

```

#importing the libraries

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from keras.models import Model, Sequential
from keras.layers import LSTM, Activation, Dense, Dropout, Input,
Embedding
from keras.optimizers import Adam
from keras.preprocessing.text import Tokenizer
from keras.preprocessing import sequence
from keras.utils import pad_sequences
from keras.utils import to_categorical
from keras.callbacks import EarlyStopping
%matplotlib inline

#Reading the Dataset

df = pd.read_csv('/content/drive/MyDrive/spam.csv', encoding='latin-1')
df.head()


```

| | v1 | v2 | Unnamed: 2 |
|---|------|---|------------|
| 0 | ham | Go until jurong point, crazy.. Available only ... | NaN |
| 1 | ham | Ok lar... Joking wif u oni... | NaN |
| 2 | spam | Free entry in 2 a wkly comp to win FA Cup fina... | NaN |
| 3 | ham | U dun say so early hor... U c already then say... | NaN |
| 4 | ham | Nah I don't think he goes to usf, he lives aro... | NaN |

```


```

| | Unnamed: 3 | Unnamed: 4 |
|---|------------|------------|
| 0 | NaN | NaN |
| 1 | NaN | NaN |
| 2 | NaN | NaN |
| 3 | NaN | NaN |
| 4 | NaN | NaN |

```

df.drop(['Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'], axis=1, inplace=True)
df.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5572 entries, 0 to 5571

```

Data columns (total 2 columns):

| # | Column | Non-Null Count | Dtype |
|---|--------|----------------|--------|
| 0 | v1 | 5572 non-null | object |
| 1 | v2 | 5572 non-null | object |

dtypes: object(2)

memory usage: 87.2+ KB

```
from google.colab import drive
```

```
drive.mount('/content/drive')
```

Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).

```
sns.countplot(df.v1)
```

```
plt.xlabel('Label')
```

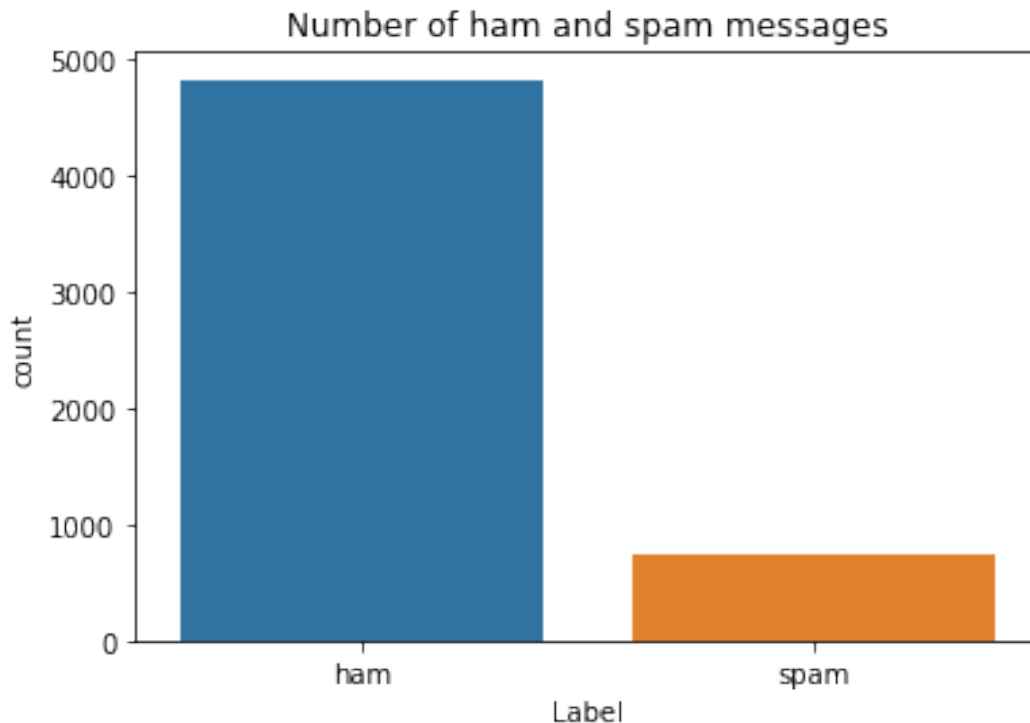
```
plt.title('Number of ham and spam messages')
```

/usr/local/lib/python3.7/dist-packages/seaborn/_decorators.py:43:

FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.

FutureWarning

```
Text(0.5, 1.0, 'Number of ham and spam messages')
```



#Process the Data

```

X = df.v2
Y = df.v1
le = LabelEncoder()
Y = le.fit_transform(Y)
Y = Y.reshape(-1,1)
X_train,X_test,Y_train,Y_test = train_test_split(X,Y,test_size=0.15)

```

```

max_words = 1000
max_len = 150
tok = Tokenizer(num_words=max_words)
tok.fit_on_texts(X_train)
sequences = tok.texts_to_sequences(X_train)
sequences_matrix = pad_sequences(sequences,maxlen=max_len)
sequences_matrix

```

```

array([[ 0,  0,  0, ...,  1, 28, 14],
       [ 0,  0,  0, ...,  1, 64,  3],
       [ 0,  0,  0, ..., 140, 322, 195],
       ...,
       [ 0,  0,  0, ..., 35,  7, 459],
       [ 0,  0,  0, ..., 128, 454, 981],
       [ 0,  0,  0, ..., 86, 245, 66]], dtype=int32)

```

```

tok.index_word

```

```

{1: 'i',
 2: 'to',
 3: 'you',
 4: 'a',
 5: 'the',
 6: 'u',
 7: 'and',
 8: 'in',
 9: 'is',
10: 'me',
11: 'my',
12: 'for',
13: 'your',
14: 'it',
15: 'of',
16: 'call',
17: 'have',
18: 'on',
19: '2',
20: 'that',
21: 'are',
22: 'now',
23: 'so',
24: 'or',
25: 'not',
26: 'do',

```

27: 'but',
28: 'can',
29: 'be',
30: 'get',
31: 'at',
32: 'i'm',
33: 'will',
34: 'ur',
35: 'with',
36: 'if',
37: 'just',
38: 'no',
39: 'this',
40: 'we',
41: 'gt',
42: 'lt',
43: '4',
44: 'up',
45: 'when',
46: 'ok',
47: 'free',
48: 'out',
49: 'how',
50: 'go',
51: 'from',
52: 'all',
53: 'what',
54: 'like',
55: 'know',
56: 'then',
57: 'good',
58: 'was',
59: 'got',
60: 'come',
61: 'its',
62: 'am',
63: 'day',
64: 'love',
65: 'time',
66: 'only',
67: 'want',
68: 'there',
69: 'text',
70: 'he',
71: 'send',
72: 'as',
73: 'txt',
74: 'one',
75: 'by',
76: 'need',

77: "i'll",
78: 'home',
79: 'going',
80: 'about',
81: 'sorry',
82: 'see',
83: 'r',
84: 'still',
85: 'today',
86: 'stop',
87: 'lor',
88: 'da',
89: 'k',
90: 'our',
91: 'n',
92: 'mobile',
93: 'dont',
94: 'tell',
95: 'new',
96: 'reply',
97: 'later',
98: "don't",
99: 'hi',
100: 'she',
101: 'take',
102: 'her',
103: 'think',
104: 'back',
105: 'any',
106: 'been',
107: 'pls',
108: 'please',
109: 'did',
110: 'some',
111: 'i',
112: 'phone',
113: 'l',
114: 'dear',
115: 'they',
116: 'week',
117: 'here',
118: 'great',
119: 'too',
120: 'much',
121: 'well',
122: 'has',
123: 'night',
124: 'hope',
125: 'him',
126: 'an',

127: 'happy',
128: 'more',
129: 'oh',
130: 'hey',
131: 'msg',
132: 'where',
133: 'claim',
134: 'yes',
135: 'd',
136: 'who',
137: 'c',
138: 'had',
139: 'work',
140: 'www',
141: 'give',
142: 'wat',
143: 'make',
144: 'e',
145: "it's",
146: 'way',
147: 'number',
148: 'amp',
149: 'tomorrow',
150: '3',
151: 'should',
152: 'cash',
153: 'message',
154: 'prize',
155: 'why',
156: 'already',
157: 'said',
158: 'ask',
159: 'really',
160: 'yeah',
161: 'after',
162: 'very',
163: 'say',
164: 'life',
165: 'meet',
166: 'right',
167: 'doing',
168: 'them',
169: 'morning',
170: 't',
171: 'find',
172: 'im',
173: 'miss',
174: 'thanks',
175: 'last',
176: 'win',

177: 'sure',
178: 'babe',
179: 'cos',
180: 'won',
181: 'also',
182: 'let',
183: 'lol',
184: 'sent',
185: 'nokia',
186: 'wait',
187: 'would',
188: 'keep',
189: 'every',
190: 'uk',
191: '150p',
192: 'cant',
193: 'first',
194: 'care',
195: 'com',
196: 'before',
197: '5',
198: "i've",
199: 'us',
200: 'something',
201: 'urgent',
202: 'anything',
203: 'next',
204: 'late',
205: 's',
206: 'min',
207: 'contact',
208: 'b',
209: 'even',
210: 'someone',
211: 'pick',
212: 'buy',
213: 'again',
214: 'thing',
215: 'feel',
216: 'tonight',
217: 'around',
218: 'place',
219: 'tone',
220: "can't",
221: 'over',
222: '50',
223: 'which',
224: 'sleep',
225: 'money',
226: 'things',

227: 'soon',
228: 'dun',
229: 'wan',
230: 'co',
231: 'went',
232: 'off',
233: 'ya',
234: 'were',
235: 'friends',
236: 'nice',
237: 'could',
238: 'his',
239: 'v',
240: 'always',
241: 'other',
242: 'down',
243: 'gonna',
244: '16',
245: '18',
246: 'service',
247: 'per',
248: 'many',
249: 'gud',
250: 'customer',
251: "that's",
252: 'fine',
253: 'x',
254: 'leave',
255: 'people',
256: 'wish',
257: 'chat',
258: 'sms',
259: 'haha',
260: 'year',
261: '6',
262: 'help',
263: 'heart',
264: 'special',
265: 'try',
266: 'friend',
267: "you're",
268: 'use',
269: 'told',
270: 'same',
271: 'mins',
272: 'thk',
273: 'yet',
274: 'guaranteed',
275: 'waiting',
276: 'coming',

277: 'live',
278: 'best',
279: 'cs',
280: 'lunch',
281: 'few',
282: 'may',
283: 'thought',
284: 'never',
285: 'hello',
286: 'stuff',
287: 'ii',
288: 'y',
289: 'trying',
290: '7',
291: 'draw',
292: 'name',
293: 'getting',
294: 'holiday',
295: 'god',
296: 'having',
297: 'finish',
298: 'days',
299: 'house',
300: 'thats',
301: 'cool',
302: 'man',
303: 'meeting',
304: "didn't",
305: 'done',
306: 'dat',
307: 'end',
308: 'class',
309: 'ready',
310: 'latest',
311: 'ill',
312: 'world',
313: 'line',
314: 'eat',
315: 'car',
316: 'wanna',
317: 'check',
318: 'half',
319: 'better',
320: 'lar',
321: 'person',
322: 'real',
323: 'because',
324: 'nothing',
325: 'guess',
326: 'long',

327: 'chance',
328: 'than',
329: 'åf1',
330: 'talk',
331: 'being',
332: 'yup',
333: 'enjoy',
334: 'play',
335: 'bit',
336: 'job',
337: 'shows',
338: 'smile',
339: 'mind',
340: 'another',
341: 'lst',
342: 'box',
343: 'big',
344: 'aight',
345: 'problem',
346: 'receive',
347: 'guys',
348: 'dinner',
349: 'camera',
350: 'watching',
351: 'word',
352: 'åf1000',
353: 'cost',
354: 'room',
355: 'sweet',
356: 'start',
357: '150ppm',
358: 'jus',
359: 'boy',
360: 'awarded',
361: 'two',
362: 'account',
363: 'birthday',
364: 'wk',
365: 'lot',
366: 'ah',
367: 'apply',
368: 'month',
369: 'video',
370: 'sir',
371: 'maybe',
372: 'princess',
373: 'bt',
374: 'plan',
375: 'watch',
376: 'early',

377: 'might',
378: 'minutes',
379: 'called',
380: 'ever',
381: 'xxx',
382: '9',
383: 'into',
384: 'forgot',
385: 'hear',
386: 'liao',
387: 'offer',
388: 'quite',
389: 'luv',
390: 'girl',
391: 'm',
392: 'shit',
393: 'dunno',
394: 'bed',
395: 'dis',
396: 'landline',
397: "he's",
398: 'office',
399: 'between',
400: 'thank',
401: 'code',
402: 'does',
403: 'weekend',
404: 'part',
405: 'shall',
406: 'yo',
407: 'pa',
408: '10',
409: 'hour',
410: 'fun',
411: 'without',
412: 'easy',
413: 'asked',
414: 'rate',
415: 'kiss',
416: 'orange',
417: 'look',
418: 'leh',
419: 'selected',
420: 'baby',
421: 'little',
422: 'face',
423: 'wont',
424: 'left',
425: 'working',
426: 'll',

427: 'details',
428: 'missing',
429: 'network',
430: 'bad',
431: '000',
432: 'didn't',
433: 'town',
434: 'probably',
435: 'speak',
436: 'ringtone',
437: 'reach',
438: 'den',
439: 'po',
440: 'fuck',
441: 'put',
442: 'entry',
443: 'once',
444: 'xmas',
445: 'sexy',
446: 'most',
447: 'since',
448: 'sat',
449: 'thanx',
450: 'hav',
451: 'actually',
452: 'looking',
453: 'shopping',
454: 'until',
455: 'tv',
456: 'means',
457: 'though',
458: 'made',
459: 'dad',
460: 'pay',
461: 'update',
462: 'collect',
463: 'join',
464: 'texts',
465: 'award',
466: 'bus',
467: 'everything',
468: 'enough',
469: 'wanted',
470: 'evening',
471: "how's",
472: 'anyway',
473: 'important',
474: "there's",
475: 'plus',
476: 'those',

477: 'afternoon',
478: '8',
479: 'g',
480: 'remember',
481: '£100',
482: 'school',
483: 'gift',
484: 'de',
485: 'pain',
486: 'able',
487: 'says',
488: '2nd',
489: 'came',
490: 'tones',
491: 'wake',
492: 'tmr',
493: 'till',
494: 'double',
495: 'wif',
496: 'music',
497: 'abt',
498: 'bring',
499: 'while',
500: 'away',
501: 'true',
502: 'must',
503: 'wife',
504: 'wot',
505: 'saw',
506: 'else',
507: 'juz',
508: 'book',
509: 'alright',
510: 'worry',
511: 'price',
512: 'either',
513: 'net',
514: 'colour',
515: 'run',
516: 'collection',
517: 'online',
518: 'weekly',
519: 'feeling',
520: '500',
521: 'oso',
522: 'making',
523: 'question',
524: 'mail',
525: 'okay',
526: 'coz',

527: 'til',
528: 'show',
529: 'friendship',
530: 'game',
531: 'these',
532: "what's",
533: 'decimal',
534: 'calls',
535: 'messages',
536: 'plz',
537: 'family',
538: 'yourself',
539: 'attempt',
540: 'havent',
541: 'full',
542: '10p',
543: 'years',
544: 'guy',
545: 'hurt',
546: 'sad',
547: 'vouchers',
548: 'answer',
549: 'words',
550: 'mob',
551: 'hot',
552: 'yesterday',
553: 'id',
554: 'dude',
555: 'goes',
556: 'makes',
557: 'driving',
558: 'points',
559: 'nite',
560: 'valid',
561: "haven't",
562: 'shop',
563: 'set',
564: 'wants',
565: 'times',
566: "won't",
567: 'http',
568: 'date',
569: 'comes',
570: 'both',
571: 'test',
572: 'busy',
573: 'eve',
574: 'happen',
575: 'games',
576: 'charge',

577: 'åf5000',
578: 'close',
579: 'trip',
580: 'todays',
581: 'believe',
582: 'pic',
583: 'movie',
584: 'bored',
585: 'wen',
586: 're',
587: 'cause',
588: 'ard',
589: 'neva',
590: 'sae',
591: 'åf500',
592: 'yours',
593: 'lose',
594: 'lei',
595: 'order',
596: 'hours',
597: 'pounds',
598: 'story',
599: '8007',
600: 'national',
601: 'top',
602: 'hair',
603: 'noe',
604: 'stay',
605: 'tot',
606: 'food',
607: 'lets',
608: 'private',
609: 'whats',
610: 'w',
611: 'missed',
612: 'email',
613: 'change',
614: 'ring',
615: 'post',
616: 'saying',
617: 'card',
618: 'available',
619: 'old',
620: 'pm',
621: 'leaving',
622: 'haf',
623: 'dreams',
624: 'news',
625: 'forget',
626: 'delivery',

627: 'second',
628: 'started',
629: 'await',
630: 'beautiful',
631: 'finished',
632: 'aft',
633: 'bonus',
634: 'together',
635: 'rite',
636: 'walk',
637: 'congrats',
638: 'mean',
639: 'll',
640: 'worth',
641: 'huh',
642: 'taking',
643: 'expires',
644: 'drink',
645: 'everyone',
646: 'lucky',
647: 'lots',
648: 'pub',
649: 'auction',
650: 'âf2000',
651: 'pics',
652: 'decided',
653: 'final',
654: 'alone',
655: 'takes',
656: 'tried',
657: 'chikku',
658: "she's",
659: 'tho',
660: 'drop',
661: "c's",
662: 'address',
663: 'simple',
664: 'tomo',
665: '86688',
666: 'pobox',
667: 'ltd',
668: 'winner',
669: 'don',
670: 'congratulations',
671: "you've",
672: 'touch',
673: 'calling',
674: 'choose',
675: 'statement',
676: 'identifier',

677: 'company',
678: 'drive',
679: 'visit',
680: 'found',
681: 'row',
682: 'hows',
683: 'goin',
684: 'prob',
685: 'thinking',
686: 'land',
687: 'services',
688: 'okie',
689: 'poly',
690: 'type',
691: 'smth',
692: '08000930705',
693: 'sch',
694: 'kind',
695: 'club',
696: '750',
697: 'fast',
698: 'wid',
699: 'minute',
700: 'whatever',
701: "we're",
702: 'gd',
703: 'smoke',
704: "''",
705: 'head',
706: 'knw',
707: 'far',
708: 'mobileupd8',
709: '08000839402',
710: '100',
711: 'hand',
712: "we'll",
713: 'oredi',
714: 'open',
715: 'happened',
716: 'lesson',
717: 'darlin',
718: 'hard',
719: 'åf3',
720: 'camcorder',
721: 'operator',
722: '30',
723: 'msgs',
724: 'friday',
725: 'gone',
726: 'anytime',

727: 'voucher',
728: 'break',
729: 'awesome',
730: 'mine',
731: 'wil',
732: 'mum',
733: 'search',
734: 'took',
735: 'sleeping',
736: 'savamob',
737: 'offers',
738: 'frnd',
739: "doesn't",
740: 'crazy',
741: 'goodmorning',
742: 'mates',
743: 'fr',
744: 'loving',
745: 'pretty',
746: 'wkly',
747: 'support',
748: 'whole',
749: 'gr8',
750: 'press',
751: 'party',
752: 'happiness',
753: 'sounds',
754: 'india',
755: 'quiz',
756: 'sun',
757: 'xx',
758: '12hrs',
759: 'unsubscribe',
760: 'gas',
761: 'mate',
762: "'",
763: 'brother',
764: 'sex',
765: 'bout',
766: 'credit',
767: 'opt',
768: 'o',
769: 'fone',
770: 'dating',
771: 'nt',
772: 'angry',
773: 'smiling',
774: 'each',
775: 'ni8',
776: 'boytoy',

777: 'un',
778: 'wrong',
779: 'saturday',
780: 'case',
781: 'mr',
782: 'used',
783: 'sister',
784: 'tc',
785: 'cut',
786: 'wit',
787: '\x89û',
788: 'lovely',
789: 'info',
790: 'ends',
791: 'phones',
792: '87066',
793: 'ans',
794: 'treat',
795: 'hee',
796: 'mah',
797: 'carlos',
798: 'gal',
799: 'knew',
800: 'telling',
801: 'dnt',
802: 'least',
803: 'project',
804: 'light',
805: 'lost',
806: 'welcome',
807: 'anyone',
808: 'suite342',
809: '2lands',
810: 'cum',
811: 'currently',
812: 'parents',
813: 'etc',
814: 'almost',
815: 'fucking',
816: 'fancy',
817: 'gym',
818: 'couple',
819: 'motorola',
820: 'chennai',
821: 'sis',
822: 'hold',
823: 'âf2',
824: '03',
825: 'girls',
826: 'mobiles',

827: 'understand',
828: 'tel',
829: 'mom',
830: 'unlimited',
831: 'mu',
832: 'wonderful',
833: 'luck',
834: 'through',
835: 'park',
836: 'b4',
837: 'ten',
838: 'bslvyl',
839: 'ago',
840: '2003',
841: '800',
842: 'redeemed',
843: '04',
844: 'snow',
845: 'hit',
846: 'outside',
847: 'fri',
848: 'secret',
849: 'weeks',
850: 'player',
851: 'f',
852: 'å£250',
853: 'frnds',
854: 'crave',
855: "you'll",
856: 'hmmm',
857: 'meant',
858: 'nope',
859: 'remove',
860: 'å£350',
861: 'talking',
862: 'read',
863: 'christmas',
864: 'college',
865: 'numbers',
866: 'difficult',
867: 'listen',
868: 'finally',
869: 'abiola',
870: 'course',
871: 'seeing',
872: 'st',
873: 'tired',
874: 'age',
875: 'caller',
876: 'information',

877: 'log',
878: 'mrng',
879: 'feels',
880: 'earlier',
881: 'th',
882: 'loads',
883: 'dogging',
884: 'yr',
885: 'rest',
886: 'blue',
887: 'safe',
888: 'within',
889: '20',
890: 'ac',
891: 'laptop',
892: 'slowly',
893: 'clean',
894: 'thinks',
895: 'direct',
896: 'father',
897: 'their',
898: 'sea',
899: 'yar',
900: 'frm',
901: 'via',
902: 'semester',
903: 'askd',
904: 'loved',
905: 'comin',
906: 'die',
907: 'comp',
908: 'ipod',
909: 'supposed',
910: 'gn',
911: 'txtting',
912: 'invited',
913: 'film',
914: 'slow',
915: 'knows',
916: 'write',
917: 'felt',
918: 'point',
919: 'met',
920: 'std',
921: '0800',
922: 'rental',
923: 'hmm',
924: 'gets',
925: 'figure',
926: 'rs',

927: 'mayb',
928: 'orchard',
929: 'balance',
930: 'freemsg',
931: 'checking',
932: 'hungry',
933: 'reward',
934: 'eh',
935: 'england',
936: 'call2optout',
937: 'callertune',
938: 'voice',
939: 'reason',
940: 'exam',
941: 'area',
942: 'jay',
943: 'seen',
944: 'bathe',
945: 'discount',
946: 'ass',
947: 'bank',
948: 'mm',
949: 'surprise',
950: 'lovable',
951: 'song',
952: '00',
953: 'truth',
954: 'red',
955: 'shower',
956: 'computer',
957: 'correct',
958: 'small',
959: 'blood',
960: 'monday',
961: 'charged',
962: 'confirm',
963: 'complimentary',
964: 'hospital',
965: 'sort',
966: 'ge',
967: 'pass',
968: 'stupid',
969: "wasn't",
970: 'picking',
971: 'na',
972: 'march',
973: 'woke',
974: 'content',
975: 'rock',
976: 'empty',

```

977: 'rply',
978: 'paper',
979: 'gotta',
980: 'heard',
981: 'sunday',
982: 'sound',
983: 'ntt',
984: 'tonite',
985: 'water',
986: 'somewhere',
987: 'dead',
988: 'lessons',
989: 'ive',
990: 'match',
991: 'months',
992: 'cd',
993: 'enter',
994: 'doin',
995: 'valentines',
996: 'oops',
997: 'different',
998: 'ugh',
999: 'download',
1000: 'al',
...}

```

#Creating model and Adding the layers

```

TOT_SIZE = len(tok.word_index)+1
lstm_model = Sequential()
lstm_model.add(Embedding(TOT_SIZE, 32, input_length=max_len))
lstm_model.add(LSTM(100))
lstm_model.add(Dropout(0.4))
lstm_model.add(Dense(20, activation="relu"))
lstm_model.add(Dropout(0.3))
lstm_model.add(Dense(1, activation = "sigmoid"))

```

#Compile the model

```

lstm_model.compile(loss = "binary_crossentropy", optimizer = "adam",
metrics = ["accuracy"])
lstm_model.summary()

```

Model: "sequential_1"

| Layer (type) | Output Shape | Param # |
|-------------------------|-----------------|---------|
| embedding_1 (Embedding) | (None, 150, 32) | 262240 |
| lstm_1 (LSTM) | (None, 100) | 53200 |

| | | |
|---------------------|-------------|------|
| dropout_2 (Dropout) | (None, 100) | 0 |
| dense_2 (Dense) | (None, 20) | 2020 |
| dropout_3 (Dropout) | (None, 20) | 0 |
| dense_3 (Dense) | (None, 1) | 21 |

```

=====
Total params: 317,481
Trainable params: 317,481
Non-trainable params: 0
=====

```

#Fit the model

```
lstm_model.fit(sequences_matrix,Y_train,batch_size=128,epochs=10,
validation_split=0.2,
```

```
workers=10,
callbacks=[EarlyStopping(monitor='val_loss',min_delta=0.0001)])
```

Epoch 1/10

```
30/30 [=====] - 9s 224ms/step - loss: 0.4494
- accuracy: 0.8593 - val_loss: 0.2674 - val_accuracy: 0.8650
```

Epoch 2/10

```
30/30 [=====] - 6s 209ms/step - loss: 0.1906
- accuracy: 0.9430 - val_loss: 0.1178 - val_accuracy: 0.9747
```

<keras.callbacks.History at 0x7f35ed115790>

#Save the model

```
lstm_model.save('sms.h5')
```

#Test the model

```
test_sequences = tok.texts_to_sequences(X_test)
test_sequences_matrix = pad_sequences(test_sequences,maxlen=max_len)
acc = lstm_model.evaluate(test_sequences_matrix,Y_test)
```

```
27/27 [=====] - 1s 19ms/step - loss: 0.1137 -
accuracy: 0.9725
```

```
print('Test set\n Loss: {:.3f}\n Accuracy:
{:.3f}'.format(acc[0],acc[1]))
```

Test set

Loss: 0.114

Accuracy:0.972