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```
import numpy
import os
import re
import binascii
from time import time

def get_fnames():
    """Read all text files in a folder.
    """
    fnames = []
    for root, _, files in os.walk("NSF Research Award"):
        for fname in files:
            if fname[-4:] == ".txt":
                fnames.append(os.path.join(root, fname))
    return fnames
```

```
print("number of different files: {}".format(len(get_fnames())))
```

```
# just open one file and read its abstract

def read_file(fname):
    with open(fname, 'r') as f:
        # skip all lines until abstract
        for line in f:
            if "Abstract" in line:
                break

        # get abstract as a single string
        abstract = ''.join([line[:-1].strip() for line in f])
        abstract = re.sub(' +', ' ', abstract) # remove double spaces
        return abstract

fname = get_fnames()[999]
print(fname, read_file(fname))
```

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Find the similar items using pair-wise comparisons, MinHash (vectorized version) and LSH. For each item describe your results. Compare the time and results for k=5 and 10 for the three methods and s=0.9.

In [4]:

```
def get_shingles(fname, k):
    """Get all shingles from requested file (hashes of these shingles)
    """
    with open(fname, 'r', errors = 'ignore') as f:
        # skip all lines until abstract
        for line in f:
            if "Abstract" : in line:
                break

        # get abstract as a single string
        abstract = ' '.join([line[:-1].strip() for line in f])
        abstract = re.sub(' +', ' ', abstract) # remove double spaces

    L = len(abstract)
    shingles = set() # we use a set to automatically eliminate duplicate
    for i in range(L-k+1):
        shingle = abstract[i:i+k]
        crc = binascii.crc32(shingle.encode('utf-8')) #& 0xffffffff # ha
        shingles.add(crc)
    return shingles
```

In [5]:

```
fname = get_fnames()[999]
for i in [5,10]:
    print("file: {}".format(fname))
    print("number of shingles: {}".format(len(get_shingles(fname, i))))
    print("number of shingles: {}".format(get_shingles(fname, i)))
```

file: NSF Research Award\awards_1990\awd_1990_02\a9002673.txt

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file: NSF Research Award\awards_1990\awd_1990_02\awd002673.txt

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```

In [6]:

```
def jaccard_similarity_score(x, y):
    intersection_cardinality = len(set(x).intersection(set(y)))
    union_cardinality = len(set(x).union(set(y)))
    return intersection_cardinality / float(union_cardinality)
```

In [7]:

```
fnames = get_fnames()[:1000]
shingles_vectors = []
for file in fnames:
    sh = list(get_shingles(file, k=5))
    shingles_vectors.append(sh)
print("Jaccard_similarity_score pair_wise k=5: {}".format(jaccard_similarity_
```

Jaccard_similarity_score pair_wise k=5: 0.09054527263631816

In [8]:

```
fnames = get_fnames()[:1000]
shingles_vectors1 = []
for file in fnames:
    sh = list(get_shingles(file, k=10))
    shingles_vectors1.append(sh)
print("Jaccard_similarity_score pair_wise k=10: {}".format(jaccard_similarity_
```

Jaccard_similarity_score pair_wise k=10: 0.013148283418553688

In [9]:

```

%%time
import itertools

s = 0.9
fnames = get_fnames()[1:1000]

pair_wise = []
for pair in itertools.combinations(fnames,2):
    js = jaccard_similarity_score(get_shingles(pair[0], k=5),get_shingles(pair[1], k=5))

    if js > s:
        print(pair)
        pair_wise.append(pair)
print("Number of similar items k=5: {}".format(len(pair_wise)))

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Number of similar items k=5: 575

Wall time: 18min 38s

In [10]:

```
%%time
import itertools

s = 0.9
fnames = get_fnames()[:1000]

pair_wisel = []
for pair in itertools.combinations(fnames,2):
    js = jaccard_similarity_score(get_shingles(pair[0], k=10),get_shingles(pair[1], k=10))

    if js > s:
        print(pair)
        pair_wisel.append(pair)
print("Number of similar items k=10: {}".format(len(pair_wisel)))
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('NSF Research Award\\awards_1990\\awd_1990_02\\a9002476.txt', 'NSF Research Award\\awards_1990\\awd_1990_02\\a9002485.txt')

('NSF Research Award\\awards_1990\\awd_1990_02\\a9002479.txt', 'NSF Research Award\\awards_1990\\awd_1990_02\\a9002485.txt')

```
ward\\awards_1990\\awd_1990_02\\a9002484.txt')
('NSF Research Award\\awards_1990\\awd_1990_02\\a9002519.txt', 'NSF Research A
ward\\awards_1990\\awd_1990_02\\a9002570.txt')
Number of similar items k=10: 575
Wall time: 17min 9s
```

Minhash_vectorized method

```
In [11]: # set global parameters to process the whole dataset
bands = 5
rows = 5
nsig = bands*rows # number of elements in signature, or the number of differ

maxShingleID = 2**32-1 # record the maximum shingle ID that we assigned
nextPrime = 4294967311 # next prime number after maxShingleID

A = numpy.random.randint(0, nextPrime/2, size=(nsig,), dtype=numpy.int64)
B = numpy.random.randint(0, nextPrime/2, size=(nsig,), dtype=numpy.int64)
```

```
In [12]: print(len(A),A)

25 [1141323798  633531676  367712933 1424617046  311088446 1268720329
    1460876892 1102172141  467763116  766573562  399553721 1418774302
    2044329893  843080240  702275610  544967034 1183207659 1646604486
    2091868304 1182256917 1918254418 2054617894  242686343  549607344
    53650881]
```

```
In [13]: def minhash_vectorized(shingles, A, B, nextPrime, maxShingleID, nsig):
signature = numpy.ones((nsig,)) * (maxShingleID + 1)

for ShingleID in shingles:
    hashCodes = ((A*ShingleID + B) % nextPrime) % maxShingleID
    numpy.minimum(signature, hashCodes, out=signature)

return signature
```

```

signatures = [] # signatures for all files
fnames = get_fnames()[0:1000]
for fname in fnames:
    shingles = list(get_shingles(fname, k=5))
    sig = minhash_vectorized(shingles, A, B, nextPrime, maxShingleID, nsig)
    signatures.append(sig)
print("Jaccard_similarity_score: {}".format(jaccard_similarity_score(signatures)))
s = 0.9 # similarity threshold
Nfiles = len(signatures)
t = time()
minhash = []
for i in range(Nfiles):
    for j in range(i+1, Nfiles):
        Jsim = numpy.mean(signatures[i] == signatures[j]) # average number of
        if Jsim >= s:
            minhash.append((i,j))
t2 = time() - t
print("finding minhash similar pairs k=5 s=0.9 took {} seconds".format(t2))
print("found {} minhash similar pairs k=5 s=0.9 ".format(len(minhash)))
print("minhash similar pairs k=5 s=0.9 of files are:")
for i,j in minhash:
    print(fnames[i], fnames[j])

```

```
Jaccard_similarity_score: 0.041666666666666664
finding minhash similar pairs k=5 s=0.9 took 5.961978435516357 seconds
found 576 minhash similar pairs k=5 s=0.9
minhash similar pairs k=5 s=0.9 of files are:
NSF Research Award\awards_1990\awd_1990_00\a9000046.txt NSF Research Award\awards_1990\awd_1990_00\a9000158.txt
NSF Research Award\awards_1990\awd_1990_00\a9000177.txt NSF Research Award\awards_1990\awd_1990_00\a9000458.txt
NSF Research Award\awards_1990\awd_1990_00\a9000221.txt NSF Research Award\awards_1990\awd_1990_00\a9000222.txt
NSF Research Award\awards_1990\awd_1990_00\a9000221.txt NSF Research Award\awards_1990\awd_1990_00\a9000223.txt
NSF Research Award\awards_1990\awd_1990_00\a9000221.txt NSF Research Award\awards_1990\awd_1990_00\a9000396.txt
NSF Research Award\awards_1990\awd_1990_00\a9000221.txt NSF Research Award\awards_1990\awd_1990_00\a9000404.txt
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In [15]:

```
signatures1 = [] # signatures for all files
fnames = get_fnames()[:1000]
for fname in fnames:
    shingles1 = get_shingles(fname, k=10)
    sig1 = minhash_vectorized(shingles1, A, B, nextPrime, maxShingleID, nsig)
    signatures1.append(sig1)

print("Jaccard_similarity_score: {}".format(jaccard_similarity_score(signatures1, s = 0.9 # similarity threshold
Nfiles1 = len(signatures1)
t3 = time()
minhash1 = []
for i in range(Nfiles1):
    for j in range(i+1, Nfiles1):
        Jsims1 = numpy.mean(signatures1[i] == signatures1[j]) # average number of similar shingles
        if Jsims1 >= s:
            minhash1.append((i,j))
t4 = time() - t3
print("finding minhash similar pairs k=10 s=0.9 took {} seconds".format(t4))
print("found {} minhash similar pairs k=10 s=0.9 ".format(len(minhash1)))
print("minhash similar pairs k=10 s=0.9 of files are:")
for i,j in minhash1:
    print(fnames[i], fnames[j])
```

```
Jaccard_similarity_score: 0.02040816326530612
finding minhash similar pairs k=10 s=0.9 took 5.965031862258911 seconds
found 577 minhash similar pairs k=10 s=0.9
minhash similar pairs k=10 s=0.9 of files are:
NSF Research Award\awards_1990\awd_1990_00\a9000177.txt NSF Research Award\awards_1990\awd_1990_00\a9000458.txt
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NSF Research Award\awards_1990\awd_1990_00\a9000221.txt NSF Research Award\awards_1990\awd_1990_00\a9000396.txt
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LSH method

In [16]:

```
def LSH(signatures, bands, rows, Ab, Bb, nextPrime, maxShingleID):

    numItems = signatures.shape[1]
    signBands = numpy.array_split(signatures, bands, axis=0)
    candidates = set()
    for nb in range(bands):
        hashTable = {}
        for ni in range(numItems):
            item = signBands[nb][:,ni]
            hash = (numpy.dot(Ab[nb,:], item) + Bb[nb]) % nextPrime % maxShin
            if hash not in hashTable:
                hashTable[hash] = [ni]
            else:
                hashTable[hash].append(ni)
        for _, items in hashTable.items():
            if len(items) > 1:
                L = len(items)
                for i in range(L-1):
                    for j in range(i+1, L):
                        cand = [items[i], items[j]]
                        numpy.sort(cand)
                        candidates.add(tuple(cand))

    return candidates
```

In [17]:

```
# find candidates with LSH
signatures2 = [] # signatures for all files
fnames = get_fnames()[:1000]
for fname in fnames:
    shingles2 = get_shingles(fname, k=5)
    sig2 = minhash_vectorized(shingles2, A, B, nextPrime, maxShingleID, nsig)
    signatures2.append(sig2)

# prepare data for LSH
A2 = numpy.random.randint(0, nextPrime/2, size=(bands, rows), dtype=numpy.int
B2 = numpy.random.randint(0, nextPrime/2, size=(bands, ), dtype=numpy.int64)
signatures2 = numpy.array(signatures2).T # LSH needs a matrix of signatures,

s = 0.9 # similarity threshold
Nfiles2 = signatures2.shape[1] # number of different files
t5 = time()
candidates = LSH(signatures2, bands, rows, A2, B2, nextPrime, maxShingleID)
t6 = time() - t5
print("finding candidates k=5 s=0.9 took {} seconds".format(t6))
print("found {} candidates k=5 s=0.9 ".format(len(candidates)))
print("candidate similar pairs k=5 s=0.9 of files are:")
for i,j in candidates:
    print(fnames[i], fnames[j])
```

```
finding candidates k=5 s=0.9 took 0.047614336013793945 seconds
found 617 candidates k=5 s=0.9
```


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In [18]:

```

signatures3 = [] # signatures for all files
fnames = get_fnames()[1:1000]
for fname in fnames:
    shingles3 = get_shingles(fname, k=10)
    sig3 = minhash_vectorized(shingles3, A, B, nextPrime, maxShingleID, nsig)
    signatures3.append(sig3)

# prepare data for LSH
A2 = numpy.random.randint(0, nextPrime/2, size=(bands, rows), dtype=numpy.int)
B2 = numpy.random.randint(0, nextPrime/2, size=(bands, ), dtype=numpy.int64)
signatures3 = numpy.array(signatures).T # LSH needs a matrix of signatures,

s = 0.9 # similarity threshold
Nfiles3 = signatures3.shape[1] # number of different files
t7 = time()
candidates1 = LSH(signatures3, bands, rows, A2, B2, nextPrime, maxShingleID)
t8 = time() - t7
print("finding candidates k=10 s=0.9 took {} seconds".format(t8))
print("found {} candidates k=10 s=0.9 ".format(len(candidates1)))
print("candidate similar pairs k=10 s=0.9 of files are:")
for i,j in candidates1:
    print(fnames[i], fnames[j])

```

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finding candidates k=10 s=0.9 took 0.0379786491394043 seconds
found 617 candidates k=10 s=0.9
candidate similar pairs k=10 s=0.9 of files are:
NSF Research Award\awards_1990\awd_1990_00\a9000962.txt NSF Research Award\awards_1990\awd_1990_01\a9001029.txt
NSF Research Award\awards_1990\awd_1990_00\a9000221.txt NSF Research Award\awards_1990\awd_1990_00\a9000222.txt
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In [40]:

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print("Jaccard_similarity_score pair_wise k=5: {}".format(jaccard_similarity_score pair_wise k=5))
print("Jaccard_similarity_score pair_wise k=10: {}".format(jaccard_similarity_score pair_wise k=10))
print("Jaccard_similarity_score Minhash_vectorizer k=5: {}".format(jaccard_similarity_score Minhash_vectorizer k=5))
print("Jaccard_similarity_score Minhash_vectorizer k=10: {}".format(jaccard_similarity_score Minhash_vectorizer k=10))
```

```
Jaccard_similarity_score pair_wise k=5: 0.09054527263631816
Jaccard_similarity_score pair_wise k=10: 0.013148283418553688
Jaccard_similarity_score Minhash_vectorizer k=5: 0.041666666666666664
Jaccard_similarity_score Minhash_vectorizer k=10: 0.02040816326530612
```

In [41]:

```
print("Number of similar items k=5: {}".format(len(pair_wise)))
print("Number of similar items k=10: {}".format(len(pair_wise1)))
print("found {} minhash similar pairs k=5 s=0.9 ".format(len(minhash)))
print("found {} minhash similar pairs k=10 s=0.9 ".format(len(minhash1)))
print("found {} LSH candidates k=5 s=0.9 ".format(len(candidates)))
print("found {} LSH candidates k=10 s=0.9 ".format(len(candidates1)))
```

```
Number of similar items k=5: 575
Number of similar items k=10: 575
found 576 minhash similar pairs k=5 s=0.9
found 577 minhash similar pairs k=10 s=0.9
found 617 LSH candidates k=5 s=0.9
found 617 LSH candidates k=10 s=0.9
```

In [42]:

```
print("finding minhash similar pairs k=5 s=0.9 took {} seconds".format(t2))
print("finding minhash similar pairs k=10 s=0.9 took {} seconds".format(t4))
print("finding LSH candidates k=5 s=0.9 took {} seconds".format(t6))
print("finding LSH candidates k=10 s=0.9 took {} seconds".format(t8))
```

```
finding minhash similar pairs k=5 s=0.9 took 5.961978435516357 seconds
finding minhash similar pairs k=10 s=0.9 took 5.965031862258911 seconds
finding LSH candidates k=5 s=0.9 took 0.047614336013793945 seconds
finding LSH candidates k=10 s=0.9 took 0.0379786491394043 seconds
```

Conclusion:

1. Jaccard_similarity_score for k=10 is smaller than k=5
2. The number of similarity pairs is nearly same in case of k=5 or 10
3. Time for k=10 in LSH method is less than for k=5, but for Minhash_vectorizer time is the same for k=5 or 10

Compare the results for different similarity thresholds ($s = 0.5, 0.9$ and 0.95) for MinHash and LSH (10, 100 and 200 hashing functions).

MinHash_vectorized $s = 0.5, 0.9, 0.95$

In [24]:

```
signatures4 = [] # signatures for all files
fnames = get_fnames()[:1000]
for fname in fnames:
    shingles2 = list(get_shingles(fname, k=5))
    sig4 = minhash_vectorized(shingles2, A, B, nextPrime, maxShingleID, nsig)
    signatures4.append(sig4)
print("Jaccard_similarity_score: {}".format(jaccard_similarity_score(signatures4,
s = 0.5 # similarity threshold
Nfiles4 = len(signatures4)
t9 = time()
minhash2 = []
for i in range(Nfiles4):
    for j in range(i+1, Nfiles4):
        Jsim2 = numpy.mean(signatures4[i] == signatures4[j]) # average number of similar shingles
        if Jsim2 >= s:
            minhash2.append((i,j))
t10 = time() - t9
print("finding candidates k=5 s=0.5 took {} seconds".format(t10))
print("found {} candidates k=5 s=0.5 ".format(len(minhash2)))
print("candidate similar pairs k=5 s=0.5 of files are:")
for i,j in minhash2:
    print(fnames[i], fnames[j])
```

```
Jaccard_similarity_score: 0.041666666666666664
finding candidates k=5 s=0.5 took 6.456842660903931 seconds
found 689 candidates k=5 s=0.5
candidate similar pairs k=5 s=0.5 of files are:
NSF Research Award\awards_1990\awd_1990_00\a9000046.txt NSF Research Award\awards_1990\awd_1990_00\a9000049.txt
NSF Research Award\awards_1990\awd_1990_00\a9000046.txt NSF Research Award\awards_1990\awd_1990_00\a9000130.txt
NSF Research Award\awards_1990\awd_1990_00\a9000046.txt NSF Research Award\awards_1990\awd_1990_00\a9000158.txt
NSF Research Award\awards_1990\awd_1990_00\a9000046.txt NSF Research Award\awards_1990\awd_1990_00\a9000246.txt
NSF Research Award\awards_1990\awd_1990_00\a9000046.txt NSF Research Award\awards_1990\awd_1990_00\a9000251.txt
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NSF Research Award\awards_1990\awd_1990_00\a9000046.txt NSF Research Award\awards_1990\awd_1990_01\a9001169.txt
NSF Research Award\awards_1990\awd_1990_00\a9000048.txt NSF Research Award\awards_1990\awd_1990_00\a9000049.txt
```

http://localhost:8888/nbconvert/html/MYDATA/Big%20Data%20Analyti.../ML2_DA_Finding_Similar_Items_Anh%26Phuong.ipynb?download=false Sivu 146/282

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In [25]:

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signatures5 = [] # signatures for all files
fnames = get_fnames()[0:1000]
for fname in fnames:
    shingles3 = list(get_shingles(fname, k=5))
    sig5 = minhash_vectorized(shingles3, A, B, nextPrime, maxShingleID, nsig)
    signatures5.append(sig5)
print("Jaccard_similarity_score: {}".format(jaccard_similarity_score(signatures5)))
s = 0.95 # similarity threshold
Nfiles5 = len(signatures5)
t11 = time()
minhash3 = []
for i in range(Nfiles5):
    for j in range(i+1, Nfiles5):
        Jsim3 = numpy.mean(signatures5[i] == signatures5[j]) # average number of similar shingles
        if Jsim3 >= s:
            minhash3.append((i,j))
t12 = time() - t11
print("finding candidates k=5 s=0.95 took {} seconds".format(t12))
print("found {} candidates k=5 s=0.95 ".format(len(minhash3)))
print("candidate similar pairs k=5 s=0.95 of files are:")
for i,j in minhash3:
    print(fnames[i], fnames[j])

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Jaccard_similarity_score: 0.041666666666666664
finding candidates k=5 s=0.95 took 7.316863775253296 seconds
found 575 candidates k=5 s=0.95
candidate similar pairs k=5 s=0.95 of files are:
NSF Research Award\awards_1990\awd_1990_00\a9000177.txt NSF Research Award\awards_1990\awd_1990_00\a9000458.txt
NSF Research Award\awards_1990\awd_1990_00\a9000221.txt NSF Research Award\awards_1990\awd_1990_00\a9000222.txt
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LSH 10, 100, 200 hashing functions

In [26]:

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bands1 = 2
rows1 = 5
nsig1 = bands1*rows1 # number of elements in signature, or the number of dif

maxShingleID = 2**32-1 # record the maximum shingle ID that we assigned
nextPrime = 4294967311 # next prime number after maxShingleID

A1 = numpy.random.randint(0, nextPrime/2, size=(nsig1,), dtype=numpy.int64)
B1 = numpy.random.randint(0, nextPrime/2, size=(nsig1,), dtype=numpy.int64)
```

In [27]:

```
signatures6 = [] # signatures for all files
fnames = get_fnames()[:1000]
for fname in fnames:
    shingles4 = get_shingles(fname, k=5)
    sig6 = minhash_vectorized(shingles4, A1, B1, nextPrime, maxShingleID, nsig1)
    signatures6.append(sig6)

# prepare data for LSH
A3 = numpy.random.randint(0, nextPrime/2, size=(bands1, rows1), dtype=numpy.int64)
B3 = numpy.random.randint(0, nextPrime/2, size=(bands1, ), dtype=numpy.int64)
signatures6 = numpy.array(signatures6).T # LSH needs a matrix of signatures,

s = 0.9 # similarity threshold
Nfiles6 = signatures6.shape[1] # number of different files
t13 = time()
candidates2 = LSH(signatures6, bands1, rows1, A3, B3, nextPrime, maxShingleID)
t14 = time() - t13
print("finding candidates 10 hash functions took {} seconds".format(t14))
print("found {} candidates 10 hash functions ".format(len(candidates2)))
print("candidate similar pairs 10 hash functions of files are:")
for i,j in candidates2:
    print(fnames[i], fnames[j])
```

```
finding candidates 10 hash functions took 0.014989852905273438 seconds
found 591 candidates 10 hash functions
candidate similar pairs 10 hash functions of files are:
```

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In [30]:

```
bands3 = 20
rows3 = 10
nsig3 = bands3*rows3 # number of elements in signature, or the number of dif

maxShingleID = 2**32-1 # record the maximum shingle ID that we assigned
nextPrime = 4294967311 # next prime number after maxShingleID

A5 = numpy.random.randint(0, nextPrime/2, size=(nsig3,), dtype=numpy.int64)
B5 = numpy.random.randint(0, nextPrime/2, size=(nsig3,), dtype=numpy.int64)
```

In [31]:

```
signatures8 = [] # signatures for all files
fnames = get_fnames()[:1000]
for fname in fnames:
    shingles6 = get_shingles(fname, k=5)
    sig8 = minhash_vectorized(shingles6, A5, B5, nextPrime, maxShingleID, nsig3)
    signatures8.append(sig8)

# prepare data for LSH
A7 = numpy.random.randint(0, nextPrime/2, size=(bands3, rows3), dtype=numpy.int64)
B7 = numpy.random.randint(0, nextPrime/2, size=(bands3, rows3), dtype=numpy.int64)
signatures8 = numpy.array(signatures8).T # LSH needs a matrix of signatures,

s = 0.9 # similarity threshold
Nfiles8 = signatures8.shape[1] # number of different files
t17 = time()
candidates4 = LSH(signatures8, bands3, rows3, A7, B7, nextPrime, maxShingleID)
t18 = time() - t17
print("finding candidates 200 hash function took {} seconds".format(t18))
print("found {} candidates 200 hash function ".format(len(candidates4)))
print("candidate similar pairs 200 hash function of files are:")
for i,j in candidates4:
    print(fnames[i], fnames[j])
```

finding candidates 200 hash function took 0.19128870964050293 seconds

found 594 candidates 200 hash function

candidate similar pairs 200 hash function of files are:

```
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Comparison the results

1. Time for LSH with higher hash function is longer than smaller hash function
2. The similarity pairs for Minhash_vectorizer with smaller s are more than with higher s
3. The similarity pairs for LSH with 100 hash function are found more than with 10 or 200 hash function. It is necessary of finding the optimal hash function.

Using a 1-NN criteria, identify the clusters of similar abstracts for each method and s. Are the cluster different?, Upon inspection, what is the topic of each cluster? Check for example <https://www.coursera.org/lecture/ml-clustering-and-retrieval/1-nn-algorithm-6wIOD>

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In [35]: print(type(candidates3))
```

```
<class 'set'>
```

```
In [36]: print(len(candidates3))
```

```
713
```

```
In [37]: l = list(candidates3)

result = []
if len(l) > 1:
    tmp = [l[0]]
    for i in range(1, len(l)):
        if l[i][0] == l[i-1][1] or l[i][1] == l[i-1][0] or l[i][1] == l[i-1][1] or l[i][0] == l[i-1][0]:
            tmp.append(l[i])
        else:
            result.append(tmp)
            tmp = [l[i]]
    result.append(tmp)
else:
    result = l

for elem in result:
    print(elem)
```

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```

Implement a cosine distance and compare with a Jaccard distance for the vectorized MinHash algorithm. How they compare in performance? Results?

In [38]:

```

dis_sig = [] # signatures for all files
fnames = get_fnames()[:1000]
for fname in fnames:
    shingles7 = list(get_shingles(fname, k=5))
    sig9 = minhash_vectorized(shingles7, A4, B4, nextPrime, maxShingleID, nsi
    dis_sig.append(sig9)
a, b = dis_sig[0], dis_sig[1]

print("Jaccard_similarity_score: {}".format(jaccard_similarity_score(a,b)))
print("Jaccard_distance: {}".format(1-jaccard_similarity_score(a,b)))
from scipy import spatial
print("Cosine_distance: {}".format(spatial.distance.cosine(a,b)))

```

```

Jaccard_similarity_score: 0.03626943005181347
Jaccard_distance: 0.9637305699481865
Cosine_distance: 0.4447566743654381

```

It gives you a score between 0 and 1 based on the grade of similarity and this grade of similarity signifies how much two sets are overlapping each other

Cosine distance is smaller than Jaccard distance.

In []: