

# lab10a\_corrected

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## 0.1 Training a word2vec model from scratch

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We will start by training a word2vec model from scratch using the gensim library. You will need to ensure that you have gensim installed, and a file decompressor to load our dataset.

Note: these models may take a while to train. Be sure to switch the runtime of Google Colab to us a TPU or GPU hardware accellerator (in the menu at the top).

Let's start by installing some libraries that we will use:

```
In [0]: !pip install gensim
        !pip install wget
```

```
Requirement already satisfied: gensim in /usr/local/lib/python3.6/dist-packages (3.6.0)
Requirement already satisfied: numpy>=1.11.3 in /usr/local/lib/python3.6/dist-packages (from gensim)
Requirement already satisfied: smart-open>=1.2.1 in /usr/local/lib/python3.6/dist-packages (from gensim)
Requirement already satisfied: scipy>=0.18.1 in /usr/local/lib/python3.6/dist-packages (from gensim)
Requirement already satisfied: six>=1.5.0 in /usr/local/lib/python3.6/dist-packages (from gensim)
Requirement already satisfied: boto3 in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: boto>=2.32 in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: requests in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: botocore<1.14.0,>=1.13.14 in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: jmespath<1.0.0,>=0.7.1 in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: s3transfer<0.3.0,>=0.2.0 in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: idna<2.9,>=2.5 in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: urllib3<1.25,>=1.21.1 in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: chardet<3.1.0,>=3.0.2 in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: docutils<0.16,>=0.10 in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: python-dateutil<2.8.1,>=2.1; python_version >= "2.7" in /usr/local/lib/python3.6/dist-packages (from smart-open)
Requirement already satisfied: wget in /usr/local/lib/python3.6/dist-packages (3.2)
```

Now we can import these libraries:

```
In [0]: # imports needed
        import gensim
        import wget
```

We will train our model using a very small dataset for demonstrative purposes. Note that for a real data science project you should train on a much larger dataset.

We will use the complete works of Shakespeare. You can find the file at <https://dorienherremans.com/drop/CDS/CNNs/shakespeare.txt>

```
In [0]: # download the dataset
        wget.download("https://dorienherremans.com/drop/CDS/CNNs/shakespeare.txt")

--2019-11-14 10:03:09--  https://dorienherremans.com/drop/CDS/CNNs/shakespeare.txt
Resolving dorienherremans.com (dorienherremans.com)... 96.127.180.74
Connecting to dorienherremans.com (dorienherremans.com)|96.127.180.74|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 5447743 (5.2M) [text/plain]
Saving to: shakespeare.txt

shakespeare.txt      100%[=====>]      5.20M  --.-KB/s    in 0.1s

2019-11-14 10:03:09 (46.5 MB/s) - shakespeare.txt saved [5447743/5447743]
```

Let's read the input file and convert each line into a list of words (tokenizing). Do do this, we create a function `read_input` which is called in the penultimate line below:

```
In [0]: def read_input(input_file):

        print("reading file...")

        with open (input_file, 'r') as f:
            lines = f.readlines()
            for line in lines:
                # do some pre-processing and return a (tokenized) list
                # of words for each review text
                # you can print the output here to understand
                # the preprocessing (tokenizing)
                yield gensim.utils.simple_preprocess (line)

        # each review item new becomes a series of words
        # this is a list of lists

        # point to the location on your filesystem
        data_file = 'shakespeare.txt'

        documents = list (read_input (data_file))
        print("Done reading data file")

reading file...
Done reading data file
```

In [0]: documents

```
Out[0]: [[],
          [],
          ['the', 'sonnets'],
          [],
          ['by', 'william', 'shakespeare'],
          [],
          [],
          [],
          [],
          ['from', 'fairest', 'creatures', 'we', 'desire', 'increase'],
          ['that', 'thereby', 'beauty', 'rose', 'might', 'never', 'die'],
          ['but', 'as', 'the', 'riper', 'should', 'by', 'time', 'decease'],
          ['his', 'tender', 'heir', 'might', 'bear', 'his', 'memory'],
          ['but', 'thou', 'contracted', 'to', 'thine', 'own', 'bright', 'eyes'],
          ['feed',
           'st',
           'thy',
           'light',
           'flame',
           'with',
           'self',
           'substantial',
           'fuel'],
          ['making', 'famine', 'where', 'abundance', 'lies'],
          ['thy', 'self', 'thy', 'foe', 'to', 'thy', 'sweet', 'self', 'too', 'cruel'],
          ['thou', 'that', 'art', 'now', 'the', 'world', 'fresh', 'ornament'],
          ['and', 'only', 'herald', 'to', 'the', 'gaudy', 'spring'],
          ['within', 'thine', 'own', 'bud', 'buried', 'thy', 'content'],
          ['and', 'tender', 'churl', 'mak', 'st', 'waste', 'in', 'niggarding'],
          ['pity', 'the', 'world', 'or', 'else', 'this', 'glutton', 'be'],
          ['to', 'eat', 'the', 'world', 'due', 'by', 'the', 'grave', 'and', 'thee'],
          [],
          [],
          [],
          ['when', 'forty', 'winters', 'shall', 'besiege', 'thy', 'brow'],
          ['and', 'dig', 'deep', 'trenches', 'in', 'thy', 'beauty', 'field'],
          ['thy', 'youth', 'proud', 'livery', 'so', 'gazed', 'on', 'now'],
          ['will', 'be', 'tattered', 'weed', 'of', 'small', 'worth', 'held'],
          ['then', 'being', 'asked', 'where', 'all', 'thy', 'beauty', 'lies'],
          ['where', 'all', 'the', 'treasure', 'of', 'thy', 'lusty', 'days'],
          ['to', 'say', 'within', 'thine', 'own', 'deep', 'sunken', 'eyes'],
          ['were', 'an', 'all', 'eating', 'shame', 'and', 'thrifless', 'praise'],
          ['how', 'much', 'more', 'praise', 'deserved', 'thy', 'beauty', 'use'],
          ['if', 'thou', 'couldst', 'answer', 'this', 'fair', 'child', 'of', 'mine'],
          ['shall', 'sum', 'my', 'count', 'and', 'make', 'my', 'old', 'excuse'],
          ['proving', 'his', 'beauty', 'by', 'succession', 'thine'],
```

['this', 'were', 'to', 'be', 'new', 'made', 'when', 'thou', 'art', 'old'],  
 ['and',  
   'see',  
   'thy',  
   'blood',  
   'warm',  
   'when',  
   'thou',  
   'feel',  
   'st',  
   'it',  
   'cold'],  
 [],  
 [],  
 [],  
 ['look',  
   'in',  
   'thy',  
   'glass',  
   'and',  
   'tell',  
   'the',  
   'face',  
   'thou',  
   'viewest'],  
 ['now', 'is', 'the', 'time', 'that', 'face', 'should', 'form', 'another'],  
 ['whose', 'fresh', 'repair', 'if', 'now', 'thou', 'not', 'renewest'],  
 ['thou', 'dost', 'beguile', 'the', 'world', 'unbless', 'some', 'mother'],  
 ['for', 'where', 'is', 'she', 'so', 'fair', 'whose', 'uneared', 'womb'],  
 ['disdains', 'the', 'tillage', 'of', 'thy', 'husbandry'],  
 ['or', 'who', 'is', 'he', 'so', 'fond', 'will', 'be', 'the', 'tomb'],  
 ['of', 'his', 'self', 'love', 'to', 'stop', 'posterity'],  
 ['thou', 'art', 'thy', 'mother', 'glass', 'and', 'she', 'in', 'thee'],  
 ['calls', 'back', 'the', 'lovely', 'april', 'of', 'her', 'prime'],  
 ['so', 'thou', 'through', 'windows', 'of', 'thine', 'age', 'shalt', 'see'],  
 ['despite', 'of', 'wrinkles', 'this', 'thy', 'golden', 'time'],  
 ['but', 'if', 'thou', 'live', 'remembered', 'not', 'to', 'be'],  
 ['die', 'single', 'and', 'thine', 'image', 'dies', 'with', 'thee'],  
 [],  
 [],  
 [],  
 ['unthrifty', 'loveliness', 'why', 'dost', 'thou', 'spend'],  
 ['upon', 'thy', 'self', 'thy', 'beauty', 'legacy'],  
 ['nature', 'bequest', 'gives', 'nothing', 'but', 'doth', 'lend'],  
 ['and', 'being', 'frank', 'she', 'lends', 'to', 'those', 'are', 'free'],  
 ['then', 'beauteous', 'niggard', 'why', 'dost', 'thou', 'abuse'],  
 ['the', 'bounteous', 'largess', 'given', 'thee', 'to', 'give'],  
 ['profitless', 'usurer', 'why', 'dost', 'thou', 'use'],

['so', 'great', 'sum', 'of', 'sums', 'yet', 'canst', 'not', 'live'],  
 ['for', 'having', 'traffic', 'with', 'thy', 'self', 'alone'],  
 ['thou', 'of', 'thy', 'self', 'thy', 'sweet', 'self', 'dost', 'deceive'],  
 ['then', 'how', 'when', 'nature', 'calls', 'thee', 'to', 'be', 'gone'],  
 ['what', 'acceptable', 'audit', 'canst', 'thou', 'leave'],  
 ['thy', 'unused', 'beauty', 'must', 'be', 'tomed', 'with', 'thee'],  
 ['which', 'used', 'lives', 'th', 'executor', 'to', 'be'],  
 [],  
 [],  
 [],  
 ['those', 'hours', 'that', 'with', 'gentle', 'work', 'did', 'frame'],  
 ['the', 'lovely', 'gaze', 'where', 'every', 'eye', 'doth', 'dwell'],  
 ['will', 'play', 'the', 'tyrants', 'to', 'the', 'very', 'same'],  
 ['and', 'that', 'unfair', 'which', 'fairly', 'doth', 'excel'],  
 ['for', 'never', 'resting', 'time', 'leads', 'summer', 'on'],  
 ['to', 'hideous', 'winter', 'and', 'confounds', 'him', 'there'],  
 ['sap',  
   'checked',  
   'with',  
   'frost',  
   'and',  
   'lusty',  
   'leaves',  
   'quite',  
   'gone'],  
 ['beauty', 'er', 'snowed', 'and', 'bareness', 'every', 'where'],  
 ['then', 'were', 'not', 'summer', 'distillation', 'left'],  
 ['liquid', 'prisoner', 'pent', 'in', 'walls', 'of', 'glass'],  
 ['beauty', 'effect', 'with', 'beauty', 'were', 'bereft'],  
 ['nor', 'it', 'nor', 'no', 'remembrance', 'what', 'it', 'was'],  
 ['but', 'flowers', 'distilled', 'though', 'they', 'with', 'winter', 'meet'],  
 ['leese',  
   'but',  
   'their',  
   'show',  
   'their',  
   'substance',  
   'still',  
   'lives',  
   'sweet'],  
 [],  
 [],  
 [],  
 ['then', 'let', 'not', 'winter', 'ragged', 'hand', 'deface'],  
 ['in', 'thee', 'thy', 'summer', 'ere', 'thou', 'be', 'distilled'],  
 ['make', 'sweet', 'some', 'vial', 'treasure', 'thou', 'some', 'place'],  
 ['with', 'beauty', 'treasure', 'ere', 'it', 'be', 'self', 'killed'],  
 ['that', 'use', 'is', 'not', 'forbidden', 'usury'],

['which', 'happies', 'those', 'that', 'pay', 'the', 'willing', 'loan'],  
 ['that', 'for', 'thy', 'self', 'to', 'breed', 'another', 'thee'],  
 ['or', 'ten', 'times', 'happier', 'be', 'it', 'ten', 'for', 'one'],  
 ['ten', 'times', 'thy', 'self', 'were', 'happier', 'than', 'thou', 'art'],  
 ['if', 'ten', 'of', 'thine', 'ten', 'times', 'refigured', 'thee'],  
 ['then', 'what', 'could', 'death', 'do', 'if', 'thou', 'shouldst', 'depart'],  
 ['leaving', 'thee', 'living', 'in', 'posterity'],  
 ['be', 'not', 'self', 'willed', 'for', 'thou', 'art', 'much', 'too', 'fair'],  
 ['to', 'be', 'death', 'conquest', 'and', 'make', 'worms', 'thine', 'heir'],  
 [],  
 [],  
 [],  
 ['lo', 'in', 'the', 'orient', 'when', 'the', 'gracious', 'light'],  
 ['lifts', 'up', 'his', 'burning', 'head', 'each', 'under', 'eye'],  
 ['doth', 'homage', 'to', 'his', 'new', 'appearing', 'sight'],  
 ['serving', 'with', 'looks', 'his', 'sacred', 'majesty'],  
 ['and', 'having', 'climbed', 'the', 'steep', 'up', 'heavenly', 'hill'],  
 ['resembling', 'strong', 'youth', 'in', 'his', 'middle', 'age'],  
 ['yet', 'mortal', 'looks', 'adore', 'his', 'beauty', 'still'],  
 ['attending', 'on', 'his', 'golden', 'pilgrimage'],  
 ['but', 'when', 'from', 'highmost', 'pitch', 'with', 'weary', 'car'],  
 ['like', 'feeble', 'age', 'he', 'reeleth', 'from', 'the', 'day'],  
 ['the', 'eyes', 'fore', 'duteous', 'now', 'converted', 'are'],  
 ['from', 'his', 'low', 'tract', 'and', 'look', 'another', 'way'],  
 ['so', 'thou', 'thy', 'self', 'out', 'going', 'in', 'thy', 'noon'],  
 ['unlooked', 'on', 'diest', 'unless', 'thou', 'get', 'son'],  
 [],  
 [],  
 [],  
 ['music', 'to', 'hear', 'why', 'hear', 'st', 'thou', 'music', 'sadly'],  
 ['sweets', 'with', 'sweets', 'war', 'not', 'joy', 'delights', 'in', 'joy'],  
 ['why',  
 'lov',  
 'st',  
 'thou',  
 'that',  
 'which',  
 'thou',  
 'receiv',  
 'st',  
 'not',  
 'gladly'],  
 ['or', 'else', 'receiv', 'st', 'with', 'pleasure', 'thine', 'annoy'],  
 ['if', 'the', 'true', 'concord', 'of', 'well', 'tuned', 'sounds'],  
 ['by', 'unions', 'married', 'do', 'offend', 'thine', 'ear'],  
 ['they', 'do', 'but', 'sweetly', 'chide', 'thee', 'who', 'confounds'],  
 ['in', 'singleness', 'the', 'parts', 'that', 'thou', 'shouldst', 'bear'],  
 ['mark', 'how', 'one', 'string', 'sweet', 'husband', 'to', 'another'],

['strikes', 'each', 'in', 'each', 'by', 'mutual', 'ordering'],  
 ['resembling', 'sire', 'and', 'child', 'and', 'happy', 'mother'],  
 ['who', 'all', 'in', 'one', 'one', 'pleasing', 'note', 'do', 'sing'],  
 ['whose', 'speechless', 'song', 'being', 'many', 'seeming', 'one'],  
 ['sings', 'this', 'to', 'thee', 'thou', 'single', 'wilt', 'prove', 'none'],  
 [],  
 [],  
 [],  
 ['is', 'it', 'for', 'fear', 'to', 'wet', 'widow', 'eye'],  
 ['that', 'thou', 'consum', 'st', 'thy', 'self', 'in', 'single', 'life'],  
 ['ah', 'if', 'thou', 'issueless', 'shalt', 'hap', 'to', 'die'],  
 ['the', 'world', 'will', 'wail', 'thee', 'like', 'makeless', 'wife'],  
 ['the', 'world', 'will', 'be', 'thy', 'widow', 'and', 'still', 'weep'],  
 ['that', 'thou', 'no', 'form', 'of', 'thee', 'hast', 'left', 'behind'],  
 ['when', 'every', 'private', 'widow', 'well', 'may', 'keep'],  
 ['by', 'children', 'eyes', 'her', 'husband', 'shape', 'in', 'mind'],  
 ['look', 'what', 'an', 'unthrift', 'in', 'the', 'world', 'doth', 'spend'],  
 ['shifts',  
 'but',  
 'his',  
 'place',  
 'for',  
 'still',  
 'the',  
 'world',  
 'enjoys',  
 'it'],  
 ['but', 'beauty', 'waste', 'hath', 'in', 'the', 'world', 'an', 'end'],  
 ['and', 'kept', 'unused', 'the', 'user', 'so', 'destroys', 'it'],  
 ['no', 'love', 'toward', 'others', 'in', 'that', 'bosom', 'sits'],  
 ['that', 'on', 'himself', 'such', 'murd', 'rous', 'shame', 'commits'],  
 [],  
 [],  
 [],  
 ['for', 'shame', 'deny', 'that', 'thou', 'bear', 'st', 'love', 'to', 'any'],  
 ['who', 'for', 'thy', 'self', 'art', 'so', 'unprovident'],  
 ['grant', 'if', 'thou', 'wilt', 'thou', 'art', 'beloved', 'of', 'many'],  
 ['but', 'that', 'thou', 'none', 'lov', 'st', 'is', 'most', 'evident'],  
 ['for', 'thou', 'art', 'so', 'possessed', 'with', 'murd', 'rous', 'hate'],  
 ['that',  
 'gainst',  
 'thy',  
 'self',  
 'thou',  
 'stick',  
 'st',  
 'not',  
 'to',

'conspire'],  
 ['seeking', 'that', 'beauteous', 'roof', 'to', 'ruinate'],  
 ['which', 'to', 'repair', 'should', 'be', 'thy', 'chief', 'desire'],  
 ['change', 'thy', 'thought', 'that', 'may', 'change', 'my', 'mind'],  
 ['shall', 'hate', 'be', 'fairer', 'lodged', 'than', 'gentle', 'love'],  
 ['be', 'as', 'thy', 'presence', 'is', 'gracious', 'and', 'kind'],  
 ['or', 'to', 'thy', 'self', 'at', 'least', 'kind', 'hearted', 'prove'],  
 ['make', 'thee', 'another', 'self', 'for', 'love', 'of', 'me'],  
 ['that', 'beauty', 'still', 'may', 'live', 'in', 'thine', 'or', 'thee'],  
 [],  
 [],  
 [],  
 ['as',  
   'fast',  
   'as',  
   'thou',  
   'shalt',  
   'wane',  
   'so',  
   'fast',  
   'thou',  
   'grow',  
   'st'],  
 ['in', 'one', 'of', 'thine', 'from', 'that', 'which', 'thou', 'departest'],  
 ['and', 'that', 'fresh', 'blood', 'which', 'youngly', 'thou', 'bestow', 'st'],  
 ['thou',  
   'mayst',  
   'call',  
   'thine',  
   'when',  
   'thou',  
   'from',  
   'youth',  
   'convertest'],  
 ['herein', 'lives', 'wisdom', 'beauty', 'and', 'increase'],  
 ['without', 'this', 'folly', 'age', 'and', 'cold', 'decay'],  
 ['if', 'all', 'were', 'minded', 'so', 'the', 'times', 'should', 'cease'],  
 ['and', 'threescore', 'year', 'would', 'make', 'the', 'world', 'away'],  
 ['let', 'those', 'whom', 'nature', 'hath', 'not', 'made', 'for', 'store'],  
 ['harsh', 'featureless', 'and', 'rude', 'barrenly', 'perish'],  
 ['look', 'whom', 'she', 'best', 'endowed', 'she', 'gave', 'thee', 'more'],  
 ['which', 'bounteous', 'gift', 'thou', 'shouldst', 'in', 'bounty', 'cherish'],  
 ['she', 'carved', 'thee', 'for', 'her', 'seal', 'and', 'meant', 'thereby'],  
 ['thou', 'shouldst', 'print', 'more', 'not', 'let', 'that', 'copy', 'die'],  
 [],  
 [],  
 [],  
 ['when', 'do', 'count', 'the', 'clock', 'that', 'tells', 'the', 'time'],



['and', 'see', 'the', 'brave', 'day', 'sunk', 'in', 'hideous', 'night'],  
 ['when', 'behold', 'the', 'violet', 'past', 'prime'],  
 ['and', 'sable', 'curls', 'all', 'silvered', 'er', 'with', 'white'],  
 ['when', 'lofty', 'trees', 'see', 'barren', 'of', 'leaves'],  
 ['which', 'erst', 'from', 'heat', 'did', 'canopy', 'the', 'herd'],  
 ['and', 'summer', 'green', 'all', 'girded', 'up', 'in', 'sheaves'],  
 ['borne', 'on', 'the', 'bier', 'with', 'white', 'and', 'bristly', 'beard'],  
 ['then', 'of', 'thy', 'beauty', 'do', 'question', 'make'],  
 ['that', 'thou', 'among', 'the', 'wastes', 'of', 'time', 'must', 'go'],  
 ['since', 'sweets', 'and', 'beauties', 'do', 'themselves', 'forsake'],  
 ['and', 'die', 'as', 'fast', 'as', 'they', 'see', 'others', 'grow'],  
 ['and', 'nothing', 'gainst', 'time', 'scythe', 'can', 'make', 'defence'],  
 ['save',  
   'breed',  
   'to',  
   'brave',  
   'him',  
   'when',  
   'he',  
   'takes',  
   'thee',  
   'hence'],  
 [],  
 [],  
 [],  
 ['that', 'you', 'were', 'your', 'self', 'but', 'love', 'you', 'are'],  
 ['no', 'longer', 'yours', 'than', 'you', 'your', 'self', 'here', 'live'],  
 ['against', 'this', 'coming', 'end', 'you', 'should', 'prepare'],  
 ['and', 'your', 'sweet', 'semblance', 'to', 'some', 'other', 'give'],  
 ['so', 'should', 'that', 'beauty', 'which', 'you', 'hold', 'in', 'lease'],  
 ['find', 'no', 'determination', 'then', 'you', 'were'],  
 ['your', 'self', 'again', 'after', 'your', 'self', 'decease'],  
 ['when', 'your', 'sweet', 'issue', 'your', 'sweet', 'form', 'should', 'bear'],  
 ['who', 'lets', 'so', 'fair', 'house', 'fall', 'to', 'decay'],  
 ['which', 'husbandry', 'in', 'honour', 'might', 'uphold'],  
 ['against', 'the', 'stormy', 'gusts', 'of', 'winter', 'day'],  
 ['and', 'barren', 'rage', 'of', 'death', 'eternal', 'cold'],  
 ['none', 'but', 'unthrifths', 'dear', 'my', 'love', 'you', 'know'],  
 ['you', 'had', 'father', 'let', 'your', 'son', 'say', 'so'],  
 [],  
 [],  
 [],  
 ['not', 'from', 'the', 'stars', 'do', 'my', 'judgement', 'pluck'],  
 ['and', 'yet', 'methinks', 'have', 'astronomy'],  
 ['but', 'not', 'to', 'tell', 'of', 'good', 'or', 'evil', 'luck'],  
 ['of', 'plagues', 'of', 'dearths', 'or', 'seasons', 'quality'],  
 ['nor', 'can', 'fortune', 'to', 'brief', 'minutes', 'tell'],  
 ['pointing', 'to', 'each', 'his', 'thunder', 'rain', 'and', 'wind'],

['or', 'say', 'with', 'princes', 'if', 'it', 'shall', 'go', 'well'],  
 ['by', 'oft', 'predict', 'that', 'in', 'heaven', 'find'],  
 ['but', 'from', 'thine', 'eyes', 'my', 'knowledge', 'derive'],  
 ['and', 'constant', 'stars', 'in', 'them', 'read', 'such', 'art'],  
 ['as', 'truth', 'and', 'beauty', 'shall', 'together', 'thrive'],  
 ['if', 'from', 'thy', 'self', 'to', 'store', 'thou', 'wouldst', 'convert'],  
 ['or', 'else', 'of', 'thee', 'this', 'prognosticate'],  
 ['thy', 'end', 'is', 'truth', 'and', 'beauty', 'doom', 'and', 'date'],  
 [],  
 [],  
 [],  
 ['when', 'consider', 'every', 'thing', 'that', 'grows'],  
 ['holds', 'in', 'perfection', 'but', 'little', 'moment'],  
 ['that', 'this', 'huge', 'stage', 'presenteth', 'nought', 'but', 'shows'],  
 ['whereon', 'the', 'stars', 'in', 'secret', 'influence', 'comment'],  
 ['when', 'perceive', 'that', 'men', 'as', 'plants', 'increase'],  
 ['cheered', 'and', 'checked', 'even', 'by', 'the', 'self', 'same', 'sky'],  
 ['vaunt', 'in', 'their', 'youthful', 'sap', 'at', 'height', 'decrease'],  
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 ['clouds', 'and', 'eclipses', 'stain', 'both', 'moon', 'and', 'sun'],  
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   'self',  
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   'st',  
   'love',  
   'her'],  
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 ['when', 'swift', 'extremity', 'can', 'seem', 'but', 'slow'],  
 ['then', 'should', 'spur', 'though', 'mounted', 'on', 'the', 'wind'],  
 ['in', 'winged', 'speed', 'no', 'motion', 'shall', 'know'],  
 ['then', 'can', 'no', 'horse', 'with', 'my', 'desire', 'keep', 'pace'],  
 ['therefore', 'desire', 'of', 'perfect', 'st', 'love', 'being', 'made'],  
 ['shall', 'neigh', 'no', 'dull', 'flesh', 'in', 'his', 'fiery', 'race'],  
 ['but', 'love', 'for', 'love', 'thus', 'shall', 'excuse', 'my', 'jade'],  
 ['since', 'from', 'thee', 'going', 'he', 'went', 'wilful', 'slow'],  
 ['towards', 'thee', 'll', 'run', 'and', 'give', 'him', 'leave', 'to', 'go'],  
 [],  
 [],  
 [],  
 ['so', 'am', 'as', 'the', 'rich', 'whose', 'blessed', 'key'],  
 ['can', 'bring', 'him', 'to', 'his', 'sweet', 'up', 'locked', 'treasure'],  
 ['the', 'which', 'he', 'will', 'not', 'every', 'hour', 'survey'],  
 ['for', 'blunting', 'the', 'fine', 'point', 'of', 'seldom', 'pleasure'],  
 ['therefore', 'are', 'feasts', 'so', 'solemn', 'and', 'so', 'rare'],  
 ['since', 'seldom', 'coming', 'in', 'that', 'long', 'year', 'set'],  
 ['like', 'stones', 'of', 'worth', 'they', 'thinly', 'placed', 'are'],  
 ['or', 'captain', 'jewels', 'in', 'the', 'carcanet'],  
 ['so', 'is', 'the', 'time', 'that', 'keeps', 'you', 'as', 'my', 'chest'],

['or', 'as', 'the', 'wardrobe', 'which', 'the', 'robe', 'doth', 'hide'],  
 ['to', 'make', 'some', 'special', 'instant', 'special', 'blest'],  
 ['by', 'new', 'unfolding', 'his', 'imprisoned', 'pride'],  
 ['blessed', 'are', 'you', 'whose', 'worthiness', 'gives', 'scope'],  
 ['being', 'had', 'to', 'triumph', 'being', 'lacked', 'to', 'hope'],  
 [],  
 [],  
 [],  
 ['what', 'is', 'your', 'substance', 'whereof', 'are', 'you', 'made'],  
 ['that', 'millions', 'of', 'strange', 'shadows', 'on', 'you', 'tend'],  
 ['since', 'every', 'one', 'hath', 'every', 'one', 'one', 'shade'],  
 ['and', 'you', 'but', 'one', 'can', 'every', 'shadow', 'lend'],  
 ['describe', 'adonis', 'and', 'the', 'counterfeit'],  
 ['is', 'poorly', 'imitated', 'after', 'you'],  
 ['on', 'helen', 'cheek', 'all', 'art', 'of', 'beauty', 'set'],  
 ['and', 'you', 'in', 'grecian', 'tires', 'are', 'painted', 'new'],  
 ['speak', 'of', 'the', 'spring', 'and', 'foison', 'of', 'the', 'year'],  
 ['the', 'one', 'doth', 'shadow', 'of', 'your', 'beauty', 'show'],  
 ['the', 'other', 'as', 'your', 'bounty', 'doth', 'appear'],  
 ['and', 'you', 'in', 'every', 'blessed', 'shape', 'we', 'know'],  
 ['in', 'all', 'external', 'grace', 'you', 'have', 'some', 'part'],  
 ['but', 'you', 'like', 'none', 'none', 'you', 'for', 'constant', 'heart'],  
 [],  
 [],  
 [],  
 ['how', 'much', 'more', 'doth', 'beauty', 'beauteous', 'seem'],  
 ['by', 'that', 'sweet', 'ornament', 'which', 'truth', 'doth', 'give'],  
 ['the', 'rose', 'looks', 'fair', 'but', 'fairer', 'we', 'it', 'deem'],  
 ['for', 'that', 'sweet', 'odour', 'which', 'doth', 'in', 'it', 'live'],  
 ['the', 'canker', 'blooms', 'have', 'full', 'as', 'deep', 'dye'],  
 ['as', 'the', 'perfumed', 'tincture', 'of', 'the', 'roses'],  
 ['hang', 'on', 'such', 'thorns', 'and', 'play', 'as', 'wantonly'],  
 ['when', 'summer', 'breath', 'their', 'masked', 'buds', 'discloses'],  
 ['but', 'for', 'their', 'virtue', 'only', 'is', 'their', 'show'],  
 ['they', 'live', 'unwooded', 'and', 'unrespected', 'fade'],  
 ['die', 'to', 'themselves', 'sweet', 'roses', 'do', 'not', 'so'],  
 ['of', 'their', 'sweet', 'deaths', 'are', 'sweetest', 'odours', 'made'],  
 ['and', 'so', 'of', 'you', 'beauteous', 'and', 'lovely', 'youth'],  
 ['when', 'that', 'shall', 'vade', 'by', 'verse', 'distills', 'your', 'truth'],  
 [],  
 [],  
 [],  
 ['not', 'marble', 'nor', 'the', 'gilded', 'monuments'],  
 ['of', 'princes', 'shall', 'outlive', 'this', 'powerful', 'rhyme'],  
 ['but', 'you', 'shall', 'shine', 'more', 'bright', 'in', 'these', 'contents'],  
 ['than', 'unswept', 'stone', 'besmeared', 'with', 'sluttish', 'time'],  
 ['when', 'wasteful', 'war', 'shall', 'statues', 'overturn'],  
 ['and', 'broils', 'root', 'out', 'the', 'work', 'of', 'masonry'],

['nor',  
 'mars',  
 'his',  
 'sword',  
 'nor',  
 'war',  
 'quick',  
 'fire',  
 'shall',  
 'burn'],  
 ['the', 'living', 'record', 'of', 'your', 'memory'],  
 ['gainst', 'death', 'and', 'all', 'oblivious', 'enmity'],  
 ['shall',  
 'you',  
 'pace',  
 'forth',  
 'your',  
 'praise',  
 'shall',  
 'still',  
 'find',  
 'room'],  
 ['even', 'in', 'the', 'eyes', 'of', 'all', 'posterity'],  
 ['that', 'wear', 'this', 'world', 'out', 'to', 'the', 'ending', 'doom'],  
 ['so', 'till', 'the', 'judgment', 'that', 'your', 'self', 'arise'],  
 ['you', 'live', 'in', 'this', 'and', 'dwell', 'in', 'lovers', 'eyes'],  
 [],  
 [],  
 [],  
 ['sweet', 'love', 'renew', 'thy', 'force', 'be', 'it', 'not', 'said'],  
 ['thy', 'edge', 'should', 'blunter', 'be', 'than', 'appetite'],  
 ['which', 'but', 'to', 'day', 'by', 'feeding', 'is', 'allayed'],  
 ['to', 'morrow', 'sharpened', 'in', 'his', 'former', 'might'],  
 ['so', 'love', 'be', 'thou', 'although', 'to', 'day', 'thou', 'fill'],  
 ['thy', 'hungry', 'eyes', 'even', 'till', 'they', 'wink', 'with', 'fulness'],  
 ['to', 'morrow', 'see', 'again', 'and', 'do', 'not', 'kill'],  
 ['the', 'spirit', 'of', 'love', 'with', 'perpetual', 'dulness'],  
 ['let', 'this', 'sad', 'interim', 'like', 'the', 'ocean', 'be'],  
 ['which', 'parts', 'the', 'shore', 'where', 'two', 'contracted', 'new'],  
 ['come', 'daily', 'to', 'the', 'banks', 'that', 'when', 'they', 'see'],  
 ['return', 'of', 'love', 'more', 'blest', 'may', 'be', 'the', 'view'],  
 ['or', 'call', 'it', 'winter', 'which', 'being', 'full', 'of', 'care'],  
 ['makes', 'summer', 'welcome', 'thrice', 'more', 'wished', 'more', 'rare'],  
 [],  
 [],  
 [],  
 ['being', 'your', 'slave', 'what', 'should', 'do', 'but', 'tend'],  
 ['upon', 'the', 'hours', 'and', 'times', 'of', 'your', 'desire'],

```

['have', 'no', 'precious', 'time', 'at', 'all', 'to', 'spend'],
['nor', 'services', 'to', 'do', 'till', 'you', 'require'],
['nor', 'dare', 'chide', 'the', 'world', 'without', 'end', 'hour'],
['whilst', 'my', 'sovereign', 'watch', 'the', 'clock', 'for', 'you'],
['nor', 'think', 'the', 'bitterness', 'of', 'absence', 'sour'],
['when', 'you', 'have', 'bid', 'your', 'servant', 'once', 'adieu'],
['nor', 'dare', 'question', 'with', 'my', 'jealous', 'thought'],
['where', 'you', 'may', 'be', 'or', 'your', 'affairs', 'suppose'],
['but', 'like', 'sad', 'slave', 'stay', 'and', 'think', 'of', 'nought'],
['save', 'where', 'you', 'are', 'how', 'happy', 'you', 'make', 'those'],
['so', 'true', 'fool', 'is', 'love', 'that', 'in', 'your', 'will'],
['though', 'you', 'do', 'any', 'thing', 'he', 'thinks', 'no', 'ill'],
[],
[],
[],
['that', 'god', 'forbid', 'that', 'made', 'me', 'first', 'your', 'slave'],
['should', 'in', 'thought', 'control', 'your', 'times', 'of', 'pleasure'],
['or', 'at', 'your', 'hand', 'th', 'account', 'of', 'hours', 'to', 'crave'],
['being', 'your', 'vassal', 'bound', 'to', 'stay', 'your', 'leisure'],
['let', 'me', 'suffer', 'being', 'at', 'your', 'beck'],
['th', 'imprisoned', 'absence', 'of', 'your', 'liberty'],
['and', 'patience', 'tame', 'to', 'sufferance', 'bide', 'each', 'check'],
['without', 'accusing', 'you', 'of', 'injury'],
['be', 'where', 'you', 'list', 'your', 'charter', 'is', 'so', 'strong'],
['that', 'you', 'your', 'self', 'may', 'privilage', 'your', 'time'],
['to', 'what', 'you', 'will', 'to', 'you', 'it', 'doth', 'belong'],
['your', 'self', 'to', 'pardon', 'of', 'self', 'doing', 'crime'],
['am', 'to', 'wait', 'though', 'waiting', 'so', 'be', 'hell'],
['not', 'blame', 'your', 'pleasure', 'be', 'it', 'ill', 'or', 'well'],
[],
[],
[],
['if', 'there', 'be', 'nothing', 'new', 'but', 'that', 'which', 'is'],
['hath', 'been', 'before', 'how', 'are', 'our', 'brains', 'beguiled'],
['which', 'labouring', 'for', 'invention', 'bear', 'amis'],
['the', 'second', 'burthen', 'of', 'former', 'child'],
['that', 'record', 'could', 'with', 'backward', 'look'],
...]

```

Now let's train the word2vec model using our document variable (which is a list of word lists). Note that you can specify a number of hyperparameters below: \* min\_count removes all words that occur less than min\_count \* window: window size in the skip-gram \* workers: how many threads to use \* size: number of dimension of your new word embedding vector (typically 100-200). Smaller datasets require a smaller number

```

In [0]: model = gensim.models.Word2Vec (documents, size=150, window=5, min_count=2, workers=4)
        model.train(documents,total_examples=len(documents),epochs=10)

```

```

Out [0]: (6704888, 8675160)

```

That's it! Now you've trained the model!

Now let's explore some properties of our new word space. You can get the words most close (read: most similar) to a given word. Remember, the only texts the model has seen is shakespeare!

```
In [0]: w1 = "king"
        model.wv.most_similar (positive=w1)
```

```
/usr/local/lib/python3.6/dist-packages/gensim/matutils.py:737: FutureWarning: Conversion of the
if np.issubdtype(vec.dtype, np.int):
```

```
Out[0]: [('prince', 0.6637360453605652),
         ('bolingbroke', 0.5787448287010193),
         ('fifth', 0.5630384683609009),
         ('sixth', 0.5574467778205872),
         ('duke', 0.555621325969696),
         ('warwick', 0.5485361814498901),
         ('emperor', 0.523899257183075),
         ('ghost', 0.5001928806304932),
         ('gaunt', 0.4832296371459961),
         ('plantagenet', 0.4831539988517761)]
```

```
In [0]: # look up top 6 words similar to 'smile'
        w1 = ["smile"]
        model.wv.most_similar (positive=w1,topn=6)
```

```
/usr/local/lib/python3.6/dist-packages/gensim/matutils.py:737: FutureWarning: Conversion of the
if np.issubdtype(vec.dtype, np.int):
```

```
Out[0]: [('laugh', 0.778375506401062),
         ('shine', 0.7289828658103943),
         ('lodge', 0.6914820671081543),
         ('rejoice', 0.6843976378440857),
         ('tremble', 0.6827942728996277),
         ('scowl', 0.6783110499382019)]
```

```
In [0]: # look up top 6 words similar to 'france'
        w1 = ["france"]
        model.wv.most_similar (positive=w1,topn=6)
```

```
/usr/local/lib/python3.6/dist-packages/gensim/matutils.py:737: FutureWarning: Conversion of the
if np.issubdtype(vec.dtype, np.int):
```

```
Out[0]: [('england', 0.6262168884277344),
         ('princess', 0.60029137134552),
         ('charles', 0.5759135484695435),
         ('orleans', 0.557037889957428),
         ('ireland', 0.5540443062782288),
         ('kings', 0.5341139435768127)]
```

```
In [0]: # look up top 6 words similar to 'sword'
        w1 = ["sword"]
        model.wv.most_similar (positive=w1,topn=6)
```

```
/usr/local/lib/python3.6/dist-packages/gensim/matutils.py:737: FutureWarning: Conversion of the
if np.issubdtype(vec.dtype, np.int):
```

```
Out[0]: [('knife', 0.7401856780052185),
         ('pocket', 0.7381002902984619),
         ('head', 0.7250351309776306),
         ('neck', 0.6968185901641846),
         ('fingers', 0.6878458261489868),
         ('dagger', 0.68181973695755)]
```

```
In [0]: # get everything related to stuff on the royalty and not related to farmer
        w1 = ["king", 'queen', 'prince']
        w2 = ['farmer']
        model.wv.most_similar (positive=w1,negative=w2,topn=10)
```

```
/usr/local/lib/python3.6/dist-packages/gensim/matutils.py:737: FutureWarning: Conversion of the
if np.issubdtype(vec.dtype, np.int):
```

```
Out[0]: [('princess', 0.632810652256012),
         ('duke', 0.5970571041107178),
         ('warwick', 0.5757090449333191),
         ('bolingbroke', 0.5671865940093994),
         ('emperor', 0.5435048341751099),
         ('duchess', 0.540212094783783),
         ('cousin', 0.530179500579834),
         ('uncle', 0.5046942830085754),
         ('ghost', 0.502541720867157),
         ('cause', 0.502470076084137)]
```

Explore the similarity (e.g. distance) between two words. Does it make sense?

```
In [0]: # similarity between two similar words
        model.wv.similarity(w1="pretty",w2="beautiful")
```

```
/usr/local/lib/python3.6/dist-packages/gensim/matutils.py:737: FutureWarning: Conversion of the
if np.issubdtype(vec.dtype, np.int):
```

```
Out[0]: 0.5449006
```

```
In [0]: # similarity between two opposing words
        model.wv.similarity(w1="king",w2="farmer")
```



```
/usr/local/lib/python3.6/dist-packages/gensim/matutils.py:737: FutureWarning: Conversion of the  
if np.issubdtype(vec.dtype, np.int):
```

```
Out[0]: 0.009076139
```

Try some other combinations :)

We can even use it to perform more 'smart' assignments:

```
In [0]: # Which one is the odd one out in this list?  
model.wv.doesnt_match(["cat", "dog", "france"])
```

```
/usr/local/lib/python3.6/dist-packages/gensim/models/keyedvectors.py:895: FutureWarning: array  
vectors = vstack(self.word_vec(word, use_norm=True) for word in used_words).astype(REAL)  
/usr/local/lib/python3.6/dist-packages/gensim/matutils.py:737: FutureWarning: Conversion of the  
if np.issubdtype(vec.dtype, np.int):
```

```
Out[0]: 'france'
```

If you are interested in plotting the words in a multidimensional space, you can actually get the vector coordinates of each word:

```
In [0]: model.wv['france']
```

```
Out[0]: array([ 1.0197705 ,  0.44881007,  0.31932268,  0.02383145, -0.23176159,  
                0.20569536,  0.60627794,  0.39987743, -0.9515703 ,  0.4142828 ,  
               -0.60628   , -0.69530237,  1.0318936 , -1.1305163 , -0.8180311 ,  
               -0.47863126,  0.92082417, -0.84451693,  0.16861367, -0.5226272 ,  
               -0.6902815 ,  0.79099643,  1.365395   ,  0.35602307, -0.08457448,  
               -0.5668897 , -0.09828843, -1.5369692 , -0.48207185, -0.294741  ,  
                0.792997   , -0.62820256,  0.36249533, -0.6615187 , -1.3769151 ,  
                0.03109001,  0.15089849,  0.3313757 ,  1.8875285 , -0.0245728 ,  
                0.77070147,  0.9470159 ,  0.25629687, -0.29598927,  0.44341362,  
                0.48870742, -0.45678386, -1.0671146 , -0.2974088 ,  0.3277891 ,  
                0.4130305 , -0.59487164, -1.0871751 ,  0.6710369 ,  0.59362406,  
               -2.0236723 , -0.35781616,  0.1337221 , -1.1078902 , -0.5135816 ,  
                1.3742491 ,  0.5712652 ,  1.2975744 , -0.07966353, -0.40934303,  
                1.0450964 ,  0.17061508, -0.6297654 , -0.39215726, -0.25218567,  
                0.18968461, -0.97811544,  0.994242   , -0.42447072,  0.18724278,  
               -0.46376514, -0.48296592, -0.07904538,  0.72070944, -0.33523524,  
               -0.1254106 , -0.21354091, -1.0704911 ,  1.4872189 , -0.80734676,  
                0.11116387, -0.660585   ,  0.83737266, -1.2770686 ,  0.6909421 ,  
               -1.2727413 , -0.70032245,  0.3743446 , -0.3408204 ,  0.3424541 ,  
                0.03539267,  0.16686079,  0.24503307,  0.3545546 ,  0.10402475,  
                1.7598131 , -1.6744354 , -0.9700667 ,  0.05907201,  0.26798543,  
                0.38056484,  1.8402451 , -0.57384866, -0.59498876, -0.7565171 ,  
                0.31648824, -0.09337381,  0.26198778, -1.0453447 ,  0.8112996 ,  
               -0.22696687,  1.4382293 , -0.08576896,  1.2584329 ,  0.10717181,
```

```

0.410654 , -0.74530625, -1.8694701 , 0.08746815, -1.0238185 ,
0.16641314, -0.22549377, 0.9687293 , -0.2050606 , -0.8355118 ,
-0.07546067, 0.21632072, -0.02943058, 0.15096462, -0.32335198,
0.36352596, 0.4273267 , 0.39446467, 1.1102039 , 1.0142521 ,
-0.08208741, 0.5238783 , -1.2147725 , -0.8483968 , -0.91651654,
-0.59887487, -0.42655212, 0.6894982 , 0.81414706, -0.9018873 ],
dtype=float32)

```

## 0.2 Bonus: visualising our model in t-SNE:

```

In [0]: from sklearn.manifold import TSNE
import matplotlib.pyplot as plt
%matplotlib inline

def tsne_plot(model):
    "Creates and TSNE model and plots it"

    # fyi: to test specific labels instead of all the words in the vocab:
    # labels = ['king', 'queen', 'prince', 'farmer', 'blue', 'red']
    # tokens = []
    # for label in labels:
    #     tokens.append(model[label])

    labels = []
    tokens = []

    count = 0
    for word in model.wv.vocab:
        # to speed up the process, let's limit to the first 100 elements
        if count < 100:
            tokens.append(model[word])
            labels.append(word)
            count = count+1

    # set the t-sne values
    tsne_model = TSNE(perplexity=40, n_components=2, init='pca', n_iter=2500, random_s
    new_values = tsne_model.fit_transform(tokens)

    x = []
    y = []
    for value in new_values:
        x.append(value[0])
        y.append(value[1])

    plt.figure(figsize=(16, 16))
    for i in range(len(x)):
        plt.scatter(x[i],y[i])
        plt.annotate(labels[i],

```

```

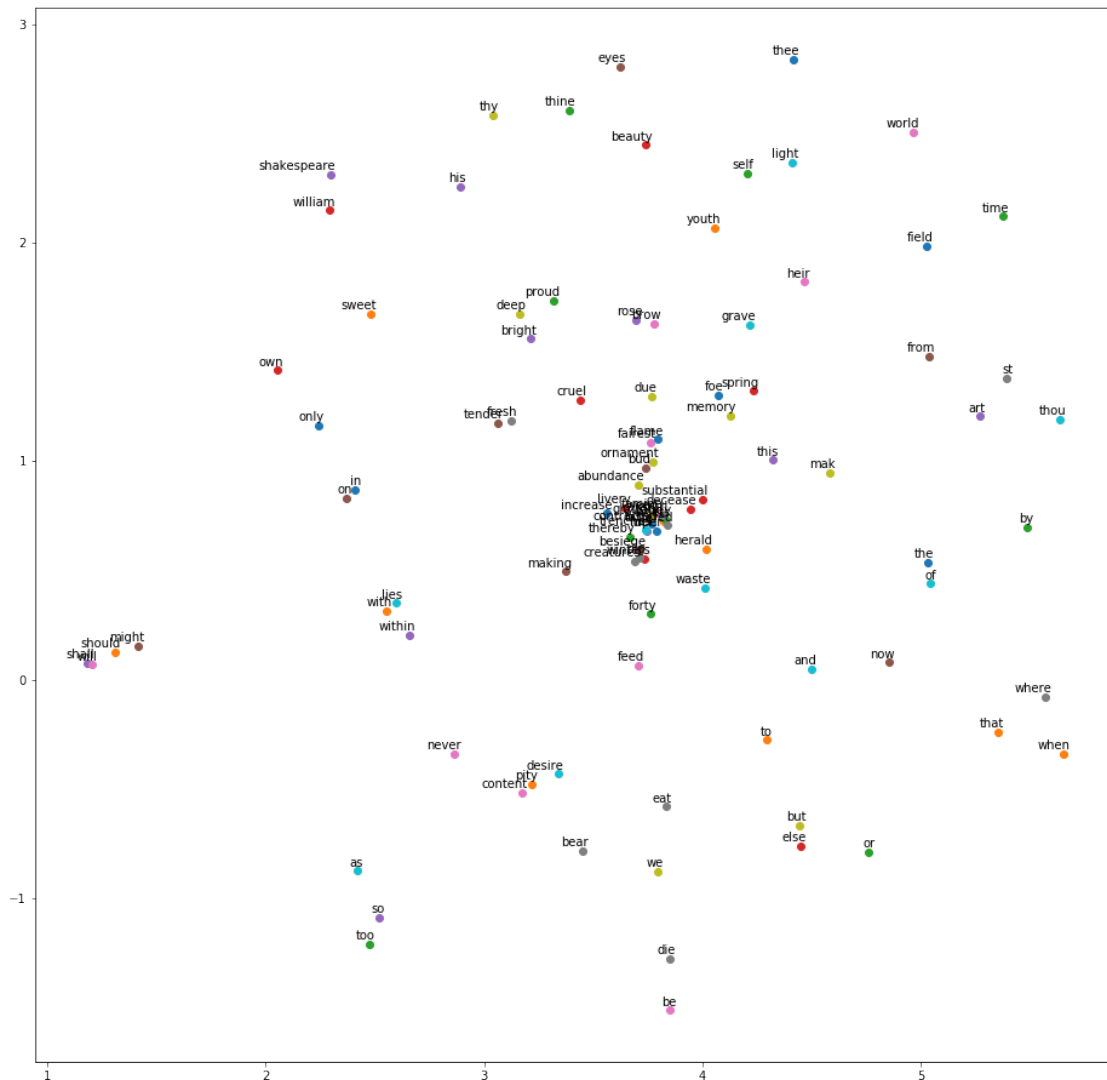
xy=(x[i], y[i]),
xytext=(5, 2),
textcoords='offset points',
ha='right',
va='bottom')

plt.show()

```

```
tsne_plot(model)
```

/usr/local/lib/python3.6/dist-packages/ipykernel\_launcher.py:21: DeprecationWarning: Call to d



### 0.3 References

- <https://radimrehurek.com/gensim/models/word2vec.html>

- <https://towardsdatascience.com/multi-class-text-classification-model-comparison-and-selection-5eb066197568>
- <https://github.com/kavgan/nlp-text-mining-working-examples/tree/master/word2vec>
- <https://medium.com/@mishra.thedeeepak/doc2vec-simple-implementation-example-df2afbbfbad5>

In [0]: !wget

wget: missing URL

Usage: wget [OPTION]... [URL]...

Try `wget --help' for more options.

In [0]: