
Python for Collective Intelligence
and Collaborative Filtering

What is Collective Intelligence?

“A shared or group intelligence that emerges from the collaboration and competition of many individuals”

-Wikipedia


stackoverflow
99 designs
python
Linux
YAHOO! ANSWERS

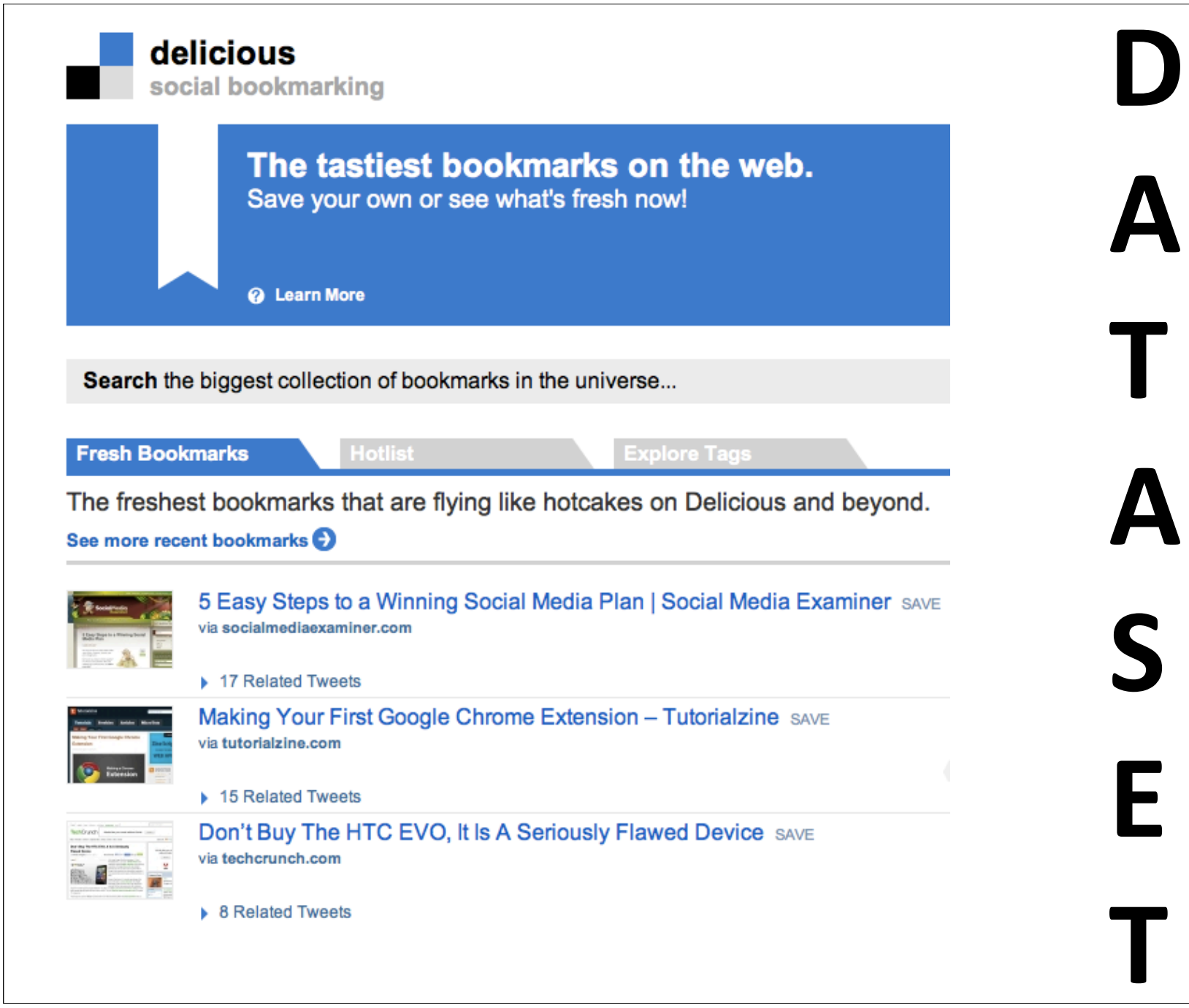
Collaborative Filtering

"The process of filtering for information or patterns using techniques involving collaboration among multiple agents, viewpoints, data sources, etc."
-Wikipedia

Implementation

Concepts

* DataSet
* User Ratings
*“Similarity Score”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DATASET

http://code.google.com/p/pydelicious/

Owners:
gregpin...@gmail.com,
berend.van.berkum

Committers:
nelson.minar, dfdeshom, alexcoppe,
aman.coe

```
from pydelicious import get_popular, get_userposts, get_urlposts
```

Delicious API

```
def initializeUserDict(tag,count=5):
  user_dict={}
  #get the top count popular posts
  for p1 in get_popular(tag=tag)[0:count]:
    #find all users who posted this
    for p2 in get_urlposts(p1['url']):
      user=p2['user']
      user_dict[user]={}
  return user_dict
```

Get list of recent posters

```
def fillItems(user_dict):
  all_items={}
  # Find links posted by all users
  for user in user_dict:
    for i in range(3):
      try:
        posts=get_userposts(user)
        break
      except:
        print "Failed user "+user+", retrying"
        tim.sleep(4)
    for post in posts:
      url=post['url']
      user_dict[user][url]=1.0
      all_items[url]=1
```

get recent items posted by recent posters

```
In [11]: pythonistas = initializeUserDict('python')

In [12]: pythonistas
Out[12]:
{u'3rdparty': {},
 u'AlexTreppass': {},
 u'BLConger': {},
 u'Chaseology': {},
 u'HiwayBK': {},
 u'Passy89': {},
 u'Pgawlik': {},
 u'antoni.aloy': {},
 u'asenchi': {},
 u'bandini': {},
 u'binary_core': {},
 u'catalinc': {},
 u'coffeebucket': {},
 u'contro': {},
 u'crowesesse': {},
 u'deduce': {},
 u'deltasig': {},
 u'eheder': {},
 u'ericbrothers': {},
 u'guatepapi': {},
 u'gwendoux': {},
 u'hergo': {},
```

User Ratings

```
def fillItems(user_dict):
  all_items={}
  # Find links posted by all users
  for user in user_dict:
    for i in range(3):
      try:
        posts=get_userposts(user)
        break
      except:
        print "Fialed user "+user+", retrying"
        time.sleep(4)
    for post in posts:
      url=post['url']
      user_dict[user][url]=1.0
      all_items[url]=1
```

User Ratings:
if user posted the link = 1
else = 0

```
In [16]: fillItems(pythonistas)

In [17]: pythonistas
Out[17]:
{u'3rdparty': {u'http://$http://blogs.msdn.com/jonbox/archive/2010/02/20/ie8-building-a-web-slice-does
               u'http://$http://blogs.msdn.com/jonbox/archive/2010/02/28/ie8-fundamentals-of-visual-se
               u'http://0xfe.blogspot.com/2010/05/music-notation-with-html5-canvas.html': 0.0,
               u'http://4sysops.com/archives/microsoft-vdi-resources/?utm_source=feedburner&utm_medium
               u'http://4sysops.com/archives/scan-your-website-for-malware-with-free-tools/?utm_source
               u'http://abcnews.go.com/print?id=3951187': 0.0,
               u'http://abovethelaw.com/2010/05/a-massachusetts-lawyer-you-dont-want-to-work-for-and-d
               u'http://activemq.apache.org/': 0.0,
               u'http://aencre.org/blog/2010/bol-directors-cut/': 0.0,
               u'http://aht.seriouseats.com/archives/2010/05/the-burger-lab-how-to-make-perfect-mcdond
               u'http://aja-aja.com/': 0.0,
               u'http://ajaxian.com/archives/the-vml-changes-in-ie-8': 0.0,
               u'http://alestic.com/2010/05/ec2-move-ebs-boot-instance?utm_source=feedburner&utm_mediu
               u'http://alexpogosyan.com/color-theme-creator/': 0.0,
               u'http://alicebob.cryptoland.net/closure-gotcha-with-python/': 0.0,
               u'http://alistrol.com/': 0.0,
               u'http://alt.pluralsight.com/wiki/default.aspx/Keith.GuideBook/HomePage.html': 0.0,
               u'http://anchor.com.au/hosting/dedicated/Tuning_PostgreSQL_on_your_Dedicated_Server': 0
               u'http://andyman3000.posterous.com/the-coke-zero-and-mentos-rocket-car-25': 0.0,
               u'http://answers.oreilly.com/topic/1463-create-3d-photographs-with-processing/': 0.0,
               u'http://apirocks.com/html5/html5.html#slide1': 0.0,
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               u'http://arstechnica.com/web/news/2009/12/commonjs-effort-sets-javascript-on-path-for-w
               u'http://arsvox.com/': 0.0,
               u'http://article.yeeyan.org/view/127113/109664': 0.0,
               u'http://article.yeeyan.org/view/135134/109783': 0.0,
               u'http://article.yeeyan.org/view/149012/109781': 0.0,
               u'http://article.yeeyan.org/view/151032/109762': 0.0,
```
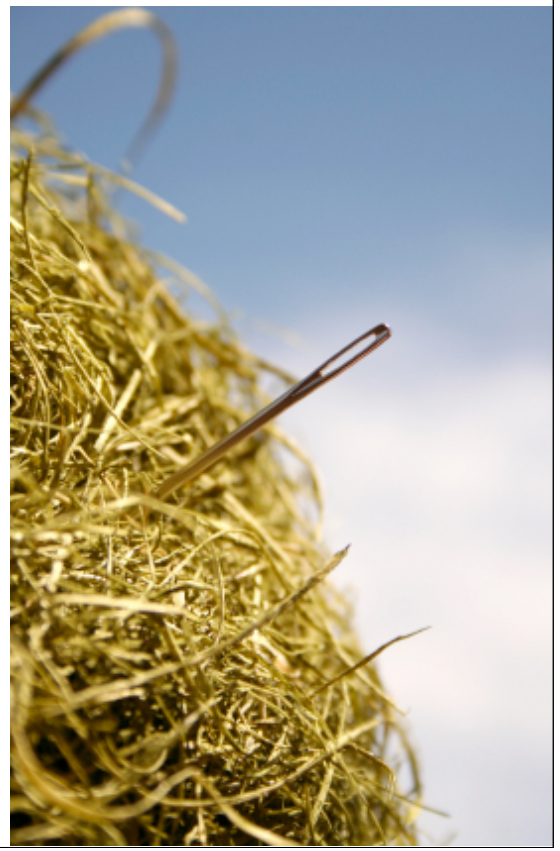
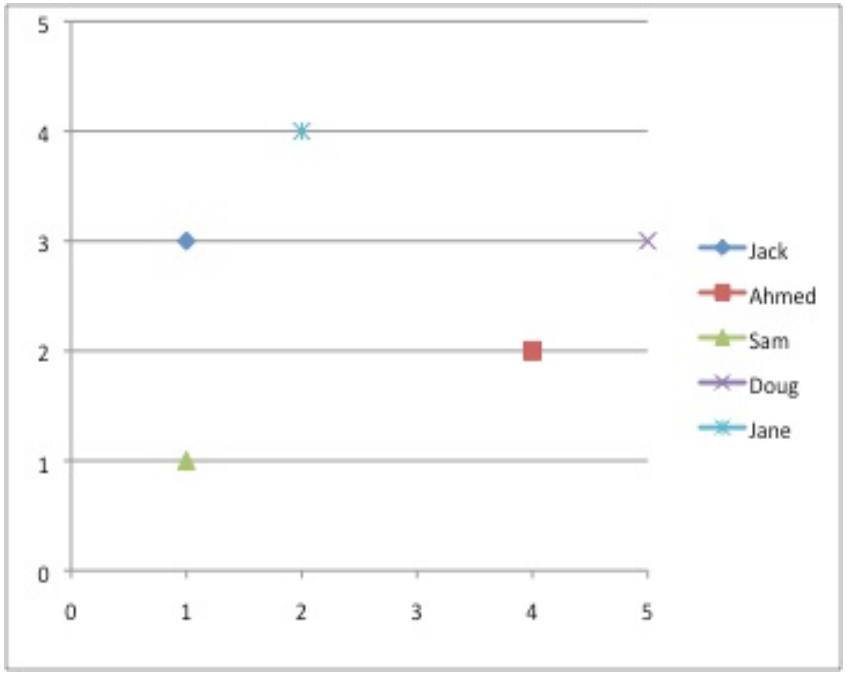

“Similarity Scores”

i.e.



Filtering Techniques

Euclidean Distance



“In mathematics the Euclidean distance or Euclidean metric is the "ordinary" distance between two points that one would measure with a ruler, and is given by the Pythagorean Formula.” -Wikipedia

the formula:

$$\mathrm{d}(\mathbf{p}, \mathbf{q}) = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2 + \cdots + (p_n - q_n)^2} = \sqrt{\sum_{i=1}^{n} (p_i - q_i)^2}.$$

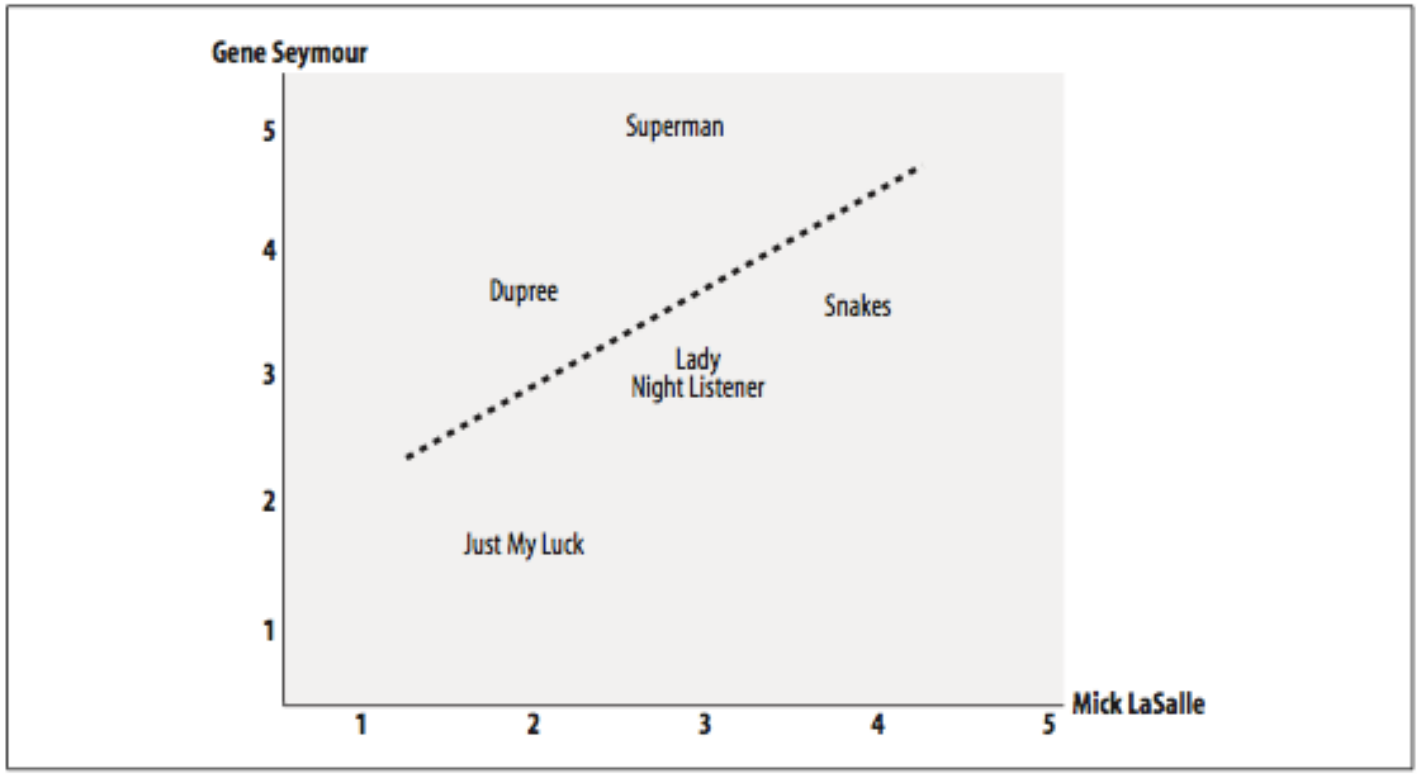
the code:

```
from math import sqrt
def euclidean_distance(prefs,p1,p2):
    '''Returns a distance-based similarity score for person1 and person2
    this is an example of the Euclidean distance formula for making recommendations
    between two people'''
    si={}
    for item in prefs[p1]:
        if item in prefs[p2]:
            si[item]=1

    #if they have no ratings in common, return 0
    if len(si)==0: return 0

    # Add up the squares of all the differences
    sum_of_squares=sum([pow(prefs[p1][item]-prefs[p2][item],2)
        for item in prefs[p1] if item in prefs[p2]])

    return 1/(1+sum_of_squares)
```

```
In [46]:
In [46]: euclidean_distance(pythonistas, '3rdparty','binary_core')
Out[46]: 0.032258064516129031
```

```
In [53]: for item in pythonistas :
   ....:     euclidean_distance(pythonistas, 'binary_core', item)
   ....:
Out[53]: 0.032258064516129031
Out[53]: 0.032258064516129031
Out[53]: 0.040000000000000001
Out[53]: 0.032258064516129031
Out[53]: 0.032258064516129031
Out[53]: 0.032258064516129031
Out[53]: 0.032258064516129031
Out[53]: 0.032258064516129031
Out[53]: 0.032258064516129031
Out[53]: 0.032258064516129031
Out[53]: 0.032258064516129031
Out[53]: 1.0
Out[53]: 0.032258064516129031
Out[53]: 0.03125
Out[53]: 0.034482758620689655
Out[53]: 0.028571428571428571
```

Pearson's Correlation Coefficient



For the case where users have similar preferences but user A consistently gives higher ratings than user B the Euclidian distance score will not produce accurate results. However the Pearson Correlation Coefficient will factor out that bias because it focuses on measuring the data's fit to a straight line. It will return a number between 1 and -1 with a value of 1 indicating two users have rated all items the same.

the formula: $P_{a,u} = \frac{\sum_{i=1}^{m} (r_{a,i} - \overline{r}_a) \times (r_{u,i} - \overline{r}_u)}{\sqrt{\sum_{i=1}^{m} (r_{a,i} - \overline{r}_a)^2 \times \sum_{i=1}^{m} (r_{u,i} - \overline{r}_u)^2}}$

the code:

```
def pearson_correlation(prefsMapping, p1, p2):
    '''returns the pearson Correlation Coefficient, which is a measure of how similar p1 and p2s
    to one another.  Value is between 1 and 0 with 1 meaning p1 and p2 have identical preferences
    itemRatings={}
    for item in prefsMapping[p1]:
        if item in prefsMapping[p2]: itemRatings[item]=1 #both parties rated the items

    n=len(itemRatings)
    if n==0: return 0

    # Add up all the preferences
    sum1=sum([prefsMapping[p1][it] for it in itemRatings])
    sum2=sum([prefsMapping[p2][it] for it in itemRatings])
    #sum up the squares
    sum1Sq=sum([pow(prefsMapping[p1][it],2) for it in itemRatings])
    sum2Sq=sum([pow(prefsMapping[p2][it],2) for it in itemRatings])
    #sum up the products
    pSum=sum([prefsMapping[p1][it]*prefsMapping[p2][it] for it in itemRatings])
    #Calculate Pearson score
    num=pSum-(sum1*sum2/n)
    den=sqrt((sum1Sq-pow(sum1,2)/n)*(sum2Sq-pow(sum2,2)/n))
    if den==0: return 0

    r=num/den
    return r
```

```
In [58]: pearson_correlation(pythonistas, '3rdparty', 'binary_core')
Out[58]: -0.015822784810126583

In [59]: for item in pythonistas :
   ....:     pearson_correlation(pythonistas, 'binary_core', item)
   ....:
Out[59]: -0.015822784810126583
Out[59]: -0.015822784810126583
Out[59]: -0.015822784810126583
Out[59]: -0.015822784810126583
Out[59]: -0.015822784810126583
Out[59]: -0.015822784810126583
Out[59]: -0.015822784810126583
Out[59]: -0.015822784810126583
Out[59]: 1.0
Out[59]: -0.015822784810126583
Out[59]: -0.016350327748670335
Out[59]: 0.051898734177215189
```

Which Similarity Metric to Use?

- For del.ici.ous the user ranking score is only 1 or 0
- Euclidean is the most straight forward
- Pearson's Correlation is perhaps better for 1 to 10 user rankings
- There are also many others:
  - Tanimoto Coefficient
  - Manhattan Distance

Choose Similar People

```
def findPeopleWithSimilarInterests(prefs, subject, scoringAlgorithm=euclidean_distance, numResults=5):
    '''call the scoring Algorighm for everybody in the prefs dataset and compare
    that person to subject.  The return the dataset ordered by similarity to subject'''

    scores=[(scoringAlgorithm(prefs,subject,otherPerson),otherPerson)
            for otherPerson in prefs if otherPerson != subject]

    #sort by similarity with most similar on top
    scores.sort()
    scores.reverse()
    return scores[0:numResults]
```

Euclidean Distance

```
In [69]: from recommendations import findPeopleWithSimilarInterests

In [70]: findPeopleWithSimilarInterests(pythonistas, 'j1z0')
Out[70]:
[(0.14285714285714285, u'lixipeng'),
 (0.0625, u'sixh'),
 (0.052631578947368418, u'zecharia'),
 (0.052631578947368418, u'zbskii'),
 (0.052631578947368418, u'virkang')]
```

Pearson's Correlation

```
In [71]: findPeopleWithSimilarInterests(pythonistas, 'j1z0', scoringAlgorithm=pearson_correlation)
Out[71]:
[(-0.0031120331950207471, u'lixipeng'),
 (-0.0062533256777233589, u'sixh'),
 (-0.0070024378952024437, u'zecharia'),
 (-0.0070024378952024437, u'zbskii'),
 (-0.0070024378952024437, u'virkang')]
```


Making Recommendations
Use similarity score
or better yet
use weighted rankings

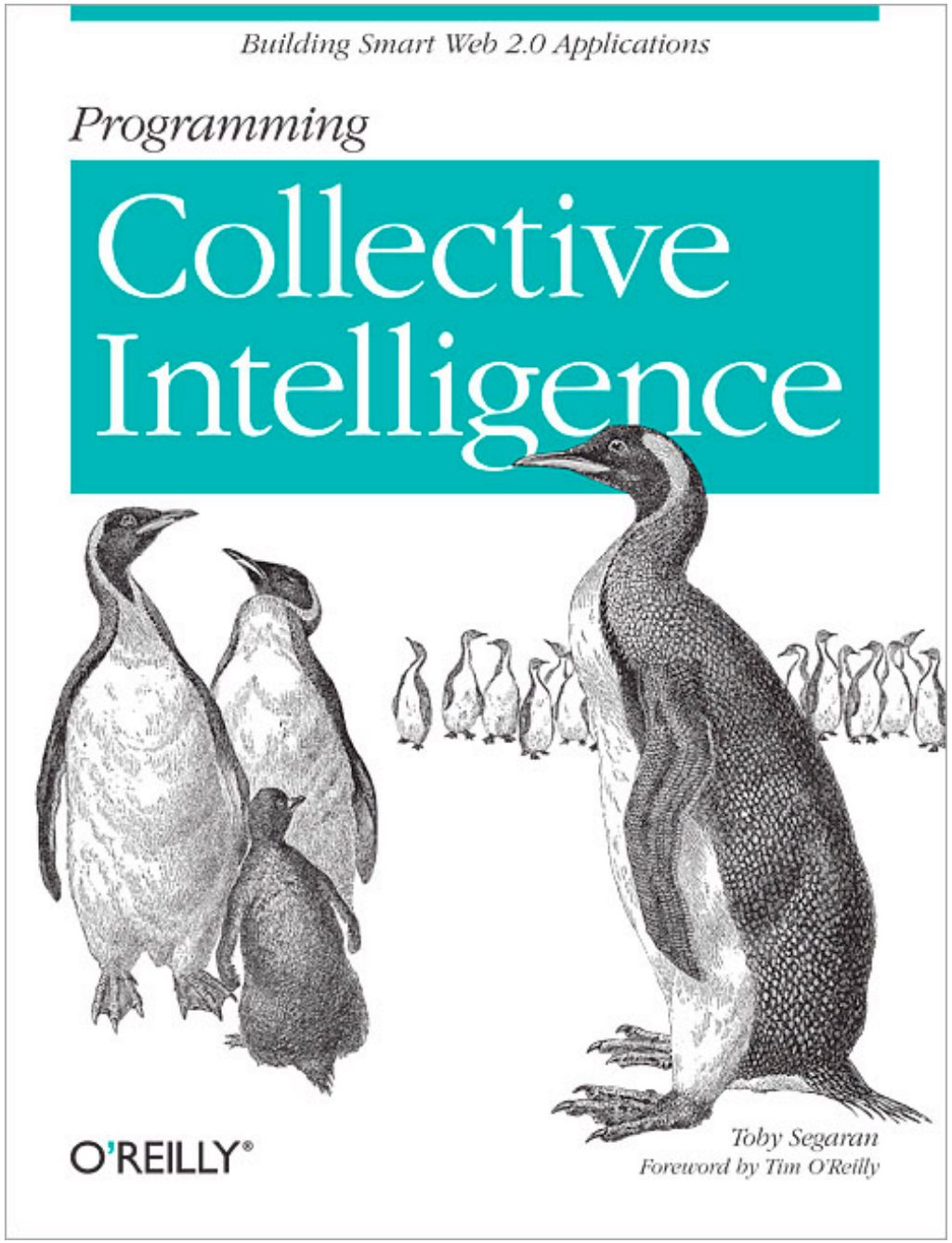
Recommendations = similarity score * user rankings

```
def getRecommendations(prefs, subject, scoringAlgorithm=euclidean_distance):
    #could use defaultdict(int) here
    totals={}
    weights={}
    for otherPerson in prefs:
        if otherPerson==subject: continue
        score=scoringAlgorithm(prefs,subject,otherPerson)
        #ignore zero scores
        if score<=0: continue
        for item in prefs[otherPerson]:
            #only score items I haven't rated (i.e. not viewed)
            if item not in prefs[subject] or prefs[subject][item] == 0:
                #store the weighted score for the item in totals
                totals.setdefault(item,0)
                totals[item]+=prefs[otherPerson][item]*score
                weights.setdefault(item,0)
                weights[item]+=score

    #take the average weights so popular sites are rated higher
    rankings=[(total/weights[item],item) for item,total in totals.items()]

    #return sorted list
    rankings.sort()
    rankings.reverse()
    return rankings
```

```
In [72]: getRecommendations(pythonistas,'j1z0')[:5]
Out[72]:
[(0.15574531950510848, u'http://stackp.online.fr/?p=28'),
 (0.11236420311327462,
  u'http://pythonconquerstheuniverse.wordpress.com/2009/09/10/debugging-in-python/'),
 (0.10972272998402947, u'https://wiki.ubuntu.com/Xpresser'),
 (0.07307229031575296 4,
  u'http://tech.blog.aknin.name/2010/05/19/guidos-python-objects-102/'),
 (0.07040541840641891, u'http://cb.vu/unixtoolbox.xhtml')]
```

End to End Code

```
#build delicious dataset
pythonistas = initializeUserDict('python')
#fill data set with user rankings
fillItems(pythonistas)
#find other people with the same interests as you
findPeopleWithSimilarInterests(pythonistas, 'j1z0', scoringAlgorithm=euclidean_distance)
#get a list of recommended links
getRecommendations(pythonistas, 'j1z0')[:10]
```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Foreword by Tim O'Reilly

Thanks Toby


Q & A


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