0.26252004504203796],
'accuracy': [0.4921039640903473,
0.7444940209388733,
0.8243042230606079,
0.8818780779838562,
0.9157283306121826],
'val_loss': [1.0128041505813599,
0.8044811487197876,
0.7691896557807922,
0.7694537043571472,
0.8643127083778381],
'val_acc': [0.6785638332366943,
0.7456979155540466,
0.7718291878700256,
0.7915869951248169,
0.7890375852584839],

```

```
'f1 score': [],  
'AUC score': []}
```

```
In [ ]: %tensorboard --logdir logs/fits
```

```
Reusing TensorBoard on port 6006 (pid 2201), started 0:08:05 ago. (Use '!kill 2201' to kill it.)
```

```
In [ ]: model1.summary()
```

```
Model: "model"
```

Layer (type)	Output Shape	Param #	Connected to
=====			
input_1 (InputLayer)	[(None, 2069)]	0	[]
embedding (Embedding)	(None, 2069, 300)	22350300	['input_1[0][0]']
conv1d (Conv1D)	(None, 2067, 25)	22525	['embedding[0][0]']
conv1d_1 (Conv1D)	(None, 2066, 25)	30025	['embedding[0][0]']
conv1d_2 (Conv1D)	(None, 2065, 25)	37525	['embedding[0][0]']
concatenate (Concatenate)	(None, 6198, 25)	0	['conv1d[0][0]', 'conv1d_1[0][0]', 'conv1d_2[0][0]']
max_pooling1d (MaxPooling1D)	(None, 3099, 25)	0	['concatenate[0][0]']
conv1d_3 (Conv1D)	(None, 3097, 25)	1900	['max_pooling1d[0][0]']
conv1d_4 (Conv1D)	(None, 3096, 25)	2525	['max_pooling1d[0][0]']
conv1d_5 (Conv1D)	(None, 3095, 25)	3150	['max_pooling1d[0][0]']
concatenate_1 (Concatenate)	(None, 9288, 25)	0	['conv1d_3[0][0]', 'conv1d_4[0][0]',

'conv1d_5[0][0]']

max_pooling1d_1 (MaxPooling1D)	(None, 4644, 25)	0	['concatenate_1[0][0]']
conv1d_6 (Conv1D)	(None, 4642, 25)	1900	['max_pooling1d_1[0][0]']
max_pooling1d_2 (MaxPooling1D)	(None, 2321, 25)	0	['conv1d_6[0][0]']
conv1d_7 (Conv1D)	(None, 2319, 25)	1900	['max_pooling1d_2[0][0]']
flatten (Flatten)	(None, 57975)	0	['conv1d_7[0][0]']
dropout (Dropout)	(None, 57975)	0	['flatten[0][0]']
dense (Dense)	(None, 20)	1159520	['dropout[0][0]']

```
=====
Total params: 23,611,270
Trainable params: 1,260,970
Non-trainable params: 22,350,300
```

Observations:

Initially the exact same architecture shared was used for the model with adam optimizer with 0.02, 0.001 learning rates. The models converged way too quickly with very poor performance of 5% accuracy for train and test.

RMSProp optimizer in general performed way better than the Adam optimizer for our problem.

RMSprop with a learning rate of 0.001 performed better than RMSprop with 0.01 learning rate.

Adding an additional conv1D layer and maxpool layer helped improve the performance of the model.

```
In [ ]: model1.save_weights('Model1_best1')
```

```
In [ ]: tf.keras.backend.clear_session()
!rm -rf ./logs/
```

```
In [ ]: embedding_layer = Embedding(no_of_words+1, 300, weights = [weight_matrix], input_length
                                     trainable = False )
input_layer = Input(shape = (2069,), dtype = 'int32' )
embedded_input = embedding_layer(input_layer)
conv_layer_1 = []
```

```

for k in [3,4,5]:
    conv_layer = Conv1D(filters = 25, kernel_size = k, activation = 'relu')(embedded_input)
    conv_layer_1.append(conv_layer)
concatenate_layer_1 = Concatenate(axis = 1)(conv_layer_1)
maxpool_layer_1 = MaxPooling1D()(concatenate_layer_1)
conv_layer_2 = []
for k in [3,4,5]:
    conv_layer = Conv1D(filters = 25, kernel_size = k, activation = 'relu')(maxpool_layer_1)
    conv_layer_2.append(conv_layer)
concatenate_layer_2 = Concatenate(axis = 1)(conv_layer_2)
maxpool_layer_2 = MaxPooling1D()(concatenate_layer_2)
conv_layer_3 = Conv1D(filters = 25, kernel_size = 3, activation = 'relu')(maxpool_layer_2)
dropout_layer_1 = Dropout(0.2)(conv_layer_3)
maxpool_layer_3 = MaxPooling1D()(dropout_layer_1)
conv_layer_4 = Conv1D(filters = 25, kernel_size = 3, activation = 'relu')(maxpool_layer_3)
flatten_layer = Flatten()(conv_layer_4)
dropout_layer_2 = Dropout(0.5)(flatten_layer)
output_layer = Dense(units = 20, activation = 'softmax')(dropout_layer_2)
model1b = Model(input_layer, output_layer)

```

```

In [ ]: Optimiser = tf.keras.optimizers.RMSprop(0.001)
earlystop = EarlyStopping(monitor = 'val_loss', patience = 2)

model1b.compile(optimizer= Optimiser, loss='categorical_crossentropy', metrics=['accuracy'])

log_dir = os.path.join("logs", 'fits', datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir, histogram_freq=1,

custom_callbacks = custom_callback(validation_data = (padded_test, y_test_coded))

model1b.fit(x = padded_train, y = y_train_coded, epochs = 20, validation_data = (padded_test, y_test_coded),
            callbacks = [custom_callbacks, earlystop, tensorboard_callback])

```

Epoch 1/20

6/707 [.....] - ETA: 29s - loss: 3.1606 - accuracy: 0.0500

WARNING:tensorflow:Callback method `on_train_batch_end` is slow compared to the batch time (batch time: 0.0161s vs `on_train_batch_end` time: 0.0269s). Check your callbacks.

707/707 [=====] - 29s 39ms/step - loss: 1.6401 - accuracy: 0.4660 - val_loss: 1.0912 - val_accuracy: 0.6439

Epoch 2/20

707/707 [=====] - 27s 38ms/step - loss: 0.8393 - accuracy: 0.7286 - val_loss: 0.8972 - val_accuracy: 0.7215

Epoch 3/20

707/707 [=====] - 27s 38ms/step - loss: 0.5693 - accuracy: 0.8187 - val_loss: 0.7530 - val_accuracy: 0.7693

Epoch 4/20

707/707 [=====] - 27s 38ms/step - loss: 0.3979 - accuracy: 0.8725 - val_loss: 0.7091 - val_accuracy: 0.7907

Epoch 5/20

707/707 [=====] - 27s 38ms/step - loss: 0.2846 - accuracy: 0.9073 - val_loss: 0.7830 - val_accuracy: 0.7909

Epoch 6/20

707/707 [=====] - 27s 38ms/step - loss: 0.2260 - accuracy: 0.9259 - val_loss: 0.7918 - val_accuracy: 0.8016

<keras.callbacks.History at 0x7f3982b45450>

Out[]:

Model1_best2 -> Model1 with 2 dropout layers of 0.2 and 0.5 respectively.

```

In [ ]: model1b.save_weights('Model1_best2')

```

```

In [ ]: model1b.summary()

```

Model: "model_1"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_2 (InputLayer)	[(None, 2069)]	0	[]
embedding_1 (Embedding)	(None, 2069, 300)	22350300	['input_2[0][0]']
conv1d_8 (Conv1D)	(None, 2067, 25)	22525	['embedding_1[0][0]']
conv1d_9 (Conv1D)	(None, 2066, 25)	30025	['embedding_1[0][0]']
conv1d_10 (Conv1D)	(None, 2065, 25)	37525	['embedding_1[0][0]']
concatenate_2 (Concatenate)	(None, 6198, 25)	0	['conv1d_8[0][0]', 'conv1d_9[0][0]', 'conv1d_10[0][0]']
max_pooling1d_3 (MaxPooling1D)	(None, 3099, 25)	0	['concatenate_2[0][0]']
conv1d_11 (Conv1D)	(None, 3097, 25)	1900	['max_pooling1d_3[0][0]']
conv1d_12 (Conv1D)	(None, 3096, 25)	2525	['max_pooling1d_3[0][0]']
conv1d_13 (Conv1D)	(None, 3095, 25)	3150	['max_pooling1d_3[0][0]']
concatenate_3 (Concatenate)	(None, 9288, 25)	0	['conv1d_11[0][0]', 'conv1d_12[0][0]', 'conv1d_13[0][0]']
max_pooling1d_4 (MaxPooling1D)	(None, 4644, 25)	0	['concatenate_3[0][0]']
conv1d_14 (Conv1D)	(None, 4642, 25)	1900	['max_pooling1d_4[0][0]']
dropout_2 (Dropout)	(None, 4642, 25)	0	['conv1d_14[0][0]']

max_pooling1d_5 (MaxPooling1D)	(None, 2321, 25)	0	['dropout_2[0][0]']
conv1d_15 (Conv1D)	(None, 2319, 25)	1900	['max_pooling1d_5[0][0]']
flatten_1 (Flatten)	(None, 57975)	0	['conv1d_15[0][0]']
dropout_3 (Dropout)	(None, 57975)	0	['flatten_1[0][0]']
dense_1 (Dense)	(None, 20)	1159520	['dropout_3[0][0]']

```

=====
Total params: 23,611,270
Trainable params: 1,260,970
Non-trainable params: 22,350,300
=====

```

```
In [ ]: %tensorboard --logdir logs/fits
```

Reusing TensorBoard on port 6006 (pid 2201), started 0:38:12 ago. (Use '!kill 2201' to kill it.)

```
In [ ]: embedding_layer = Embedding(no_of_words+1, 300, weights = [weight_matrix], input_length
                                     trainable = False )
input_layer = Input(shape = (2069,), dtype = 'int32' )
embedded_input = embedding_layer(input_layer)
conv_layer_1 = []
for k in [3,4,5]:
    conv_layer = Conv1D(filters = 25, kernel_size = k, activation = 'relu')(embedded_input)
    conv_layer_1.append(conv_layer)
concatenate_layer_1 = Concatenate(axis = 1)(conv_layer_1)
maxpool_layer_1 = MaxPooling1D()(concatenate_layer_1)
conv_layer_2 = []
for k in [3,4,5]:
    conv_layer = Conv1D(filters = 25, kernel_size = k, activation = 'relu')(maxpool_layer_1)
    conv_layer_2.append(conv_layer)
concatenate_layer_2 = Concatenate(axis = 1)(conv_layer_2)
maxpool_layer_2 = MaxPooling1D()(concatenate_layer_2)
conv_layer_3 = Conv1D(filters = 25, kernel_size = 3, activation = 'relu')(maxpool_layer_2)
dropout_layer_1 = Dropout(0.5)(conv_layer_3)
maxpool_layer_3 = MaxPooling1D()(dropout_layer_1)
conv_layer_4 = Conv1D(filters = 25, kernel_size = 3, activation = 'relu')(maxpool_layer_3)
flatten_layer = Flatten()(conv_layer_4)
dropout_layer_2 = Dropout(0.5)(flatten_layer)
output_layer = Dense(units = 20, activation = 'softmax')(dropout_layer_2)
model1c = Model(input_layer, output_layer)
```

```
In [ ]: Optimiser = tf.keras.optimizers.RMSprop(0.001)
earlystop = EarlyStopping(monitor = 'val_loss', patience = 2)

model1c.compile(optimizer= Optimiser, loss='categorical_crossentropy', metrics=['accuracy'])
```

```
log_dir = os.path.join("logs", 'fits', datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir, histogram_freq=1, w

custom_callbacks = custom_callback(validation_data = (padded_test, y_test_coded))

model1c.fit(x = padded_train, y = y_train_coded, epochs = 20, validation_data = (padded_
callbacks = [custom_callbacks, earlystop, tensorboard_callback])
```

Epoch 1/20

5/707 [.....] - ETA: 36s - loss: 3.1926 - accuracy: 0.0600

WARNING:tensorflow:Callback method `on_train_batch_end` is slow compared to the batch time (batch time: 0.0176s vs `on_train_batch_end` time: 0.0313s). Check your callbacks.

707/707 [=====] - 29s 39ms/step - loss: 1.6852 - accuracy: 0.4552 - val_loss: 1.2085 - val_accuracy: 0.6250

Epoch 2/20

707/707 [=====] - 27s 38ms/step - loss: 0.8899 - accuracy: 0.7131 - val_loss: 0.8885 - val_accuracy: 0.7228

Epoch 3/20

707/707 [=====] - 27s 38ms/step - loss: 0.6470 - accuracy: 0.7917 - val_loss: 0.7409 - val_accuracy: 0.7633

Epoch 4/20

707/707 [=====] - 27s 38ms/step - loss: 0.4851 - accuracy: 0.8419 - val_loss: 0.7789 - val_accuracy: 0.7542

Epoch 5/20

707/707 [=====] - 27s 38ms/step - loss: 0.3776 - accuracy: 0.8790 - val_loss: 0.8473 - val_accuracy: 0.7655

<keras.callbacks.History at 0x7f3982c47190>

Out[]:

In []: model1c.summary()

Model: "model"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_1 (InputLayer)	(None, 2069)	0	[]
embedding (Embedding)	(None, 2069, 300)	22350300	['input_1[0][0]']
conv1d (Conv1D)	(None, 2067, 25)	22525	['embedding[0][0]']
conv1d_1 (Conv1D)	(None, 2066, 25)	30025	['embedding[0][0]']
conv1d_2 (Conv1D)	(None, 2065, 25)	37525	['embedding[0][0]']
concatenate (Concatenate)	(None, 6198, 25)	0	['conv1d[0][0]', 'conv1d_1[0][0]', 'conv1d_2[0][0]']

max_pooling1d (MaxPooling1D)	(None, 3099, 25)	0	['concatenate[0][0]']
conv1d_3 (Conv1D)	(None, 3097, 25)	1900	['max_pooling1d[0][0]']
conv1d_4 (Conv1D)	(None, 3096, 25)	2525	['max_pooling1d[0][0]']
conv1d_5 (Conv1D)	(None, 3095, 25)	3150	['max_pooling1d[0][0]']
concatenate_1 (Concatenate)	(None, 9288, 25)	0	['conv1d_3[0][0]', 'conv1d_4[0][0]', 'conv1d_5[0][0]']
max_pooling1d_1 (MaxPooling1D)	(None, 4644, 25)	0	['concatenate_1[0][0]']
conv1d_6 (Conv1D)	(None, 4642, 25)	1900	['max_pooling1d_1[0][0]']
dropout (Dropout)	(None, 4642, 25)	0	['conv1d_6[0][0]']
max_pooling1d_2 (MaxPooling1D)	(None, 2321, 25)	0	['dropout[0][0]']
conv1d_7 (Conv1D)	(None, 2319, 25)	1900	['max_pooling1d_2[0][0]']
flatten (Flatten)	(None, 57975)	0	['conv1d_7[0][0]']
dropout_1 (Dropout)	(None, 57975)	0	['flatten[0][0]']
dense (Dense)	(None, 20)	1159520	['dropout_1[0][0]']

```

=====
Total params: 23,611,270
Trainable params: 1,260,970
Non-trainable params: 22,350,300

```

```
In [ ]: model1c.save_weights('model1_best3')

In [ ]: from sklearn.metrics import f1_score

y_pred_1b = np.asarray(model1b.predict(padded_test))
y_pred_1c = np.asarray(model1c.predict(padded_test))

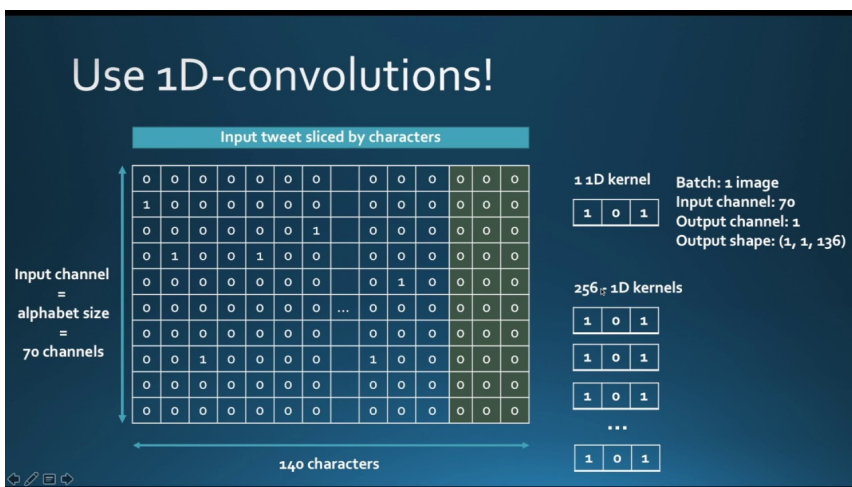
y_pred_1b_labels = list(np.argmax(y_pred_1b, axis=1))
y_pred_1c_labels = list(np.argmax(y_pred_1c, axis=1))

print("F1 Score of Model1b: ", f1_score(y_test['label_coded'], y_pred_1b_labels, average='micro'))
print("F1 Score of Model1c: ", f1_score(y_test['label_coded'], y_pred_1c_labels, average='micro'))

F1 Score of Model1b: 0.8015721266199277
F1 Score of Model1c: 0.7654557042702358
```

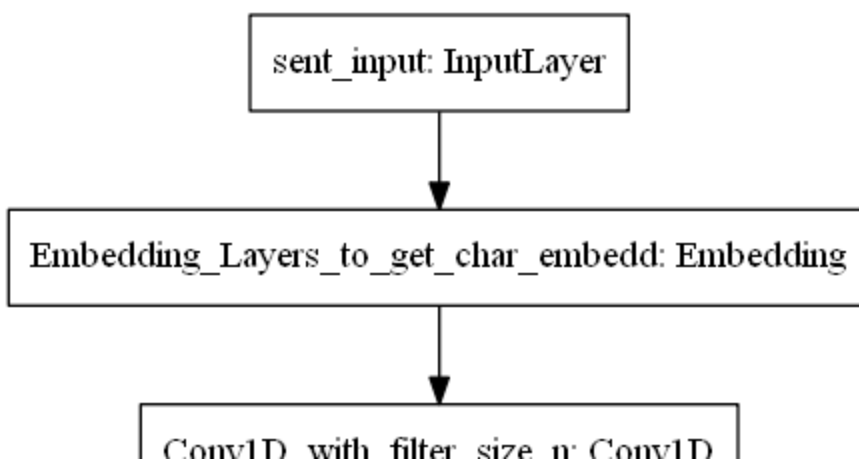
The model1b seems to have a better performance than model1c. Both a higher test accuracy and higher F1 score of model1b than that of model1c suggests the above.

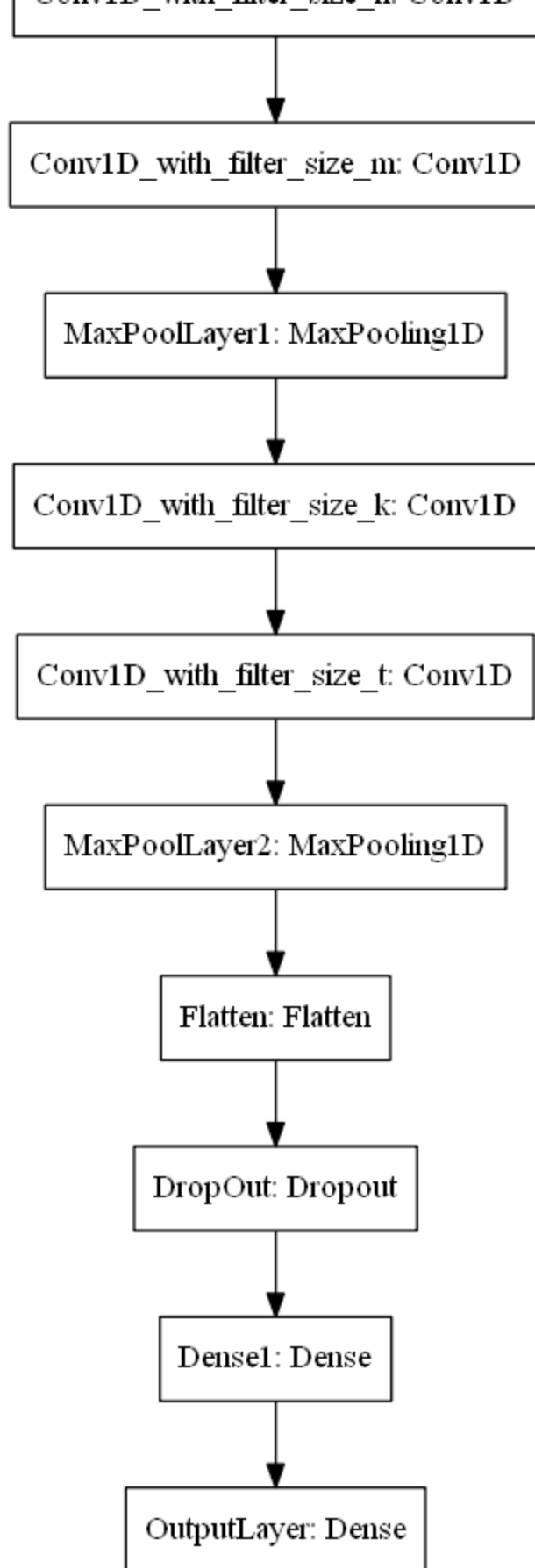
Model-2 : Using 1D convolutions with character embedding



Here are the some papers based on Char-CNN

1. Xiang Zhang, Junbo Zhao, Yann LeCun. [Character-level Convolutional Networks for Text Classification](#). NIPS 2015
2. Yoon Kim, Yacine Jernite, David Sontag, Alexander M. Rush. [Character-Aware Neural Language Models](#). AAAI 2016
3. Shaojie Bai, J. Zico Kolter, Vladlen Koltun. [An Empirical Evaluation of Generic Convolutional and Recurrent Networks for Sequence Modeling](#)
4. Use the pretrained char embeddings <https://github.com/minimaxir/char-embeddings/blob/master/glove.840B.300d-char.txt>





```

In [13]: import tensorflow as tf
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences

filters_ = '!"#$%&()*+,-./:;<=>@[\\]^_`{|}~\t\n'+ 'i' # <= removed '_' to prevent tokeni
my_tokenizer2 = Tokenizer(filters=filters_ , char_level = True)

```



```
my_tokenizer2.fit_on_texts(X_train['combined_text'])
sequences_train2 = my_tokenizer2.texts_to_sequences(X_train['combined_text'])
padded_train2 = pad_sequences(sequences_train2, padding = 'post', truncating = 'pre', ma
```

```
In [14]: sequences_test2 = my_tokenizer2.texts_to_sequences(X_test['combined_text'])
padded_test2 = pad_sequences(sequences_test2, padding = 'post', truncating = 'pre', maxl
```

```
In [15]: char_dict = my_tokenizer2.word_index
n = len(char_dict.items())
```

```
In [16]: padded_train2.shape
```

```
Out[16]: (14121, 2069)
```

```
In [17]: from google.colab import files

file = files.upload()
```

No file chosen

Upload widget is only available when the cell has been executed in

the current browser session. Please rerun this cell to enable.

Saving glove.840B.300d-char.txt to glove.840B.300d-char.txt

```
In [18]: def load_embedding(filename,encoding):
        file = open(filename,'r',encoding=encoding)
        lines = file.readlines()[1:]
        file.close()
        embedding = dict()
        for line in lines:
            parts = line.split()
            embedding[parts[0]] = np.asarray(parts[1:], dtype='float32')
        return embedding
```

```
In [19]: raw_embedding2 = load_embedding('glove.840B.300d-char.txt','utf8')

weight_matrix2 = np.zeros((n, 300))
for word,i in char_dict.items():
    if word in raw_embedding2:
        weight_matrix2[i] = raw_embedding2[word]
```

```
In [20]: weight_matrix2.shape
```

```
Out[20]: (43, 300)
```

```
In [53]: tf.keras.backend.clear_session()
!rm -rf ./logs/
```

```
In [54]: #FunctionalAPI -> Model 2
embedding_layer = Embedding(n, 300, weights = [weight_matrix2], input_length = 2069,
                             trainable = False )
input_layer = Input(shape = (2069,), dtype = 'int32' )
embedded_input = embedding_layer(input_layer)
conv_layer_1 = Conv1D(filters = 200, kernel_size = 5, activation = 'relu')(embedded_inpu
conv_layer_2 = Conv1D(filters = 150, kernel_size = 7, activation = 'relu')(conv_layer_1)
maxpool_layer_1 = MaxPooling1D()(conv_layer_2)
conv_layer_3 = Conv1D(filters = 150, kernel_size = 4, activation = 'relu')(maxpool_layer
conv_layer_4 = Conv1D(filters = 200, kernel_size = 3, activation = 'relu')(conv_layer_3)
maxpool_layer_2 = MaxPooling1D()(conv_layer_4)
conv_layer_5 = Conv1D(filters = 200, kernel_size = 3, activation = 'relu')(maxpool_layer
conv_layer_6 = Conv1D(filters = 200, kernel_size = 3, activation = 'relu')(conv_layer_5)
maxpool_layer_3 = MaxPooling1D()(conv_layer_6)
conv_layer_7 = Conv1D(filters = 200, kernel_size = 3, activation = 'relu')(maxpool_layer
maxpool_layer_4 = MaxPooling1D()(conv_layer_7)
```

```

conv_layer_8 = Conv1D(filters = 200, kernel_size = 3, activation = 'relu')(maxpool_layer)
maxpool_layer_5 = MaxPooling1D()(conv_layer_8)
flatten_layer = Flatten()(maxpool_layer_5)
dropout_layer = Dropout(0.2)(flatten_layer)
output_layer = Dense(units = 20, activation = 'softmax')(dropout_layer)
model2 = Model(input_layer, output_layer)

```

```

In [55]: from tensorflow.keras.callbacks import EarlyStopping
import datetime

Optimiser = tf.keras.optimizers.RMSprop(0.001)
earlystop = EarlyStopping(monitor = 'val_loss', patience = 2)
model2.compile(optimizer= Optimiser, loss='categorical_crossentropy', metrics=['accuracy'])

log_dir = os.path.join("logs", 'fits', datetime.datetime.now().strftime("%Y%m%d-%H%M%S"))
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir, histogram_freq=1, write_graph=True)

custom_callbacks = custom_callback(validation_data = (padded_test2, y_test_coded))

model2.fit(x = padded_train2, y = y_train_coded, epochs = 20, validation_data = (padded_test2, y_test_coded),
          callbacks = [custom_callbacks, earlystop, tensorboard_callback])

Epoch 1/20
6/707 [.....] - ETA: 40s - loss: 5.1427 - accuracy: 0.0500
WARNING:tensorflow:Callback method `on_train_batch_end` is slow compared to the batch time (batch time: 0.0245s vs `on_train_batch_end` time: 0.0316s). Check your callbacks.
707/707 [=====] - 49s 67ms/step - loss: 2.9691 - accuracy: 0.0770 - val_loss: 2.9308 - val_accuracy: 0.0914
Epoch 2/20
707/707 [=====] - 46s 65ms/step - loss: 2.9206 - accuracy: 0.0901 - val_loss: 2.9075 - val_accuracy: 0.1022
Epoch 3/20
707/707 [=====] - 46s 65ms/step - loss: 2.8995 - accuracy: 0.0955 - val_loss: 2.8975 - val_accuracy: 0.0924
Epoch 4/20
707/707 [=====] - 46s 65ms/step - loss: 2.8767 - accuracy: 0.1033 - val_loss: 3.1100 - val_accuracy: 0.0907
Epoch 5/20
707/707 [=====] - 46s 65ms/step - loss: 2.8573 - accuracy: 0.1091 - val_loss: 2.8982 - val_accuracy: 0.1009
Out[55]: <keras.callbacks.History at 0x7f20921ac390>

```

```

In [56]: model2.summary()

```

Model: "model"

Layer (type)	Output Shape	Param #
=====		
input_1 (InputLayer)	[(None, 2069)]	0
embedding (Embedding)	(None, 2069, 300)	12900
conv1d (Conv1D)	(None, 2065, 200)	300200
conv1d_1 (Conv1D)	(None, 2059, 150)	210150
max_pooling1d (MaxPooling1D)	(None, 1029, 150)	0
conv1d_2 (Conv1D)	(None, 1026, 150)	90150
conv1d_3 (Conv1D)	(None, 1024, 200)	90200
max_pooling1d_1 (MaxPooling1D)	(None, 512, 200)	0

conv1d_4 (Conv1D)	(None, 510, 200)	120200
conv1d_5 (Conv1D)	(None, 508, 200)	120200
max_pooling1d_2 (MaxPooling1D)	(None, 254, 200)	0
conv1d_6 (Conv1D)	(None, 252, 200)	120200
max_pooling1d_3 (MaxPooling1D)	(None, 126, 200)	0
conv1d_7 (Conv1D)	(None, 124, 200)	120200
max_pooling1d_4 (MaxPooling1D)	(None, 62, 200)	0
flatten (Flatten)	(None, 12400)	0
dropout (Dropout)	(None, 12400)	0
dense (Dense)	(None, 20)	248020

```
=====
Total params: 1,432,420
Trainable params: 1,419,520
Non-trainable params: 12,900
```

```
In [57]: %load_ext tensorboard
         %tensorboard --logdir logs/fits
```

```
The tensorboard extension is already loaded. To reload it, use:
  %reload_ext tensorboard
Reusing TensorBoard on port 6006 (pid 684), started 0:15:41 ago. (Use '!kill 684' to kill it.)
```

```
In [59]: from sklearn.metrics import f1_score

y_pred_2 = np.asarray(model2.predict(padded_test2))

y_pred_2_labels = list(np.argmax(y_pred_2, axis=1))

print("F1 Score of Model2: ", f1_score(y_test['label_coded'], y_pred_2_labels, average = 'micro'))

F1 Score of Model2:  0.10091353303590397
```

This model achieved a accuracy of approx. 10% for both train and test data.