06_sec_preprocessing

September 29, 2021

1 Word vectors from SEC filings using Gensim: Preprocessing

In this section, we will learn word and phrase vectors from annual SEC filings using gensim to illustrate the potential value of word embeddings for algorithmic trading. In the following sections, we will combine these vectors as features with price returns to train neural networks to predict equity prices from the content of security filings.

In particular, we use a dataset containing over 22,000 10-K annual reports from the period 2013-2016 that are filed by listed companies and contain both financial information and management commentary (see chapter 3 on Alternative Data). For about half of 11K filings for companies that we have stock prices to label the data for predictive modeling

1.1 Imports & Settings

[1]:

```
import warnings
warnings.filterwarnings('ignore')
```

[2]:

```
from dateutil.relativedelta import relativedelta
from pathlib import Path
import numpy as np
import pandas as pd
from time import time
from collections import Counter
import logging
import spacy

from gensim.models import Word2Vec
from gensim.models.word2vec import LineSentence
from gensim.models.phrases import Phrases, Phraser
```

[3]:

```
np.random.seed(42)
```

[4]:

```
def format_time(t):
    m, s = divmod(t, 60)
    h, m = divmod(m, 60)
    return f'{h:02.0f}:{m:02.0f}:{s:02.0f}'
```

1.1.1 Logging Setup

[5]:
```
logging.basicConfig(
        filename='preprocessing.log',
        level=logging.DEBUG,
        format='%(asctime)s - %(name)s - %(levelname)s - %(message)s',
        datefmt='%H:%M:%S')
```

1.2 Data Download

The data can be downloaded from here. Unzip and move into the `data` folder in the repository's root directory and rename to `filings`.

1.2.1 Paths

Each filing is a separate text file and a master index contains filing metadata. We extract the most informative sections, namely - Item 1 and 1A: Business and Risk Factors - Item 7 and 7A: Management's Discussion and Disclosures about Market Risks

The notebook preprocessing shows how to parse and tokenize the text using spaCy, similar to the approach in chapter 14. We do not lemmatize the tokens to preserve nuances of word usage.

We use gensim to detect phrases. The Phrases module scores the tokens and the Phraser class transforms the text data accordingly. The notebook shows how to repeat the process to create longer phrases.

[6]:
```
sec_path = Path('..', 'data', 'sec-filings')
filing_path = sec_path / 'filings'
sections_path = sec_path / 'sections'
```

[7]:
```
if not sections_path.exists():
    sections_path.mkdir(exist_ok=True, parents=True)
```

1.3 Identify Sections

[8]:
```
for i, filing in enumerate(filing_path.glob('*.txt'), 1):
    if i % 500 == 0:
        print(i, end=' ', flush=True)
    filing_id = int(filing.stem)
    items = {}
    for section in filing.read_text().lower().split('°'):
        if section.startswith('item '):
            if len(section.split()) > 1:
                item = section.split()[1].replace('.', '').replace(':', '').
↪replace(',', '')
                text = ' '.join([t for t in section.split()[2:]])
                if items.get(item) is None or len(items.get(item)) < len(text):
                    items[item] = text
    txt = pd.Series(items).reset_index()
    txt.columns = ['item', 'text']
    txt.to_csv(sections_path / (filing.stem + '.csv'), index=False)
```

```
500  1000  1500  2000  2500  3000  3500  4000  4500  5000  5500  6000  6500  7000  7500  8000
8500  9000  9500  10000  10500  11000  11500  12000  12500  13000  13500  14000  14500  15000
15500  16000  16500  17000  17500  18000  18500  19000  19500  20000  20500  21000  21500
22000  22500
```

1.4 Parse Sections

Select the following sections:

[9]:
```
sections = ['1', '1a', '7', '7a']
```

[9]:
```
clean_path = sec_path / 'selected_sections'
if not clean_path.exists():
    clean_path.mkdir(exist_ok=True)
```

[14]:
```
nlp = spacy.load('en', disable=['ner'])
nlp.max_length = 6000000
```

[16]:
```
vocab = Counter()
t = total_tokens = 0
stats = []

start = time()
to_do = len(list(sections_path.glob('*.csv')))
done = len(list(clean_path.glob('*.csv'))) + 1
for text_file in sections_path.glob('*.csv'):
    file_id = int(text_file.stem)
    clean_file = clean_path / f'{file_id}.csv'
    if clean_file.exists():
        continue
    items = pd.read_csv(text_file).dropna()
    items.item = items.item.astype(str)
    items = items[items.item.isin(sections)]
    if done % 100 == 0:
        duration = time() - start
        to_go = (to_do - done) * duration / done
        print(f'{done:>5}\t{format_time(duration)}\t{total_tokens / duration:,.
 ↪0f}\t{format_time(to_go)}')

    clean_doc = []
    for _, (item, text) in items.iterrows():
        doc = nlp(text)
        for s, sentence in enumerate(doc.sents):
            clean_sentence = []
            if sentence is not None:
                for t, token in enumerate(sentence, 1):
                    if not any([token.is_stop,
                                token.is_digit,
                                not token.is_alpha,
                                token.is_punct,
                                token.is_space,
                                token.lemma_ == '-PRON-',
                                token.pos_ in ['PUNCT', 'SYM', 'X']]):
                        clean_sentence.append(token.text.lower())
                total_tokens += t
                if len(clean_sentence) > 0:
                    clean_doc.append([item, s, ' '.join(clean_sentence)])
    (pd.DataFrame(clean_doc,
                  columns=['item', 'sentence', 'text'])
     .dropna()
     .to_csv(clean_file, index=False))
    done += 1
```

```
 100   00:02:38        18,125  09:53:45
 200   00:05:36        17,183  10:28:08
 300   00:08:30        16,514  10:32:46
 400   00:10:57        17,093  10:08:36
 500   00:13:21        17,482  09:50:42
 600   00:15:56        17,806  09:45:08
 700   00:18:33        18,003  09:41:23
 800   00:20:46        18,139  09:26:55
 900   00:23:07        18,262  09:18:06
1000   00:25:33        18,342  09:12:43
1100   00:27:51        18,425  09:05:06
1200   00:30:27        18,486  09:03:41
1300   00:33:05        18,536  09:02:49
1400   00:35:36        18,579  08:59:47
1500   00:38:15        18,621  08:58:47
1600   00:40:39        18,666  08:54:19
1700   00:42:57        18,714  08:48:44
1800   00:45:36        18,759  08:47:41
1900   00:47:52        18,805  08:42:17
2000   00:50:14        18,853  08:38:10
2100   00:52:23        18,879  08:32:06
2200   00:54:43        18,908  08:28:11
2300   00:57:17        18,908  08:26:20
2400   00:59:48        18,834  08:24:02
2500   01:01:56        18,868  08:18:43
2600   01:04:21        18,898  08:15:43
2700   01:06:23        18,924  08:10:03
```

2800	01:08:29	18,951	08:05:05
2900	01:10:42	18,981	08:01:03
3000	01:12:49	19,008	07:56:28
3100	01:15:12	19,030	07:53:45
3200	01:17:46	19,052	07:52:11
3300	01:20:04	19,074	07:49:02
3400	01:22:17	19,098	07:45:27
3500	01:24:32	19,117	07:42:03
3600	01:26:45	19,134	07:38:35
3700	01:28:52	19,151	07:34:43
3800	01:31:00	19,167	07:30:58
3900	01:33:15	19,189	07:27:52
4000	01:35:44	19,204	07:25:53
4100	01:37:58	19,217	07:22:49
4200	01:40:21	19,227	07:20:22
4300	01:42:40	19,241	07:17:39
4400	01:45:03	19,250	07:15:15
4500	01:47:19	19,258	07:12:23
4600	01:49:34	19,269	07:09:30
4700	01:51:51	19,277	07:06:45
4800	01:53:55	19,286	07:03:12
4900	01:56:07	19,298	07:00:11
5000	01:58:29	19,305	06:57:47
5100	02:00:38	19,316	06:54:42
5200	02:02:47	19,322	06:51:34
5300	02:04:53	19,328	06:48:21
5400	02:07:18	19,336	06:46:11
5500	02:09:56	19,347	06:44:43
5600	02:12:05	19,354	06:41:42
5700	02:14:05	19,359	06:38:18
5800	02:16:29	19,368	06:36:04
5900	02:18:34	19,378	06:32:57
6000	02:20:58	19,382	06:30:43
6100	02:23:23	19,388	06:28:33
6200	02:25:33	19,396	06:25:44
6300	02:27:41	19,405	06:22:51
6400	02:30:02	19,412	06:20:31
6500	02:32:16	19,418	06:17:53
6600	02:34:22	19,424	06:14:57
6700	02:36:32	19,430	06:12:13
6800	02:38:56	19,432	06:10:01
6900	02:41:05	19,433	06:07:15
7000	02:43:38	19,436	06:05:23
7100	02:46:09	19,439	06:03:27
7200	02:48:23	19,443	06:00:53
7300	02:50:49	19,442	05:58:44
7400	02:53:09	19,444	05:56:24
7500	02:55:20	19,448	05:53:45

7600	02:57:48	19,452	05:51:38
7700	03:00:12	19,451	05:49:26
7800	03:02:39	19,453	05:47:18
7900	03:04:59	19,456	05:44:57
8000	03:06:55	19,460	05:41:51
8100	03:09:12	19,464	05:39:26
8200	03:11:20	19,469	05:36:44
8300	03:13:31	19,473	05:34:09
8400	03:15:45	19,478	05:31:38
8500	03:18:02	19,483	05:29:13
8600	03:20:21	19,488	05:26:52
8700	03:22:28	19,494	05:24:12
8800	03:24:48	19,498	05:21:53
8900	03:27:06	19,504	05:19:31
9000	03:29:28	19,511	05:17:16
9100	03:31:41	19,514	05:14:45
9200	03:33:53	19,518	05:12:14
9300	03:36:15	19,521	05:09:59
9400	03:38:35	19,528	05:07:41
9500	03:40:50	19,534	05:05:14
9600	03:43:02	19,539	05:02:45
9700	03:45:23	19,539	05:00:28
9800	03:47:45	19,541	04:58:12
9900	03:49:56	19,545	04:55:41
10000	03:51:60	19,549	04:53:02
10100	03:54:13	19,553	04:50:36
10200	03:56:37	19,558	04:48:22
10300	03:59:01	19,562	04:46:09
10400	04:01:29	19,566	04:44:00
10500	04:03:49	19,568	04:41:41
10600	04:06:03	19,573	04:39:16
10700	04:08:28	19,577	04:37:04
10800	04:10:45	19,581	04:34:41
10900	04:13:10	19,585	04:32:28
11000	04:15:13	19,588	04:29:51
11100	04:17:46	19,592	04:27:47
11200	04:20:06	19,593	04:25:27
11300	04:22:25	19,596	04:23:09
11400	04:24:29	19,599	04:20:34
11500	04:26:39	19,603	04:18:06
11600	04:29:06	19,605	04:15:54
11700	04:31:25	19,609	04:13:35
11800	04:33:43	19,612	04:11:14
11900	04:35:54	19,613	04:08:48
12000	04:38:21	19,617	04:06:36
12100	04:40:38	19,619	04:04:15
12200	04:43:09	19,621	04:02:05
12300	04:45:18	19,623	03:59:37

12400	04:47:37	19,626	03:57:18
12500	04:49:53	19,629	03:54:57
12600	04:51:59	19,631	03:52:27
12700	04:54:05	19,634	03:49:58
12800	04:56:16	19,636	03:47:33
12900	04:58:43	19,639	03:45:20
13000	05:01:04	19,643	03:43:02
13100	05:03:13	19,646	03:40:36
13200	05:05:34	19,648	03:38:19
13300	05:07:57	19,650	03:36:03
13400	05:10:23	19,652	03:33:49
13500	05:12:43	19,654	03:31:31
13600	05:14:42	19,657	03:28:59
13700	05:17:04	19,658	03:26:42
13800	05:19:11	19,662	03:24:15
13900	05:21:22	19,665	03:21:51
14000	05:23:52	19,668	03:19:40
14100	05:26:12	19,669	03:17:22
14200	05:28:30	19,671	03:15:03
14300	05:30:26	19,674	03:12:30
14400	05:32:47	19,676	03:10:13
14500	05:35:05	19,679	03:07:54
14600	05:37:30	19,682	03:05:39
14700	05:39:50	19,685	03:03:21
14800	05:41:54	19,689	03:00:54
14900	05:44:06	19,692	02:58:32
15000	05:46:16	19,694	02:56:10
15100	05:48:32	19,696	02:53:50
15200	05:50:45	19,698	02:51:29
15300	05:52:56	19,700	02:49:06
15400	05:55:12	19,702	02:46:47
15500	05:57:27	19,704	02:44:27
15600	05:59:48	19,704	02:42:10
15700	06:01:60	19,705	02:39:48
15800	06:04:10	19,707	02:37:27
15900	06:06:17	19,708	02:35:04
16000	06:08:18	19,710	02:32:38
16100	06:10:21	19,713	02:30:14
16200	06:12:48	19,713	02:27:60
16300	06:14:58	19,715	02:25:38
16400	06:17:09	19,714	02:23:18
16500	06:19:26	19,715	02:20:59
16600	06:21:36	19,717	02:18:38
16700	06:23:39	19,719	02:16:15
16800	06:25:57	19,720	02:13:57
16900	06:28:29	19,721	02:11:44
17000	06:30:55	19,723	02:09:29
17100	06:33:19	19,725	02:07:13

17200	06:35:40	19,725	02:04:56
17300	06:37:54	19,727	02:02:37
17400	06:40:24	19,728	02:00:22
17500	06:42:43	19,730	01:58:05
17600	06:44:57	19,733	01:55:45
17700	06:47:14	19,734	01:53:27
17800	06:49:27	19,735	01:51:08
17900	06:51:35	19,737	01:48:47
18000	06:53:39	19,738	01:46:25
18100	06:55:52	19,740	01:44:06
18200	06:58:01	19,741	01:41:46
18300	07:00:07	19,741	01:39:26
18400	07:02:40	19,739	01:37:11
18500	07:04:53	19,737	01:34:52
18600	07:07:11	19,736	01:32:35
18700	07:09:44	19,735	01:30:20
18800	07:12:01	19,733	01:28:02
18900	07:14:23	19,731	01:25:45
19000	07:16:51	19,730	01:23:29
19100	07:19:04	19,730	01:21:10
19200	07:21:27	19,728	01:18:53
19300	07:23:60	19,725	01:16:38
19400	07:26:18	19,726	01:14:20
19500	07:28:50	19,724	01:12:04
19600	07:31:13	19,724	01:09:47
19700	07:33:37	19,722	01:07:29
19800	07:35:47	19,721	01:05:10
19900	07:38:20	19,719	01:02:54
20000	07:40:44	19,719	01:00:37
20100	07:42:56	19,720	00:58:18
20200	07:45:08	19,720	00:55:59
20300	07:47:17	19,720	00:53:39
20400	07:49:17	19,720	00:51:19
20500	07:51:35	19,721	00:49:01
20600	07:53:55	19,720	00:46:43
20700	07:56:16	19,720	00:44:26
20800	07:58:14	19,719	00:42:06
20900	08:00:33	19,719	00:39:48
21000	08:02:53	19,718	00:37:30
21100	08:04:54	19,718	00:35:11
21200	08:07:18	19,717	00:32:54
21300	08:09:40	19,716	00:30:36
21400	08:11:56	19,716	00:28:18
21500	08:14:09	19,716	00:25:60
21600	08:16:32	19,715	00:23:42
21700	08:18:49	19,715	00:21:24
21800	08:21:02	19,714	00:19:06
21900	08:23:18	19,714	00:16:48

```
22000   08:25:44        19,713  00:14:30
22100   08:28:19        19,711  00:12:13
22200   08:30:33        19,709  00:09:55
22300   08:33:16        19,698  00:07:37
22400   08:35:44        19,696  00:05:19
22500   08:38:06        19,704  00:03:01
22600   08:39:59        19,712  00:00:43
```

1.5 Create ngrams

[10]:

```python
ngram_path = sec_path / 'ngrams'
stats_path = sec_path / 'corpus_stats'
for path in [ngram_path, stats_path]:
    if not path.exists():
        path.mkdir(parents=True)
```

[19]:

```python
unigrams = ngram_path / 'ngrams_1.txt'
```

[20]:

```python
def create_unigrams(min_length=3):
    texts = []
    sentence_counter = Counter()
    vocab = Counter()
    for i, f in enumerate(clean_path.glob('*.csv')):
        if i % 1000 == 0:
            print(i, end=' ', flush=True)
        df = pd.read_csv(f)
        df.item = df.item.astype(str)
        df = df[df.item.isin(sections)]
        sentence_counter.update(df.groupby('item').size().to_dict())
        for sentence in df.text.dropna().str.split().tolist():
            if len(sentence) >= min_length:
                vocab.update(sentence)
                texts.append(' '.join(sentence))

    (pd.DataFrame(sentence_counter.most_common(),
                  columns=['item', 'sentences'])
     .to_csv(stats_path / 'selected_sentences.csv', index=False))
    (pd.DataFrame(vocab.most_common(), columns=['token', 'n'])
     .to_csv(stats_path / 'sections_vocab.csv', index=False))

    unigrams.write_text('\n'.join(texts))
    return [l.split() for l in texts]
```

[21]:

```python
start = time()
if not unigrams.exists():
    texts = create_unigrams()
else:
    texts = [l.split() for l in unigrams.open()]
print('\nReading: ', format_time(time() - start))
```

```
0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000 13000 14000
15000 16000 17000 18000 19000 20000 21000 22000
Reading:  00:04:14
```

[22]:

```
def create_ngrams(max_length=3):
    """Using gensim to create ngrams"""

    n_grams = pd.DataFrame()
    start = time()
    for n in range(2, max_length + 1):
        print(n, end=' ', flush=True)

        sentences = LineSentence(ngram_path / f'ngrams_{n - 1}.txt')
        phrases = Phrases(sentences=sentences,
                          min_count=25,  # ignore terms with a lower count
                          threshold=0.5,  # accept phrases with higher score
                          max_vocab_size=40000000,  # prune of less common␣
 ↪words to limit memory use
                          delimiter=b'_',  # how to join ngram tokens
                          progress_per=50000,  # log progress every
                          scoring='npmi')

        s = pd.DataFrame([[k.decode('utf-8'), v] for k, v in phrases.
 ↪export_phrases(sentences)],
                         columns=['phrase', 'score']).assign(length=n)

        n_grams = pd.concat([n_grams, s])
        grams = Phraser(phrases)
        sentences = grams[sentences]
        (ngram_path / f'ngrams_{n}.txt').write_text('\n'.join([' '.join(s) for␣
 ↪s in sentences]))

    n_grams = n_grams.sort_values('score', ascending=False)
    n_grams.phrase = n_grams.phrase.str.replace('_', ' ')
    n_grams['ngram'] = n_grams.phrase.str.replace(' ', '_')

    n_grams.to_parquet(sec_path / 'ngrams.parquet')

    print('\n\tDuration: ', format_time(time() - start))
    print('\tngrams: {:,d}\n'.format(len(n_grams)))
    print(n_grams.groupby('length').size())
```

[ ]:

```
create_ngrams()
```

2 3

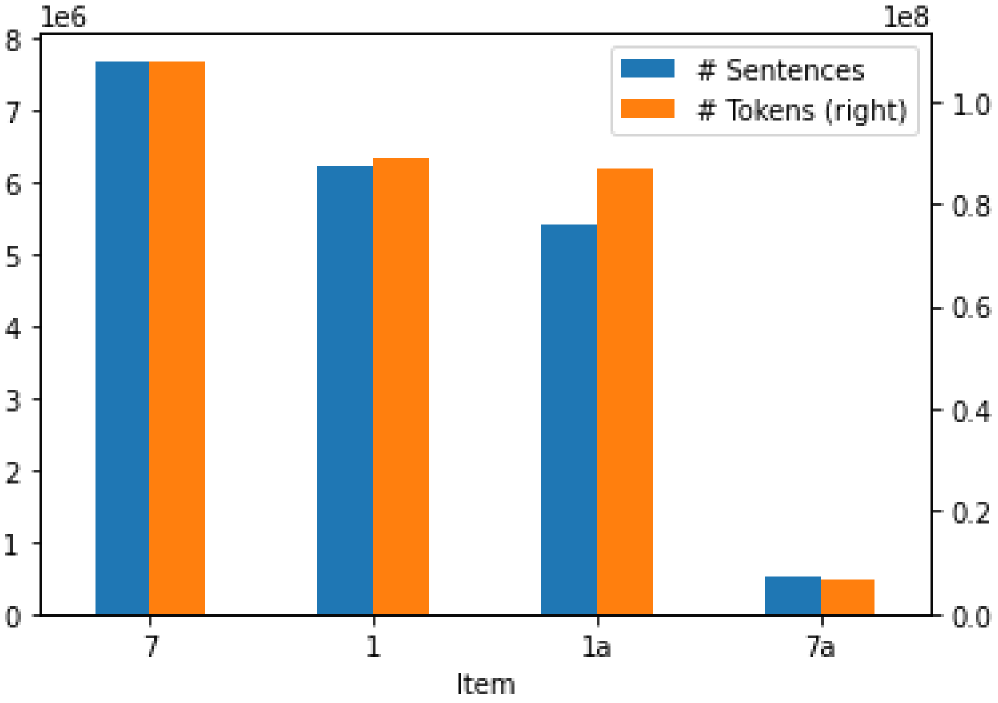
1.6 Inspect Corpus

[18]:
```
percentiles=np.arange(.1, 1, .1).round(2)
```

[11]:
```
nsents, ntokens = Counter(), Counter()
for f in clean_path.glob('*.csv'):
    df = pd.read_csv(f)
    nsents.update({str(k): v for k, v in df.item.value_counts().to_dict().
 ↪items()})
    df['ntokens'] = df.text.str.split().str.len()
    ntokens.update({str(k): v for k, v in df.groupby('item').ntokens.sum().
 ↪to_dict().items()})
```

[12]:
```
ntokens = pd.DataFrame(ntokens.most_common(), columns=['Item', '# Tokens'])
nsents = pd.DataFrame(nsents.most_common(), columns=['Item', '# Sentences'])
```

[13]:
```
nsents.set_index('Item').join(ntokens.set_index('Item')).plot.
 ↪bar(secondary_y='# Tokens', rot=0);
```



[ ]:
```
ngrams = pd.read_parquet(sec_path / 'ngrams.parquet')
```

[ ]:
```
ngrams.info()
```

[ ]:

```
ngrams.head()
```

[ ]:

```
ngrams.score.describe(percentiles=percentiles)
```

[ ]:

```
ngrams[ngrams.score>.7].sort_values(['length', 'score']).head(10)
```

[15]:

```
vocab = pd.read_csv(stats_path / 'sections_vocab.csv').dropna()
```

[16]:

```
vocab.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 200867 entries, 0 to 200868
Data columns (total 2 columns):
 #   Column  Non-Null Count   Dtype
---  ------  --------------   -----
 0   token   200867 non-null  object
 1   n       200867 non-null  int64
dtypes: int64(1), object(1)
memory usage: 4.6+ MB
```

[19]:

```
vocab.n.describe(percentiles).astype(int)
```

[19]:

```
count     200867
mean        1439
std        22312
min            1
10%            1
20%            2
30%            3
40%            4
50%            7
60%           12
70%           24
80%           61
90%          260
max      2574572
Name: n, dtype: int64
```

[20]:

```
tokens = Counter()
for l in (ngram_path / 'ngrams_2.txt').open():
    tokens.update(l.split())
```

[21]:

```
tokens = pd.DataFrame(tokens.most_common(),
                      columns=['token', 'count'])
```

[22]:

```
tokens.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 230112 entries, 0 to 230111
Data columns (total 2 columns):
 #   Column  Non-Null Count   Dtype 
---  ------  --------------   ----- 
 0   token   230112 non-null  object
 1   count   230112 non-null  int64 
dtypes: int64(1), object(1)
memory usage: 3.5+ MB
```

[23]:
```
tokens.head()
```

[23]:
```
      token    count
0   million  2340187
1  business  1696732
2  december  1512367
3   company  1490617
4  products  1367413
```

[24]:
```
tokens.loc[tokens.token.str.contains('_'), 'count'].describe(percentiles).
↪astype(int)
```

[24]:
```
count     29951
mean        926
std        9611
min           1
10%          26
20%          31
30%          37
40%          46
50%          61
60%          85
70%         131
80%         237
90%         666
max      593859
Name: count, dtype: int64
```

[25]:
```
tokens[tokens.token.str.contains('_')].head(20).to_csv(sec_path /␣
↪'ngram_examples.csv', index=False)
```

[26]:
```
tokens[tokens.token.str.contains('_')].head(20)
```

[26]:
```
                     token   count
46              year_ended  593859
64      results_operations  492047
71          table_contents  436034
```

```
78                company_s  412971
85      financial_condition  396164
86             common_stock  387629
107              fair_value  341108
152           united_states  276401
158              cash_flows  266725
168    financial_statements  255115
187           interest_rate  234621
188   approximately_million  234385
199         adversely_affect  227984
223               long_term  203600
238             real_estate  192824
239         material_adverse  192238
240             fiscal_year  192189
243          interest_rates  190754
248              income_tax  186923
267             natural_gas  178765
```

1.7 Get returns

[27]:

```
DATA_FOLDER = Path('..', 'data')
```

[28]:

```
with pd.HDFStore(DATA_FOLDER / 'assets.h5') as store:
    prices = store['quandl/wiki/prices'].adj_close
```

[29]:

```
sec = pd.read_csv(sec_path / 'filing_index.csv').rename(columns=str.lower)
sec.date_filed = pd.to_datetime(sec.date_filed)
```

[30]:

```
sec.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 22631 entries, 0 to 22630
Data columns (total 11 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   cik           22631 non-null  int64
 1   company_name  22631 non-null  object
 2   form_type     22631 non-null  object
 3   date_filed    22631 non-null  datetime64[ns]
 4   edgar_link    22631 non-null  object
 5   quarter       22631 non-null  int64
 6   ticker        22631 non-null  object
 7   sic           22461 non-null  object
 8   exchange      20619 non-null  object
 9   hits          22555 non-null  object
 10  year          22631 non-null  int64
dtypes: datetime64[ns](1), int64(3), object(7)
```

```
memory usage: 1.9+ MB
```

[31]:

```
idx = pd.IndexSlice
```

[32]:

```
first = sec.date_filed.min() + relativedelta(months=-1)
last = sec.date_filed.max() + relativedelta(months=1)
prices = (prices
          .loc[idx[first:last, :]]
          .unstack().resample('D')
          .ffill()
          .dropna(how='all', axis=1)
          .filter(sec.ticker.unique()))
```

[33]:

```
sec = sec.loc[sec.ticker.isin(prices.columns), ['ticker', 'date_filed']]

price_data = []
for ticker, date in sec.values.tolist():
    target = date + relativedelta(months=1)
    s = prices.loc[date: target, ticker]
    price_data.append(s.iloc[-1] / s.iloc[0] - 1)

df = pd.DataFrame(price_data,
                  columns=['returns'],
                  index=sec.index)
```

[34]:

```
df.returns.describe()
```

[34]:

```
count    11101.000000
mean         0.022839
std          0.126137
min         -0.555556
25%         -0.032213
50%          0.017349
75%          0.067330
max          1.928826
Name: returns, dtype: float64
```

[35]:

```
sec['returns'] = price_data
sec.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 11375 entries, 0 to 22629
Data columns (total 3 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   ticker      11375 non-null  object
 1   date_filed  11375 non-null  datetime64[ns]
 2   returns     11101 non-null  float64
```

```
dtypes: datetime64[ns](1), float64(1), object(1)
memory usage: 355.5+ KB
```

[36]:

```
sec.dropna().to_csv(sec_path / 'sec_returns.csv', index=False)
```