07_lda_financial_news

September 29, 2021

1 Topic Modeling: Financial News

This notebook contains an example of LDA applied to financial news articles.

1.1 Imports & Settings

[1]:
```
import warnings
warnings.filterwarnings('ignore')
```

[2]:
```
%matplotlib inline

from collections import Counter
from pathlib import Path
import logging

import numpy as np
import pandas as pd

# Visualization
import matplotlib.pyplot as plt
import seaborn as sns

# spacy for language processing
import spacy

# sklearn for feature extraction
from sklearn.feature_extraction.text import TfidfVectorizer

# gensim for topic models
from gensim.models import LdaModel
from gensim.corpora import Dictionary
from gensim.matutils import Sparse2Corpus

# topic model viz
import pyLDAvis
from pyLDAvis.gensim_models import prepare
```

[3]:
```
sns.set_style('white')
pyLDAvis.enable_notebook()
```

[4]:
```
stop_words = set(pd.read_csv('http://ir.dcs.gla.ac.uk/resources/
↪linguistic_utils/stop_words',
                             header=None,
                             squeeze=True).tolist())
```

1.2 Helper Viz Functions

[6]:
```
def show_word_list(model, corpus, top=10, save=False):
    top_topics = model.top_topics(corpus=corpus, coherence='u_mass', topn=20)
    words, probs = [], []
    for top_topic, _ in top_topics:
        words.append([t[1] for t in top_topic[:top]])
        probs.append([t[0] for t in top_topic[:top]])

    fig, ax = plt.subplots(figsize=(model.num_topics*1.2, 5))
    sns.heatmap(pd.DataFrame(probs).T,
                annot=pd.DataFrame(words).T,
                fmt='',
                ax=ax,
                cmap='Blues',
                cbar=False)
    fig.tight_layout()
    if save:
        fig.savefig(f'fin_news_wordlist_{top}', dpi=300)
```

[7]:
```
def show_coherence(model, corpus, tokens, top=10, cutoff=0.01):
    top_topics = model.top_topics(corpus=corpus, coherence='u_mass', topn=20)
    word_lists = pd.DataFrame(model.get_topics().T, index=tokens)
    order = []
    for w, word_list in word_lists.items():
        target = set(word_list.nlargest(top).index)
        for t, (top_topic, _) in enumerate(top_topics):
            if target == set([t[1] for t in top_topic[:top]]):
                order.append(t)

    fig, axes = plt.subplots(ncols=2, figsize=(15,5))
    title = f'# Words with Probability > {cutoff:.2%}'
    (word_lists.loc[:, order]>cutoff).sum().reset_index(drop=True).plot.
↪bar(title=title, ax=axes[1]);

    umass = model.top_topics(corpus=corpus, coherence='u_mass', topn=20)
    pd.Series([c[1] for c in umass]).plot.bar(title='Topic Coherence',␣
↪ax=axes[0])
```

```
    fig.tight_layout()
    fig.savefig(f'fin_news_coherence_{top}', dpi=300);
```

[8]:
```
def show_top_docs(model, corpus, docs):
    doc_topics = model.get_document_topics(corpus)
    df = pd.concat([pd.DataFrame(doc_topic,
                                 columns=['topicid', 'weight']).assign(doc=i)
                    for i, doc_topic in enumerate(doc_topics)])

    for topicid, data in df.groupby('topicid'):
        print(topicid, docs[int(data.sort_values('weight', ascending=False).
 ↪iloc[0].doc)])
        print(pd.DataFrame(lda.show_topic(topicid=topicid)))
```

1.3 Load Financial News

The data is avaialble from Kaggle.

Download and unzip into data directory in repository root folder, then rename the enclosing folder to `us-financial-news` and the subfolders so you get the following directory structure:

```
data
  |-us-financial-news
     |-2018_01
     |-2018_02
     |-2018_03
     |-2018_04
     |-2018_05
```

[ ]:
```
data_path = Path('..', 'data', 'us-financial-news')
```

We limit the article selection to the following sections in the dataset:

[9]:
```
section_titles = ['Press Releases - CNBC',
                  'Reuters: Company News',
                  'Reuters: World News',
                  'Reuters: Business News',
                  'Reuters: Financial Services and Real Estate',
                  'Top News and Analysis (pro)',
                  'Reuters: Top News',
                  'The Wall Street Journal &amp; Breaking News, Business,␣
 ↪Financial and Economic News, World News and Video',
                  'Business &amp; Financial News, U.S &amp; International␣
 ↪Breaking News | Reuters',
                  'Reuters: Money News',
                  'Reuters: Technology News']
```

[10]:
```
def read_articles():
    articles = []
    counter = Counter()
    for f in data_path.glob('*/**/*.json'):
        article = json.load(f.open())
        if article['thread']['section_title'] in set(section_titles):
            text = article['text'].lower().split()
            counter.update(text)
            articles.append(' '.join([t for t in text if t not in stop_words]))
    return articles, counter
```

[11]:
```
articles, counter = read_articles()
print(f'Done loading {len(articles):,.0f} articles')
```

```
Done loading 125,964 articles
```

[12]:
```
most_common = (pd.DataFrame(counter.most_common(), columns=['token', 'count'])
               .pipe(lambda x: x[~x.token.str.lower().isin(stop_words)]))
```

[13]:
```
most_common.head(10)
```

[13]:
```
       token   count
8          $  592548
17       net  317060
18         )  315742
23   million  269721
25         -  258943
26    income  257158
31      2018  227890
32      said  217339
33         %  214997
34   company  213316
```

1.4 Preprocessing with SpaCy

[24]:
```
results_path = Path('results', 'financial_news')
if not results_path.exists():
    results_path.mkdir(parents=True)
```

[14]:
```
def clean_doc(d):
    doc = []
    for t in d:
        if not any([t.is_stop, t.is_digit, not t.is_alpha, t.is_punct, t.
 ↪is_space, t.lemma_ == '-PRON-']):
            doc.append(t.lemma_)
    return ' '.join(doc)
```

[15]:
```
nlp = spacy.load('en')
nlp.max_length = 6000000
nlp.disable_pipes('ner')
```

[15]:
```
[('ner', <spacy.pipeline.pipes.EntityRecognizer at 0x7f7b43da6fa0>)]
```

[16]:
```
nlp.pipe_names
```

[16]:
```
['tagger', 'parser']
```

[17]:
```
def preprocess(articles):
    iter_articles = (article for article in articles)
    clean_articles = []
    for i, doc in enumerate(nlp.pipe(iter_articles,
                                     batch_size=100,
                                     n_threads=8), 1):
        if i % 1000 == 0:
            print(f'{i / len(articles):.2%}', end=' ', flush=True)
        clean_articles.append(clean_doc(doc))
    return clean_articles
```

[18]:
```
clean_articles = preprocess(articles)
```

```
/home/stefan/.pyenv/versions/miniconda3-latest/envs/ml4t/lib/python3.7/site-
packages/spacy/language.py:771: DeprecationWarning: [W016] The keyword argument
`n_threads` is now deprecated. As of v2.2.2, the argument `n_process` controls
parallel inference via multiprocessing.
  warnings.warn(Warnings.W016, DeprecationWarning)
```

```
0.79% 1.59% 2.38% 3.18% 3.97% 4.76% 5.56% 6.35% 7.14% 7.94% 8.73% 9.53% 10.32%
11.11% 11.91% 12.70% 13.50% 14.29% 15.08% 15.88% 16.67% 17.47% 18.26% 19.05%
19.85% 20.64% 21.43% 22.23% 23.02% 23.82% 24.61% 25.40% 26.20% 26.99% 27.79%
28.58% 29.37% 30.17% 30.96% 31.76% 32.55% 33.34% 34.14% 34.93% 35.72% 36.52%
37.31% 38.11% 38.90% 39.69% 40.49% 41.28% 42.08% 42.87% 43.66% 44.46% 45.25%
46.04% 46.84% 47.63% 48.43% 49.22% 50.01% 50.81% 51.60% 52.40% 53.19% 53.98%
54.78% 55.57% 56.37% 57.16% 57.95% 58.75% 59.54% 60.33% 61.13% 61.92% 62.72%
63.51% 64.30% 65.10% 65.89% 66.69% 67.48% 68.27% 69.07% 69.86% 70.66% 71.45%
72.24% 73.04% 73.83% 74.62% 75.42% 76.21% 77.01% 77.80% 78.59% 79.39% 80.18%
80.98% 81.77% 82.56% 83.36% 84.15% 84.94% 85.74% 86.53% 87.33% 88.12% 88.91%
89.71% 90.50% 91.30% 92.09% 92.88% 93.68% 94.47% 95.27% 96.06% 96.85% 97.65%
98.44% 99.23%
```

[19]:
```
clean_path = results_path / 'clean_text'
clean_path.write_text('\n'.join(clean_articles))
```

[19]:
```
333868354
```

1.5 Vectorize data

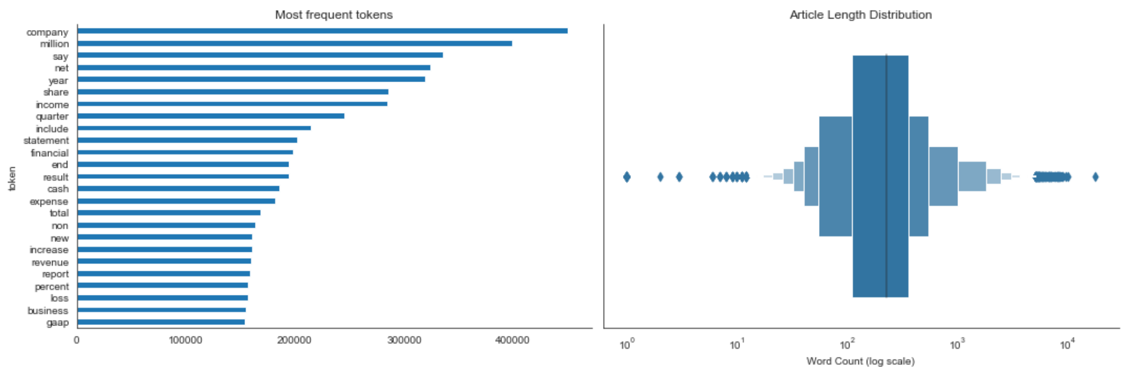
```
[20]: docs = clean_path.read_text().split('\n')
      len(docs)
```

```
[20]: 125964
```

1.5.1 Explore cleaned data

```
[21]: article_length, token_count = [], Counter()
      for i, doc in enumerate(docs, 1):
          if i % 1e6 == 0:
              print(i, end=' ', flush=True)
          d = doc.lower().split()
          article_length.append(len(d))
          token_count.update(d)
```

```
[25]: fig, axes = plt.subplots(ncols=2, figsize=(15, 5))
      (pd.DataFrame(token_count.most_common(), columns=['token', 'count'])
       .pipe(lambda x: x[~x.token.str.lower().isin(stop_words)])
       .set_index('token')
       .squeeze()
       .iloc[:25]
       .sort_values()
       .plot
       .barh(ax=axes[0], title='Most frequent tokens'))
      sns.boxenplot(x=pd.Series(article_length), ax=axes[1])
      axes[1].set_xscale('log')
      axes[1].set_xlabel('Word Count (log scale)')
      axes[1].set_title('Article Length Distribution')
      sns.despine()
      fig.tight_layout()
      fig.savefig(results_path / 'fn_explore', dpi=300);
```



[26]:
```
pd.Series(article_length).describe(percentiles=np.arange(.1, 1.0, .1))
```

[26]:
```
count    125964.000000
mean        354.514091
std         534.782734
min           1.000000
10%          48.000000
20%          85.000000
30%         135.000000
40%         180.000000
50%         225.000000
60%         267.000000
70%         324.000000
80%         413.000000
90%         622.000000
max       17838.000000
dtype: float64
```

[27]:
```
docs = [x.lower() for x in docs]
```

[28]:
```
docs[3]
```

[28]:
```
'washington reuters treasury secretary steven mnuchin tuesday say want know
consumer financial protection bureau handling probe hack credit bureau equifax
report agency acting director pull investigate matter equifax disclose september
hacker steal personal datum collect million americans monday reuters report act
cfpb chief mick mulvaney brakes agency equifax investigation speak director
mulvaney mnuchin tell house representatives financial services committee go
discuss tuesday cfpb say examine equifax breach decline detail bureau look
equifax datum breach response agency say statement reuters cite people familiar
matter report monday cfpb open investigation equifax mulvaney rein work begin
predecessor richard cordray mulvaney order subpoenas equifax seek swear
testimony executive routine step scale probe source say add cfpb shelve plan
ground test equifax protect datum idea back cordray cfpb recently rebuff bank
regulator federal reserve federal deposit insurance corp office comptroller
currency offer help site exam credit bureau source say republican president
donald trump administration seek curb power cfpb create democratic predecessor
barack obama protect consumer financial industry abuse agency criticize fiercely
industry mulvaney seek new operating fund agency opt instead finance slimme
budget shrink reserve fund establish cordray report patrick rucker lindsay
dunsmuir editing franklin paul'
```

1.5.2 Set vocab parameters

[29]:
```
min_df = .005
max_df = .1
ngram_range = (1, 1)
binary = False
```

[30]:
```
vectorizer = TfidfVectorizer(stop_words='english',
                             min_df=min_df,
                             max_df=max_df,
                             ngram_range=ngram_range,
                             binary=binary)
dtm = vectorizer.fit_transform(docs)
tokens = vectorizer.get_feature_names()
dtm.shape
```

[30]:
```
(125964, 3736)
```

[31]:
```
corpus = Sparse2Corpus(dtm, documents_columns=False)
id2word = pd.Series(tokens).to_dict()
dictionary = Dictionary.from_corpus(corpus, id2word)
```

1.6 Train & Evaluate LDA Model

[32]:
```
logging.basicConfig(filename='gensim.log',
                    format="%(asctime)s:%(levelname)s:%(message)s",
                    level=logging.DEBUG)
logging.root.level = logging.DEBUG
```

1.6.1 Train models with 5-25 topics

[33]:
```
num_topics = [5, 10, 15, 20]
```

[36]:
```
for topics in num_topics:
    print(topics)
    lda_model = LdaModel(corpus=corpus,
                         id2word=id2word,
                         num_topics=topics,
                         chunksize=len(docs),
                         update_every=1,
                         alpha='auto',                  # a-priori belief for␣
 ↪the each topics' probability
                         eta='auto',                    # a-priori belief on␣
 ↪word probability
                         decay=0.5,                     # percentage of previous␣
 ↪lambda value forgotten
                         offset=1.0,
                         eval_every=1,
                         passes=10,
                         iterations=50,
                         gamma_threshold=0.001,
                         minimum_probability=0.01,         # filter topics with␣
↪lower probability
                         minimum_phi_value=0.01,           # lower bound on term␣
↪probabilities
                         random_state=42)
    lda_model.save((results_path / f'model_{topics}').as_posix())
```

```
5
10
15
20
25
```

1.6.2 Evaluate results

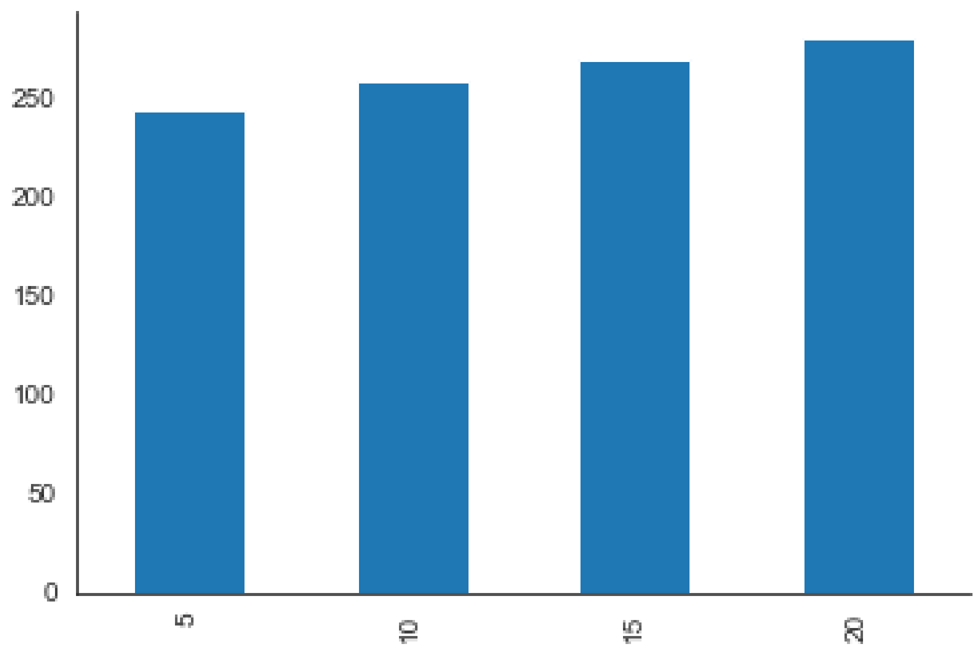
We show results for one model using a vocabulary of 3,800 tokens based on min_df=0.1% and max_df=25% with a single pass to avoid length training time for 20 topics. We can use pyldavis topic_info attribute to compute relevance values for lambda=0.6 that produces the following word list

[37]:
```
def eval_lda_model(ntopics, model, corpus=corpus, tokens=tokens):
    show_word_list(model=model, corpus=corpus, top=ntopics, save=True)
    show_coherence(model=model, corpus=corpus, tokens=tokens, top=ntopics)
    vis = prepare(model, corpus, dictionary, mds='tsne')
    pyLDAvis.save_html(vis, f'lda_{ntopics}.html')
    return 2 ** (-model.log_perplexity(corpus))
```

[ ]:
```
lda_models = {}
perplexity ={}
for ntopics in num_topics:
    print(ntopics)
    lda_models[ntopics] = LdaModel.load((results_path / f'model_{ntopics}').
↪as_posix())
    perplexity[ntopics] = eval_lda_model(ntopics=ntopics,␣
↪model=lda_models[ntopics])
```

1.6.3 Perplexity

[41]:
```
pd.Series(perplexity).plot.bar()
sns.despine();
```



1.6.4 PyLDAVis for 15 Topics

```
[42]: vis = prepare(lda_models[15], corpus, dictionary, mds='tsne')
      pyLDAvis.display(vis)
```

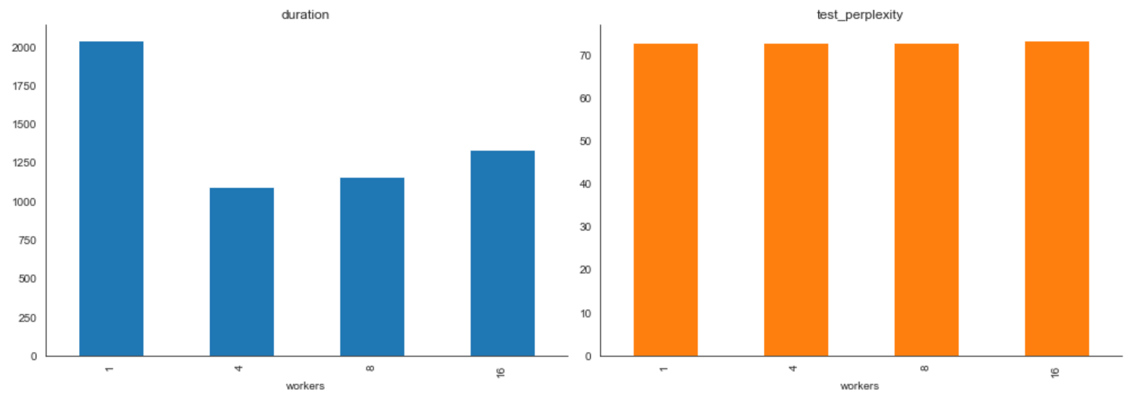
```
[42]: <IPython.core.display.HTML object>
```

1.7 LDAMultiCore Timing

```
[43]: df = pd.read_csv(results_path / 'lda_multicore_test_results.csv')
      df.head()
```

```
[43]:    workers  num_topics     duration  test_perplexity
      0        1          10  2035.206371        72.621968
      1        1          50  1611.578738        84.457663
      2        4          10  1093.389884        72.742675
      3        4          50  1067.982344        82.115884
      4        8          10  1154.867700        72.791885
```

```
[45]: df[df.num_topics==10].set_index('workers')[['duration', 'test_perplexity']].
       ↪plot.bar(subplots=True, layout=(1,2), figsize=(14,5), legend=False)
      sns.despine()
      plt.tight_layout();
```


duration
2000
1750
1500
1250
1000
750
500
250
0
1
4
8
16
workers
test_perplexity
70
60
50
40
30
20
10
0
1
4
8
16
workers

[ ]: