Assignment 8

Fall 2014
CS595 Web Science
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Contents

Listings

1 Question 1

1.1 Question

Create a blog-term matrix. Start by grabbing 100 blogs; include:

http://f-measure.blogspot.com/
http://ws-dl.blogspot.com/

and grab 98 more as per the method shown in class.

Use the blog title as the identifier for each blog (and row of the matrix). Use the terms from every item/title (RSS) or entry/title (Atom) for the columns of the matrix. The values are the frequency of occurrence. Essentially you are replicating the format of the "blogdata.txt" file included with the PCI book code. Limit the number of terms to the most "popular" (i.e., frequent) 500 terms, this is *after* the criteria on p. 32 (slide 7) has been satisfied.

Create a histogram of how many pages each blog has (e.g., 30 blogs with just one page, 27 with two pages, 29 with 3 pages and so on).

1.2 Answer

To complete this assignment, a blog word count dataset was required. To start off, a list of blog URIs was obtained using the method described in class, implemented as the `get_uris.py` script, which can be found in Appendix A, Listing 25. Two default blogs, F-Measure and the Old Dominion Web Science and Digital Libraries blogs, were added as defaults to the initial URI list and then, using the seed URI provided (Listing 2), the remaining 98 URIs from random blogs within the blogger.com family were added.

```
27 if __name__ == '__main__':
28     uris = set()
29     with open('blog_uris', 'a') as outfile:
30         if len(sys.argv) > 1 and sys.argv[1] == 'new':
31             for must_have in must_haves:
32                 uri = get_atom(must_have)
33                 add_uri(uri, uris, outfile)
34         else:
35             with open('blog_uris') as infile:
36                 [uris.add(line.strip()) for line in infile]
37         while len(uris) < 100:
38             uri = get_atom(default)
39             add_uri(uri, uris, outfile)
```

Listing 1: main for get_uris.py

```
7 default = 'http://www.blogger.com/next-blog?navBar=true&blogID=3471633091411211117'
8 must_haves = ['http://f-measure.blogspot.com/', 'http://ws-dl.blogspot.com/']
```

Listing 2: referenced variables in get_uris.py

The `get_uris main` function in Listing 1 was the driver that called the `get_atom` function (shown in Listing 3) to extract the atom [1] URIs from each blog and add them to the set of URIs with the `add_uri` function, shown in Listing 4.

```
10 def get_atom(uri):
11     try:
12         r = requests.get(uri)
13     except Exception, e:
14         return None
15     soup = BeautifulSoup(r.text)
16     links = soup.find_all('link', {'type':'application/atom+xml'})
17     if links:
18         return str(links[0]['href'])
19     return None
```

Listing 3: get_atom function

```
21 def add_uri(uri, uris, outfile):
22     if uri and uri not in uris:
23         uris.add(uri)
24         outfile.write(uri + '\n')
25         print len(uris), uri
```

Listing 4: add_uri function

After the full list of 100 URIs was obtained page counts for each blog were extraced and saved to a file called `pagecounts` using the `matrix.py` script. This script is a modified version of `generatefeedvectors.py` from the book *Programming Collective Intelligence* [2] and can be found in full in Appendix A, Listing 26.

The code responsible for downloading the blogs and counting the words in each is shown in Listing 5, which calls the `get_titles`, `get_words` and `get_next` functions found in Listing 6. This code loops over the list of URIs that was created with the `get_uris.py` script (Listing 25), parses each entry, and extracts all the words in each entry's title.

```
95 if __name__ == '__main__':
96     with open('blog_uris') as infile:
97         uris = [line.strip() for line in infile if line.strip()]
98     if len(sys.argv) == 2 and sys.argv[1] == 'get':
99         with futures.ThreadPoolExecutor(max_workers=8) as executor:
100             uri_futures = [executor.submit(get_titles, uri) for uri in uris]
101             for future in futures.as_completed(uri_futures):
102                 uri, title, subtitle, pages, wc = future.result()
103                 with open('wcs/' + md5.new(uri).hexdigest(), 'w') as out:
104                     out.write(title + ': ' + subtitle + '\t' + str(pages) + '\t')
105                     json.dump(wc, out)
```

Listing 5: looping over the URIs

```
def get_next(d):
    for item in d.feed.links:
        if item['rel'] == u'next':
            return item['href']
    return None

def get_words(text):
    txt = re.compile(r'<[^>]+>').sub('', text)
    words = re.compile(r'[^A-Z^a-z]+').split(txt)
    return [word.lower() for word in words if word != '']

def get_titles(uri):
    print('processing {}'.format(uri))
    next = uri
    wc = {}
    pages = 0
    while next is not None:
        d = feedparser.parse(next)
        for e in d.entries:
            words = get_words(e.title.encode('utf-8'))
            for word in words:
                wc.setdefault(word, 0)
                wc[word] += 1
        pages += 1
        next = get_next(d)
        print('next {}'.format(next))
    title = d.feed.title.encode('utf-8')
    subtitle = d.feed.subtitle[:50].encode('utf-8')
    print('finished: {}: {}'.format(title, subtitle))
    return uri, title, subtitle, pages, wc
```

Listing 6: processing each blog

The parsed results were then read by the code in Listing 7. This code used the `load_data` functions in Listing 8 and 9 to read each of the blog word counts and then created four collections to organize them all:

1. `apcount`: A dictionary containing the count for all words combined
2. `wordcounts`: A dictionary containing each blog's individual word count
3. `pagecounts`: A dictionary containing each blog's page count
4. `wordlist`: A list containing all of the words found in each blog

```
        apcount, wordcounts, pagecounts = load_data(uris)
        wordlist = build_wordlist(apcount, uris)
        if len(sys.argv) == 2 and sys.argv[1] == 'pages':
            with open('pagecounts', 'w') as outfile:
                outfile.write('blog\tpages\n')
                for blog, pagecount in pagecounts.iteritems():
                    outfile.write("\"" + blog.replace("\"", "") + "\"" + '\t' + str(
                        pagecount) + '\n')
        elif len(sys.argv) == 2 and sys.argv[1] == 'wc':
            write_data('blogdata1.txt', wordlist, wordcounts)
```

Listing 7: creating the blog data matrix

```
def load_data(uris):
    apcount = {}
    wordcounts = {}
    pagecounts = {}
    for uri in uris:
        with open('wcs/' + md5.new(uri).hexdigest()) as infile:
            try:
                lines = infile.read().split('\t')
                title = lines[0]
                pages = int(lines[1])
                wc = json.loads(lines[2])
            except Exception, e:
                print('*** {} generated an exception: {}'.format(uri, e))
                continue
        wordcounts[title] = wc
        pagecounts[title] = pages
        for word, count in wc.items():
            apcount.setdefault(word, 0)
            apcount[word] += count
    return apcount, wordcounts, pagecounts
```

Listing 8: loading the data

```
def build_wordlist(apcount, uris):
    wordlist = []
    for w, bc in sorted(apcount.items(), key=lambda x: x[1], reverse=True):
            frac = float(bc) / len(uris)
            if frac > 0.1 and frac < 0.5:
                wordlist.append(w)
    return wordlist
```

Listing 9: building the master wordlist

The code in Listing 10 then created the matrix using the `write_data` function.

```
def write_data(filename, wordlist, wordcounts, form=lambda wc, word, wordcounts: wc[word]):
    with open(filename, 'w') as out:
        out.write('Blog')
        for word in wordlist[:500]:
            out.write('\t%s' % word)
        out.write('\n')
        for blog, wc in wordcounts.items():
            print blog
            out.write(blog)
            for word in wordlist[:500]:
                if word in wc:
                    out.write('\t{}'.format(form(wc,word,wordcounts)))
                else:
                    out.write('\t0')
            out.write('\n')
```

Listing 10: writing the data

To build a histogram showing the blog page counts, the `pagecounts` file was parsed by the R script in Listing 11 and saved as a pdf, which is shown in Figure 1.

```
#! /usr/bin/Rscript

data <- read.table("pagecounts", sep="\t", header=TRUE, comment.char="")
counts <- table(data$pages)
pdf("hist.pdf")
barplot(counts, ylab="Number of Blogs", xlab="Page Count", main="Page Count per Blog")
dev.off()
```

Listing 11: building the histogram

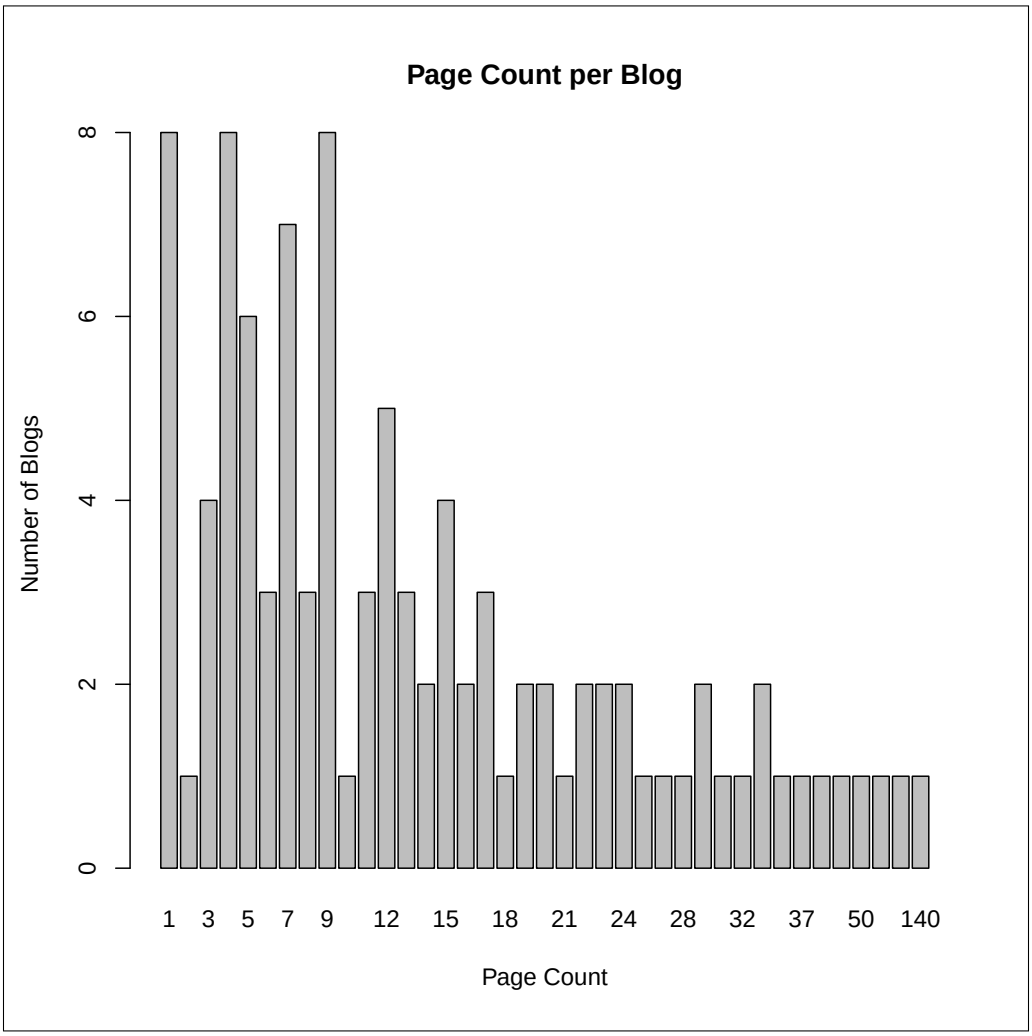

Figure 1: Page Count per Blog

2 Question 2

2.1 Question

Create an ASCII and JPEG dendrogram that clusters (i.e., HAC) the most similar blogs (see slides 12 & 13). Include the JPEG in your report and upload the ascii file to github (it will be too unwieldy for inclusion in the report).

2.2 Answer

The ascii and jpeg dendrograms were created using the method shown in Listing 12, which is modeled after the example from class.

```
286     blognames, words, data = readfile('q1/blogdata1.txt')
287     clust = hcluster(data)
288     with open('dendrogram.txt', 'w') as outfile:
289         stdout = sys.stdout
290         sys.stdout = outfile
291         printclust(clust, labels=blognames)
292         sys.stdout = stdout
293     drawdendrogram(clust, blognames, jpeg='blogclust.jpg')
```

Listing 12: creating the dendrograms

This uses the `readfile` function shown in Listing 13 to read the data that was compiled from Question 1 into the script where it is then processed by the `hcluster` function found in Listing 14 to produce the clustered representation of the blogs.

```
3  def readfile(filename):
4    lines=[line for line in file(filename)]
5
6    # First line is the column titles
7    colnames=lines[0].strip().split('\t')[1:]
8    rownames=[]
9    data=[]
10   for line in lines[1:]:
11     p=line.strip().split('\t')
12     # First column in each row is the rowname
13     rownames.append(p[0])
14     # The data for this row is the remainder of the row
15     data.append([float(x) for x in p[1:]])
16   return rownames,colnames,data
```

Listing 13: creating the dendrograms

```
48 def hcluster(rows,distance=pearson):
49   distances={}
50   currentclustid=-1
51
52   # Clusters are initially just the rows
53   clust=[bicluster(rows[i],id=i) for i in range(len(rows))]
54
55   while len(clust)>1:
56     lowestpair=(0,1)
57     closest=distance(clust[0].vec,clust[1].vec)
58
59     # loop through every pair looking for the smallest distance
60     for i in range(len(clust)):
61       for j in range(i+1,len(clust)):
62         # distances is the cache of distance calculations
63         if (clust[i].id,clust[j].id) not in distances:
64           distances[(clust[i].id,clust[j].id)]=distance(clust[i].vec,clust[j].vec)
65
66         d=distances[(clust[i].id,clust[j].id)]
67
68         if d<closest:
69           closest=d
```

```
70              lowestpair=(i,j)
71
72      # calculate the average of the two clusters
73      mergevec=[
74      (clust[lowestpair[0]].vec[i]+clust[lowestpair[1]].vec[i])/2.0
75      for i in range(len(clust[0].vec))]
76
77      # create the new cluster
78      newcluster=bicluster(mergevec,left=clust[lowestpair[0]],
79                           right=clust[lowestpair[1]],
80                           distance=closest,id=currentclustid)
81
82      # cluster ids that weren't in the original set are negative
83      currentclustid-=1
84      del clust[lowestpair[1]]
85      del clust[lowestpair[0]]
86      clust.append(newcluster)
87
88    return clust[0]
```

Listing 14: hcluster function

The `printclust` function from Listing 15 prints the ascii dendrogram of the cluster object parameter to sys.stdout, which is redirected to write to a file with the code in Listing 12.

```
90  def printclust(clust,labels=None,n=0):
91    # indent to make a hierarchy layout
92    for i in range(n): print ' ',
93    if clust.id<0:
94      # negative id means that this is branch
95      print '-'
96    else:
97      # positive id means that this is an endpoint
98      if labels==None: print clust.id
99      else: print labels[clust.id]
100
101   # now print the right and left branches
102   if clust.left!=None: printclust(clust.left,labels=labels,n=n+1)
103   if clust.right!=None: printclust(clust.right,labels=labels,n=n+1)
```

Listing 15: printclust function

The `drawdendrogram` function from Listing 16 creates a jpeg image of the cluster, which is shown in Figure 2.

```
122 def drawdendrogram(clust,labels,jpeg='clusters.jpg'):
123   # height and width
124   h=getheight(clust)*20
125   w=1200
126   depth=getdepth(clust)
127
128   # width is fixed, so scale distances accordingly
129   scaling=float(w-150)/depth
130
131   # Create a new image with a white background
132   img=Image.new('RGB',(w,h),(255,255,255))
133   draw=ImageDraw.Draw(img)
134
135   draw.line((0,h/2,10,h/2),fill=(255,0,0))
136
137   # Draw the first node
138   drawnode(draw,clust,10,(h/2),scaling,labels)
139   img.save(jpeg,'JPEG')
```

Listing 16: drawdendrogram function

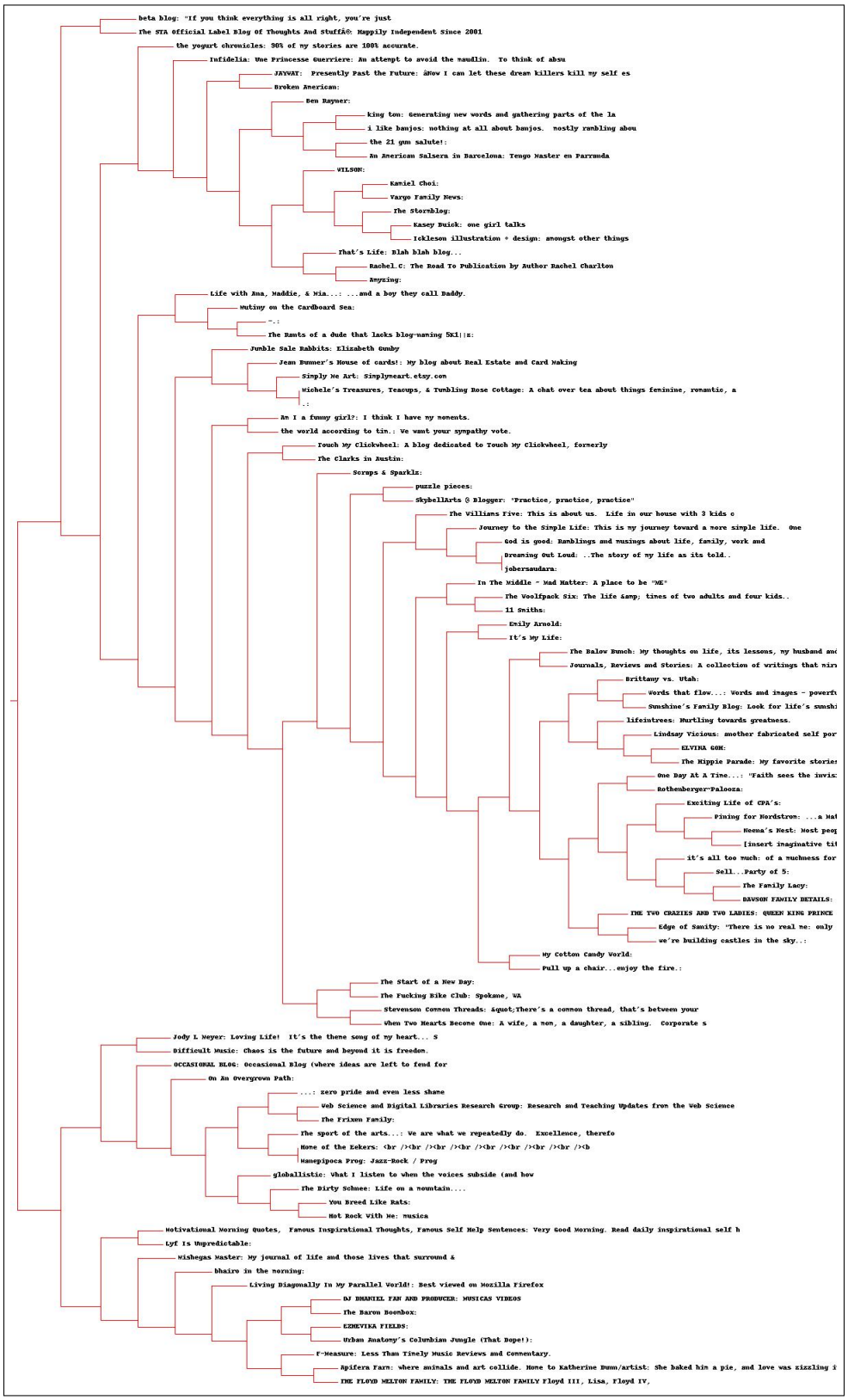

Figure 2: blog dendrogram

3 Question 3

3.1 Question

`Cluster the blogs using K-Means, using k=5,10,20. (see slide 18).`
`How many interations were required for each value of k?`

3.2 Answer

Using the code in Listing 17 kclustering was performed with values for $n = 5$, $n = 10$ and $n = 20$. The main function calls the kcluster function, which is shown in Listing 18.

```
295     print "K=5"
296     kclust=kcluster(data, k=5)
297     print "K=10"
298     kclust=kcluster(data, k=10)
299     print "K=20"
300     kclust=kcluster(data, k=20)
```

Listing 17: kclustering main

```
174 def kcluster(rows,distance=pearson,k=4):
175   # Determine the minimum and maximum values for each point
176   ranges=[(min([row[i] for row in rows]),max([row[i] for row in rows]))
177   for i in range(len(rows[0]))]
178
179   # Create k randomly placed centroids
180   clusters=[[random.random()*(ranges[i][1]-ranges[i][0])+ranges[i][0]
181   for i in range(len(rows[0]))] for j in range(k)]
182
183   lastmatches=None
184   for t in range(100):
185     print 'Iteration %d' % t
186     bestmatches=[[] for i in range(k)]
187
188     # Find which centroid is the closest for each row
189     for j in range(len(rows)):
190       row=rows[j]
191       bestmatch=0
192       for i in range(k):
193         d=distance(clusters[i],row)
194         if d<distance(clusters[bestmatch],row): bestmatch=i
195       bestmatches[bestmatch].append(j)
196
197     # If the results are the same as last time, this is complete
198     if bestmatches==lastmatches: break
199     lastmatches=bestmatches
200
201     # Move the centroids to the average of their members
202     for i in range(k):
203       avgs=[0.0]*len(rows[0])
204       if len(bestmatches[i])>0:
205         for rowid in bestmatches[i]:
206           for m in range(len(rows[rowid])):
207             avgs[m]+=rows[rowid][m]
208         for j in range(len(avgs)):
209           avgs[j]/=len(bestmatches[i])
210         clusters[i]=avgs
211
212   return bestmatches
```

Listing 18: kcluster function

The output is shown in Listing 19. As the output reads, a kcluster with $n = 5$ required nine iterations, $n = 10$ required four iterations and $n = 20$ also required four iterations.

```
Done with dendrograms
K=5
 Iteration 0
 Iteration 1
 Iteration 2
 Iteration 3
 Iteration 4
 Iteration 5
 Iteration 6
 Iteration 7
 Iteration 8
K=10
 Iteration 0
 Iteration 1
 Iteration 2
 Iteration 3
K=20
 Iteration 0
 Iteration 1
 Iteration 2
 Iteration 3
```

Listing 19: output of kclustering algorithm

4 Question 4

4.1 Question

`Use MDS to create a JPEG of the blogs similar to slide 29.`
`How many iterations were required?`

4.2 Answer

With the code in Listing 20, multidimensional scaling (MDS) was used to create a two-dimensional visualization of the blog distance graph.

```
    coords=scaledown(data)
    draw2d(coords, blognames, jpeg='blogs2d.jpg')
```

Listing 20: main for scaledown

This main code calls the scaledown function, which is shown in Listing 21. The algorithm continues until the error factor stops decreasing, as shown in the output in Appendix A, Listing 28.

```
def scaledown(data,distance=pearson,rate=0.01):
  n=len(data)

  # The real distances between every pair of items
  realdist=[[distance(data[i],data[j]) for j in range(n)]
            for i in range(0,n)]

  # Randomly initialize the starting points of the locations in 2D
  loc=[[random.random(),random.random()] for i in range(n)]
  fakedist=[[0.0 for j in range(n)] for i in range(n)]

  lasterror=None
  for m in range(0,1000):
    # Find projected distances
    for i in range(n):
      for j in range(n):
        fakedist[i][j]=sqrt(sum([pow(loc[i][x]-loc[j][x],2)
                                 for x in range(len(loc[i]))]))

    # Move points
    grad=[[0.0,0.0] for i in range(n)]

    totalerror=0
    for k in range(n):
      for j in range(n):
        if j==k: continue
        # The error is percent difference between the distances
        if realdist[j][k] != 0:
            errorterm=(fakedist[j][k]-realdist[j][k])/realdist[j][k]

        # Each point needs to be moved away from or towards the other
        # point in proportion to how much error it has
        grad[k][0]+=((loc[k][0]-loc[j][0])/fakedist[j][k])*errorterm
        grad[k][1]+=((loc[k][1]-loc[j][1])/fakedist[j][k])*errorterm

        # Keep track of the total error
        totalerror+=abs(errorterm)
    print totalerror

    # If the answer got worse by moving the points, we are done
    if lasterror and lasterror<totalerror: break
    lasterror=totalerror

    # Move each of the points by the learning rate times the gradient
    for k in range(n):
      loc[k][0]-=rate*grad[k][0]
      loc[k][1]-=rate*grad[k][1]

  return loc
```

Listing 21: scaledown function

The scaledown function returns the coordinates for each of the blogs in 2D space. This data was then used with the `draw2d` function in Listing 22, which produced the two-dimensional visualation created from the MDS algorithm, as shown in Figure 3.

```
def draw2d(data,labels,jpeg='mds2d.jpg'):
  img=Image.new('RGB',(2000,2000),(255,255,255))
  draw=ImageDraw.Draw(img)
  for i in range(len(data)):
    x=(data[i][0]+0.5)*1000
    y=(data[i][1]+0.5)*1000
    draw.text((x,y),labels[i],(0,0,0))
  img.save(jpeg,'JPEG')
```

Listing 22: draw2d function

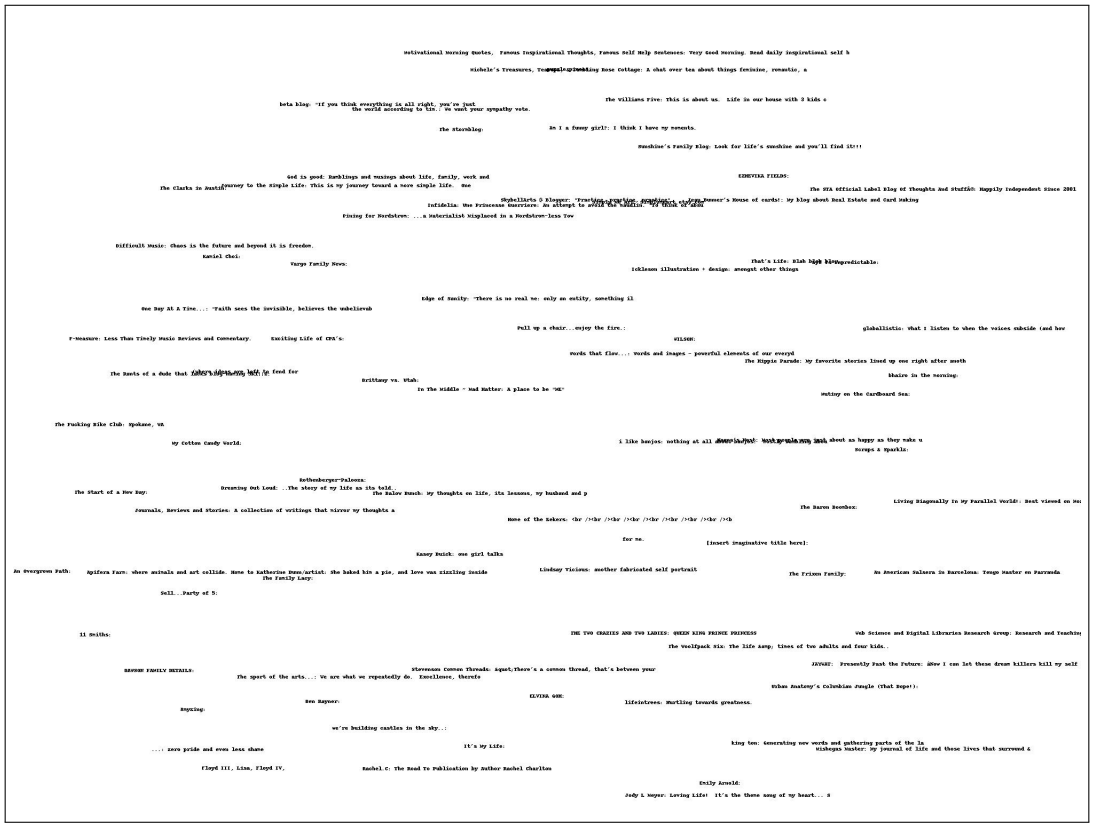

Figure 3: MDS 2d visualization

5 Question 5

5.1 Question

Re-run question 2, but this time with proper TFIDF calculations instead of the hack discussed on slide 7 (p. 32). Use the same 500 words, but this time replace their frequency count with TFIDF scores as computed in assignment #3. Document the code, techniques, methods, etc. used to generate these TFIDF values. Upload the new data file to github.

Compare and contrast the resulting dendrogram with the dendrogram from question #2.

Note: ideally you would not reuse the same 500 terms and instead come up with TFIDF scores for all the terms and then choose the top 500 from that list, but I'm trying to limit the amount of work necessary.

5.2 Answer

To answer this question, `matrix.py` was modified to add the capability to calculate *Term Frequency Inverse Document Frequency (TF/IDF)*. This process normalizes the term frequency against the entire corpus of documents. The added functions for computing TF/IDF are found in Listing 24. These functions use the master word count dictionary (`wordcounts`) and each blog's individual word count (`wc`) for each of the words in the `wordlist` from Question 1/2.

```
116         elif len(sys.argv) == 2 and sys.argv[1] == 'tfidf':
117             write_data('blogdata2.txt', wordlist, wordcounts, form=lambda wc, word,
                    wordcounts: tf(wc, word) * idf(wordcounts, word))
```

Listing 23: use of tfidf function

```
40 def tf(wc, word):
41     return float(wc[word]) / float(sum(wc.values()))
42
43 def idf(wordcounts, word):
44     present = 0
45     for wc in wordcounts.values():
46         if word in wc:
47             present += 1
48     return math.log(len(wordcounts) / present, 2)
```

Listing 24: tf idf functions

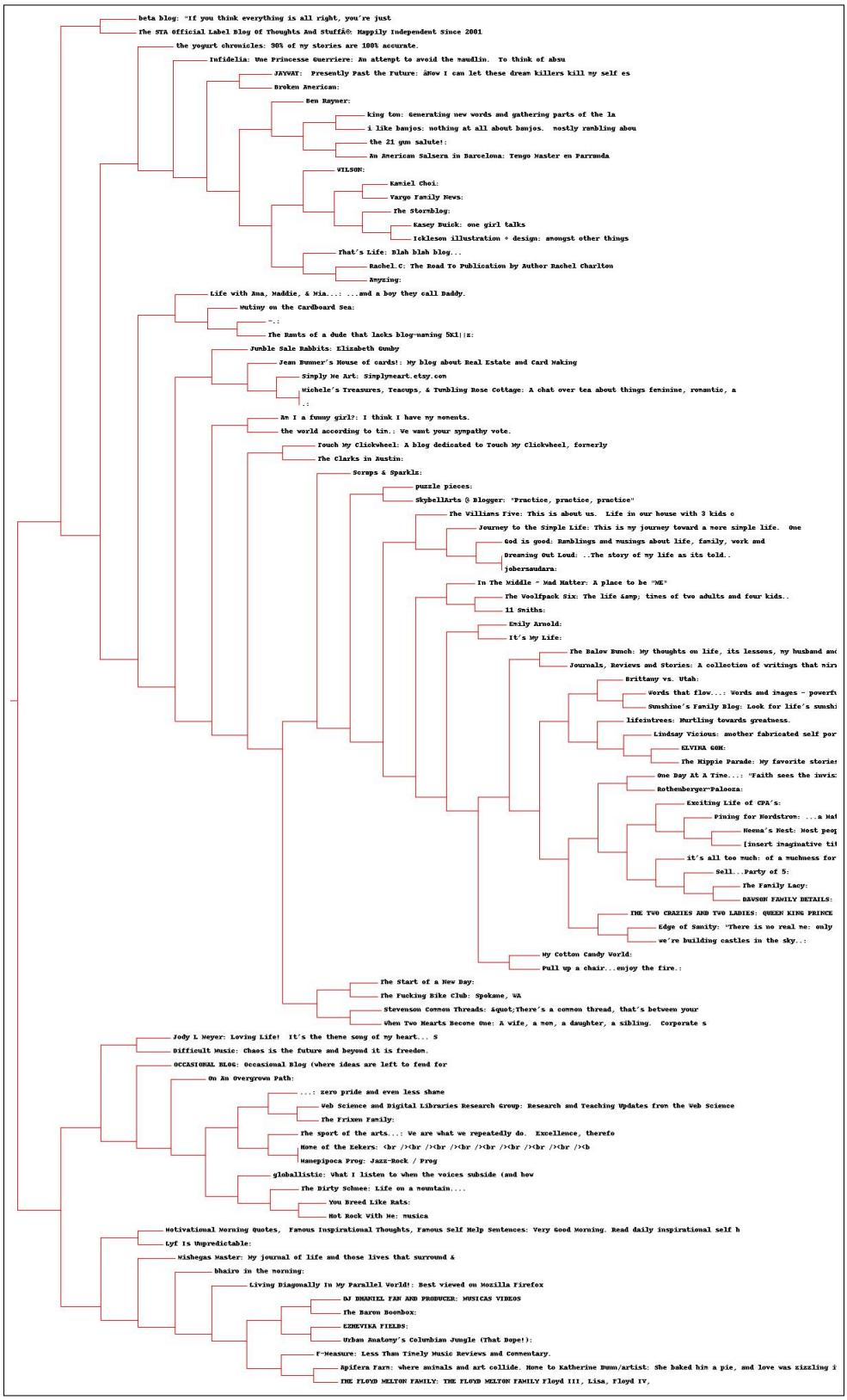

Figure 4: plain count dendrogram

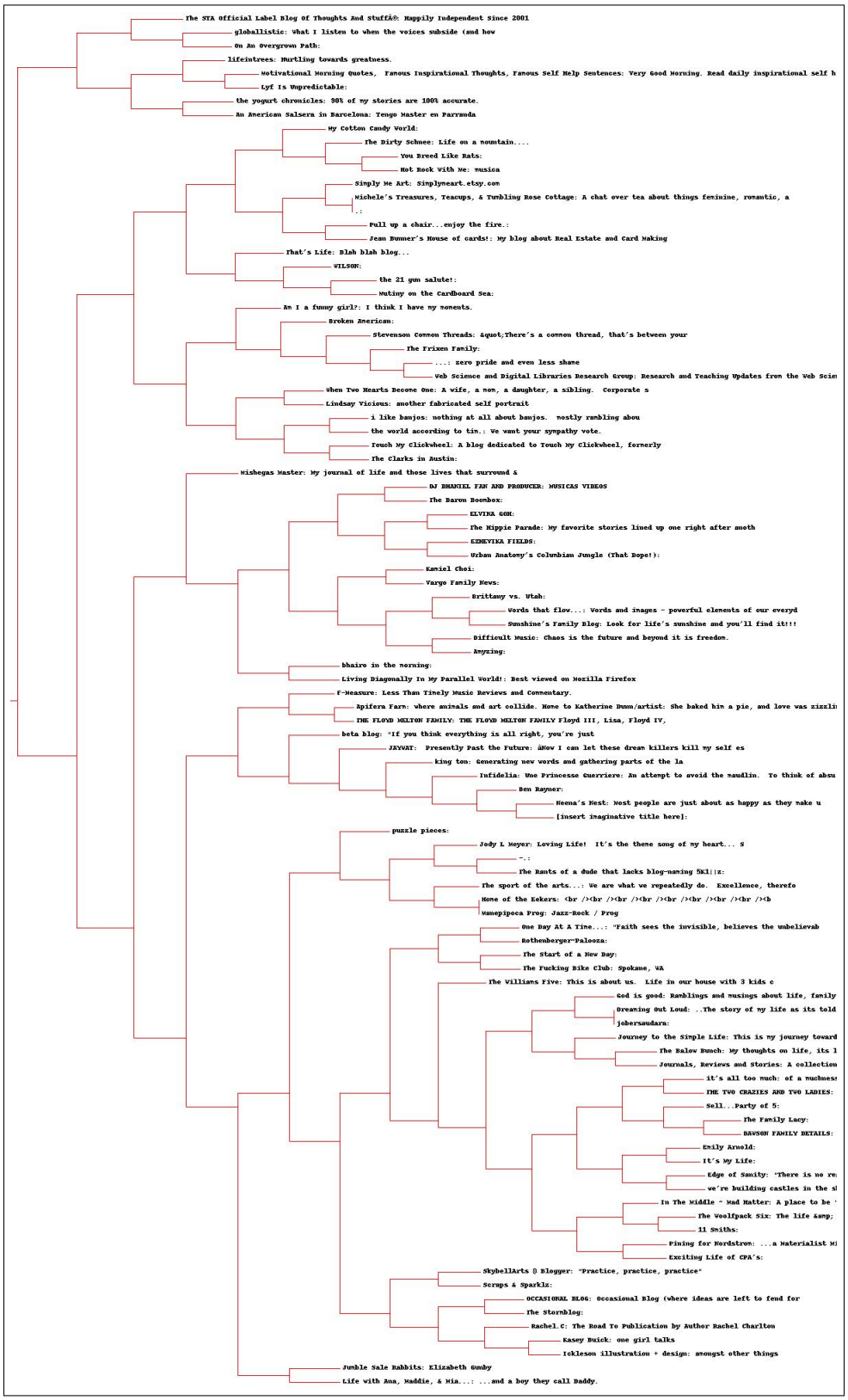

Figure 5: TF/IDF driven dendrogram

6 Appendix A

```
#! /usr/bin/env python

import requests
import sys
from bs4 import BeautifulSoup

default = 'http://www.blogger.com/next-blog?navBar=true&blogID=3471633091411211117'
must_haves = ['http://f-measure.blogspot.com/', 'http://ws-dl.blogspot.com/']

def get_atom(uri):
    try:
        r = requests.get(uri)
    except Exception, e:
        return None
    soup = BeautifulSoup(r.text)
    links = soup.find_all('link', {'type':'application/atom+xml'})
    if links:
        return str(links[0]['href'])
    return None

def add_uri(uri, uris, outfile):
    if uri and uri not in uris:
        uris.add(uri)
        outfile.write(uri + '\n')
        print len(uris), uri

if __name__ == '__main__':
    uris = set()
    with open('blog_uris', 'a') as outfile:
        if len(sys.argv) > 1 and sys.argv[1] == 'new':
            for must_have in must_haves:
                uri = get_atom(must_have)
                add_uri(uri, uris, outfile)
        else:
            with open('blog_uris') as infile:
                [uris.add(line.strip()) for line in infile]
        while len(uris) < 100:
            uri = get_atom(default)
            add_uri(uri, uris, outfile)
```

Listing 25: get_uris.py

```
import feedparser
import futures
import math
import md5
import re
import sys
import json

def get_next(d):
    for item in d.feed.links:
        if item['rel'] == u'next':
            return item['href']
    return None

def get_words(text):
    txt = re.compile(r'<[^>]+>').sub('', text)
    words = re.compile(r'[^A-Z^a-z]+').split(txt)
    return [word.lower() for word in words if word != '']

def get_titles(uri):
    print('processing {}'.format(uri))
    next = uri
    wc = {}
    pages = 0
    while next is not None:
        d = feedparser.parse(next)
        for e in d.entries:
            words = get_words(e.title.encode('utf-8'))
            for word in words:
                wc.setdefault(word, 0)
                wc[word] += 1
        pages += 1
        next = get_next(d)
        print('next {}'.format(next))
    title = d.feed.title.encode('utf-8')
    subtitle = d.feed.subtitle[:50].encode('utf-8')
    print('finished: {}: {}'.format(title, subtitle))
    return uri, title, subtitle, pages, wc

def tf(wc, word):
    return float(wc[word]) / float(sum(wc.values()))

def idf(wordcounts, word):
    present = 0
    for wc in wordcounts.values():
        if word in wc:
            present += 1
    return math.log(len(wordcounts) / present, 2)

def load_data(uris):
    apcount = {}
    wordcounts = {}
    pagecounts = {}
    for uri in uris:
        with open('wcs/' + md5.new(uri).hexdigest()) as infile:
            try:
                lines = infile.read().split('\t')
                title = lines[0]
                pages = int(lines[1])
                wc = json.loads(lines[2])
            except Exception, e:
                print('*** {} generated an exception: {}'.format(uri, e))
                continue
        wordcounts[title] = wc
        pagecounts[title] = pages
        for word, count in wc.items():
            apcount.setdefault(word, 0)
            apcount[word] += count
    return apcount, wordcounts, pagecounts

def build_wordlist(apcount, uris):
    wordlist = []
    for w, bc in sorted(apcount.items(), key=lambda x: x[1], reverse=True):
            frac = float(bc) / len(uris)
            if frac > 0.1 and frac < 0.5:
                wordlist.append(w)
```

```
77      return wordlist
78
79  def write_data(filename, wordlist, wordcounts, form=lambda wc, word, wordcounts: wc[word]):
80      with open(filename, 'w') as out:
81          out.write('Blog')
82          for word in wordlist[:500]:
83              out.write('\t%s' % word)
84          out.write('\n')
85          for blog, wc in wordcounts.items():
86              print blog
87              out.write(blog)
88              for word in wordlist[:500]:
89                  if word in wc:
90                      out.write('\t{}'.format(form(wc,word,wordcounts)))
91                  else:
92                      out.write('\t0')
93              out.write('\n')
94
95  if __name__ == '__main__':
96      with open('blog_uris') as infile:
97          uris = [line.strip() for line in infile if line.strip()]
98      if len(sys.argv) == 2 and sys.argv[1] == 'get':
99          with futures.ThreadPoolExecutor(max_workers=8) as executor:
100             uri_futures = [executor.submit(get_titles, uri) for uri in uris]
101             for future in futures.as_completed(uri_futures):
102                 uri, title, subtitle, pages, wc = future.result()
103                 with open('wcs/' + md5.new(uri).hexdigest(), 'w') as out:
104                     out.write(title + ': ' + subtitle + '\t' + str(pages) + '\t')
105                     json.dump(wc, out)
106     else:
107         apcount, wordcounts, pagecounts = load_data(uris)
108         wordlist = build_wordlist(apcount, uris)
109         if len(sys.argv) == 2 and sys.argv[1] == 'pages':
110             with open('pagecounts', 'w') as outfile:
111                 outfile.write('blog\tpages\n')
112                 for blog, pagecount in pagecounts.iteritems():
113                     outfile.write("\"" + blog.replace("\"", "") + "\"" + '\t' + str(
                            pagecount) + '\n')
114         elif len(sys.argv) == 2 and sys.argv[1] == 'wc':
115             write_data('blogdata1.txt', wordlist, wordcounts)
116         elif len(sys.argv) == 2 and sys.argv[1] == 'tfidf':
117             write_data('blogdata2.txt', wordlist, wordcounts, form=lambda wc, word,
                        wordcounts: tf(wc, word) * idf(wordcounts, word))
```

Listing 26: matrix.py

```
from PIL import Image,ImageDraw

def readfile(filename):
  lines=[line for line in file(filename)]

  # First line is the column titles
  colnames=lines[0].strip().split('\t')[1:]
  rownames=[]
  data=[]
  for line in lines[1:]:
    p=line.strip().split('\t')
    # First column in each row is the rowname
    rownames.append(p[0])
    # The data for this row is the remainder of the row
    data.append([float(x) for x in p[1:]])
  return rownames,colnames,data


from math import sqrt

def pearson(v1,v2):
  # Simple sums
  sum1=sum(v1)
  sum2=sum(v2)

  # Sums of the squares
  sum1Sq=sum([pow(v,2) for v in v1])
  sum2Sq=sum([pow(v,2) for v in v2])

  # Sum of the products
  pSum=sum([v1[i]*v2[i] for i in range(len(v1))])

  # Calculate r (Pearson score)
  num=pSum-(sum1*sum2/len(v1))
  den=sqrt((sum1Sq-pow(sum1,2)/len(v1))*(sum2Sq-pow(sum2,2)/len(v1)))
  if den==0: return 0

  return 1.0-num/den

class bicluster:
  def __init__(self,vec,left=None,right=None,distance=0.0,id=None):
    self.left=left
    self.right=right
    self.vec=vec
    self.id=id
    self.distance=distance

def hcluster(rows,distance=pearson):
  distances={}
  currentclustid=-1

  # Clusters are initially just the rows
  clust=[bicluster(rows[i],id=i) for i in range(len(rows))]

  while len(clust)>1:
    lowestpair=(0,1)
    closest=distance(clust[0].vec,clust[1].vec)

    # loop through every pair looking for the smallest distance
    for i in range(len(clust)):
      for j in range(i+1,len(clust)):
        # distances is the cache of distance calculations
        if (clust[i].id,clust[j].id) not in distances:
          distances[(clust[i].id,clust[j].id)]=distance(clust[i].vec,clust[j].vec)

        d=distances[(clust[i].id,clust[j].id)]

        if d<closest:
          closest=d
          lowestpair=(i,j)

    # calculate the average of the two clusters
    mergevec=[
    (clust[lowestpair[0]].vec[i]+clust[lowestpair[1]].vec[i])/2.0
    for i in range(len(clust[0].vec))]

```

```
    # create the new cluster
    newcluster=bicluster(mergevec,left=clust[lowestpair[0]],
                         right=clust[lowestpair[1]],
                         distance=closest,id=currentclustid)

    # cluster ids that weren't in the original set are negative
    currentclustid-=1
    del clust[lowestpair[1]]
    del clust[lowestpair[0]]
    clust.append(newcluster)

  return clust[0]

def printclust(clust,labels=None,n=0):
  # indent to make a hierarchy layout
  for i in range(n): print ' ',
  if clust.id<0:
    # negative id means that this is branch
    print '-'
  else:
    # positive id means that this is an endpoint
    if labels==None: print clust.id
    else: print labels[clust.id]

  # now print the right and left branches
  if clust.left!=None: printclust(clust.left,labels=labels,n=n+1)
  if clust.right!=None: printclust(clust.right,labels=labels,n=n+1)

def getheight(clust):
  # Is this an endpoint? Then the height is just 1
  if clust.left==None and clust.right==None: return 1

  # Otherwise the height is the same of the heights of
  # each branch
  return getheight(clust.left)+getheight(clust.right)

def getdepth(clust):
  # The distance of an endpoint is 0.0
  if clust.left==None and clust.right==None: return 0

  # The distance of a branch is the greater of its two sides
  # plus its own distance
  return max(getdepth(clust.left),getdepth(clust.right))+clust.distance


def drawdendrogram(clust,labels,jpeg='clusters.jpg'):
  # height and width
  h=getheight(clust)*20
  w=1200
  depth=getdepth(clust)

  # width is fixed, so scale distances accordingly
  scaling=float(w-150)/depth

  # Create a new image with a white background
  img=Image.new('RGB',(w,h),(255,255,255))
  draw=ImageDraw.Draw(img)

  draw.line((0,h/2,10,h/2),fill=(255,0,0))

  # Draw the first node
  drawnode(draw,clust,10,(h/2),scaling,labels)
  img.save(jpeg,'JPEG')

def drawnode(draw,clust,x,y,scaling,labels):
  if clust.id<0:
    h1=getheight(clust.left)*20
    h2=getheight(clust.right)*20
    top=y-(h1+h2)/2
    bottom=y+(h1+h2)/2
    # Line length
    ll=clust.distance*scaling
    # Vertical line from this cluster to children
    draw.line((x,top+h1/2,x,bottom-h2/2),fill=(255,0,0))

    # Horizontal line to left item
    draw.line((x,top+h1/2,x+ll,top+h1/2),fill=(255,0,0))
```

```
154
155     # Horizontal line to right item
156     draw.line((x,bottom-h2/2,x+ll,bottom-h2/2),fill=(255,0,0))
157
158     # Call the function to draw the left and right nodes
159     drawnode(draw,clust.left,x+ll,top+h1/2,scaling,labels)
160     drawnode(draw,clust.right,x+ll,bottom-h2/2,scaling,labels)
161   else:
162     # If this is an endpoint, draw the item label
163     draw.text((x+5,y-7),labels[clust.id],(0,0,0))
164
165 def rotatematrix(data):
166   newdata=[]
167   for i in range(len(data[0])):
168     newrow=[data[j][i] for j in range(len(data))]
169     newdata.append(newrow)
170   return newdata
171
172 import random
173
174 def kcluster(rows,distance=pearson,k=4):
175   # Determine the minimum and maximum values for each point
176   ranges=[(min([row[i] for row in rows]),max([row[i] for row in rows]))
177   for i in range(len(rows[0]))]
178
179   # Create k randomly placed centroids
180   clusters=[[random.random()*(ranges[i][1]-ranges[i][0])+ranges[i][0]
181   for i in range(len(rows[0]))] for j in range(k)]
182
183   lastmatches=None
184   for t in range(100):
185     print 'Iteration %d' % t
186     bestmatches=[[] for i in range(k)]
187
188     # Find which centroid is the closest for each row
189     for j in range(len(rows)):
190       row=rows[j]
191       bestmatch=0
192       for i in range(k):
193         d=distance(clusters[i],row)
194         if d<distance(clusters[bestmatch],row): bestmatch=i
195       bestmatches[bestmatch].append(j)
196
197     # If the results are the same as last time, this is complete
198     if bestmatches==lastmatches: break
199     lastmatches=bestmatches
200
201     # Move the centroids to the average of their members
202     for i in range(k):
203       avgs=[0.0]*len(rows[0])
204       if len(bestmatches[i])>0:
205         for rowid in bestmatches[i]:
206           for m in range(len(rows[rowid])):
207             avgs[m]+=rows[rowid][m]
208         for j in range(len(avgs)):
209           avgs[j]/=len(bestmatches[i])
210         clusters[i]=avgs
211
212   return bestmatches
213
214 def tanamoto(v1,v2):
215   c1,c2,shr=0,0,0
216
217   for i in range(len(v1)):
218     if v1[i]!=0: c1+=1 # in v1
219     if v2[i]!=0: c2+=1 # in v2
220     if v1[i]!=0 and v2[i]!=0: shr+=1 # in both
221
222   return 1.0-(float(shr)/(c1+c2-shr))
223
224 def scaledown(data,distance=pearson,rate=0.01):
225   n=len(data)
226
227   # The real distances between every pair of items
228   realdist=[[distance(data[i],data[j]) for j in range(n)]
229             for i in range(0,n)]
230
```

```
231   # Randomly initialize the starting points of the locations in 2D
232   loc=[[random.random(),random.random()] for i in range(n)]
233   fakedist=[[0.0 for j in range(n)] for i in range(n)]
234
235   lasterror=None
236   for m in range(0,1000):
237     # Find projected distances
238     for i in range(n):
239       for j in range(n):
240         fakedist[i][j]=sqrt(sum([pow(loc[i][x]-loc[j][x],2)
241                                  for x in range(len(loc[i]))]))
242
243     # Move points
244     grad=[[0.0,0.0] for i in range(n)]
245
246     totalerror=0
247     for k in range(n):
248       for j in range(n):
249         if j==k: continue
250         # The error is percent difference between the distances
251         if realdist[j][k] != 0:
252             errorterm=(fakedist[j][k]-realdist[j][k])/realdist[j][k]
253
254         # Each point needs to be moved away from or towards the other
255         # point in proportion to how much error it has
256         grad[k][0]+=((loc[k][0]-loc[j][0])/fakedist[j][k])*errorterm
257         grad[k][1]+=((loc[k][1]-loc[j][1])/fakedist[j][k])*errorterm
258
259         # Keep track of the total error
260         totalerror+=abs(errorterm)
261     print totalerror
262
263     # If the answer got worse by moving the points, we are done
264     if lasterror and lasterror<totalerror: break
265     lasterror=totalerror
266
267     # Move each of the points by the learning rate times the gradient
268     for k in range(n):
269       loc[k][0]-=rate*grad[k][0]
270       loc[k][1]-=rate*grad[k][1]
271
272   return loc
273
274 def draw2d(data,labels,jpeg='mds2d.jpg'):
275   img=Image.new('RGB',(2000,2000),(255,255,255))
276   draw=ImageDraw.Draw(img)
277   for i in range(len(data)):
278     x=(data[i][0]+0.5)*1000
279     y=(data[i][1]+0.5)*1000
280     draw.text((x,y),labels[i],(0,0,0))
281   img.save(jpeg,'JPEG')
282
283 import sys
284
285 if __name__ == '__main__':
286     blognames, words, data = readfile('q1/blogdata1.txt')
287     clust = hcluster(data)
288     with open('dendrogram.txt', 'w') as outfile:
289         stdout = sys.stdout
290         sys.stdout = outfile
291         printclust(clust, labels=blognames)
292         sys.stdout = stdout
293     drawdendrogram(clust, blognames, jpeg='blogclust.jpg')
294     print "Done with dendrograms"
295     print "K=5"
296     kclust=kcluster(data, k=5)
297     print "K=10"
298     kclust=kcluster(data, k=10)
299     print "K=20"
300     kclust=kcluster(data, k=20)
301     coords=scaledown(data)
302     draw2d(coords, blognames, jpeg='blogs2d.jpg')
```

Listing 27: clusters.py

```
4827.50419137
3357.0495173
3337.77451337
3329.39524222
3325.08734145
3323.50421842
3323.33337939
3324.2545901
```

Listing 28: scaledown output

7 References

[1] Internet Engineering Task Force (IETF). RFC-4287 The Atom Syndication Format. https://tools.ietf.org/html/rfc4287, 2005.

[2] Toby Segaran. *Programming Collective Intelligence*. O'Reilly, first edition, 2007.