

Natural Language Processing - Project

Technology opportunity discovery by structuring user needs based on natural language processing and machine learning

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[Research Paper \(paper.pdf\)](#)

```
In [330]: # Importing all dependencies
import pandas as pd
import numpy as np
from wordcloud import WordCloud
from nltk.tokenize import sent_tokenize, word_tokenize
import spacy
nlp = spacy.load('en_core_web_sm')
pd.set_option('display.max_colwidth', 100)
pd.set_option('max_rows', 60)
```

Load dataset

```
In [331]: # Read data from csv
data = pd.read_csv("reviews_iphone.csv")
```

```
In [332]: df = pd.DataFrame(data)
```

Remove any tabs and line breaks

```
In [333]: df.review_text = df.review_text.apply(lambda x: x.replace("\n", "."))
df.review_text = df.review_text.apply(lambda x: x.replace("\t", "."))
df
```

```
Out[333]:
```

	website	review_text
0	cnn	"iPhone SE review: Apple's 399iPhonelivesuptothehype. Thenew399 iPhone SE looks like a...
1	cnet	.In a normal year, the process of reviewing a new iPhone might start with a flashy press event f...
2	techradar	"iPhone SE (2020) review. The 2020 iPhone SE is lightweight, cheap and future-proofed - well don...
3	digitaltrends	.Light, compact design. Class-leading performance. Loud, enjoyable audio. Great camera. iOS is e...
4	pcmag	.For the past few years, phonemakers have said that if you want a small phone, you must have sma...
5	trustedreviews	Even at launch, the Apple iPhone SE wasn't the most exciting phone that the company ever release...

```
In [334]: pd.options.mode.chained_assignment = None # default='warn' # Set to remove SettingWithCopyWarning
```

Use sentence tokeniser on the corpus

```
In [335]: df['tokenized_text'] = df['review_text'].apply(lambda x: sent_tokenize(x))
```

```
In [336]: df.to_csv("df.csv")
```

```
In [337]: # Create a distinct index column for tracking purpose Later
df.insert (0,"idx",df.index)
df
```

Out[337]:

	idx	website	review_text	tokenized_text
0	0	cnn	399iPhone lives upto the hype. The new 399 iPhone SE looks like a...	["iPhone SE review: Apple's 399iPhone lives upto the hype., The new 399 iPhone SE looks like...
1	1	cnet	.In a normal year, the process of reviewing a new iPhone might start with a flashy press event f...	[.In a normal year, the process of reviewing a new iPhone might start with a flashy press event ...
2	2	techradar	"iPhone SE (2020) review. The 2020 iPhone SE is lightweight, cheap and future-proofed - well don...	["iPhone SE (2020) review., The 2020 iPhone SE is lightweight, cheap and future-proofed - well d...
3	3	digitaltrends	.Light, compact design. Class-leading performance. Loud, enjoyable audio. Great camera. iOS is e...	[.Light, compact design., Class-leading performance., Loud, enjoyable audio., Great camera., iOS...
4	4	pcmag	.For the past few years, phonemakers have said that if you want a small phone, you must have sma...	[.For the past few years, phonemakers have said that if you want a small phone, you must have sm...
5	5	trustedreviews	Even at launch, the Apple iPhone SE wasn't the most exciting phone that the company ever release...	[Even at launch, the Apple iPhone SE wasn't the most exciting phone that the company ever releas...

Flatten DataFrame to get every sentence in separate lines

```
In [338]: sent = df.tokenized_text.apply(pd.Series)\
            .melt() \
            .dropna().reset_index().drop(["index", "variable"], axis=1)

# All the sentences. Ready for opinion extraction.
sent
```

Out[338]:

	value
0	"iPhone SE review: Apple's \$399 iPhone lives up to the hype.
1	.In a normal year, the process of reviewing a new iPhone might start with a flashy press event f...
2	"iPhone SE (2020) review.
3	.Light, compact design.
4	.For the past few years, phonemakers have said that if you want a small phone, you must have sma...
...	...
707	Should you buy it.
708	Yes.
709	The iPhone SE is a solid entry-level iPhone.
710	You can buy a better device, but you don't need a better device.
711	If you, like me, consider a smartphone to be just one of many gadgets you could spend money on, ...

712 rows × 1 columns

Convert tokenized sentences into nlp objects

```
In [339]: sent['nlp'] = sent['value'].apply(lambda x: nlp(x))
sent.loc[sent.index == 225]
```

Out[339]:

	value	nlp
225	That's a difference you'll easily notice, and I complained that the G Stylus felt too heavy and ...	(That, 's, a, difference, you, 'll, easily, notice, ,, and, I, complained, that, the, G, Stylus,...

Perform lemmatization for each word in sentence

```
In [340]: sent['lemma'] = sent['nlp'].apply(lambda x: [word.lemma_ for word in x])
sent
```

Out[340]:

	value	nlp	lemma
0	"iPhone SE review: Apple's \$399 iPhone lives up to the hype.	(" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, lives, up, to, the, hype, .)	[" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, live, up, to, the, hype, .]
1	.In a normal year, the process of reviewing a new iPhone might start with a flashy press event f...	(.In, a, normal, year, ,, the, process, of, reviewing, a, new, iPhone, might, start, with, a, fl...	[.In, a, normal, year, ,, the, process, of, review, a, new, iPhone, may, start, with, a, flashy,...
2	"iPhone SE (2020) review.	(" iPhone, SE, (, 2020,), review, .)	[" iPhone, SE, (, 2020,), review, .]
3	.Light, compact design.	(.Light, ,, compact, design, .)	[.Light, ,, compact, design, .]
4	.For the past few years, phonemakers have said that if you want a small phone, you must have sma...	(.For, the, past, few, years, ,, phonemakers, have, said, that, if, you, want, a, small, phone, ...	[.For, the, past, few, year, ,, phonemaker, have, say, that, if, -PRON-, want, a, small, phone, ...
...
707	Should you buy it.	(Should, you, buy, it, .)	[Should, -PRON-, buy, -PRON-, .]
708	Yes.	(Yes, .)	[yes, .]
709	The iPhone SE is a solid entry-level iPhone.	(The, iPhone, SE, is, a, solid, entry, -, level, iPhone, .)	[the, iPhone, SE, be, a, solid, entry, -, level, iPhone, .]
710	You can buy a better device, but you don't need a better device.	(You, can, buy, a, better, device, ,, but, you, do, n't, need, a, better, device, .)	[-PRON-, can, buy, a, well, device, ,, but, -PRON-, do, not, need, a, well, device, .]
711	If you, like me, consider a smartphone to be just one of many gadgets you could spend money on, ...	(If, you, ,, like, me, ,, consider, a, smartphone, to, be, just, one, of, many, gadgets, you, co...	[if, -PRON-, ,, like, -PRON-, ,, consider, a, smartphone, to, be, just, one, of, many, gadget, -...

712 rows × 3 columns

POS Tagging for corpus

```
In [341]: sent['pos'] = sent['nlp'].apply(lambda x: [(i,i.tag_) for i in x])
sent
```

Out[341]:

	value	nlp	lemma	pos
0	"iPhone SE review: Apple's \$399 iPhone lives up to the hype.	(" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, lives, up, to, the, hype, .)	[" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, live, up, to, the, hype, .]	[(" ", ``), (iPhone, NNP), (SE, NNP), (review, NN), (:, :), (Apple, NNP), ('s, POS), (,), (399,...
1	.In a normal year, the process of reviewing a new iPhone might start with a flashy press event f...	(.In, a, normal, year, ,, the, process, of, reviewing, a, new, iPhone, might, start, with, a, fl...	[.In, a, normal, year, ,, the, process, of, review, a, new, iPhone, may, start, with, a, flashy...	[(.In, NFP), (a, DT), (normal, JJ), (year, NN), (, ,), (the, DT), (process, NN), (of, IN), (rev...
2	"iPhone SE (2020) review.	(" iPhone, SE, (, 2020,), review, .)	[" iPhone, SE, (, 2020,), review, .]	[(" ", ``), (iPhone, NNP), (SE, NNP), ((, -LRB-), (2020, CD), (, -RRB-), (review, NN), (, .)]
3	.Light, compact design.	(.Light, ,, compact, design, .)	[.Light, ,, compact, design, .]	[(.Light, NFP), (, ,), (compact, JJ), (design, NN), (, .)]
4	.For the past few years, phonemakers have said that if you want a small phone, you must have sma...	(.For, the, past, few, years, ,, phonemakers, have, said, that, if, you, want, a, small, phone, ...	[.For, the, past, few, year, ,, phonemaker, have, say, that, if, -PRON-, want, a, small, phone, ...	[(.For, NFP), (the, DT), (past, JJ), (few, JJ), (years, NNS), (, ,), (phonemakers, NNS), (have,...
...
707	Should you buy it.	(Should, you, buy, it, .)	[Should, -PRON-, buy, -PRON-, .]	[(Should, MD), (you, PRP), (buy, VB), (it, PRP), (, .)]
708	Yes.	(Yes, .)	[yes, .]	[(Yes, UH), (, .)]
709	The iPhone SE is a solid entry-level iPhone.	(The, iPhone, SE, is, a, solid, entry, -, level, iPhone, .)	[the, iPhone, SE, be, a, solid, entry, -, level, iPhone, .]	[(The, DT), (iPhone, NNP), (SE, NNP), (is, VBZ), (a, DT), (solid, JJ), (entry, NN), (-, HYPH), (...
710	You can buy a better device, but you don't need a better device.	(You, can, buy, a, better, device, ,, but, you, do, n't, need, a, better, device, .)	[-PRON-, can, buy, a, well, device, ,, but, -PRON-, do, not, need, a, well, device, .]	[(You, PRP), (can, MD), (buy, VB), (a, DT), (better, JJR), (device, NN), (, ,), (but, CC), (you...
711	If you, like me, consider a smartphone to be just one of many gadgets you could spend money on, ...	(If, you, ,, like, me, ,, consider, a, smartphone, to, be, just, one, of, many, gadgets, you, co...	[if, -PRON-, ,, like, -PRON-, ,, consider, a, smartphone, to, be, just, one, of, many, gadget, -...	[(If, IN), (you, PRP), (, ,), (like, IN), (me, PRP), (, ,), (consider, VB), (a, DT), (smartpho...

712 rows × 4 columns

TF-IDF calculations

In [342]: *# Create a copy of the dataframe*

```
d1 = sent
d1
```

Out[342]:

	value	nlp	lemma	pos
0	"iPhone SE review: Apple's \$399 iPhone lives up to the hype.	(" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, lives, up, to, the, hype, .)	[" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, live, up, to, the, hype, .]	[(" ", ``), (iPhone, NNP), (SE, NNP), (review, NN), (:, :), (Apple, NNP), ('s, POS), (., .), (399,...
1	.In a normal year, the process of reviewing a new iPhone might start with a flashy press event f...	(.In, a, normal, year, ,, the, process, of, reviewing, a, new, iPhone, might, start, with, a, fl...	[.In, a, normal, year, ,, the, process, of, review, a, new, iPhone, may, start, with, a, flashy...	[(.In, NFP), (a, DT), (normal, JJ), (year, NN), (., .), (the, DT), (process, NN), (of, IN), (rev...
2	"iPhone SE (2020) review.	(" iPhone, SE, (, 2020,), review, .)	[" iPhone, SE, (, 2020,), review, .]	[(" ", ``), (iPhone, NNP), (SE, NNP), ((, -LRB-), (2020, CD), (.), -RRB-), (review, NN), (., .)]
3	.Light, compact design.	(.Light, ,, compact, design, .)	[.Light, ,, compact, design, .]	[(.Light, NFP), (., .), (compact, JJ), (design, NN), (., .)]
4	.For the past few years, phonemakers have said that if you want a small phone, you must have sma...	(.For, the, past, few, years, ,, phonemakers, have, said, that, if, you, want, a, small, phone, ...	[.For, the, past, few, year, ,, phonemaker, have, say, that, if, -PRON-, want, a, small, phone, ...	[(.For, NFP), (the, DT), (past, JJ), (few, JJ), (years, NNS), (., .), (phonemakers, NNS), (have,...
...
707	Should you buy it.	(Should, you, buy, it, .)	[Should, -PRON-, buy, -PRON-, .]	[(Should, MD), (you, PRP), (buy, VB), (it, PRP), (., .)]
708	Yes.	(Yes, .)	[yes, .]	[(Yes, UH), (., .)]
709	The iPhone SE is a solid entry-level iPhone.	(The, iPhone, SE, is, a, solid, entry, -, level, iPhone, .)	[the, iPhone, SE, be, a, solid, entry, -, level, iPhone, .]	[(The, DT), (iPhone, NNP), (SE, NNP), (is, VBZ), (a, DT), (solid, JJ), (entry, NN), (-, HYPH), (...
710	You can buy a better device, but you don't need a better device.	(You, can, buy, a, better, device, ,, but, you, do, n't, need, a, better, device, .)	[-PRON-, can, buy, a, well, device, ,, but, -PRON-, do, not, need, a, well, device, .]	[(You, PRP), (can, MD), (buy, VB), (a, DT), (better, JJR), (device, NN), (., .), (but, CC), (you...
711	If you, like me, consider a smartphone to be just one of many gadgets you could spend money on, ...	(If, you, ,, like, me, ,, consider, a, smartphone, to, be, just, one, of, many, gadgets, you, co...	[if, -PRON-, ,, like, -PRON-, ,, consider, a, smartphone, to, be, just, one, of, many, gadget, -...	[(If, IN), (you, PRP), (., .), (like, IN), (me, PRP), (., .), (consider, VB), (a, DT), (smartpho...

712 rows × 4 columns

In [343]: *# Split sentences into words for idf calculations*

```
d1['words'] = d1.value.str.strip().str.split('[\W_]+')
```

In [344]: dl

Out[344]:

	value	nlp	lemma	pos	words
0	"iPhone SE review: Apple's \$399 iPhone lives up to the hype.	(" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, lives, up, to, the, hype, .)	[" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, live, up, to, the, hype, .]	[(" ", ``), (iPhone, NNP), (SE, NNP), (review, NN), (:, :), (Apple, NNP), ('s, POS), (,), (399,...	[iPhone, SE, review, Apple, s, 399, iPhone, lives, up, to, the, hype,]
1	.In a normal year, the process of reviewing a new iPhone might start with a flashy press event f...	(.In, a, normal, year, ,, the, process, of, reviewing, a, new, iPhone, might, start, with, a, fl...	[.In, a, normal, year, ,, the, process, of, review, a, new, iPhone, may, start, with, a, flashy,...	[(.In, NFP), (a, DT), (normal, JJ), (year, NN), (, ,), (the, DT), (process, NN), (of, IN), (rev...	[In, a, normal, year, the, process, of, reviewing, a, new, iPhone, might, start, with, a, flas...
2	"iPhone SE (2020) review.	(" iPhone, SE, (, 2020,), review, .)	[" iPhone, SE, (, 2020,), review, .]	[(" ", ``), (iPhone, NNP), (SE, NNP), ((, -LRB-), (2020, CD), (,), -RRB-), (review, NN), (, ., .)]	[iPhone, SE, 2020, review,]
3	.Light, compact design.	(.Light, ,, compact, design, .)	[.Light, ,, compact, design, .]	[(.Light, NFP), (, , ,), (compact, JJ), (design, NN), (, ., .)]	[Light, compact, design,]
4	.For the past few years, phonemakers have said that if you want a small phone, you must have sma...	(.For, the, past, few, years, ,, phonemakers, have, said, that, if, you, want, a, small, phone, ...	[.For, the, past, few, year, ,, phonemaker, have, say, that, if, -PRON-, want, a, small, phone, ...	[(.For, NFP), (the, DT), (past, JJ), (few, JJ), (years, NNS), (, , ,), (phonemakers, NNS), (have,...	[For, the, past, few, years, phonemakers, have, said, that, if, you, want, a, small, phone, yo...
...
707	Should you buy it.	(Should, you, buy, it, .)	[Should, -PRON-, buy, -PRON-, .]	[(Should, MD), (you, PRP), (buy, VB), (it, PRP), (, ., .)]	[Should, you, buy, it,]
708	Yes.	(Yes, .)	[yes, .]	[(Yes, UH), (, ., .)]	[Yes,]
709	The iPhone SE is a solid entry-level iPhone.	(The, iPhone, SE, is, a, solid, entry, -, level, iPhone, .)	[the, iPhone, SE, be, a, solid, entry, -, level, iPhone, .]	[(The, DT), (iPhone, NNP), (SE, NNP), (is, VBZ), (a, DT), (solid, JJ), (entry, NN), (-, HYPH), (...	[The, iPhone, SE, is, a, solid, entry, level, iPhone,]
710	You can buy a better device, but you don't need a better device.	(You, can, buy, a, better, device, ,, but, you, do, n't, need, a, better, device, .)	[-PRON-, can, buy, a, well, device, ,, but, -PRON-, do, not, need, a, well, device, .]	[(You, PRP), (can, MD), (buy, VB), (a, DT), (better, JJR), (device, NN), (, , ,), (but, CC), (you...	[You, can, buy, a, better, device, but, you, don, t, need, a, better, device,]
711	If you, like me, consider a smartphone to be just one of many gadgets you could spend money on, ...	(If, you, ,, like, me, ,, consider, a, smartphone, to, be, just, one, of, many, gadgets, you, co...	[if, -PRON-, ,, like, -PRON-, ,, consider, a, smartphone, to, be, just, one, of, many, gadget, -...	[(If, IN), (you, PRP), (, , ,), (like, IN), (me, PRP), (, , ,), (consider, VB), (a, DT), (smartpho...	[If, you, like, me, consider, a, smartphone, to, be, just, one, of, many, gadgets, you, could, s...

712 rows × 5 columns

In [345]: # Create a words List with the correct POS tagging

```
dl['idx'] = dl.index
rows = list()
for row in dl[['idx', 'pos']].iterrows():
    r = row[1]
    # print(r.pos)
    for index,word in enumerate(r.pos):
        rows.append((r.idx, word[0],word[1]))

words = pd.DataFrame(rows, columns=['idx', 'word', 'pos'])
words.to_csv("word.csv")
```

In [346]:

```
words
```

Out[346]:

	idx	word	pos
0	0	"	``
1	0	iPhone	NNP
2	0	SE	NNP
3	0	review	NN
4	0	:	:
...
16699	711	a	DT
16700	711	lot	NN
16701	711	of	IN
16702	711	sense	NN
16703	711	.	.

16704 rows × 3 columns

In [347]:

```
# convert words to lower case for matching with corresponding tf-idf calculations
words['word'] = words['word'].apply(lambda x: str(x).lower())
words.head()
```

Out[347]:

	idx	word	pos
0	0	"	``
1	0	iphone	NNP
2	0	se	NNP
3	0	review	NN
4	0	:	:

In [348]:

```
# Copy of dataframe to be used later
word_pos = words.copy() # here we keep a copy of the word/pos dataframe for merging later with our tf-idf calculations
```

In [349]:

```
word_pos
```

Out[349]:

	idx	word	pos
0	0	"	``
1	0	iphone	NNP
2	0	se	NNP
3	0	review	NN
4	0	:	:
...
16699	711	a	DT
16700	711	lot	NN
16701	711	of	IN
16702	711	sense	NN
16703	711	.	.

16704 rows × 3 columns

```
In [350]: # Calculation of TF-IDF

counts = words.groupby('idx')\
    .word.value_counts()\
    .to_frame()\
    .rename(columns={'word': 'n_w'})

word_sum = counts.groupby(level=0)\
    .sum()\
    .rename(columns={'n_w': 'n_d'})

tf = counts.join(word_sum)

tf['tf'] = tf.n_w/tf.n_d

c_d = words.idx.nunique()

idf = words.groupby('word')\
    .idx\
    .nunique()\
    .to_frame()\
    .rename(columns={'idx': 'i_d'})\
    .sort_values('i_d')

idf['idf'] = np.log(c_d/idf.i_d.values)

tf_idf = tf.join(idf)

tf_idf['tf_idf'] = tf_idf.tf * tf_idf.idf

tf_idf.sort_values(by='idf')

idf = tf_idf[['idf']]
idf['word'] = idf.index
idf['words'] = idf.word.apply(lambda x: x[1])
idf = idf.drop(columns=['word'],axis=1)
idf = idf.reset_index()
idf = idf.drop(columns=['words', 'idx'],axis=1)
idf = idf.sort_values(by='idf',ascending=True)
idf = idf.drop_duplicates()
```

Combining TF-IDF and POS tagged word list

```
In [351]: tf_idf
```

```
Out[351]:
```

		n_w	n_d	tf	i_d	idf	tf_idf
idx	word						
0	iphone	2	16	0.125000	293	0.887905	0.110988
	"	1	16	0.062500	7	4.622168	0.288885
	\$	1	16	0.062500	36	2.984559	0.186535
	's	1	16	0.062500	70	2.319583	0.144974
	.	1	16	0.062500	702	0.014145	0.000884
...
711	sense	1	35	0.028571	4	5.181784	0.148051
	smartphone	1	35	0.028571	13	4.003129	0.114375
	spend	1	35	0.028571	3	5.469466	0.156270
	the	1	35	0.028571	505	0.343519	0.009815
	to	1	35	0.028571	232	1.121341	0.032038

14719 rows × 6 columns

In [352]: word_pos

Out[352]:

	idx	word	pos
0	0	"	``
1	0	iphone	NNP
2	0	se	NNP
3	0	review	NN
4	0	:	:
...
16699	711	a	DT
16700	711	lot	NN
16701	711	of	IN
16702	711	sense	NN
16703	711	.	.

16704 rows × 3 columns

In [353]: combined = word_pos.join(tf_idf, on=['idx', 'word'], how='left')
combined

Out[353]:

	idx	word	pos	n_w	n_d	tf	i_d	idf	tf_idf
0	0	"	``	1	16	0.062500	7	4.622168	0.288885
1	0	iphone	NNP	2	16	0.125000	293	0.887905	0.110988
2	0	se	NNP	1	16	0.062500	249	1.050625	0.065664
3	0	review	NN	1	16	0.062500	5	4.958640	0.309915
4	0	:	:	1	16	0.062500	29	3.200782	0.200049
...
16699	711	a	DT	2	35	0.057143	294	0.884498	0.050543
16700	711	lot	NN	1	35	0.028571	15	3.860028	0.110287
16701	711	of	IN	2	35	0.057143	198	1.279811	0.073132
16702	711	sense	NN	1	35	0.028571	4	5.181784	0.148051
16703	711	.	.	1	35	0.028571	702	0.014145	0.000404

16704 rows × 9 columns

```
In [354]: # Clean up NaN
combined.dropna()
```

Out[354]:

	idx	word	pos	n_w	n_d	tf	i_d	idf	tf_idf
0	0	"	"	1	16	0.062500	7	4.622168	0.288885
1	0	iphone	NNP	2	16	0.125000	293	0.887905	0.110988
2	0	se	NNP	1	16	0.062500	249	1.050625	0.065664
3	0	review	NN	1	16	0.062500	5	4.958640	0.309915
4	0	:	:	1	16	0.062500	29	3.200782	0.200049
...
16699	711	a	DT	2	35	0.057143	294	0.884498	0.050543
16700	711	lot	NN	1	35	0.028571	15	3.860028	0.110287
16701	711	of	IN	2	35	0.057143	198	1.279811	0.073132
16702	711	sense	NN	1	35	0.028571	4	5.181784	0.148051
16703	711	.	.	1	35	0.028571	702	0.014145	0.000404

16704 rows × 9 columns

Extract Sentiment Keywords

```
In [355]: sentiment_keywords = combined[combined['pos'].str.startswith(("JJ", "RB"), na = False)]
sentiment_keywords
```

Out[355]:

	idx	word	pos	n_w	n_d	tf	i_d	idf	tf_idf
18	1	normal	JJ	1	40	0.025000	7	4.622168	0.115554
26	1	new	JJ	1	40	0.025000	78	2.211369	0.055284
32	1	flashy	JJ	1	40	0.025000	1	6.568078	0.164202
38	1	later	RB	1	40	0.025000	3	5.469466	0.136737
41	1	carefully	RB	1	40	0.025000	1	6.568078	0.164202
...
16657	710	better	JJR	2	16	0.125000	25	3.349202	0.418650
16663	710	n't	RB	1	16	0.062500	80	2.186051	0.136628
16666	710	better	JJR	2	16	0.125000	25	3.349202	0.418650
16680	711	just	RB	1	35	0.028571	31	3.134091	0.089545
16683	711	many	JJ	1	35	0.028571	17	3.734865	0.106710

2423 rows × 9 columns

```
In [356]: sentiment_keywords.sort_values(by='idf')
```

Out[356]:

	idx	word	pos	n_w	n_d	tf	i_d	idf	tf_idf
1820	87	in	RB	1	37	0.027027	160	1.492904	0.040349
10941	421	-	JJ	1	11	0.090909	140	1.626435	0.147858
14642	593	-	JJ	1	20	0.050000	140	1.626435	0.081322
14681	594	-	JJ	5	41	0.121951	140	1.626435	0.198346
14805	602	-	JJ	1	25	0.040000	140	1.626435	0.065057
...
15208	625	dual	JJ	1	26	0.038462	1	6.568078	0.252618
4035	166	accurately	RB	1	23	0.043478	1	6.568078	0.285569
1746	84	mediocre	JJ	1	5	0.200000	1	6.568078	1.313616
15289	629	unfortunately	RB	1	22	0.045455	1	6.568078	0.298549
14006	552	wayward	JJ	1	17	0.058824	1	6.568078	0.386358

2423 rows × 9 columns

```
In [357]: sentiment_keywords.to_csv("sent_key.csv")
```

Filtering by IDF > 2.4

311	14557	492	as	RB	1	99	0.010101	92	2.394926	0.024191
312	15614	522	as	RB	2	44	0.045455	92	2.394926	0.10886
313	17776	597	as	RB	1	91	0.010989	92	2.394926	0.026318
314	21651	783	as	RB	2	13	0.153846	92	2.394926	0.36845
315	21664	784	as	RB	2	13	0.153846	92	2.394926	0.36845
316	22486	831	as	RB	2	22	0.090909	92	2.394926	0.217721
317	22508	832	as	RB	2	22	0.090909	92	2.394926	0.217721
318	227	3	not	RB	2	87	0.022989	90	2.416905	0.055561
319	252	3	not	RB	2	87	0.022989	90	2.416905	0.055561
320	314	4	not	RB	2	87	0.022989	90	2.416905	0.055561
321	339	4	not	RB	2	87	0.022989	90	2.416905	0.055561
322	529	9	not	RB	1	56	0.017857	90	2.416905	0.043159
323	1364	37	not	RB	1	56	0.017857	90	2.416905	0.043159
324	1808	50	not	RB	1	44	0.022727	90	2.416905	0.05493
325	2238	65	not	RB	2	21	0.095238	90	2.416905	0.230181
326	2253	65	not	RB	2	21	0.095238	90	2.416905	0.230181

```
In [358]: sentiment_keywords = sentiment_keywords.loc[sentiment_keywords.idf > 2.4]
          sentiment_keywords
```

Out[358]:

	idx	word	pos	n_w	n_d	tf	i_d	idf	tf_idf
18	1	normal	JJ	1	40	0.025000	7	4.622168	0.115554
32	1	flashy	JJ	1	40	0.025000	1	6.568078	0.164202
38	1	later	RB	1	40	0.025000	3	5.469466	0.136737
41	1	carefully	RB	1	40	0.025000	1	6.568078	0.164202
47	1	professional	JJ	1	40	0.025000	1	6.568078	0.164202
...
16647	709	solid	JJ	1	11	0.090909	10	4.265493	0.387772
16657	710	better	JJR	2	16	0.125000	25	3.349202	0.418650
16666	710	better	JJR	2	16	0.125000	25	3.349202	0.418650
16680	711	just	RB	1	35	0.028571	31	3.134091	0.089545
16683	711	many	JJ	1	35	0.028571	17	3.734865	0.106710

2221 rows x 9 columns

Generate Word Cloud

```
In [359]: word_cloud = WordCloud().generate(' '.join(sentiment_keywords['word']))
```

```
In [360]: import matplotlib.pyplot as plt
```

```
plt.figure(figsize = (20,20))
plt.imshow(word_cloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



```
In [361]: unique_keywords = pd.DataFrame(sentiment_keywords['word'].unique())
unique_keywords
```

Out[361]:

	0
0	normal
1	flashy
2	later
3	carefully
4	professional
...	...
594	seriously
595	wild
596	lovely
597	cohesive
598	sizable

599 rows × 1 columns

```
In [362]: keywords = sentiment_keywords['word'].unique()  
keywords
```

```
Out[362]: array(['normal', 'flashy', 'later', 'carefully', 'professional',
'perfectly', 'compact', 'past', 'few', 'small', 'even', "n't",
'most', 'exciting', 'ever', 'top', 'virtual', 'front', 'anxiously',
'lightweight', 'cheap', 'proofed', 'just', 'true', 'neat', 'large',
'last', 'truly', 'typical', 'loud', 'enjoyable', 'big', 'now',
'hard', 'once', 'more', 'affordable', 'surprisingly', 'similar',
'yet', 'decent', 'not', 'then', 'good', 'enough', 'great',
'lighter', 'current', 'many', 'careful', 'also', 'midrange',
'still', 'very', 'alright', 'original', 'lower', 'better',
'overall', 'smart', 'best', 'excellent', 'nuts', 'increasingly',
'simpler', 'handed', 'smallest', 'cheapest', 'currently', 'long',
'rather', 'less', 'well', 'smaller', 'favorite', 'white', 'black',
'red', 'back', 'ok', 'here', 'quick', 'same', 'easily', 'old',
'familiar', 'recently', 'before', 'complete', 'fresh', 'solid',
'recent', 'pocketable', 'latest', 'hardly', 'first', 'rear',
'average', 'so', 'far', 'only', 'open', 'pleasingly', 'resistant',
'older', 'headphone', 'slightly', 'bright', 'like', 'essentially',
'identical', 'poor', 'much', 'improved', 'notably', 'inside',
'nearly', 'everywhere', 'really', 'usual', 'pro', 'level',
'arguably', 'powerful', 'quite', 'off', 'super', 'easy', 'else',
'a13', 'too', 'discernible', 'single', 'lazy', 'obsolete',
'physical', 'little', 'available', 'harder', 'ready', 'mediocre',
'exactly', 'intentionally', 'second', 'precise', 'odd',
'indisputable', 'least', 'expensive', 'important', 'no', 'matter',
'visible', 'beveled', 'shiny', 'classic', 'especially',
'impressive', 'dark', 'gray', 'alone', 'probably', 'biggest',
'particularly', 'light', 'awkward', 'clever', 'immediately',
'practically', 'hungry', 'there', 'pretty', '6s', 'bigger', 'away',
'faster', 'cheaper', 'modern', 'simple', 'majorly', 'oddly',
'prescient', 'appropriate', 'however', 'high', 'happy', 'brighter',
'richer', 'higher', 'vibrant', 'likely', 'future', 'ios', 'after',
'all', 'facial', 'daily', 'refined', 'useful', 'splendid',
'everyday', 'nice', 'usable', 'real', 'surprising', 'full', 'fat',
'wisely', 'pre', 'live', 'low', 'chunky', 'about', 'previously',
'tiny', 'thick', 'massive', 'other', 'easier', 'amazing', 'below',
'slim', 'maximum', 'frustrating', 'almost', 'fetching', 'primary',
'differently', 'iconic', 'attractive', 'fantastic', 'certainly',
'social', 'larger', 'quickly', 'various', 'wonderful', 'ago',
'whole', 'firmly', 'never', 'sometimes', 'brushed', 'cool',
'regardless', 'physically', 'newer', 'though', 'comfortable',
'actually', 'safely', 'giant', 'able', 'again', 'nostalgic',
'barely', 'premium', 'jealously', 'always', 'difficult',
'accurately', 'closer', 'above', 'indeed', 'unfair', 'ironically',
'often', 'embarrassing', 'intact', 'immersive', 'worse', 'heavier',
'thankfully', 'bad', 'adequate', 'spectacular', 'used', 'thrilled',
'extra', 'zoom', 'archaic', 'desirable', 'sleek', 'clear',
'cramped', 'precisely', 'daintier', 'ugly', 'clickable', 'haptic',
'extended', 'tall', 'wide', 'lightest', 'notable', 'half',
'taller', 'wider', 'thicker', 'free', 'unlocked', 'perfect',
'dated', 'crisp', 'beefy', 'harsh', 'rounded', 'contemporary',
'strange', 'noticeably', 'lacking', 'slow', 'wireless',
'different', 'automatic', 'mostly', 'unused', 'right', 'anyway',
'already', 'basic', 'european', 'creatively', 'rich', 'fine',
'heavy', 'dead', 'exact', 'meanwhile', 'nearby', 'critical',
'home', 'huge', 'fancy', 'sharp', 'reddish', 'instead', 'obvious',
'silly', '5s', 'speedy', 'double', 'hugely', 'up', 'strong',
'negative', 'possible', 'slight', 'acceptable', 'outdoors',
'fuzzy', 'own', 'latter', 'short', 'consistently', 'significant',
'lightly', 'outstanding', 'portable', 'widely', 'appetite',
'external', 'nigh', 'down', 'audio', 'balanced', 'thin', 'highest',
'computational', 'call', 'accurate', 'sunny', 'serious',
'flawless', 'distracting', 'quicker', 'subtle', 'perhaps',
'louder', 'windy', 'graphically', 'intensive', 'at', 'normally',
'noteworthy', 'interesting', 'clearly', 'intuitive', 'benchmark',
'newest', 'raw', 'proprietary', 'generally', 'striking', 'sure',
'longer', 'interested', 'absolute', 'regular', 'multi', 'touch',
'animated', 'apart', 'looped', 'grand', 'instantly', 'somewhat',
'mobile', 'frequent', 'close', 'third', 'anecdotally', 'straight',
'key', 'undeniably', 'next', 'elsewhere', 'rigid', 'early',
'handsomely', 'general', 'realistic', 'flexible', 'myriad', 'fast',
'basically', 'sapphire', 'simply', 'necessary', 'slower', 'f/1.8',
```

```
'bionic', 'efficient', 'quiet', 'standard', 'continuously',
'sharpness', 'darker', 'main', 'warm', 'visually', 'appealing',
'nimble', 'peppy', 'understandable', 'constrained', 'such',
'together', 'particular', 'massively', 'smarthdr', 'usually',
'grainy', 'impressionist', 'f1.8', 'ultrawide', 'f/2.4', 'direct',
'superb', 'worth', 'additional', 'ultra', '2x', 'viable',
'considerably', 'aforementioned', 'android', 'complex', 'middling',
'terrible', 'tighter', 'algorithmically', 'frequently', 'robust',
'behemothic', 'mid', 'relative', 'mild', 'impressed', 'deep',
'worst', 'willing', 'relatively', 'smarter', 'dazzling', 'muffled',
'simultaneously', 'medium', 'clean', 'smooth', 'closely',
'unnatural', 'blurred', 'optical', 'secret', 'out', 'natural',
'slick', 'nicer', 'potential', 'stellar', 'pleasing', 'outdoor',
'bottom', 'neutral', 'prone', 'dramatic', 'practical', 'mixed',
'regularly', 'flat', 'largely', 'excessive', 'indoor', 'overnight',
'standby', 'comfortably', 'definitely', 'dynamic', 'blue',
'finicky', 'rapidly', 'empty', 'around', 'capable', 'mo', 'noisy',
'subpar', 'eventually', 'plenty', 'ideal', 'responsive',
'significantly', 'popular', 'novel', 'surprised', 'downright',
'weighty', 'partly', 'strongest', 'mightily', 'stereotypical',
'merely', 'punchy', 'inexpensive', 'functional', 'stunning',
'suddenly', 'awesome', 'special', 'entirely', 'curly', 'common',
'plus', 'fortunately', 'evident', 'cloudy', 'comparable', 'fro',
'aggressive', 'wayward', 'lush', 'overly', 'hearty', 'sharper',
'commonly', 'steady', 'casual', 'snappy', 'semi', 'equivalent',
'core', 'supersonic', 'range', 'deeper', 'podcast', 'unnecessary',
'annoying', 'constantly', 'die', 'dual', 'local', 'unfortunately',
'personal', '3d', 'earlier', 'forth', 'preferable', 'secure',
'pointless', 'previous', 'pure', 'fluid', 'monthly', 'seriously',
'wild', 'lovely', 'cohesive', 'sizable'], dtype=object)
```

```
In [363]: sentiments = pd.DataFrame(sent['value'])
sentiments
```

Out[363]:

	value
0	"iPhone SE review: Apple's \$399 iPhone lives up to the hype.
1	.In a normal year, the process of reviewing a new iPhone might start with a flashy press event f...
2	"iPhone SE (2020) review.
3	.Light, compact design.
4	.For the past few years, phonemakers have said that if you want a small phone, you must have sma...
...	...
707	Should you buy it.
708	Yes.
709	The iPhone SE is a solid entry-level iPhone.
710	You can buy a better device, but you don't need a better device.
711	If you, like me, consider a smartphone to be just one of many gadgets you could spend money on, ...

712 rows × 1 columns

```
In [364]: # our dataframe
import string
sentiments['value'] = sentiments['value'].apply(lambda x: x.translate(str.maketrans('', '', string.punctuation)))
```

```
In [365]: def contains_keyword(value):
wrds = value.split()
for wrd in wrds:
    if (wrd in keywords):
        return 1
return 0
```



```
In [366]: # Test of above function
contains_keyword("This is not a car")
```

```
Out[366]: 1
```

```
In [367]: sentiments['value'] = sentiments['value'].apply(lambda x: str(x).lower())
sentiments
```

```
Out[367]:
```

	value
0	iphone se review apples 399 iphone lives up to the hype
1	in a normal year the process of reviewing a new iphone might start with a flashy press event fol...
2	iphone se 2020 review
3	light compact design
4	for the past few years phonemakers have said that if you want a small phone you must have small ...
...	...
707	should you buy it
708	yes
709	the iphone se is a solid entrylevel iphone
710	you can buy a better device but you don't need a better device
711	if you like me consider a smartphone to be just one of many gadgets you could spend money on opt...

712 rows × 1 columns

```
In [368]: sentiments['has_keyword'] = sentiments['value'].apply(lambda x: contains_keyword(x))
sentiments
```

```
Out[368]:
```

	value	has_keyword
0	iphone se review apples 399 iphone lives up to the hype	1
1	in a normal year the process of reviewing a new iphone might start with a flashy press event fol...	1
2	iphone se 2020 review	0
3	light compact design	1
4	for the past few years phonemakers have said that if you want a small phone you must have small ...	1
...
707	should you buy it	0
708	yes	0
709	the iphone se is a solid entrylevel iphone	1
710	you can buy a better device but you don't need a better device	1
711	if you like me consider a smartphone to be just one of many gadgets you could spend money on opt...	1

712 rows × 2 columns

```
In [369]: sentiments.loc[sentiments.has_keyword == 0]
```

```
Out[369]:
```

		value	has_keyword
2		iphone se 2020 review	0
9		classleading performance	0
25		the new lowercost iphone se	0
49		the new iphone se goes on sale in shanghai china	0
66		iphone 11 prolevel performance	0
105		as a tech reviewer you might expect me to upgrade my gear every year	0
111		i don't	0
145		this is apples secondgeneration iphone se	0
153		i have for years	0
208		it supports lte bands 123458121317181920252629	0
276		the iphone se is rated ip67 for water and dust resistance	0
337		let me put it another way	0
391		i do enjoy the ultrawideangle on the iphone 11 but i didnt miss it during my time with the iphon...	0
407		can you tell the difference	0
411		you see my point	0
441		the 11 can capture portrait mode photos of both people and pets	0
443		it's a singlelens system with a 12mp shooter	0
452		and you know what	0
497		should i buy the iphone se	0
504		i can't fault the iphone se's lowlight performance	0
526		the iphone se has a 7mp frontfacing camera and it didn't impress me	0
558		you might wonder what 4 years of progress will get you	0
560		a lot	0
573		you can find that on some competing phones	0
587		apple's decision to buy pa	0
590		the iphone se is a testament to that	0
592		that's paired with 3gb of ram	0
607		i have nothing to add	0
610		you can upgrade to 128gb for 450 or you can choose 256gb of storage for 550	0
614		i think a lot of people can get by with the 64gb model	0
618		i don't recommend the 256gb model	0
621		the iphone se isn't a 5g phone	0
627		a 1821mah battery powers the iphone se	0
647		it's the phone's killer feature	0
655		it's the phone's killer feature	0
671		apple ships the iphone se with a oneyear limited warranty	0
673		you can purchase added protection through applecare which extends the warranty and covers some a...	0
674		applecare is 80 for 24 months of coverage or you can pay monthtomonth for 4	0
676		i don't recommend applecare for this phone	0
698		some shoppers will consider the iphone 11	0
703		the iphone se is a fiveyear phone	0
707		should you buy it	0
708		yes	0

Training a Naive Bayes Classifier to detect possibility of sentiment

```
In [370]: import nltk
          from nltk.corpus import stopwords
          from sklearn.feature_extraction.text import TfidfVectorizer
          from sklearn.model_selection import train_test_split
          from sklearn import naive_bayes
          from sklearn.metrics import roc_auc_score, accuracy_score
          nltk.download('stopwords')
```

```
[nltk_data] Downloading package stopwords to
[nltk_data] C:\Users\vchacko\AppData\Roaming\nltk_data...
[nltk_data] Package stopwords is already up-to-date!
```

Out[370]: True

```
In [371]: stopset = set(stopwords.words('english'))
          vectorizer = TfidfVectorizer(use_idf=True, lowercase=True, strip_accents='ascii', stop_words=stopset)
```

```
In [372]: y = sentiments.has_keyword
          x = vectorizer.fit_transform(sentiments.value)
```

```
print(y.shape)
print(x.shape)
```

```
(712,)
(712, 2324)
```

```
In [373]: # Create test train split
          xtrain, xtest, ytrain, ytest = train_test_split(x,y,random_state=0, test_size=0.1)

          # Training a Naive Bayes Classifier
          model = naive_bayes.MultinomialNB()
          model.fit(xtrain, ytrain)

          # Test accuracy
          # roc_auc_score(ytest, model.predict_proba(xtest)[:,:1])
          accuracy_score(ytest,model.predict(xtest))
```

Out[373]: 0.9444444444444444

```
In [374]: sentiments['pred'] = sentiments['value'].apply(lambda x: model.predict_proba(vectorizer.transform(np.array([x])))[0][1])
sentiments['class'] = sentiments['value'].apply(lambda x: model.predict(vectorizer.transform(np.array([x])))[0])
sentiments
```

Out[374]:

		value	has_keyword	pred	class
0		iphone se review apples 399 iphone lives up to the hype	1	0.971239	1
1		in a normal year the process of reviewing a new iphone might start with a flashy press event fol...	1	0.856489	1
2		iphone se 2020 review	0	0.974499	1
3		light compact design	1	0.985533	1
4		for the past few years phonemakers have said that if you want a small phone you must have small ...	1	0.982842	1
...	
707		should you buy it	0	0.917491	1
708		yes	0	0.909846	1
709		the iphone se is a solid entrylevel iphone	1	0.980405	1
710		you can buy a better device but you don't need a better device	1	0.989123	1
711		if you like me consider a smartphone to be just one of many gadgets you could spend money on opt...	1	0.989501	1

712 rows × 4 columns

```
In [375]: sentiments.loc[sentiments['has_keyword'] == 0]
```

```
Out[375]:
```

		value	has_keyword	pred	class
2		iphone se 2020 review	0	0.974499	1
9		classleading performance	0	0.880328	1
25		the new lowercost iphone se	0	0.955912	1
49		the new iphone se goes on sale in shanghai china	0	0.882920	1
66		iphone 11 prolevel performance	0	0.948877	1
105		as a tech reviewer you might expect me to upgrade my gear every year	0	0.816746	1
111		i don't	0	0.948818	1
145		this is apples secondgeneration iphone se	0	0.941824	1
153		i have for years	0	0.948060	1
208		it supports lte bands 123458121317181920252629	0	0.850763	1
276		the iphone se is rated ip67 for water and dust resistance	0	0.883701	1
337		let me put it another way	0	0.918842	1
391		i do enjoy the ultrawideangle on the iphone 11 but i didnt miss it during my time with the iphon...	0	0.976097	1
407		can you tell the difference	0	0.893585	1
411		you see my point	0	0.918021	1
441		the 11 can capture portrait mode photos of both people and pets	0	0.986077	1
443		it's a singlelens system with a 12mp shooter	0	0.859015	1
452		and you know what	0	0.914095	1
497		should i buy the iphone se	0	0.971094	1
504		i can't fault the iphone se's lowlight performance	0	0.959654	1
526		the iphone se has a 7mp frontfacing camera and it didn't impress me	0	0.957972	1
558		you might wonder what 4 years of progress will get you	0	0.891623	1
560		a lot	0	0.941093	1
573		you can find that on some competing phones	0	0.963626	1
587		apple's decision to buy pa	0	0.831704	1
590		the iphone se is a testament to that	0	0.919839	1
592		that's paired with 3gb of ram	0	0.937503	1
607		i have nothing to add	0	0.917439	1
610		you can upgrade to 128gb for 450 or you can choose 256gb of storage for 550	0	0.772102	1
614		i think a lot of people can get by with the 64gb model	0	0.972004	1
618		i don't recommend the 256gb model	0	0.894553	1
621		the iphone se isn't a 5g phone	0	0.984028	1
627		a 1821mah battery powers the iphone se	0	0.930011	1
647		it's the phone's killer feature	0	0.859570	1
655		it's the phone's killer feature	0	0.859570	1
671		apple ships the iphone se with a oneyear limited warranty	0	0.862249	1
673		you can purchase added protection through applecare which extends the warranty and covers some a...	0	0.582954	1
674		applecare is 80 for 24 months of coverage or you can pay monthtomonth for 4	0	0.699181	1
676		i don't recommend applecare for this phone	0	0.893642	1
698		some shoppers will consider the iphone 11	0	0.934458	1
703		the iphone se is a fiveyear phone	0	0.953202	1
707		should you buy it	0	0.917491	1
708		yes	0	0.909846	1

```
In [376]: sentiments.to_csv("sentiments.csv")

sentiments.sort_values(by='pred')
```

Out[376]:

		value	has_keyword	pred	class
673	you can purchase added protection through applecare which extends the warranty and covers some a...		0	0.582954	1
674	applecare is 80 for 24 months of coverage or you can pay monthtomonth for 4		0	0.699181	1
610	you can upgrade to 128gb for 450 or you can choose 256gb of storage for 550		0	0.772102	1
105	as a tech reviewer you might expect me to upgrade my gear every year		0	0.816746	1
587	apple's decision to buy pa		0	0.831704	1
...
569	the new iphone se has a great smartphone camera		1	0.997460	1
187	the new iphone se in redthe iphone se only has one rear camera lens compared to the two youll fi...		1	0.997470	1
264	the screen on the se is similar to the one on the iphone 11 especially in terms of quality and r...		1	0.997530	1
107	yet there's no getting away from the fact that the iphone se is now a little old and the iphone ...		1	0.997702	1
194	one suspects that if apple had rebooted the original iphone se shape with the smaller 4inch scre...		1	0.997794	1

712 rows × 4 columns

Extract Opinion Triggers

Here we focus of nouns only also known as Functional Opinion Triggers

```

In [377]: # rows = list()
# sent['idx'] = sent.index
# for row in sent[['idx', 'pos']].iterrows():
#     r = row[1]
#     print(r.pos)\
#     current = ""
#     for index,word in enumerate(r.pos):
#         if(word[1].startswith('NN')):
#             current = current + " " + str(word[0])
#         elif(len(current)>0):
#             rows.append(current)
#             current = ""

#     print(word[1])
#     rows.append((r.idx, word[0],word[1]))
# noun = pd.DataFrame(rows,columns=['nouns'])
# # noun = pd.DataFrame(noun['nouns'].unique(), columns=['nouns'])
# noun

rows = list()
sent['idx'] = sent.index
for row in sent[['idx', 'pos']].iterrows():
    r = row[1]
    # print(r.pos)\
    current = ""
    for index,word in enumerate(r.pos):
        if(word[1].startswith('NN')):
            rows.append(word[0])

#     print(word[1])
#     rows.append((r.idx, word[0],word[1]))
noun = pd.DataFrame(rows,columns=['nouns'])
# noun = pd.DataFrame(noun['nouns'].unique(), columns=['nouns'])
noun

```

Out[377]:

	nouns
0	iPhone
1	SE
2	review
3	Apple
4	iPhone
...	...
3928	gadgets
3929	money
3930	SE
3931	lot
3932	sense

3933 rows × 1 columns

```
In [378]: noun['count'] = 1
noun
```

Out[378]:

	nouns	count
0	iPhone	1
1	SE	1
2	review	1
3	Apple	1
4	iPhone	1
...
3928	gadgets	1
3929	money	1
3930	SE	1
3931	lot	1
3932	sense	1

3933 rows × 2 columns

```
In [379]: noun['nouns'] = noun['nouns'].apply(lambda x: str(x).lower())
noun
```

Out[379]:

	nouns	count
0	iphone	1
1	se	1
2	review	1
3	apple	1
4	iphone	1
...
3928	gadgets	1
3929	money	1
3930	se	1
3931	lot	1
3932	sense	1

3933 rows × 2 columns

```
In [380]: noun = noun.groupby('nouns').count()
```



```
In [381]: noun = noun.sort_values(by='count', ascending=False)
noun.head(20)
```

Out[381]:

	count
nouns	
iphone	400
se	261
phone	90
apple	88
camera	60
screen	51
phones	46
photos	36
battery	34
performance	28
price	28
design	27
video	26
mode	25
power	25
years	24
people	23
life	23
display	23
quality	23

```
In [ ]:
```

Naive Bayes to find Opinion Triggers

This is defined in the following excerpt from the research paper

Naïve Bayes classifier is a supervised machine learning methodology based on the assumption that each probability distribution is independent of each other. Bayes theory, which is a theoretical base of Naïve Bayes classifier is used to calculate the conditional probability that is hard to calculate using other conditional probability. [Eq \(1\)](#) shows the basic formula of Bayes theory:

$$P(A|B) = \frac{P(B|A) \times P(A)}{P(B)} = \frac{P(A \cap B)}{P(B)} \quad (1)$$

According to the definition of opinion trigger, the words used when users express their opinions can be an opinion trigger. It can be defined as $P(\text{Words} | \text{Opinion Sentence})$. In Bayes formula, $P(\text{Words} | \text{Opinion Sentence})$ and $P(\text{Words} | \text{Non-opinion Sentence})$ could be obtained using Eqs (2) and (3). If a word has a higher $P(\text{Word} | \text{Opinion sentence})$ than $P(\text{Word} | \text{Non-opinion Sentence})$, the word can be identified as an opinion trigger. This means that the word occurs more frequently in opinion sentences than non-opinion sentences. Logically, sentimental keywords always have high probability. However, sentimental keywords do not contain “what they want” or “how it works”. Thus, except sentimental keywords, the keyword that has high $P(\text{Word} | \text{Opinion sentence})$ can be identified as an opinion trigger.

$$P(\text{Word} | \text{Opinion Sentence}) = \frac{P(\text{Opinion sentence} | \text{Word}) \times P(\text{Word})}{P(\text{Opinion sentence})} \quad (2)$$

$$P(\text{Word} | \text{Non - opinion Sentence}) = \frac{P(\text{Non - opinion sentence} | \text{Word}) \times P(\text{Word})}{P(\text{Non - opinion sentence})} \quad (3)$$

Fourth, the identified opinion triggers are classified into function opinion trigger (FOT) and object opinion trigger (OOT). As mentioned above, the needs of users can be constructed with adjective/adverb, verb, and noun. Since adjective or adverb are defined as a sentimental keyword, verb and noun should be defined to construct user opinions. As an opinion trigger is defined using the probability of each word, POS-tagging in natural language processing can be used to define the verb and noun in opinions. Thus, an opinion trigger formed as a verb can be defined as FOT, while an opinion trigger formed as a noun can be defined as OOT.

Since this is a very unique case, we could calculate all the probabilities ourselves.

In our corpus, which contains 1009 sentences and out of which 71 are classified as non-sentiment.

```
In [382]: #Given our Opinion Keywords
noun.head(20)
```

Out[382]:

	count
nouns	
iphone	400
se	261
phone	90
apple	88
camera	60
screen	51
phones	46
photos	36
battery	34
performance	28
price	28
design	27
video	26
mode	25
power	25
years	24
people	23
life	23
display	23
quality	23

We can now pull up all the adjectives and adverbs used commonly with the above opinion triggers.

```
In [383]: dl.pos
```

```
Out[383]: 0      [("'", ``), (iPhone, NNP), (SE, NNP), (review, NN), (:, :), (Apple, NNP), ('s, POS), ($, $), (39
9,...
1      [(.In, NFP), (a, DT), (normal, JJ), (year, NN), (,, ), (the, DT), (process, NN), (of, IN), (r
ev...
2      [("'", ``), (iPhone, NNP), (SE, NNP), ((, -LRB-), (2020, CD), (, -RRB-), (review, NN),
(., .)]
3      [(.Light, NFP), (,, ), (compact, JJ), (design, NN),
(., .)]
4      [(.For, NFP), (the, DT), (past, JJ), (few, JJ), (years, NNS), (,, ), (phonemakers, NNS), (hav
e,...

707      ...
      [(Should, MD), (you, PRP), (buy, VB), (it, PRP),
(., .)]
708      [(Yes, UH),
(., .)]
709      [(The, DT), (iPhone, NNP), (SE, NNP), (is, VBZ), (a, DT), (solid, JJ), (entry, NN), (-, HYPH),
(...)
710      [(You, PRP), (can, MD), (buy, VB), (a, DT), (better, JJR), (device, NN), (,, ), (but, CC), (y
ou...
711      [(If, IN), (you, PRP), (,, ), (like, IN), (me, PRP), (,, ), (consider, VB), (a, DT), (smartp
ho...
Name: pos, Length: 712, dtype: object
```

Here we would calculate given a noun what is the list of sentiment keywords used with this and calculate their frequency. A higher frequency of keyword would be more relevant than of a lower value.

In [384]:

d1

Out[384]:

	value	nlp	lemma	pos	words	idx
0	"iPhone SE review: Apple's \$399 iPhone lives up to the hype.	(" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, lives, up, to, the, hype, .)	[" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, live, up, to, the, hype, .]	[((" , ``), (iPhone, NNP), (SE, NNP), (review, NN), (:, :), (Apple, NNP), ('s, POS), (,), (399,...	[iPhone, SE, review, Apple, s, 399, iPhone, lives, up, to, the, hype,]	0
1	.In a normal year, the process of reviewing a new iPhone might start with a flashy press event f...	(.In, a, normal, year, ,, the, process, of, reviewing, a, new, iPhone, might, start, with, a, fl...	[.In, a, normal, year, ,, the, process, of, review, a, new, iPhone, may, start, with, a, flashy,...	[(.In, NFP), (a, DT), (normal, JJ), (year, NN), (, ,, .), (the, DT), (process, NN), (of, IN), (rev...	[In, a, normal, year, the, process, of, reviewing, a, new, iPhone, might, start, with, a, flas...	1
2	"iPhone SE (2020) review.	(" iPhone, SE, (, 2020,), review, .)	[" iPhone, SE, (, 2020,), review, .]	[((" , ``), (iPhone, NNP), (SE, NNP), ((, -LRB-), (2020, CD), (,), -RRB-), (review, NN), (, . .)]	[iPhone, SE, 2020, review,]	2
3	.Light, compact design.	(.Light, ,, compact, design, .)	[.Light, ,, compact, design, .]	[(.Light, NFP), (, ,, .), (compact, JJ), (design, NN), (, . .)]	[Light, compact, design,]	3
4	.For the past few years, phonemakers have said that if you want a small phone, you must have sma...	(.For, the, past, few, years, ,, phonemakers, have, said, that, if, you, want, a, small, phone, ...	[.For, the, past, few, year, ,, phonemaker, have, say, that, if, -PRON-, want, a, small, phone, ...	[(.For, NFP), (the, DT), (past, JJ), (few, JJ), (years, NNS), (, ,, .), (phonemakers, NNS), (have,...	[For, the, past, few, years, phonemakers, have, said, that, if, you, want, a, small, phone, yo...	4
...
707	Should you buy it.	(Should, you, buy, it, .)	[Should, -PRON-, buy, -PRON-, .]	[(Should, MD), (you, PRP), (buy, VB), (it, PRP), (, . .)]	[Should, you, buy, it,]	707
708	Yes.	(Yes, .)	[yes, .]	[(Yes, UH), (, . .)]	[Yes,]	708
709	The iPhone SE is a solid entry-level iPhone.	(The, iPhone, SE, is, a, solid, entry, -, level, iPhone, .)	[the, iPhone, SE, be, a, solid, entry, -, level, iPhone, .]	[(The, DT), (iPhone, NNP), (SE, NNP), (is, VBZ), (a, DT), (solid, JJ), (entry, NN), (-, HYPH), (...	[The, iPhone, SE, is, a, solid, entry, level, iPhone,]	709
710	You can buy a better device, but you don't need a better device.	(You, can, buy, a, better, device, ,, but, you, do, n't, need, a, better, device, .)	[-PRON-, can, buy, a, well, device, ,, but, -PRON-, do, not, need, a, well, device, .]	[(You, PRP), (can, MD), (buy, VB), (a, DT), (better, JJR), (device, NN), (, ,, .), (but, CC), (you...	[You, can, buy, a, better, device, but, you, don, t, need, a, better, device,]	710
711	If you, like me, consider a smartphone to be just one of many gadgets you could spend money on, ...	(If, you, ,, like, me, ,, consider, a, smartphone, to, be, just, one, of, many, gadgets, you, co...	[if, -PRON-, ,, like, -PRON-, ,, consider, a, smartphone, to, be, just, one, of, many, gadget, -...	[(If, IN), (you, PRP), (, ,, .), (like, IN), (me, PRP), (, ,, .), (consider, VB), (a, DT), (smartpho...	[If, you, like, me, consider, a, smartphone, to, be, just, one, of, many, gadgets, you, could, s...	711

712 rows × 6 columns

```
In [385]: # Testing the size of longest sentence
tempdf = pd.DataFrame(d1.words, columns=['words'])
tempdf
```

Out[385]:

	words
0	[, iPhone, SE, review, Apple, s, 399, iPhone, lives, up, to, the, hype,]
1	[, In, a, normal, year, the, process, of, reviewing, a, new, iPhone, might, start, with, a, flas...
2	[, iPhone, SE, 2020, review,]
3	[, Light, compact, design,]
4	[, For, the, past, few, years, phonemakers, have, said, that, if, you, want, a, small, phone, yo...
...	...
707	[Should, you, buy, it,]
708	[Yes,]
709	[The, iPhone, SE, is, a, solid, entry, level, iPhone,]
710	[You, can, buy, a, better, device, but, you, don, t, need, a, better, device,]
711	[If, you, like, me, consider, a, smartphone, to, be, just, one, of, many, gadgets, you, could, s...

712 rows × 1 columns

```
In [386]: tempdf['length'] = tempdf.words.apply(lambda x: len(x))
tempdf.sort_values(by='length')
```

Out[386]:

	words	length
708	[Yes,]	2
147	[Certainly,]	2
606	[Not, here,]	3
35	[Great, camera,]	3
48	[Affordable, price,]	3
...
424	[But, when, you, consider, the, relative, cost, of, the, phones, and, the, fact, that, the, new,...	69
272	[Apple, looks, to, have, implemented, some, serious, performance, improvements, while, keeping, ...	70
112	[These, are, high, quality, LCDs, that, have, made, hundreds, of, millions, of, people, happy, o...	71
505	[The, iPhone, SE, from, 2016, was, popular, because, it, offered, something, novel, at, the, tim...	73
194	[One, suspects, that, if, Apple, had, rebooted, the, original, iPhone, SE, shape, with, the, sma...	76

712 rows × 2 columns

```
In [387]: tempdf.to_csv("temp.csv")
```

In [388]: noun

Out[388]:

	count
nouns	
iphone	400
se	261
phone	90
apple	88
camera	60
...	...
changes	1
champion	1
mono	1
cash	1
luxury	1

1016 rows × 1 columns

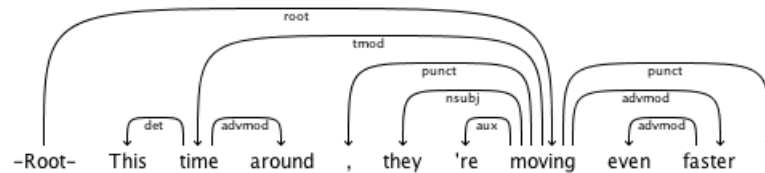
In [389]: noun.index

Out[389]: Index(['iphone', 'se', 'phone', 'apple', 'camera', 'screen', 'phones',
'photos', 'battery', 'performance',
...,
'chat', 'moons', 'mistake', 'mistakes', 'chargers', 'changes',
'champion', 'mono', 'cash', 'luxury'],
dtype='object', name='nouns', length=1016)

In [390]: dl['value'].apply(lambda x: x.lower())

Out[390]: 0 "iphone se review: apple's \$399 iphone lives up to the
hype.
1 .in a normal year, the process of reviewing a new iphone might start with a flashy press event
f...
2 "iphone se (2020) re
view.
3 .light, compact de
sign.
4 .for the past few years, phonemakers have said that if you want a small phone, you must have s
ma...
...
707 should you bu
y it.
708
yes.
709 the iphone se is a solid entry-level ip
hone.
710 you can buy a better device, but you don't need a better de
vice.
711 if you, like me, consider a smartphone to be just one of many gadgets you could spend money o
n, ...
Name: value, Length: 712, dtype: object

Dependency Parsing



<https://nlp.stanford.edu/software/nndep.html> (<https://nlp.stanford.edu/software/nndep.html>)

Danqi Chen and Christopher Manning. 2014. A Fast and Accurate Dependency Parser Using Neural Networks. In Proceedings of EMNLP 2014.

```
In [391]: # !pip install stanza
```

```
import stanza
stanza.download('en') # download English model
nlp = stanza.Pipeline('en') # initialize English neural pipeline
doc = nlp("Barack Obama was born in Hawaii. He was elected president in 2008.")
doc.sentences[0].print_dependencies()
```

```
Downloading https://raw.githubusercontent.com/stanfordnlp/stanza-resources/master/resources_1.0.0.json: 116kB [00:00, 3.32MB/s]
```

```
2020-04-30 00:13:16 INFO: Downloading default packages for language: en (English)...
```

```
2020-04-30 00:13:17 INFO: File exists: C:\Users\vchacko\stanza_resources\en\default.zip.
```

```
2020-04-30 00:13:21 INFO: Finished downloading models and saved to C:\Users\vchacko\stanza_resources.
```

```
2020-04-30 00:13:21 INFO: Loading these models for language: en (English):
```

```
=====
| Processor | Package |
|-----|
| tokenize | ewt     |
| pos      | ewt     |
| lemma    | ewt     |
| depparse | ewt     |
| ner      | ontonotes |
=====
```

```
2020-04-30 00:13:21 INFO: Use device: gpu
```

```
2020-04-30 00:13:21 INFO: Loading: tokenize
```

```
2020-04-30 00:13:21 INFO: Loading: pos
```

```
2020-04-30 00:13:22 INFO: Loading: lemma
```

```
2020-04-30 00:13:22 INFO: Loading: depparse
```

```
2020-04-30 00:13:23 INFO: Loading: ner
```

```
2020-04-30 00:13:24 INFO: Done loading processors!
```

```
('Barack', '4', 'nsubj:pass')
('Obama', '1', 'flat')
('was', '4', 'aux:pass')
('born', '0', 'root')
('in', '6', 'case')
('Hawaii', '4', 'obl')
('.', '4', 'punct')
```



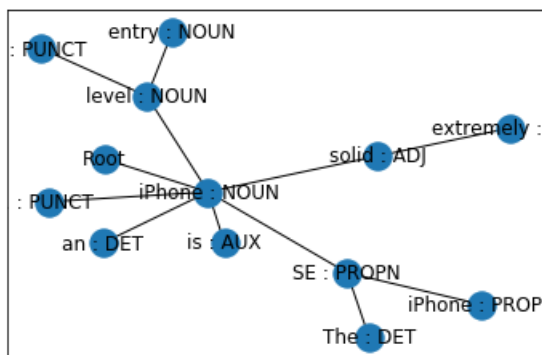
```
In [392]: doc = nlp("The iPhone SE is an extremely solid entry-level iPhone.")
# doc.sentences[0].print_dependencies()
# print(doc.sentences[0].dependencies)
# for word in doc.sentences[0].words:
#     print(f'word: {word.text}\tparent token: {word.parent.text}')
nodes = []
edges = []
print(*[f'id: {word.id}\tword: {word.text}\thead id: {word.head}\thead: {sent.words[word.head-1].text
if word.head > 0 else "root"}\tdeprel: {word.deprel}' for sent in doc.sentences for word in sent.words], sep='\n')

#     print(line)
#     deprel_stack.append(word.deprel)

# print(array)
```

id: 1	word: The	head id: 3	head: SE	deprel: det
id: 2	word: iPhone	head id: 3	head: SE	deprel: compound
id: 3	word: SE	head id: 11	head: iPhone	deprel: nsubj
id: 4	word: is	head id: 11	head: iPhone	deprel: cop
id: 5	word: an	head id: 11	head: iPhone	deprel: det
id: 6	word: extremely	head id: 7	head: solid	deprel: advmod
id: 7	word: solid	head id: 11	head: iPhone	deprel: amod
id: 8	word: entry	head id: 10	head: level	deprel: compound
id: 9	word: -	head id: 10	head: level	deprel: punct
id: 10	word: level	head id: 11	head: iPhone	deprel: compound
id: 11	word: iPhone	head id: 0	head: root	deprel: root
id: 12	word: .	head id: 11	head: iPhone	deprel: punct

```
In [393]: # !pip install networkx
import networkx as nx
import matplotlib.pyplot as plt
G = nx.Graph()
# G.add_edge(1,2)
# G.add_edge(1,3)
mapping = {'0': 'Root'}
for sent in doc.sentences:
    for word in sent.words:
        G.add_edge(str(word.id),str(word.head))
        mapping.update({word.id : word.text + " : " + word.upos})
#     print(word)
#     line = [ , word.text, word.head, word.deprel]
#     array.append(line)
# print(mapping)
# print(G.nodes())
G = nx.relabel_nodes(G,mapping)
# print(G.nodes())
nx.draw_networkx(G, with_labels=True)
plt.show()
```



```
In [394]: # Given example
doc = nlp("iPhone SE is a great phone protector")

deprel_stack = []
for sent in doc.sentences:
    for word in sent.words:
        deprel_stack.append(word.deprel)

print(deprel_stack)
```

```
['compound', 'nsubj', 'cop', 'det', 'amod', 'compound', 'root']
```

```
In [395]: noun
```

Out[395]:

	count
nouns	
iphone	400
se	261
phone	90
apple	88
camera	60
...	...
changes	1
champion	1
mono	1
cash	1
luxury	1

1016 rows × 1 columns

In [396]:

dl

Out[396]:

	value	nlp	lemma	pos	words	idx
0	"iPhone SE review: Apple's \$399 iPhone lives up to the hype.	(" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, lives, up, to, the, hype, .)	[" iPhone, SE, review, :, Apple, 's, \$, 399, iPhone, live, up, to, the, hype, .]	[((" , ``), (iPhone, NNP), (SE, NNP), (review, NN), (:, :), (Apple, NNP), ('s, POS), (,), (399,...	[, iPhone, SE, review, Apple, s, 399, iPhone, lives, up, to, the, hype,]	0
1	.In a normal year, the process of reviewing a new iPhone might start with a flashy press event f...	(.In, a, normal, year, ,, the, process, of, reviewing, a, new, iPhone, might, start, with, a, fl...	[.In, a, normal, year, ,, the, process, of, review, a, new, iPhone, may, start, with, a, flashy,...	[(.In, NFP), (a, DT), (normal, JJ), (year, NN), (, ,, .), (the, DT), (process, NN), (of, IN), (rev...	[, In, a, normal, year, the, process, of, reviewing, a, new, iPhone, might, start, with, a, flas...	1
2	"iPhone SE (2020) review.	(" iPhone, SE, (, 2020,), review, .)	[" iPhone, SE, (, 2020,), review, .]	[((" , ``), (iPhone, NNP), (SE, NNP), ((, -LRB-), (2020, CD), (,), -RRB-), (review, NN), (, . .)]	[, iPhone, SE, 2020, review,]	2
3	.Light, compact design.	(.Light, ,, compact, design, .)	[.Light, ,, compact, design, .]	[(.Light, NFP), (, ,, .), (compact, JJ), (design, NN), (, . .)]	[, Light, compact, design,]	3
4	.For the past few years, phonemakers have said that if you want a small phone, you must have sma...	(.For, the, past, few, years, ,, phonemakers, have, said, that, if, you, want, a, small, phone, ...	[.For, the, past, few, year, ,, phonemaker, have, say, that, if, -PRON-, want, a, small, phone, ...	[(.For, NFP), (the, DT), (past, JJ), (few, JJ), (years, NNS), (, ,, .), (phonemakers, NNS), (have,...	[, For, the, past, few, years, phonemakers, have, said, that, if, you, want, a, small, phone, yo...	4
...
707	Should you buy it.	(Should, you, buy, it, .)	[Should, -PRON-, buy, -PRON-, .]	[(Should, MD), (you, PRP), (buy, VB), (it, PRP), (, . .)]	[Should, you, buy, it,]	707
708	Yes.	(Yes, .)	[yes, .]	[(Yes, UH), (, . .)]	[Yes,]	708
709	The iPhone SE is a solid entry-level iPhone.	(The, iPhone, SE, is, a, solid, entry, -, level, iPhone, .)	[the, iPhone, SE, be, a, solid, entry, -, level, iPhone, .]	[(The, DT), (iPhone, NNP), (SE, NNP), (is, VBZ), (a, DT), (solid, JJ), (entry, NN), (-, HYPH), (...	[The, iPhone, SE, is, a, solid, entry, level, iPhone,]	709
710	You can buy a better device, but you don't need a better device.	(You, can, buy, a, better, device, ,, but, you, do, n't, need, a, better, device, .)	[-PRON-, can, buy, a, well, device, ,, but, -PRON-, do, not, need, a, well, device, .]	[(You, PRP), (can, MD), (buy, VB), (a, DT), (better, JJR), (device, NN), (, ,, .), (but, CC), (you...	[You, can, buy, a, better, device, but, you, don, t, need, a, better, device,]	710
711	If you, like me, consider a smartphone to be just one of many gadgets you could spend money on, ...	(If, you, ,, like, me, ,, consider, a, smartphone, to, be, just, one, of, many, gadgets, you, co...	[if, -PRON-, ,, like, -PRON-, ,, consider, a, smartphone, to, be, just, one, of, many, gadget, -...	[(If, IN), (you, PRP), (, ,, .), (like, IN), (me, PRP), (, ,, .), (consider, VB), (a, DT), (smartpho...	[If, you, like, me, consider, a, smartphone, to, be, just, one, of, many, gadgets, you, could, s...	711

712 rows × 6 columns

```

In [397]: # for row in dl['value']:
rows = ["This Iphone SE is amazing", "Iphone is great phone from Best Buy.", "The Iphone SE II is coming next week"]

key = "Iphone"
for row in rows:
    doc = nlp(row)
    for sent in doc.sentences:
        for word in sent.words:
            if word.text == key:
                print("Found", word.id)

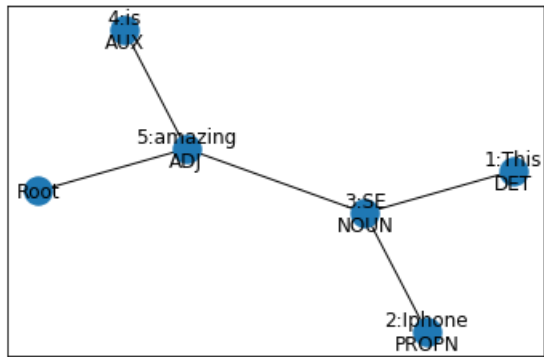
G = nx.Graph()
# G.add_edge(1,2)
# G.add_edge(1,3)
mapping = {'0': 'Root'}
for sent in doc.sentences:
    for word in sent.words:
        G.add_edge(str(word.id), str(word.head))
        mapping.update({word.id : word.id + ":" + word.text + "\n" + word.upos})
        print(*[f'id: {word.id}\tword: {word.text}\thead id: {word.head}\thead: {sent.words[word.h
ead-1].text if word.head > 0 else "root"}\tdeprel: {word.deprel}' for sent in doc.sentences for word i
n sent.words], sep='\n')
        # print(word)
        # line = [, word.text, word.head, word.deprel]
        # array.append(line)

# print(mapping)
# print(G.nodes())
G = nx.relabel_nodes(G, mapping)
# print(G.nodes())
nx.draw_networkx(G, with_labels=True)
plt.show()

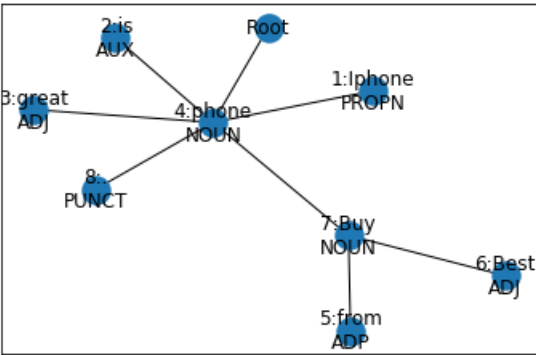
```

Found 2

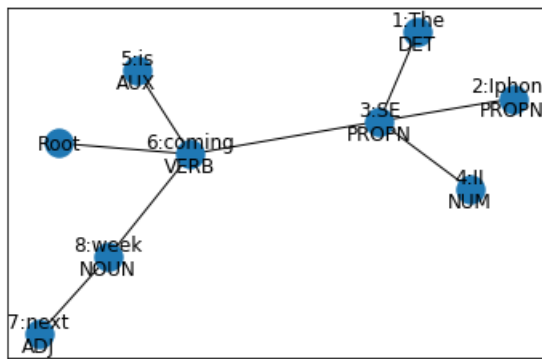
id: 1	word: This	head id: 3	head: SE	deprel: det
id: 2	word: Iphone	head id: 3	head: SE	deprel: compound
id: 3	word: SE	head id: 5	head: amazing	deprel: nsubj
id: 4	word: is	head id: 5	head: amazing	deprel: cop
id: 5	word: amazing	head id: 0	head: root	deprel: root
id: 1	word: This	head id: 3	head: SE	deprel: det
id: 2	word: Iphone	head id: 3	head: SE	deprel: compound
id: 3	word: SE	head id: 5	head: amazing	deprel: nsubj
id: 4	word: is	head id: 5	head: amazing	deprel: cop
id: 5	word: amazing	head id: 0	head: root	deprel: root
id: 1	word: This	head id: 3	head: SE	deprel: det
id: 2	word: Iphone	head id: 3	head: SE	deprel: compound
id: 3	word: SE	head id: 5	head: amazing	deprel: nsubj
id: 4	word: is	head id: 5	head: amazing	deprel: cop
id: 5	word: amazing	head id: 0	head: root	deprel: root
id: 1	word: This	head id: 3	head: SE	deprel: det
id: 2	word: Iphone	head id: 3	head: SE	deprel: compound
id: 3	word: SE	head id: 5	head: amazing	deprel: nsubj
id: 4	word: is	head id: 5	head: amazing	deprel: cop
id: 5	word: amazing	head id: 0	head: root	deprel: root



[illegible]



[illegible]



Using Word2Vec to identify needs

<https://www.geeksforgeeks.org/python-word-embedding-using-word2vec/> (<https://www.geeksforgeeks.org/python-word-embedding-using-word2vec/>)

```
In [398]: import warnings
# !pip install gensim
warnings.filterwarnings(action = 'ignore')

import gensim
from gensim.models import Word2Vec
```

```
In [399]: data = []
for i in dl['value']:
    tmp = []
    for j in word_tokenize(i):
        tmp.append(j.lower())
    data.append(tmp)

model1 = gensim.models.Word2Vec(data, window = 5, min_count = 1, iter = 1000)
model2 = gensim.models.Word2Vec(data, min_count = 1, window = 5, sg = 1, iter = 1000)
```

```
In [400]: noun
```

```
Out[400]:
```

	count
nouns	
iphone	400
se	261
phone	90
apple	88
camera	60
...	...
changes	1
champion	1
mono	1
cash	1
luxury	1

1016 rows × 1 columns

In [401]: *# Now we can test every noun with sentiment keyword*

```
noun['nouns'] = noun.index
# noun.reset_index()
# noun['idx'] = noun.reset_
noun
```

Out[401]:

	count	nouns
nouns		
iphone	400	iphone
se	261	se
phone	90	phone
apple	88	apple
camera	60	camera
...
changes	1	changes
champion	1	champion
mono	1	mono
cash	1	cash
luxury	1	luxury

1016 rows × 2 columns

In [402]:

```
keywords
```

```
Out[402]: array(['normal', 'flashy', 'later', 'carefully', 'professional',
'perfectly', 'compact', 'past', 'few', 'small', 'even', "n't",
'most', 'exciting', 'ever', 'top', 'virtual', 'front', 'anxiously',
'lightweight', 'cheap', 'proofed', 'just', 'true', 'neat', 'large',
'last', 'truly', 'typical', 'loud', 'enjoyable', 'big', 'now',
'hard', 'once', 'more', 'affordable', 'surprisingly', 'similar',
'yet', 'decent', 'not', 'then', 'good', 'enough', 'great',
'lighter', 'current', 'many', 'careful', 'also', 'midrange',
'still', 'very', 'alright', 'original', 'lower', 'better',
'overall', 'smart', 'best', 'excellent', 'nuts', 'increasingly',
'simpler', 'handed', 'smallest', 'cheapest', 'currently', 'long',
'rather', 'less', 'well', 'smaller', 'favorite', 'white', 'black',
'red', 'back', 'ok', 'here', 'quick', 'same', 'easily', 'old',
'familiar', 'recently', 'before', 'complete', 'fresh', 'solid',
'recent', 'pocketable', 'latest', 'hardly', 'first', 'rear',
'average', 'so', 'far', 'only', 'open', 'pleasingly', 'resistant',
'older', 'headphone', 'slightly', 'bright', 'like', 'essentially',
'identical', 'poor', 'much', 'improved', 'notably', 'inside',
'nearly', 'everywhere', 'really', 'usual', 'pro', 'level',
'arguably', 'powerful', 'quite', 'off', 'super', 'easy', 'else',
'a13', 'too', 'discernible', 'single', 'lazy', 'obsolete',
'physical', 'little', 'available', 'harder', 'ready', 'mediocre',
'exactly', 'intentionally', 'second', 'precise', 'odd',
'indisputable', 'least', 'expensive', 'important', 'no', 'matter',
'visible', 'beveled', 'shiny', 'classic', 'especially',
'impressive', 'dark', 'gray', 'alone', 'probably', 'biggest',
'particularly', 'light', 'awkward', 'clever', 'immediately',
'practically', 'hungry', 'there', 'pretty', '6s', 'bigger', 'away',
'faster', 'cheaper', 'modern', 'simple', 'majorly', 'oddly',
'prescient', 'appropriate', 'however', 'high', 'happy', 'brighter',
'richer', 'higher', 'vibrant', 'likely', 'future', 'ios', 'after',
'all', 'facial', 'daily', 'refined', 'useful', 'splendid',
'everyday', 'nice', 'usable', 'real', 'surprising', 'full', 'fat',
'wisely', 'pre', 'live', 'low', 'chunky', 'about', 'previously',
'tiny', 'thick', 'massive', 'other', 'easier', 'amazing', 'below',
'slim', 'maximum', 'frustrating', 'almost', 'fetching', 'primary',
'differently', 'iconic', 'attractive', 'fantastic', 'certainly',
'social', 'larger', 'quickly', 'various', 'wonderful', 'ago',
'whole', 'firmly', 'never', 'sometimes', 'brushed', 'cool',
'regardless', 'physically', 'newer', 'though', 'comfortable',
'actually', 'safely', 'giant', 'able', 'again', 'nostalgic',
'barely', 'premium', 'jealously', 'always', 'difficult',
'accurately', 'closer', 'above', 'indeed', 'unfair', 'ironically',
'often', 'embarrassing', 'intact', 'immersive', 'worse', 'heavier',
'thankfully', 'bad', 'adequate', 'spectacular', 'used', 'thrilled',
'extra', 'zoom', 'archaic', 'desirable', 'sleek', 'clear',
'cramped', 'precisely', 'daintier', 'ugly', 'clickable', 'haptic',
'extended', 'tall', 'wide', 'lightest', 'notable', 'half',
'taller', 'wider', 'thicker', 'free', 'unlocked', 'perfect',
'dated', 'crisp', 'beefy', 'harsh', 'rounded', 'contemporary',
'strange', 'noticeably', 'lacking', 'slow', 'wireless',
'different', 'automatic', 'mostly', 'unused', 'right', 'anyway',
'already', 'basic', 'european', 'creatively', 'rich', 'fine',
'heavy', 'dead', 'exact', 'meanwhile', 'nearby', 'critical',
'home', 'huge', 'fancy', 'sharp', 'reddish', 'instead', 'obvious',
'silly', '5s', 'speedy', 'double', 'hugely', 'up', 'strong',
'negative', 'possible', 'slight', 'acceptable', 'outdoors',
'fuzzy', 'own', 'latter', 'short', 'consistently', 'significant',
'lightly', 'outstanding', 'portable', 'widely', 'appetite',
'external', 'nigh', 'down', 'audio', 'balanced', 'thin', 'highest',
'computational', 'call', 'accurate', 'sunny', 'serious',
'flawless', 'distracting', 'quicker', 'subtle', 'perhaps',
'louder', 'windy', 'graphically', 'intensive', 'at', 'normally',
'noteworthy', 'interesting', 'clearly', 'intuitive', 'benchmark',
'newest', 'raw', 'proprietary', 'generally', 'striking', 'sure',
'longer', 'interested', 'absolute', 'regular', 'multi', 'touch',
'animated', 'apart', 'looped', 'grand', 'instantly', 'somewhat',
'mobile', 'frequent', 'close', 'third', 'anecdotally', 'straight',
'key', 'undeniably', 'next', 'elsewhere', 'rigid', 'early',
'handsomely', 'general', 'realistic', 'flexible', 'myriad', 'fast',
'basically', 'sapphire', 'simply', 'necessary', 'slower', 'f/1.8',
```

```
'bionic', 'efficient', 'quiet', 'standard', 'continuously',
'sharpness', 'darker', 'main', 'warm', 'visually', 'appealing',
'nimble', 'peppy', 'understandable', 'constrained', 'such',
'together', 'particular', 'massively', 'smarthdr', 'usually',
'grainy', 'impressionist', 'f1.8', 'ultrawide', 'f/2.4', 'direct',
'superb', 'worth', 'additional', 'ultra', '2x', 'viable',
'considerably', 'aforementioned', 'android', 'complex', 'middling',
'terrible', 'tighter', 'algorithmically', 'frequently', 'robust',
'behemothic', 'mid', 'relative', 'mild', 'impressed', 'deep',
'worst', 'willing', 'relatively', 'smarter', 'dazzling', 'muffled',
'simultaneously', 'medium', 'clean', 'smooth', 'closely',
'unnatural', 'blurred', 'optical', 'secret', 'out', 'natural',
'slick', 'nicer', 'potential', 'stellar', 'pleasing', 'outdoor',
'bottom', 'neutral', 'prone', 'dramatic', 'practical', 'mixed',
'regularly', 'flat', 'largely', 'excessive', 'indoor', 'overnight',
'standby', 'comfortably', 'definitely', 'dynamic', 'blue',
'finicky', 'rapidly', 'empty', 'around', 'capable', 'mo', 'noisy',
'subpar', 'eventually', 'plenty', 'ideal', 'responsive',
'significantly', 'popular', 'novel', 'surprised', 'downright',
'weighty', 'partly', 'strongest', 'mightily', 'stereotypical',
'merely', 'punchy', 'inexpensive', 'functional', 'stunning',
'suddenly', 'awesome', 'special', 'entirely', 'curly', 'common',
'plus', 'fortunately', 'evident', 'cloudy', 'comparable', 'fro',
'aggressive', 'wayward', 'lush', 'overly', 'hearty', 'sharper',
'commonly', 'steady', 'casual', 'snappy', 'semi', 'equivalent',
'core', 'supersonic', 'range', 'deeper', 'podcast', 'unnecessary',
'annoying', 'constantly', 'die', 'dual', 'local', 'unfortunately',
'personal', '3d', 'earlier', 'forth', 'preferable', 'secure',
'pointless', 'previous', 'pure', 'fluid', 'monthly', 'seriously',
'wild', 'lovely', 'cohesive', 'sizable'], dtype=object)
```

```
In [403]: threshold1 = 0.5
threshold2 = 0.4
def fetch_close_words(x, model):
    output = []
    for i in list(noun.nouns):
        try:
            if(model.similarity(x,i)>threshold1):
                output.append(i)
        except:
            pass
    return output

def fetch_keywords_words(x, model):
    output = []
    for i in keywords:
        try:
            if(model.similarity(x,i)>threshold2):
                output.append(i)
        except:
            pass
    return output
```

```
In [404]: word1 = "pixel"
word2 = "sheet"
print(model1.similarity(word1,word2))
print(model2.similarity(word1,word2))
print(model1.similarity(word1,word2))
print(model2.similarity(word1,word2))
```

```
0.36504087
0.42700535
0.36504087
0.42700535
```

```
In [405]: noun['model1'] = noun['nouns'].apply(lambda x: fetch_close_words(x,model1))
noun['model2'] = noun['nouns'].apply(lambda x: fetch_close_words(x,model2))
noun['k1'] = noun['nouns'].apply(lambda x: fetch_keywords_words(x,model1))
noun['k2'] = noun['nouns'].apply(lambda x: fetch_keywords_words(x,model2))
```

```
In [406]: noun.to_csv("wrd2vec.csv")
```

In [407]:

```
data
```

```

Out[407]: [['',
            'iphone',
            'se',
            'review',
            ':',
            'apple',
            '"s"',
            '$',
            '399',
            'iphone',
            'lives',
            'up',
            'to',
            'the',
            'hype',
            '.'],
            ['.in',
            'a',
            'normal',
            'year',
            ',',
            'the',
            'process',
            'of',
            'reviewing',
            'a',
            'new',
            'iphone',
            'might',
            'start',
            'with',
            'a',
            'flashy',
            'press',
            'event',
            'followed',
            'some',
            'days',
            'later',
            'by',
            'a',
            'carefully-staged',
            'unboxing',
            'while',
            'a',
            'professional',
            'camera',
            'rolls',
            'on',
            'a',
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            'composed',
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            '.'],
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            'years',
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            'you',
            'want',
            'a',
            'small',

```


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're',
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'that',
,',,
's',
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'the',
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'se',
'2020',
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'there',

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's',
'a',
'good',
'camera',
'',
'enough',
'power',
'',
'a',
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'app',
'store',
'to',
'plunder',
'and',
'a',
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'alternative',
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'is',
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'to',
'age',
,,
'and',
'some',
'upgraders',
'will',
'miss',
'the',
'headphone',
'jack',
,,
'but',
'overall',
,,
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'smart',
'improvements',
'make',
'this',
'-',
'for',
'the',
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```

```
In [408]: model1.similarity("iphone","samsung")
```

```
Out[408]: -0.04994742
```

```
In [409]: from sklearn.manifold import TSNE
model = model1
X = model[model.wv.vocab]
print(len(X))
print (X[0])
tsne = TSNE(n_components=2)
X_tsne = tsne.fit_transform(X[:1000,:])

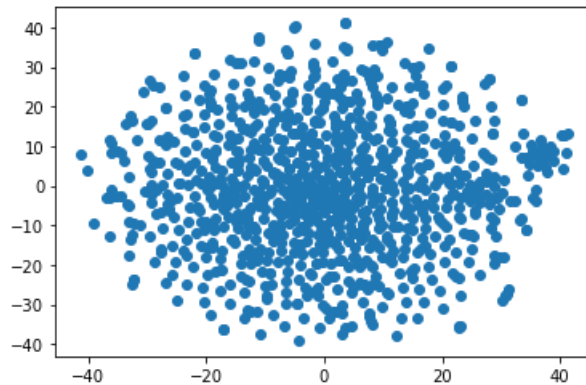
plt.scatter(X_tsne[:, 0], X_tsne[:, 1])
plt.show()

model = model2
X = model[model.wv.vocab]
print(len(X))
print (X[0])
tsne = TSNE(n_components=2)
X_tsne = tsne.fit_transform(X[:1000,:])

plt.scatter(X_tsne[:, 0], X_tsne[:, 1])
plt.show()
```

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```
[ -0.0359354  2.8285584  0.9428401 -0.06145262  4.822712  1.777114
  -0.9755715 -2.3513048  0.99365675  1.5926974 -0.48622593  1.4810592
   1.8893248 -0.36634547  0.33656844 -1.1350387  1.4172312  0.28811914
   0.46321908 -0.04957566  1.790237  3.9557943 -1.6846863  0.39264768
  -0.742688 -4.2024026 -1.154703 -1.1591271  3.2164698  2.1448824
   0.31677938 -2.266771  2.3757796 -2.044973 -0.7758362  1.150781
   1.119094 -0.5509997 -4.0982428  0.39502364  2.9987981  0.91802824
   0.9717246 -2.5371196 -1.423223 -0.23302068  0.20781782 -1.3405393
   0.21888964 -1.3877388  0.00890434 -0.34282783 -2.3406408  1.0170289
  -0.02958431 -1.0437697 -0.02397475 -2.8169277 -0.14280528  3.373782
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```



2468

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