IR Task

January 28, 2022

```python
[1]: import nltk
     import xml.etree.cElementTree as et
     import heapq
     import numpy as np #matrix
     from numpy import dot #dot product used to calcualte cosine similarity
     from numpy.linalg import norm #normalisation used to calculate cosine similarity
     from nltk.tokenize import RegexpTokenizer #used to tokenize into words and␣
      ↪remove punctuation
     from nltk.corpus import stopwords

     from tqdm import tqdm #extra function to monitor lengthy calls
     import time
```

getListOfFiles is used to retrieve the names of each file within docs/, please note for this to work
both folders will have to be in the same directory as this jupiter notebook

```python
[2]: import os

     def getListOfFiles(dirName): #fuction used to retrieve parse the document to␣
      ↪extract
         # create a list of file and sub directories
         # names in the given directory
         listOfFile = os.listdir(dirName)
         allFiles = list()
         # Iterate over all the entries
         for entry in listOfFile:
             # Create full path
             fullPath = os.path.join(dirName, entry)
             # If entry is a directory then get the list of files in this directory
             if os.path.isdir(fullPath):
                 allFiles = allFiles + getListOfFiles(fullPath)
             else:
                 allFiles.append(fullPath)

         return allFiles
     dirName = 'docs/'; #directory conatining all the documents
     listOfFiles = getListOfFiles(dirName)
     #print (listOfFiles)
```

extractData is used to extract the data in XML's tag

```
[3]:  def extractData(string):
        root = et.parse(string).getroot()
        for raw in root.iter('raw'): #extracts paragraphs of information from raw tags
          data = raw.text
        return(data)
```

tokenizer function that returns a tokenized paragraph whilst removing punctuation

```
[4]:  tokenizer = RegexpTokenizer(r'\w+')

      def tokenise(string):
        tokens_document = tokenizer.tokenize(string)
        return tokens_document

      #text = tokenise(text)
      #print(text)
```

The following three functions are used to handle the casefolding, stopwordremoval and stemming of text

```
[5]:  def caseFold (list): #function which handles casefolding
        casefoldedList = [word.casefold() for word in list]

        return casefoldedList

      #text = caseFold(text)
      #print(text)
```

```
[6]:  def stopWordRemoval(list): #stopwords is used from nltk and stopWordRemoval is␣
      ↪called to remove stop words from the passed document
        newlist = []
        stopWords = set(stopwords.words('english'))

        for word in list:
          if word not in stopWords:
              newlist.append(word)

        return newlist
```

```
[7]:  from nltk.stem import PorterStemmer
      def stemm(list): #function which handles a documents stemming
        Stem = PorterStemmer()
        stemmList = [Stem.stem(word) for word in list]
        return stemmList

      #text = stemm(text)
```

```
#print(text)
```

cleaning is the function that handles tokenization case-folding, stop-word removal and stemming

```python
[8]: def cleaning(toClean):
       text_token = tokenise(toClean)
       text_cf = caseFold(text_token)
       text_sWR = stopWordRemoval(text_cf)
       final_text = stemm(text_sWR)

       return(final_text)

     #text = cleaning(text)
     #print(text)
```

Below, the extraction of each document, tokenization and cleaning takes places and each fully cleaned document is added doc_list

tqdm is used to monitor the status of of what document has been added to the list

```python
[9]: doc_list = []

     LENGTH = len(listOfFiles)
     pbar = tqdm(total=LENGTH)# Number of iterations required to fill pbar
     for doc_name in listOfFiles:
       text = extractData(doc_name) #handles data extraction
       text = cleaning(text) #handles case-foling, stop-word removal, and stemming
       doc_list.append(text)
       pbar.update(n=1) # Increments counter

     #print(doc_list)
```

```
100%|        | 331/331 [00:20<00:00, 76.83it/s]
```

Below what has already been implemented is used to again to obtain the list of all possible queries

```python
[10]: query_list = []
      dirName = 'queries/'; #directory of queries
      listOfFilesQ = getListOfFiles(dirName)
      listOfFilesQ.pop(0)

      for query_name in listOfFilesQ:
        text = extractData(query_name)
        text = cleaning(text)
        query_list.append(text)

      print(query_list)
```

```
[['fabric', 'music', 'instrument'], ['famou', 'german', 'poetri'], ['romantic'],
['univers', 'edinburgh', 'research'], ['bridg', 'construct'], ['walk', 'fame',
```

```
'star'], ['scientist', 'work', 'atom', 'bomb'], ['invent', 'internet'],
['earli', 'telecommun', 'method'], ['explor', 'south', 'pole'], ['famou',
'member', 'royal', 'navi'], ['nobel', 'prize', 'win', 'invent'], ['south',
'america'], ['edward', 'teller', 'mari', 'curi'], ['comput', 'languag',
'program', 'artifici', 'intellig'], ['william', 'hearst', 'movi'], ['captain',
'jame', 'cook', 'becom', 'explor'], ['grace', 'hopper', 'get', 'famou'],
['comput', 'astronomi'], ['wwii', 'aircraft'], ['literari', 'critic', 'thoma',
'moor'], ['nazi', 'confisc', 'destroy', 'art', 'literatur'], ['modern', 'age',
'english', 'literatur'], ['modern', 'physiolog'], ['roman', 'empir'],
['scientist', 'contribut', 'photosynthesi'], ['aviat', 'pioneer', 'public'],
['gutenberg', 'bibl'], ['religi', 'belief', 'scientist', 'explor'], ['carl',
'friedrich', 'gauss', 'influenc', 'colleagu'], ['person', 'hannov'], ['skinner',
'experi', 'oper', 'condit', 'chamber'], ['napoleon', 'russian', 'campaign'],
['friend', 'enemi', 'napoleon', 'bonapart'], ['first', 'woman', 'nobel',
'prize']]
```

The query_list is added to the new_doc_list so that after for cosine similarity the matrices have the same length

```
[11]: doc_list.extend(query_list)
```

CalWordFreq takes a list and sorts it in the order of which term is most frequent, this is used during the calculations of tf*idf

```
[13]: def CalWordFreq(list):
        wordfreq = {}
        most_freq = []
        for sentence in list:
            tokens = sentence
            for word in tokens:
              if word not in wordfreq.keys():
                  wordfreq[word] = 1
              else:
                  wordfreq[word] += 1

        sort_orders = sorted(wordfreq.items(), key=lambda x: x[1], reverse=True)
        for i in sort_orders:
            most_freq.append(i[0])
        return(most_freq)

      print(CalWordFreq(doc_list))
```

```
['first', 'work', 'also', 'year', 'one', 'becam', 'univers', 'use', 'born',
'time', 'known', 'studi', 'publish', 'later', 'new', 'de', 'comput', 'interest',
'1', 'yovisto', 'develop', 'mathemat', 'made', 'scienc', 'howev', 'may',
'lectur', '2', 'two', 'world', 'theori', 'german', 'well', 'engin', 'school',
'found', 'age', 'research', 'earli', 'began', 'mani', 'learn', 'father',
'receiv', 'scientist', 'john', 'famou', 'system', 'includ', 'life', 'would',
'start', 'could', 'book', 'design', 'sever', 'even', 'call', 'name', 'physic',
```

'professor', '3', 'societi', 'continu', 'war', 'experi', 'die', 'famili',
'becom', 'import', 'american', 'french', 'state', 'invent', 'order', 'part',
'follow', 'histori', 'make', 'germani', 'scientif', 'return', 'move', 'natur',
'great', 'three', 'public', 'educ', 'believ', 'day', 'success', 'berlin',
'result', 'space', 'pari', 'institut', 'video', 'produc', 'creat', 'took',
'abl', 'machin', 'period', 'discov', 'colleg', 'best', 'young', 'man', 'still',
'pass', 'gener', 'idea', 'observ', 'consid', 'origin', 'compani', 'around',
'royal', 'london', 'program', 'appoint', 'centuri', 'astronom', 'alreadi',
'like', 'von', 'art', 'mechan', 'much', 'career', 'soon', 'live', 'remain',
'write', 'paper', 'field', 'georg', 'languag', 'back', 'charl', 'number',
'student', 'away', 'method', 'establish', 'today', 'franc', 'william',
'expedit', 'set', 'death', 'contribut', 'print', 'process', 'complet',
'project', 'unit', 'award', 'atom', 'describ', 'assum', 'attend', 'son',
'modern', 'differ', 'influenc', 'film', 'manag', 'human', 'posit', 'due',
'popular', 'travel', 'discoveri', 'model', 'high', 'wrote', 'base', 'academi',
'probabl', 'imag', 'build', 'august', 'though', 'citi', 'came', 'although',
'electron', 'left', 'philosoph', 'form', 'english', 'way', 'support', 'power',
'calcul', 'take', 'oper', 'york', 'anoth', 'last', 'attempt', 'photograph',
'help', 'earth', 'teach', 'person', 'mathematician', 'introduc', 'decid',
'graduat', 'air', 'law', 'group', 'construct', 'present', 'thoma', 'four',
'medicin', 'prize', 'wide', 'test', 'possibl', 'degre', 'member', 'flight',
'astronomi', 'author', 'long', 'critic', 'star', 'seri', 'achiev', 'chemistri',
'built', 'old', 'find', 'never', 'led', 'nation', 'geometri', 'england', 'end',
'british', 'increas', 'show', 'practic', 'chang', 'claim', 'major', 'line',
'robert', 'problem', 'henri', 'doctor', 'highli', 'element', 'went', 'organ',
'medic', 'philosophi', 'pioneer', '4', 'march', 'perform', 'teacher', 'especi',
'technolog', 'la', 'larg', 'next', 'play', 'sinc', 'children', 'friend',
'togeth', 'artist', 'octob', 'second', 'improv', '000', 'inventor', 'light',
'join', 'allow', 'small', 'concept', 'physician', 'caus', 'gave', 'accept',
'bridg', 'electr', 'explain', 'thu', 'ii', 'juli', 'forc', 'patent', 'televis',
'quit', 'nobel', 'spent', 'depart', 'explor', 'structur', 'king', 'fli',
'visit', 'unfortun', 'product', 'water', 'short', 'joseph', 'open', 'chemic',
'turn', 'read', 'commun', 'paint', 'lead', 'septemb', 'diseas', 'polit', 'ray',
'accord', 'museum', 'europ', 'june', 'govern', 'provid', 'river', 'rather',
'measur', 'given', 'along', 'laboratori', 'near', 'among', 'peopl', 'numer',
'assist', 'collect', 'loui', 'place', 'moon', 'stori', 'director', 'jame',
'busi', 'give', 'refer', 'appear', 'brother', 'instrument', 'cours', 'main',
'offic', 'april', 'enter', 'bodi', 'map', 'north', 'serv', 'talk', 'said',
'physicist', 'nuclear', 'function', 'point', 'plant', 'militari', 'mann',
'inform', 'knowledg', 'land', 'often', 'novemb', 'us', 'associ', 'logic',
'almost', 'earn', 'object', 'devic', 'telescop', 'intellig', 'pictur', 'plan',
'home', 'roman', 'mean', 'sun', 'observatori', 'planet', 'suggest', 'effect',
'januari', 'hand', 'reach', 'record', 'st', 'final', 'littl', 'woman', 'men',
'health', 'determin', 'activ', 'begin', 'intern', 'relat', 'area', 'fellow',
'greek', 'servic', 'financi', 'ship', 'sound', 'contain', 'propos', 'topic',
'elect', 'variou', 'e', 'tabl', 'know', 'island', 'direct', 'letter', 'without',
'thought', 'taught', 'grew', 'titl', 'met', 'draw', 'rocket', 'revolut',
'south', 'journal', 'novel', 'armi', 'principl', 'term', 'view', 'hous',

'women', 'type', 'advanc', '5', 'experiment', 'photographi', 'johann',
'friedrich', 'exist', 'prof', 'c', 'discuss', 'need', 'sent', 'reason',
'richard', 'spain', 'particl', 'offer', 'appli', 'aviat', 'demonstr', 'america',
'20', 'across', 'materi', 'sir', 'head', 'pilot', 'five', 'camera', 'translat',
'might', 'post', '1930', 'color', 'wife', 'psycholog', 'actual', 'aircraft',
'subject', 'spam', 'close', 'realli', 'understand', 'anim', 'western', 'willi',
'prove', 'industri', 'got', '10', 'civil', 'condit', 'respons', 'mari',
'control', 'eventu', 'ad', 'initi', 'econom', 'enrol', 'mass', 'frederick',
'fact', 'reput', 'instead', 'sourc', 'better', 'good', 'west', 'want', 'j',
'15', 'written', 'look', 'put', 'six', 'itali', 'music', 'theoret', 'foundat',
'enjoy', 'commerci', 'involv', 'late', 'mother', 'social', 'come', 'countri',
'matter', 'comet', 'orbit', 'softwar', 'privat', 'boy', 'paul', 'medal',
'report', 'investig', 'shortli', 'master', 'descript', 'other', 'think', 'leav',
'movement', 'jean', 'special', 'independ', 'illustr', 'plane', 'hospit', '12',
'figur', 'everi', 'data', 'issu', 'alway', 'credit', 'founder', '18',
'februari', 'event', '16', 'chemist', 'tri', 'mit', 'charg', 'futur', 'energi',
'month', 'must', 'retir', 'realiz', 'applic', 'empir', 'devot', 'taken',
'center', 'plate', 'game', 'honor', 'connect', 'role', 'signific', 'literatur',
'see', 'finish', 'theorem', 'obtain', 'volum', '14', 'watch', 'effort',
'exhibit', 'attent', 'heinrich', 'ring', 'notic', 'gain', 'examin', 'free',
'inspir', 'napoleon', 'held', 'third', 'wilhelm', 'non', 'concern', 'ever',
'carl', 'ask', 'ancient', 'local', 'throughout', 'speed', 'u', 'word',
'spanish', 'radio', 'moor', 'european', 'subsequ', 'share', 'dr', 'love',
'hire', 'maria', 'stay', '30', 'anatomi', 'version', 'arriv', 'singl',
'therefor', 'parti', 'johnson', 'church', '25', 'get', 'right', 'einstein',
'magnet', 'ga', 'battl', 'entir', 'lifetim', 'account', 'enough', 'face', 'san',
'weight', 'motion', 'russian', 'launch', 'cray', 'basi', 'belong', 'white',
'size', 'east', 'thesi', 'rule', 'note', 'less', 'latin', 'carri', 'definit',
'blood', 'cambridg', 'requir', 'rock', 'user', 'consist', 'presid', 'chain',
'addit', 'recogn', '13', 'le', 'appar', 'full', 'combin', 'histor', 'survey',
'poet', 'technic', 'avail', 'edward', 'train', 'artifici', 'writer', 'enabl',
'17', 'decemb', 'articl', 'charact', '1937', 'team', 'newspap', 'rome', 'class',
'properti', 'toward', 'parent', 'botani', 'seem', 'pole', 'cross', 'prepar',
'site', 'date', '1950', 'fossil', 'historian', 'classic', 'question', 'complex',
'marri', 'helicopt', 'priestley', 'station', 'surviv', 'employ', 'act', 'fail',
'releas', 'bell', 'italian', 'within', 'care', 'seven', 'ground', '8', 'geolog',
'ann', 'section', 'iron', 'adler', 'mariu', 'ture', 'gamow', 'eight', 'cultur',
'immedi', 'offici', 'mark', 'karl', 'saw', 'reaction', 'case', 'detail',
'individu', 'child', 'crew', 'alfr', '6', 'fire', 'say', 'edit', 'harvard',
'mantel', 'adventur', 'contemporari', 'w', 'movi', 'real', 'fundament', 'x',
'quantum', 'surfac', 'werner', 'common', 'rais', '28', 'ill', 'town', 'network',
'atmospher', 'rel', 'display', 'upon', 'heart', 'solut', 'techniqu', 'heat',
'purpos', 'argu', 'detect', 'dirichlet', 'ramsey', 'physiolog', 'sea', 'intend',
'green', '1939', 'franklin', 'chair', 'suffer', 'whose', 'evid', 'attract',
'manufactur', 'wall', 'yale', 'document', 'wave', 'california', 'mountain',
'code', 'goddard', 'edison', 'jewish', 'watson', 'irish', 'peari', 'bird',
'canal', 'distanc', 'despit', 'berkeley', '1928', 'lost', 'thing', 'rest',
'meet', 'circl', 'poem', 'equip', 'search', '11', 'attack', 'press', 'featur',

'kind', 'stoneheng', 'b', 'exampl', 'tube', 'standard', 'mostli', 'metal',
'digit', 'difficult', 'influenti', 'saint', 'librari', 'solv', '23', 'peter',
'strong', 'pythagora', 'coast', 'euclid', 'iffland', '19', 'moreov', 'lessep',
'7', 'du', 'britain', 'black', '100', 'repres', 'proof', 'christian', 'formal',
'edinburgh', 'earliest', 'introduct', 'street', 'duke', 'newli', 'job', 'munch',
'clear', 'kill', 'convinc', 'behavior', 'blue', 'approach', 'heard',
'nevertheless', '1934', 'franci', 'decad', 'similar', 'catherin', 'soviet',
'solar', 'bessel', 'journey', 'ten', 'emperor', 'seen', 'celebr', 'notabl',
'board', '1927', 'mission', 'colleagu', 'garden', 'identifi', 'ernst', 'extens',
'succeed', 'progress', 'regard', 'accur', '1925', 'copi', 'compar',
'manuscript', 'radiat', 'sphere', 'shape', 'olber', 'gauss', 'messag', 'scale',
'swedenborg', 'acid', 'literari', '1906', 'egypt', 'go', 'decis', 'level',
'sometim', 'court', 'fame', 'behind', 'göttingen', 'nazi', 'yet', 'limit',
'mind', 'certain', 'whole', 'oxford', 'specif', 'valu', '1960', 'photo', 'text',
'conclud', 'compos', '1860', 'portrait', 'locat', '24', '1903', 'promot', '26',
'lab', 'ibm', 'market', '1970', 'correct', 'corpor', 'railway', 'yeat',
'audubon', 'patient', 'poetri', 'fall', 'impress', '1920', '1902', 'princeton',
'1933', 'szilárd', 'bomb', 'lobachevski', 'express', 'telephon', 'l', 'binet',
'rememb', 'proport', 'spread', 'sister', 'total', 'meter', 'step', 'secret',
'27', 'nearli', 'solid', 'basic', 'equat', 'simpl', 'fritz', 'era', 'collabor',
'taylor', 'block', 'surgeon', 'quickli', 'let', '1856', 'wigner', 'han',
'occur', 'someth', 'previous', 'half', 'lack', 'co', 'substanc', 'situat',
'soul', 'et', 'invit', 'skill', 'switzerland', 'difficulti', 'f', 'conduct',
'brought', 'eastman', '1910', 'graphic', '1830', 'style', 'depict', 'summer',
'lawrenc', 'astrolog', 'childhood', 'vienna', 'chart', 'shaw', 'neutrino',
'internet', 'fortran', 'unix', 'martin', 'break', 'temperatur', 'middl', '19th',
'architect', 'mous', 'optic', 'albert', 'academ', 'correspond', 'usual', 'knew',
'compound', 'lord', 'statist', 'analysi', 'botanist', '9', 'bank', '1871',
'encourag', 'nine', 'oxygen', 'alexand', 'wing', 'increasingli', '1931',
'earlier', 'length', 'switch', 'whether', 'birth', 'northern', 'belief', 'pope',
'interact', 'stanford', 'higher', 'copernicu', 'separ', 'capabl', 'mine',
'tradit', 'fund', 'defin', 'engrav', 'algebra', 'satellit', 'amount', 'frank',
'whippl', 'broadcast', 'charlott', 'singer', 'page', 'hardi', 'thompson', 'gnu',
'babbag', 'food', 'remov', 'cover', 'side', 'minist', 'deal', 'bbc', '1936',
'chicago', 'formula', 'disk', 'vacuum', 'semmelwei', 'depend', 'zurich',
'samuel', 'architectur', 'princip', 'kept', 'excav', 'carbon', 'coin', 'far',
'minut', 'eye', 'gresham', 'abil', 'hour', 'steam', 'rheticu', 'steel', 'cast',
'bc', 'greatest', 'explan', 'region', 'navi', 'nicola', 'dalton', '1923',
'mead', 'r', 'merrick', 'lift', 'spirit', 'madam', 'spitzer', 'bush', 'stoke',
'jacobi', 'flammarion', '21', 'stage', '1840', 'automat', 'mention',
'necessari', 'self', 'hall', 'florenc', 'cell', '22', 'wood', 'marriag',
'grant', 'intellectu', '1929', 'gase', '1912', 'qualiti', 'chief', 'simpli',
'longer', 'munich', 'arm', 'école', 'big', 'pierr', 'reject', 'rotat', 'run',
'exact', 'socrat', 'torricelli', 'miletu', 'composit', 'command', 'purchas',
'daughter', 'destroy', 'nipkow', 'goal', 'eclips', 'announc', 'programm',
'beth', 'heveliu', 'minski', 'tarski', 'pavlov', 'wound', 'potenti', 'sail',
'1854', 'abandon', 'sold', 'leader', 'arrang', 'molecul', 'constant', 'essay',
'bernard', 'action', 'scottish', 'room', 'extend', 'ocean', 'ireland', 'true',

'stone', 'besid', 'million', 'grade', 'crown', 'stand', 'twenti', 'convers',
'compil', 'phd', 'pursu', 'approxim', 'fell', 'merchant', 'custom',
'washington', 'hydrogen', 'frankfurt', 'elizabeth', 'huge', 'reith', 'low',
'clyde', '1980', 'germain', 'mcclintock', 'chamisso', 'rotor', 'hammond',
'kummer', 'proust', 'rang', 'hole', 'wonder', 'laureat', 'focu', 'refus',
'hold', 'ferdinand', '1894', 'uncl', 'recommend', 'cut', 'commiss', 'prevent',
'1888', 'liquid', 'voyag', 'rise', 'distribut', 'captain', 'doubt', '1963',
'beltrami', 'hard', 'relationship', 'thermodynam', 'key', 'respect', 'suppli',
'admit', 'controversi', 'via', 'antoin', 'admir', 'pacif', 'largest', 'classif',
'scholar', 'varieti', 'botan', 'divid', 'hermann', 'reflect', 'stukeley',
'priest', 'money', 'central', 'burn', 'angl', 'der', 'apart', 'marsh', '29',
'wealthi', 'send', 'least', 'grand', 'innov', 'outbreak', 'editor', 'border',
'religi', 'biringuccio', 'calculu', 'equal', 'piec', 'logarithm', '20th', 'g',
'oberth', 'cro', 'condillac', 'forest', 'francisco', 'spin', 'popper', 'otto',
'sunspot', 'carolu', 'elli', 'whitman', 'ive', 'hergé', 'baili', 'codd', 'zuse',
'eniac', 'linux', 'lindbergh', 'drygalski', 'chanut', '1820', '1891', 'reduc',
'fortun', 'fascin', 'afterward', 'declar', 'boat', 'trip', 'keep', 'goeppert',
'manhattan', 'talent', 'interpret', 'done', 'replac', 'scotland', 'pressur',
'dissert', 'licens', 'particip', 'flower', 'dodoen', 'explos', '1904', 'sketch',
'prussian', 'union', 'week', 'night', 'fix', '1905', 'extrem', 'kekulé',
'predict', 'bone', 'constantin', '1932', 'assembl', 'lower', 'faculti',
'eudoxu', 'pascal', 'agre', 'schwarzschild', 'shop', 'motiv', 'ideal', 'h',
'lot', 'infect', 'jacqu', 'magazin', '1940', 'fulli', 'pluto', 'baird', 'miner',
'bishop', 'franz', 'balloon', 'tyndal', 'simon', 'bar', 'picard', 'gassendi',
'feining', 'schiller', 'camil', 'pissarro', 'mergenthal', 'legendr', 'tau',
'powel', 'lindisfarn', 'tintin', 'nightingal', 'rucker', 'licklid', 'atanasoff',
'playfair', 'simmel', 'swedish', 'femal', 'win', 'occupi', 'fever', 'failur',
'gustav', 'max', 'studio', 'mid', 'particularli', 'format', 'decay', 'scene',
'neg', '1847', 'beyond', 'clinic', 'morison', 'ph', 'fruit', 'suffici', 'swiss',
'sure', 'expand', 'sax', 'tell', 'fair', 'piano', 'save', 'dedic', 'dark',
'masterpiec', 'sell', 'former', 'rutherford', 'isol', 'conclus', 'nasa',
'prefer', 'interview', 'roll', 'frame', 'confer', 'nativ', 'escap', 'mount',
'lancisi', 'theolog', '1941', 'round', 'statu', 'mainli', 'theatr', 'contract',
'invad', 'tool', 'sky', 'insid', 'massachusett', 'fiction', 'signal',
'friedman', 'cosmic', 'cournot', 'documentari', 'park', '1919', 'nicollet',
'memori', 'rein', 'diari', 'snow', 'alcuin', 'mccarthi', 'beg', 'mong', 'zoo',
'denni', 'whymper', 'pausch', 'ritchi', 'weizenbaum', 'mercer', 'langley',
'fothergil', 'aristarchu', 'digest', '1812', 'competit', 'farm', 'accomplish',
'task', 'adopt', 'walk', 'accompani', 'profession', 'laid', 'except', '1938',
'citizen', 'weapon', 'neutron', 'differenti', 'euclidean', 'secretari', 'deriv',
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'interceptor', 'mapper', 'rhonrossitten', 'rrg', 'kohl', 'ramjet', 'fighter',
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'mon', 'vesuviu', 'portait', 'pliniu', 'ceciliu', 'encyclopedist', 'novum',
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'misenum', '24th', 'afternoon', 'sunbath', 'lunch', 'concuss', 'cinder', 'rain',
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'testifi', 'gorrel', 'everson', 'fundrais', 'quiz', 'freshman', 'edmonton',
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'dermatologist', 'benson', 'pimpl', 'menthol', 'mesopotamia', 'sumerian',
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'sweetheart', '600', 'stockhold', 'recapit', 'perfum', 'mechain', 'laon',
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'strathclyd', 'undersock', 'trinidad', 'hast', 'hatbox', 'scissor', 'darn',
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'recogniz', 'televisor', '26th', 'amplif', 'pirandello', 'derbi', 'bb',
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'capricorn', 'conni', 'tyrannosauru', 'anyhow', 'iconograph', 'spielberg',
'jeep', 'cheyenn', 'edmontosauru', 'deflat', 'uncov', 'intact', '362',
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'guidelin', 'privi', 'taint', 'insuffici', 'lazaret', 'nonmed', '886', 'ja',
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'varro', 'decrea', 'disreput', 'melodramat', 'diagnosi', 'lynch', 'outward',
'lumpi', 'boni', 'hip', 'remarri', 'hawker', 'haberdasheri', 'unintellig',
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'disloc', 'acosta', 'eighteenth', 'céneri', 'prè', 'aunou', 'orn', 'normandi',
'nun', 'needless', 'assur', 'bag', 'montgolfi', 'varnish', 'borrowdal', 'encas',
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'leakag', 'grip', 'greenhous', 'preferenti', 'weisshorn', 'narrowli', 'fireman',
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'mattress', 'limousin', 'hurrican', 'spokeswoman', 'seveer', 'perkin',
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'vercelli', 'rode', 'battlefield', '197', 'vow', 'anxieti', 'legionnair',
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'ferri', 'inductivist', 'bohemia', 'schiff', 'devout', 'epicentr',
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'discrep', 'stormi', 'inclin', 'misunderstand', 'kuhn', 'luminari',
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'pub', 'birkbeck', 'tobacco', 'mosaic', 'inelig', 'qiang', 'zhou', 'syng',
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'bartram', 'harriman', 'unchart', 'collar', 'oklahoma', 'inexor', 'rick',
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'squander', 'lyndon', 'unawar', 'facto', 'satiris', 'swath', 'engagingli',
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'tamm', 'faint', 'oblast', 'lebedev', 'phyisc', 'academician', 'emiss', 'glow',
'dim', 'blazar', 'ong', 'suzann', 'curchod', 'endow', 'calvinist', 'sober',
'impati', 'thatthey', 'magnu', 'attaché', 'legat', 'flamboy', 'vivaci',
'conversationalist', 'constitution', 'disgrac', 'ambassadress', 'safeguard',
'displeas', 'recalcitr', 'crush', 'personag', 'banish', '64km', 'counselor',
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'darmstadt', 'postdoctor', 'chur', 'williamson', 'frankland', 'odl', 'wurtz',
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'reignit', 'recur', 'père', 'lachais', 'cemeteri', 'parm', 'giuntini',
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'cadaver', 'autopsi', 'conveni', 'shrank', 'dieas', 'huff', 'rochu', 'pest',
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'sanità', 'beecham', 'weizmann', 'shapiro', 'huke', 'pragmat', 'apel',
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'seth', 'jusserand', 'bayard', 'gerard', 'elliott', 'howe', 'abolitionist',
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'pleasantli', 'hindenburg', 'monetari', 'heinkel', 'miami', 'prix', 'brno',
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'duetto', 'amoroso', 'sigh', 'groan', 'lloyd', 'webber', 'rochberg', 'capric',
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'inglefield', 'conger', 'icebound', 'toe', 'nearest', 'hecla', '280km', 'jesup',
'09', 'lancashir', 'bobbin', 'winder', 'dyer', 'calico', 'soda', 'thicker',
'dy', 'photochemistri', 'plumpton', 'combinatori', 'magdalen', 'winchest',
'maynard', 'unsusu', 'jaundic', 'abdomin', 'whitehead', 'logico',
'philosophicu', 'annot', 'predic', 'meynard', 'taxat', 'lmu', 'leitgeb',
'vesaliu', 'guidi', 'luca', 'tornabuoni', 'lobachevskian', 'nizhni', 'novgorod',
'maksimovich', 'encycloped', 'flourish', 'nokolay', 'ivanovitch', 'springer',
'225', 'concis', 'orthogon', 'criterion', 'riemann', 'montigni', 'haut', 'marn',
'humbl', 'lamarck', 'ciel', 'incarn', 'cosmogoni', 'lumen', 'sentient',
'frenchman', 'kardec', 'metempsychosi', 'cheat', 'séanc', 'levit', 'subconsci',
'telepathi', 'propag', 'rice', 'olaf', 'stapledon', 'conan', 'doyl', 'apparit',
'parapsycholog', 'opaqu', 'firmament', 'zinner', 'burin', 'earthli', '1771',
'forli', 'romagna', 'adversaria', 'sedibu', 'morborum', 'anatomen', 'indagati',
'1761', 'digniti', 'primu', 'historid', 'bolomet', 'roxburi', 'galilean',
'acadami', 'allegheni', 'proced', 'rudyard', 'kipl', 'craftsmanship', 'mirth',
'coolli', 'unharm', 'tribut', 'ego', 'starship', 'uss', 'yesterday', 'wow',
'warp', 'teleport', 'horatio', 'hornblow', 'lacon', 'imperturb', 'eyebrow',
'fist', '20150227', 'ixzz3t3ynn3zj', 'twitter', 'facebook', 'dillard', 'th',
'selfiec', 'info', 'chandeli', 'saxton', 'buzz', 'aldrin', 'sachs', 'anastasia',
'nikolaevna', 'kanon', 'weinstrass', 'shoe', 'mittweida', 'witzleben', 'déne',
'miháli', 'telecin', 'schröter', 'mechau', 'audiovisu', 'peenemünd', 'a4',
'bunker', 'rehbock', 'ntsc', 'secam', '625', 'fidel', 'chancellor', 'brandt',
'ifa', 'jelenia', 'góra', 'immanuel', 'kant', 'matheseo', 'chemia', 'ober',
'tschirnau', 'glogau', 'aeromet', 'assay', 'oberbergamt', 'areanist',
'porcelain', 'britaunnisch', 'societät', 'vol', '615', 'magnesia', 'mgo',
'sulphur', 'limnologist', 'coburg', 'ontario', 'whaler', 'tait', 'portsmouth',

'cataloug', 'granton', 'millport', 'smba', 'qualit', 'dissolut', 'calcium',
'freshwat', 'loch', 'hydrographi', 'bathymetri', 'sedimentolog', 'ballard',
'1931with', 'rightmost', 'cosmologist', 'ukrain', 'novorossiya', 'landau',
'ivanenko', 'matvey', 'bronshtein', 'musket', 'houterman', 'kochin',
'kurchatov', 'mysovskii', 'alpher', 'primordi', 'ylem', 'deuteron', 'helic',
'adenin', 'thymin', 'guanin', 'cytosin', 'amino', 'nonspecialist', 'wonderland',
'moray', '1662', 'editorship', 'munday', '136', '1677', 'incept', 'itself',
'incourag', 'oort', 'calf', 'greg', 'pirat', 'jstor', 'paywal', '1622',
'prestic', 'eton', 'outhr', 'shalford', 'alburi', 'impirt', 'clavi', 'hindu',
' ', 'circumfer', 'especailli', 'substract', '1632', 'grammelogia', 'terri',
'astrophotographi', 'bellevu', 'leter', 'vega', 'tebbutt', 'nyu', 'congressi',
'astronomisch', 'dussault', 'depasqual', 'astrophotograpi', 'thicken',
'frodsham', 'fluent', 'bradford', 'unlicens', 'bloodlet', 'purg', 'attenu',
'ulcer', 'streptococc', 'headach', 'swiftli', 'upton', 'stratford', 'linné',
'shrub', 'fothergilla', 'coffe', 'hathaway', 'conceptu', 'endicott', 'ascc',
'clutch', '500kg', '800km', '16m', 'wetheril', 'dyson', 'vought', 'bluebird',
'seaplan', 'transatlant', 'macmillan', 'enugh', 'spitzbergen', 'controvers',
'trimotor', 'prestig', 'sled', 'biogeochemistri', 'radiogeolog', 'potelti',
'dokuchaev', 'arcangelo', 'dimorphit', 'zonk', 'paragenesi', 'geochem',
'geospher', 'complement', 'pronounc', 'reshap', '1733', 'gregorian', 'pedagogi',
'nantwich', 'hackney', 'lactur', 'narrat', 'primaci', 'allud', 'timespan',
'1200', 'warrior', 'metaphysician', 'orat', 'devid', 'sugata', 'mitra',
'paterson', 'twilight', 'curl', 'membership', 'korff', 'feynman', 'ovserv',
'colllabor', 'undetect', 'chadwick', 'ganchang', 'harrison', 'kruse', 'mcguir',
'cleveland', 'campu', 'uci', 'rossi', '1987a', 'gratifi', 'imb', 'mcdonald',
'cassiopeia', 'celest', 'attouch', 'troi', 'lign', 'droit', 'touchent',
'géometri', 'coniqu', 'cylindriqu', 'indetermin', 'summaris', '1678', 'guyenn',
'1681', 'hydrostat', 'desargu', 'cardioid', 'epicycloid', 'conchoid',
'quatratur', 'crochet', 'wertheim', 'obaidullah', 'abrar', '1394', 'mongolian',
'mīrzā', 'tāraghay', 'bin', 'shāhrukh', 'mongol', 'alexandrian', 'conqueror',
'skah', '1407', 'iran', 'turkistan', 'shah', 'herat', 'khorasan', 'maragha',
'1420', 'construnct', '1428', 'zij', 'sultani', 'qadi', 'zada', '365', '1447',
'mausoleum', 'gould', 'epistemolog', 'existentialist', 'oberwiederstedt',
'arnstein', 'anhalt', 'eisleben', 'herder', 'tennstedt', 'nicht',
'liebesreligion', 'athenäum', 'blüthenstaub', 'fiance', 'hymnen', 'nacht',
'reunit', 'charpenti', 'novic', 'sai', 'apathi', 'supernumerar',
'amtshauptmann', 'magistr', 'encyclopaed', 'indirectli', 'inkl', 'capobianco',
'gleam', '310', 'anaxagora', 'lyceum', 'strato', 'architectura', 'philolau',
'apolloniu', 'perga', 'scopina', 'gnomon', 'applianc', 'siren', 'heraclid',
'pontu', 'estaim', 'nicea', 'morrison', 'reutling', 'béatric', 'stanisla',
'léon', 'motionless', '1676', '792', '458', 'luminifer', 'conjunct',
'kincardin', 'fife', 'jacksonian', 'gladston', 'smokeless', 'photometri',
'retina', 'liquifi', 'zygmunt', 'florenti', 'wróblewski', 'karol', 'olszewski',
'liquefi', 'liquif', 'convect', 'gerbrand', 'ceder', 'massachussett', 'atomist',
'stereolithograf', 'flomin', 'fineilspitz', 'mummi', 'bce', 'gendarm',
'similaunhütt', 'torso', 'innsbruck', '65m', '50kg', 'enamel', 'feldthurn',
'bolzano', 'farther', 'smelt', 'hilli', 'shepherd', 'sunken', 'ungroom', 'yew',
'ash', 'quiver', 'viburnum', 'dogwood', 'bark', 'basket', 'polypor', 'tinder',

'firestart', 'pyrit', 'riddl', 'iceman', 'tartaron', 'penn', 'watercolor',
'associé', 'militair', 'légion', 'honneur', 'regress', 'hadamard', 'vallé',
'poussin', 'lagrangian', 'hamiltonian', 'enthalpi', 'helmholtz', 'gibb',
'élément', 'enfield', 'darker', 'filippenko', 'fetu', 'lusciou', 'muscolorum',
'homini', 'ossium', 'foetu', 'meighan', 'horen', 'micha', 'dramaturg',
'calderón', 'barca', 'petrarch', 'boccaccio', 'cervant', 'torquato', 'tasso',
'luí', 'camõ', 'blumensträuss', 'italiänisch', 'spanisch', 'portugiesisch',
'indisch', 'bibliothek', 'sanskrit', 'bhagavadg', 'yana', 'rediscoveri',
'reevalu', 'aurora', 'boreali', 'eaglesfield', 'cockermouth', 'handloom',
'constitu', 'indivis', 'impedi', 'lifeless', 'luiz', 'hanseat', 'hemoptysi',
'sanatoria', 'voluntari', 'freier', 'schriftstel', 'zola', 'maupass',
'novelett', 'einer', 'schlaraffenland', 'cockaign', 'folow', 'göttinnen',
'glorif', 'esthetic', 'jagd', 'nach', 'lieb', 'merciless', 'tyrant', 'josef',
'sternberg', 'gerron', 'trude', 'hesterberg', 'kaiserreich', 'armen',
'untertan', 'kopf', 'indict', 'authoritarian', 'clara', 'kanová', 'gedanken',
'krieg', 'katja', 'spokesman', 'democraci', 'signatori', 'šufflay', 'persona',
'grata', 'reichstag', 'collaborationist', 'propaganda', 'goebbel', 'downhil',
'jugend', 'vollendung', 'exilliteratur', 'nelli', 'kröger', 'preparatori',
'behm', 'communion', 'sheer', 'skara', 'benzeliu', 'lund', 'polhem',
'bergskollegium', 'hyperboreu', 'tremul', 'ennobl', 'volumin', 'mineralia',
'vortex', 'stutter', 'occurr', 'prescient', 'hierarch', 'cerebrospin',
'pituitari', 'gland', 'perivascular', 'frontal', 'intellect', 'infinito',
'regnum', 'animal', 'unworthi', 'redempt', 'afresh', 'magnum', 'arcana',
'cœlestia', 'infiltr', 'honoré', 'balzac', 'baudelair', 'strindberg',
'holdengräb', 'conspiraci', 'bencher', 'vine', 'dresser', 'otherwis', 'manur',
'crop', 'seeder', 'irrig', 'nahilda', 'rabbin', 'din', 'merchand', 'posen',
'waken', 'steinthal', 'völkerpsychologi', 'sprachwissenschaft', 'herbart',
'emancip', 'heisst', 'rodney', 'haywood', 'sixth', 'tallest', '134', 'greenway',
'glori', 'brindley', 'unsuit', 'tender', 'dorman', 'middlesbrough', 'groot',
'slash', 'sword', 'isaacson', 'breathtak', 'frederik', 'princess', 'matt',
'damon', 'weav', 'kyli', 'minogu', 'kostya', 'tszyu', 'stanton', 'structura',
'behaviorist', 'bike', 'likelihood', 'avers', 'vise', 'versa', 'withdraw',
'scenario', 'furious', 'peddl', 'hoard', 'seligman', 'racklev', 'anchor',
'huyghen', 'horologium', 'oscillatorium', 'booth', 'alia', 'rewind', 'upsid',
'quicksilv', 'arturo', 'espinosa', 'seligmann', 'underpin', 'rickert', 'frieda',
'reichmann', 'forst', 'karen', 'horney', 'alanson', 'autonom', 'adjunct',
'misrepres', 'fri', 'manmad', 'perige', 'slight', 'asymmetri', 'pear', 'quito',
'ecuador', 'baselin', 'paiut', 'ethnologist', 'oberlin', 'teacherin',
'secretaryship', 'rowboat', 'moin', 'shiloh', 'wesleyan', 'bloomington', 'moab',
'kanab', 'mormon', 'missionari', 'geomorpholog', 'lillian', 'erector',
'remington', 'constrain', 'crunch', '7600', '8600', 'boast', 'megaflop',
'megabyt', 'penchant', 'hurdl', 'refriger', 'ceo', 'contractor', 'tenfold',
'mp', 'mflop', 'gallium', 'arsenid', 'c90', 'quip', 'plow', 'oxen', '1024',
'chicken', 'rosali', 'sartr', 'rouell', 'seminario', 'patriótico', 'vascongado',
'vergara', 'sociedad', 'económica', 'vascongada', 'amigo', 'paí', 'musé',
'impresario', 'rozier', 'segovia', 'abreast', 'backward', 'sweetish',
'flammabl', 'tin', 'bethollet', 'chevali', 'stratif', 'aqueou', 'zeal',
'osiecznica', 'voivodeship', 'solm', 'wernerwa', 'lorzendorf', 'äusserlichen',

'kennzeichen', 'fossilien', 'geognosi', 'lehmann', 'füchsel', 'tertiari',
'overturn', 'interrel', 'neptunist', 'underworld', 'earthi', 'frail',
'misfortun', 'befallen', 'aida', 'awan', 'tönni', 'metropoli', 'misinterpret',
'erv', 'goffman', 'szelenyi', '402', '401', 'introductio', 'analysin',
'infinitorum', 'anter', 'revok', 'biquadrat', 'jealou', 'theta', 'theoria',
'functionum', 'ellipticarum', 'dersch', 'sahachiro', 'hata', 'gram', 'freiburg',
'breisgau', 'frerich', 'steglitz', 'serum', 'speyer', 'vivo', 'alizarin',
'indophenol', 'plasmodiida', 'trate', 'moabit', 'hoechst', 'therapia',
'sterilisan', 'pathogen', 'arsenophenylglycin', 'topol', 'hardcastl',
'hunterian', 'dump', 'broadwick', 'voronoi', 'anomali', 'southwark',
'waterwork', 'bohumil', 'drassar', 'médecin', 'excret', 'uncontamin',
'diphtheria', 'pox', 'viral', 'ecemaml', '1584', '1563', 'tier', 'reredo',
'adorn', 'statuari', 'leon', 'leoni', 'auster', 'sepulch', 'regnant', 'monarch',
'alfonso', 'monserrato', 'acquisit', 'ottonian', 'vault', 'dialect', 'inquisit',
'oversight', 'kitab', 'tibar', 'syrian', '500000', 'rober', 'cum', 'laud',
'audiomet', 'broadli', 'mystifi', 'terrifi', 'seanc', 'spooki', 'fright', 'sat',
'boucher', 'crèvecœur', 'handax', 'abbevil', 'antediluvian', 'gravel',
'antiquité', 'celtiqu', 'antédiluvienn', 'pleistocen', 'quaternari',
'workmanship', 'endeavour', 'concur', 'reindeer', 'plateau', 'pa', 'eros',
'neanderth', 'homo', 'erectu', 'alvarez', 'broadest', 'dmitrievich', 'varvara',
'ivanovna', 'uspenskaya', 'homemak', 'pavement', 'pancrea', 'ustimovich',
'veterinari', 'centrifug', 'nervism', 'trophic', 'pharmacolog', 'vivisect',
'psychopatholog', '86', 'spaceprob', 'mare', 'imbrium', 'aristid', 'autolycu',
'impactor', 'lunik', 'geiger', 'magnetomet', 'micrometeorit', 'pennant',
'pentagon', 'blok', 'booster', 'pad', '9pm', 'stereotyp', 'nerd', 'heartach',
'heathcliff', 'forget', 'kate', 'motherli', 'mirfield', 'ellen', 'nussey',
'wellesley', 'tuition', 'veil', 'hearten', 'thornfield', 'paragraph', 'insan',
'agn', 'grief', 'villett', 'nichol', 'dld', 'franipani', 'renesi', '04',
'paola', 'trinità', 'boccon', 'pitton', 'antil', 'amériqu', 'dominican',
'labat', 'filicetum', 'americanum', 'savant', 'trévoux', 'dogban', 'apocynacea',
'hanov', 'gotha', 'ekhof', 'conspicu', 'jäger', 'dienstpflicht', 'compulsori',
'hagstolzen', 'sentiment', 'masteri', 'almanach', 'theaterfreund', 'nathan',
'gotthold', 'ephraim', 'ringparabel', 'uncertain', 'ganz', 'downfal', 'diliff',
'bloomsburi', 'fowk', 'waterhous', 'idiosyncrat', 'romanesqu', 'budgetari',
'squid', 'affection', 'archi', 'remit', 'attenborough', 'microfossil', 'festiv',
'litl', 'walbottl', 'fürth', 'eisenbahn', 'stipul', 'generaldirektor', 'drove',
'hourli', 'haul', 'bockmüller', 'overcoat', 'again', '25th', 'reenact',
'rainhil', 'cuba', 'vanderbilt', 'racetrack', 'belmont', 'fantas', 'hamel',
'trehawk', 'applaud', 'wakefield', 'wolstan', 'dixi', 'headmast', 'solihul',
'edial', 'tourett', 'iren', '773', 'lexicographi', 'hitch', 'alva', 'peephol',
'peep', 'nickl', 'funni', 'zoopraxiscop', 'kineto', 'scopo', 'coars', 'bromid',
'unaccept', 'celluloid', 'wrap', 'monkeyshin', 'dexter', 'chronophotograph',
'ottamar', 'anschütz', 'intermitt', 'momentarili', 'retent', 'loop', 'beneath',
'kinetograph', 'pine', 'bow', 'smile', 'filmstudio', 'noblewoman', 'urbino',
'1527', 'orléan', 'chenonceau', 'dian', 'dispens', 'deem', 'govenor', '74',
'104', 'regrett', 'truce', 'condé', 'allianc', 'retak', 'havr', 'alba', 'scrap',
'punit', '1566', 'moldavia', 'elisabeth', '1568', 'tout', 'valoi', 'aveng',
'lecturebi', 'diefendorf', 'barthomomew', 'champ', 'roug', 'bourg', 'ronsin',

```
'macdonald', 'bruce', 'mack', 'terk', 'galeri', 'poiret', 'relaunch',
'monochromat', 'paysag', 'au', 'disqu', 'herbst', 'orphist', 'picabia', 'gleiz',
'léger', 'futurist', 'sherri', 'buckberrough', 'paar', 'jahren', 'haben',
'begeistert', 'insbesonder', 'dies', 'erinnerung', 'geblieben', 'ihren',
'kurio', 'interessanten', 'ausführungen', 'siegerin', 'dieser', 'veranstaltung',
'hervorg', 'giulia', 'ender', 'jahr', 'alt', 'es', 'verstanden', 'mehr',
'machen', 'führt', 'inzwischen', 'ihrem', 'buch', 'darm', 'all', 'unterschätzt',
'paperback', 'sachbuch', 'mittelpunkt', 'entstandenen', 'medieninteress',
'liest', 'jetzt', 'allerorten', 'studentin', 'sie', 'thema', 'pupsen', 'kacken',
'rede', 'antwort', 'stehen', 'muss', 'wir', 'freuen', 'diesen', 'erfolg',
'stellen', 'euch', 'daher', 'heut', 'noch', 'einmal', 'mittlerweil', 'berühmt',
'siegervideo', 'periton', 'papyru', 'drool', 'abnorm', 'gait', 'shaki',
'bradykinesia', 'basal', 'ganglia', 'melita', 'petrossian', 'codorníu',
'murcia', 'escuela', 'ingeniero', 'camino', 'puerto', 'unsaf', 'rotari',
'autorot', 'satisfactorili', 'unbalanc', 'dissymmetri', 'flap', 'hing',
'industrialist', 'weir', 'hub', 'hafner', 'spider', 'jump', 'declutch',
'paracuello', 'jarama', 'klm', 'runway', 'hardwick', 'hartwick', 'fairfield',
'bowstr', 'diagon', 'liff', 'benvi', 'dunde', 'meikl', 'thresh', 'millwright',
'publicist', 'ardent', 'wiliam', 'hachur', 'galignani', 'prosecut', 'grasp',
'forev', 'fray', 'orsi', 'overland', 'sonoran', 'sonora', 'frontera', 'apporov',
'rio', 'gila', 'arcángel', '247', 'assisi', 'asiacut', 'commanch', 'apach',
'wwii']
```

For the calculation of idf, if a work appears multiple times within a document appears gets increamented the forumla for idf is used and this value is returned to be calculated with the tf values

```
[14]: def idfValues(freq_list, orig_list):
    idf = {}
    for word in freq_list:
        appears = 0
        for document in orig_list:
            if word in document:
                appears += 1
        idf[word] = np.log(len(orig_list)/(1 + appears)) #IDF: (Total number of␣
    ↪documents)/(Number of documents containing the word


    return idf


#idf_values = idfValues(most_freq,final_text)
```

TF = (Number of times term t appears in a document) / (Total number of terms in the document). The tfvalues are caluated using a list sent_tf_vector and the individual scores of TF are appended to the function

```
[15]: def tfValues(freq_list, orig_list):
    tf = {}
    for word in freq_list:
```

```
        sent_tf_vector = []
        for document in orig_list:
            doc_freq = 0
            for word_doc in document:
                if word == word_doc:
                    doc_freq += 1
            word_tf = doc_freq/len(document) #TF = (Number of times term t appears␣
    ↪in a document) / (Total number of terms in the document).
            sent_tf_vector.append(word_tf)
            tf[word] = sent_tf_vector
    return tf

#tf_values = tfValues(most_freq,final_text)
```

tfidf is calculated by multiply the values given by both tf and idf

```
[16]: def tfidf(valuesTf, valuesIdf):
      tfidf_values = []
      for word in valuesTf.keys():
          tfidf_sentences = []
          for tf_sentence in valuesTf[word]:
              tf_idf_score = tf_sentence * valuesIdf[word]
              tfidf_sentences.append(tf_idf_score)
          tfidf_values.append(tfidf_sentences)
      tf_idf_model = np.asarray(tfidf_values)
      tf_idf_model = np.transpose(tf_idf_model)

      return tf_idf_model

#print(tfidf(tf_values,idf_values))
```

The VectorSpaceModel function utilizes all the functions that have been implemented to calculate the final Term by document matrix.

```
[17]: def VectorSpaceModel(DocByTerm):

        most_freq_text = CalWordFreq(DocByTerm) #returns a list of the most frequent␣
    ↪words

        idf_values = idfValues(most_freq_text,DocByTerm)
        tf_values = tfValues(most_freq_text,DocByTerm)
        tfidf_values = tfidf(tf_values,idf_values)
        return tfidf_values
```

Finally the term by document matrix is calculated with the rows signifying the documents (upto 331) and the queries up to 336

```
[18]: TermByDocument = VectorSpaceModel(doc_list)
      print(TermByDocument)
```

```
[[0.         0.00123718 0.00181001 … 0.         0.         0.         ]
 [0.00281198 0.00128136 0.00093733 … 0.         0.         0.         ]
 [0.00132205 0.00120486 0.00044068 … 0.         0.         0.         ]
 …
 [0.         0.         0.         … 0.         0.         0.         ]
 [0.         0.         0.         … 0.         0.         0.         ]
 [0.05905166 0.         0.         … 0.         0.         0.         ]]
```

```
[19]: num_rows, num_cols = TermByDocument.shape #last 35 rows are the queries
      print ("Rows:", num_rows, "Cols:", num_cols)
```

```
Rows: 366 Cols: 13539
```

Finally the cosine similarity function is implemented via its formule dot(doc,query)/norm(doc) * norm(query)

The top 10 scores have been printed to screen but the ranked_list contains all the scores for the 331 documents

```
[20]: for j in range (332, 366):   #go over every query
          list = []
          ranked_list = []
          all_ranked_lists = []

          for i in range(331): #go over every document
              cosine_sim = dot(TermByDocument[i] , TermByDocument[j]) /␣
      →norm(TermByDocument[i]) * norm(TermByDocument[j])
              list.append(cosine_sim)

          for score in enumerate(list): #adds a value to each score that keeps track␣
      →of which document has which score
              ranked_list.append(score)

          ranked_list.sort(key=lambda x:x[1], reverse=True) #sorts the list by␣
      →greatest score
          print("first value: Document, second value:Score")
          print("Ranked list for query "+str(j-331))
          print(ranked_list[:10]) #prints top 10 scores
          print()

      #print(all_ranked_lists)
```

```
first value: Document, second value:Score
Ranked list for query 1
[(146, 0.17220632416374518), (282, 0.11071333162022277), (148,
0.09157763850166976), (290, 0.07416594790543331), (133, 0.07155201069495618),
(292, 0.06183136979725583), (22, 0.05472489302827605), (135,
```

0.04855117091021798), (1, 0.0465079112211394), (138, 0.040149150915555265)]

first value: Document, second value:Score
Ranked list for query 2
[(282, 0.8590726012252736), (290, 0.6358106762275691), (104,
0.4317236609959397), (151, 0.4206645770499912), (146, 0.4117408736485981), (317,
0.31218020528931834), (0, 0.0), (1, 0.0), (2, 0.0), (3, 0.0)]

first value: Document, second value:Score
Ranked list for query 3
[(18, 0.2310629000251795), (269, 0.20203937508890998), (48,
0.17161366480974374), (309, 0.11834119540684868), (274, 0.11369542630126248),
(9, 0.10672211578270056), (288, 0.06392390014945243), (285,
0.05748075604644014), (129, 0.041304135383553695), (329, 0.036179097243736705)]

first value: Document, second value:Score
Ranked list for query 4
[(296, 1.7650336927696535), (328, 1.451321953723601), (25, 0.828086537446529),
(28, 0.4453173173675852), (24, 0.35210277032755255), (232, 0.3026550361967281),
(256, 0.28357884248596565), (68, 0.10992626937224649), (22,
0.10650848743250337), (165, 0.09550633132460058)]

first value: Document, second value:Score
Ranked list for query 5
[(145, 0.4461971940296264), (288, 0.2977546021185488), (3, 0.22481923237623924),
(122, 0.1570165030130408), (265, 0.15051503846706218), (33,
0.14711105026614846), (41, 0.14236738382050254), (97, 0.12468923682041755),
(233, 0.09861942194482361), (112, 0.0931226799031763)]

first value: Document, second value:Score
Ranked list for query 6
[(291, 0.18810352093394134), (179, 0.17785761672386832), (250,
0.17785153402815906), (109, 0.13648779142317063), (105, 0.1232756545054967),
(116, 0.11343004130975289), (107, 0.10880613419573439), (4,
0.09770812793744721), (234, 0.09286614037703216), (245, 0.06454002121522384)]

first value: Document, second value:Score
Ranked list for query 7
[(198, 0.8815946147285517), (197, 0.5913341336197091), (216,
0.31581899909489064), (222, 0.30275833377430206), (176, 0.24483632528025365),
(219, 0.19115577619908525), (84, 0.18040575317557891), (68,
0.15255232232412186), (298, 0.14916193556716312), (51, 0.14101317207177733)]

first value: Document, second value:Score
Ranked list for query 8
[(35, 0.09951732638868195), (59, 0.09242915856573655), (230,
0.08111598997391514), (99, 0.07329403256029153), (51, 0.06683030148667216), (33,
0.04204771834762745), (71, 0.04143177719568637), (30, 0.04029472320354228), (90,

0.03460467719582593), (220, 0.03127455043409914)]

first value: Document, second value:Score
Ranked list for query 9
[(276, 0.829456012821142), (257, 0.7745335286337113), (238,
0.29651311295974336), (249, 0.25206954872822956), (175, 0.2232970205936439),
(55, 0.14666331225963397), (131, 0.12262432254121229), (300,
0.12102430721346964), (80, 0.1043975714704034), (137, 0.09599518656456464)]

first value: Document, second value:Score
Ranked list for query 10
[(48, 0.08171745558456686), (271, 0.08097638858299083), (276,
0.06895229680739613), (218, 0.0655883987157322), (55, 0.05887780625097063),
(238, 0.05844299714380274), (221, 0.036350858950211284), (275,
0.03504594443262331), (42, 0.0338240358689718), (240, 0.031716631537842155)]

first value: Document, second value:Score
Ranked list for query 11
[(144, 0.23952439063732994), (120, 0.11732945821215189), (40,
0.1147294916570053), (80, 0.10694073255311395), (90, 0.10475472198381254), (1,
0.10452096594784412), (121, 0.09956737062491913), (29, 0.0910754937465285),
(141, 0.08694188607352368), (179, 0.08688285070397675)]

first value: Document, second value:Score
Ranked list for query 12
[(183, 0.44386826167667115), (131, 0.42388617678192386), (249,
0.31002569381408807), (175, 0.2602027253653311), (276, 0.2380443070818069),
(238, 0.18428750209407824), (80, 0.16954014294976846), (94,
0.16220359099152662), (228, 0.14372965276060828), (155, 0.11302687594542869)]

first value: Document, second value:Score
Ranked list for query 13
[(171, 0.4934663213679042), (120, 0.42204140685170866), (270,
0.35491713761041643), (145, 0.3205897958115765), (90, 0.2694329945058711), (23,
0.16196659995021745), (170, 0.16031421473760119), (287, 0.15436006398376462),
(182, 0.12477919673469952), (273, 0.06665560870364355)]

first value: Document, second value:Score
Ranked list for query 14
[(191, 0.6423344700726705), (193, 0.4880622377168407), (200,
0.3738128900140589), (229, 0.29393218575219177), (209, 0.2896173045614456),
(206, 0.24831074650133825), (218, 0.21269258399923485), (221,
0.20925671169816976), (110, 0.17886390340235078), (198, 0.16971490912329532)]

first value: Document, second value:Score
Ranked list for query 15
[(178, 0.712142426889584), (322, 0.2543383799740672), (3, 0.1949722051496411),
(101, 0.19472155241468916), (272, 0.18984416206825583), (20,

0.17524922841094845), (309, 0.13305111214557874), (0, 0.127953368241701), (68, 0.12454715196551695), (329, 0.11648420792498845)]

first value: Document, second value:Score
Ranked list for query 16
[(257, 0.12891211924487528), (238, 0.1095294785825336), (265, 0.10214113229911465), (276, 0.09296920180719073), (10, 0.09269273613800709), (48, 0.08782567460157828), (55, 0.08366151672878515), (326, 0.07142312889653633), (296, 0.07121082696048313), (183, 0.05729367874164303)]

first value: Document, second value:Score
Ranked list for query 17
[(218, 1.5397219411028336), (275, 0.21066682655783495), (322, 0.05631432854274696), (25, 0.05192414751320881), (66, 0.0502792286307031), (198, 0.04456402756850283), (178, 0.03830848757150643), (83, 0.03304039919368923), (314, 0.029268332928804087), (12, 0.02504146704722275)]

first value: Document, second value:Score
Ranked list for query 18
[(198, 0.509810937532651), (218, 0.5088324361816928), (212, 0.42415007934767535), (197, 0.4216187476466819), (201, 0.39949005052490527), (209, 0.3174900133734755), (219, 0.2852698927989086), (221, 0.2829116291188473), (275, 0.2824839325278984), (210, 0.2810067891866607)]

first value: Document, second value:Score
Ranked list for query 19
[(165, 1.5383880338954212), (19, 0.9340067902343807), (327, 0.8578337151577277), (155, 0.6863231155945713), (127, 0.6803259441473213), (22, 0.6238572889336971), (264, 0.5502226888921128), (166, 0.2726735631730108), (244, 0.23901023582879752), (210, 0.1369293404272884)]

first value: Document, second value:Score
Ranked list for query 20
[(151, 0.9834262882952636), (290, 0.17165359842714098), (142, 0.1555622695197681), (170, 0.1416063704256999), (94, 0.12749226112866716), (130, 0.11356331530778249), (227, 0.10854159204451287), (65, 0.10113097639858579), (292, 0.08487910532073793), (146, 0.08250765559593495)]

first value: Document, second value:Score
Ranked list for query 21
[(102, 0.0867348898015734), (50, 0.06676902716049318), (165, 0.06547923422215063), (53, 0.06379978821247666), (65, 0.056015926422209754), (135, 0.05240413950751412), (66, 0.0510439233127518), (106, 0.04716002812879643), (131, 0.04677307998084791), (57, 0.04556827976786824)]

first value: Document, second value:Score
Ranked list for query 22
[(135, 0.06028860507218176), (315, 0.05446913880931985), (290,

0.043344209778510233), (65, 0.040058547083776666), (158, 0.03312105729286099),
(34, 0.03127614346185204), (278, 0.031215488104709282), (55,
0.03038902057784228), (173, 0.030299253657139834), (321, 0.0252526895322172)]

first value: Document, second value:Score
Ranked list for query 23
[(313, 0.5673791761874093), (36, 0.4197035181433944), (0, 0.39090124400233356),
(112, 0.32924854369766376), (260, 0.21087303005517302), (119,
0.15867361186553985), (132, 0.13165407204571652), (158, 0.11226452355074845),
(45, 0.09910475177949861), (61, 0.09801218703615104)]

first value: Document, second value:Score
Ranked list for query 24
[(89, 1.1106565661644432), (24, 0.8299911752006965), (66, 0.5410332071201026),
(138, 0.41138010717867135), (30, 0.21637285798344813), (144,
0.17301229903323773), (91, 0.15705847492535574), (139, 0.14151804627824638),
(253, 0.1187010885094374), (304, 0.11238358045663656)]

first value: Document, second value:Score
Ranked list for query 25
[(247, 0.15372784842371354), (220, 0.05521939222951791), (223,
0.05206719352513668), (311, 0.04681680907360423), (112, 0.041280425892930385),
(74, 0.037993355987833675), (39, 0.037734045295955636), (215,
0.03602932608058064), (36, 0.03536410312366498), (137, 0.035332066286577035)]

first value: Document, second value:Score
Ranked list for query 26
[(256, 0.3222268742557971), (320, 0.31618800711346096), (149,
0.29729619091604004), (22, 0.26099720322219055), (246, 0.23200330927270937),
(276, 0.210588627201892), (264, 0.17479280682002546), (327,
0.10055920972393538), (155, 0.09779663088304973), (222, 0.049970669729455124)]

first value: Document, second value:Score
Ranked list for query 27
[(168, 1.1153902324822809), (115, 0.33754560407090395), (61,
0.2594959060672152), (34, 0.19448372978644216), (293, 0.19404369875912353),
(208, 0.18136751089197437), (326, 0.1518288421572631), (116,
0.1511366091062974), (119, 0.13998289061749108), (230, 0.1227789728971184)]

first value: Document, second value:Score
Ranked list for query 28
[(238, 0.10042375699589422), (262, 0.08472498380823561), (35,
0.06447140147968945), (137, 0.057224984299744534), (293, 0.04866539184542707),
(55, 0.04669390400220227), (160, 0.04453512658929848), (228,
0.044013531664910614), (66, 0.03898616942258848), (117, 0.038491115748716595)]

first value: Document, second value:Score
Ranked list for query 29

[(306, 0.14983750102299834), (282, 0.11944263617628582), (249, 0.10993244152436499), (41, 0.10528044782896565), (46, 0.09755228460798587), (227, 0.07102526096431548), (251, 0.07028102332701462), (261, 0.05709368260210791), (241, 0.05148329072132668), (111, 0.04794797492611261)]

first value: Document, second value:Score
Ranked list for query 30
[(149, 0.27898684632906334), (173, 0.25460733617310394), (267, 0.2422004278727682), (290, 0.1734307345571103), (127, 0.15838698756800232), (120, 0.12113906631052695), (35, 0.11927585332491454), (13, 0.09849566056502339), (49, 0.07207440957493459), (329, 0.06694666933130583)]

first value: Document, second value:Score
Ranked list for query 31
[(297, 0.8466392493496774), (313, 0.08708677812549862), (217, 0.0793478875641273), (124, 0.06833429792403414), (215, 0.05640480789951053), (223, 0.05443556833493443), (47, 0.05240944950985644), (207, 0.05204730032469713), (173, 0.051429509972977), (202, 0.04680330079736499)]

first value: Document, second value:Score
Ranked list for query 32
[(28, 0.5588390041651661), (104, 0.4270946572688602), (238, 0.32072834353948937), (184, 0.20738635081093143), (163, 0.2019685570680833), (253, 0.16740805193025687), (245, 0.1232054477508366), (84, 0.11722774440564128), (313, 0.1034877911304142), (125, 0.09124935956595243)]

first value: Document, second value:Score
Ranked list for query 33
[(104, 0.41576973616230156), (125, 0.20570583514704305), (28, 0.16623435509784973), (84, 0.161233505284455), (184, 0.14364668068551303), (169, 0.12434223351626858), (163, 0.10287346608205607), (253, 0.09254766079958866), (301, 0.0767116371201729), (251, 0.07355326958507202)]

first value: Document, second value:Score
Ranked list for query 34
[(144, 0.1762036660868617), (12, 0.1255110079051425), (320, 0.12416304278536687), (132, 0.11160669476505206), (120, 0.10139471353773731), (121, 0.09463415339631064), (80, 0.08605795012971326), (40, 0.08352124730787656), (90, 0.08045770296883024), (29, 0.0786676961040288)]

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