Using Matlab for LSA

Introduction to Information Retrieval
INF 141/ CS 121

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Learning Objective

"Be able to use MATLAB to conduct LSI analysis on your own data"

What is MATLAB?

- A numerical computing environment
- An interpreter for a specialized programming language
- Many libraries for complex mathematical operations
- Support for:
  - Matrix Operations
  - Graphing
  - User Interfaces
- Great for rapid prototyping complex algorithms
- Cross -platform

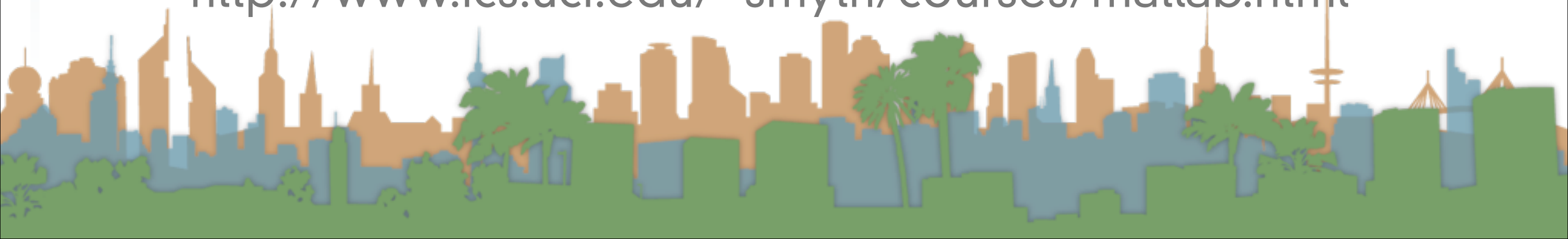
What MATLAB isn't

- A production ready commercial software development tool
- Free
- Open-source

Where is MATLAB at UCI?

- CS 364 Lab - about 30 machines with one machine licenses
- NACS PC Labs - “mpc cluster”
- Remote access through openlab if you buy a license and tell ICS support.
- Student edition is about $100.00
- Open-source alternative called “octave” is available.

http://www.ics.uci.edu/~smyth/courses/matlab.html



Demo

- 6 documents
  - Wikipedia entry for “baseball bat”
  - Wikipedia entry for “bat”
  - Wikipedia entry for “coffee”
  - Wikipedia entry for “starbucks”
  - Starbucks’ home page
  - First page of a recent publication of mine

Demo

- I pulled out 14 words
  - BALL
  - BASEBALL
  - BAT
  - CALIFORNIA
  - COFFEE
  - COMPANY
  - ENCYCLOPEDIA
  - IRVINE
  - RUN
  - SPECIES
  - STARBUCKS
  - STORES
  - UNIVERSITY
  - USERS

Demo

- Create a fake TFIDF matrix with a strong concept
- Plot the matrix on a two term axis
- Perform SVD decomposition
- Plot the new axes
- Reduce the dimensionality of SVD
- Plot the new axes

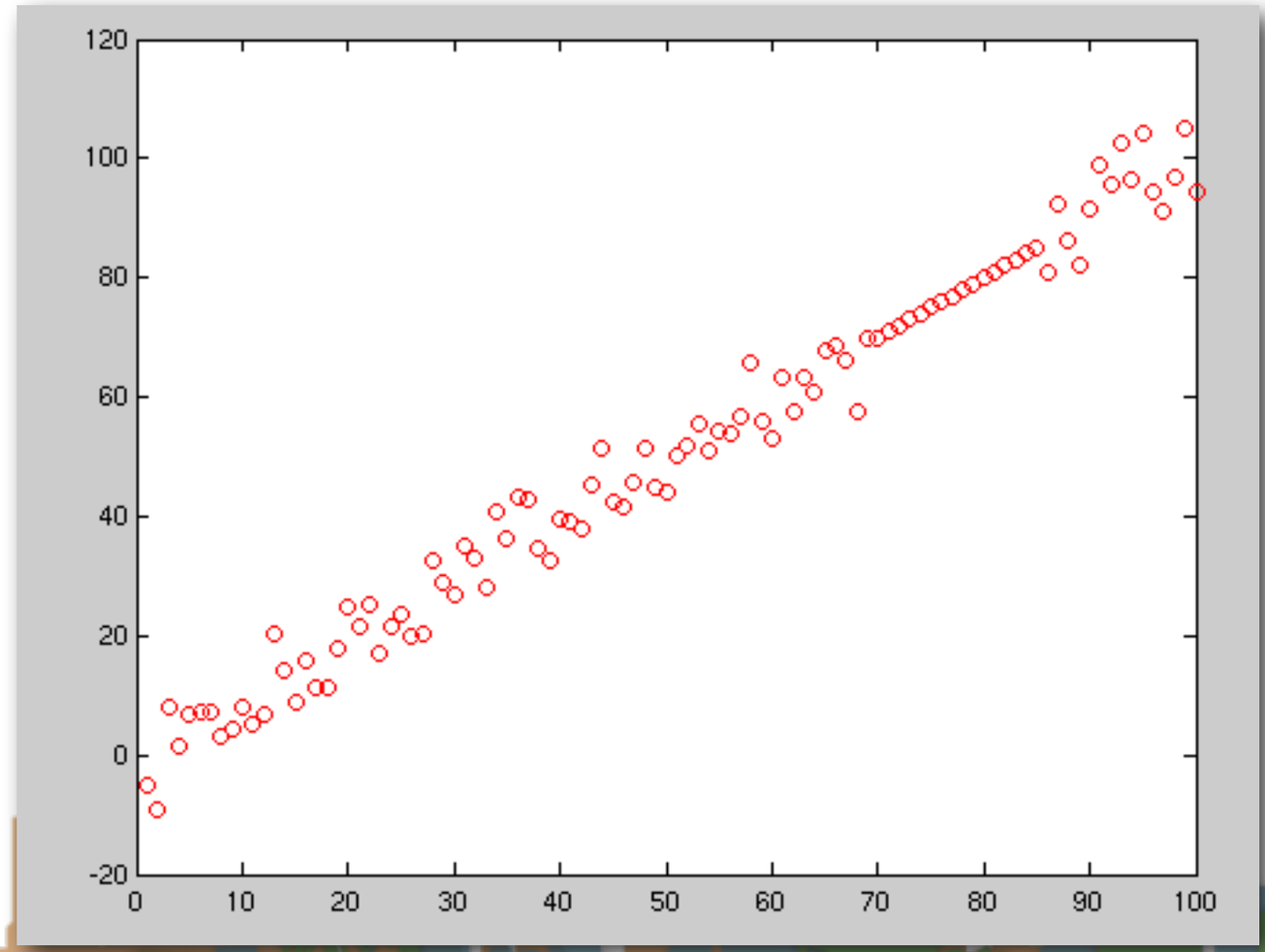
Visualizing LSA

Demo

- Create a fake TFIDF matrix with a strong concept
- Plot the matrix on a two term axis

```
>> x = [1:100];
>> y = random('norm',0,5,1,100);
>> y = x +y;
>> y(70:85) = [70:85];
>> plot(x,y,'ro')
```

```
>> size(x)

ans =

     1   100

>> size(y)

ans =

     1   100
```



Visualizing LSA

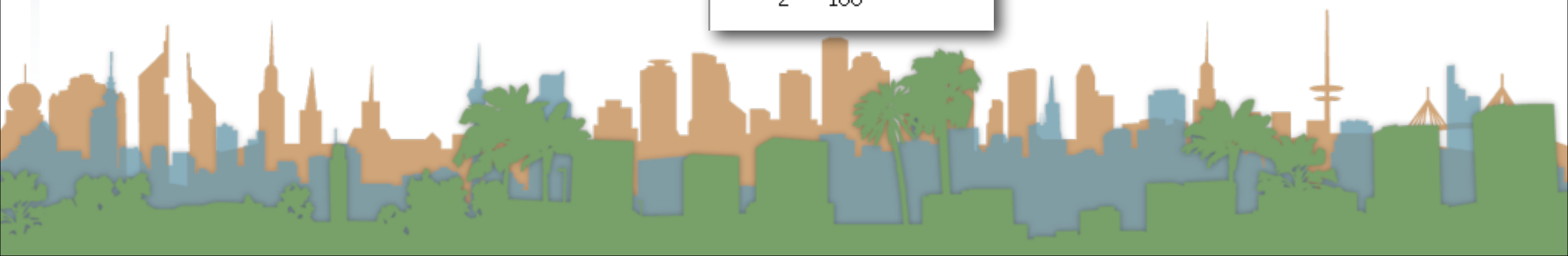
Demo

- Perform SVD decomposition

```
>> C = [x;y];
>> size(C)

ans =

     2   100

>> [U S V ] = svd(C);
>> size(U)

ans =

     2     2
```

```
>> size(S)

ans =

     2   100

>> S(1:2,1:2)

ans =

  822.6330         0
         0   30.2548

>> size(V)

ans =

   100   100
```

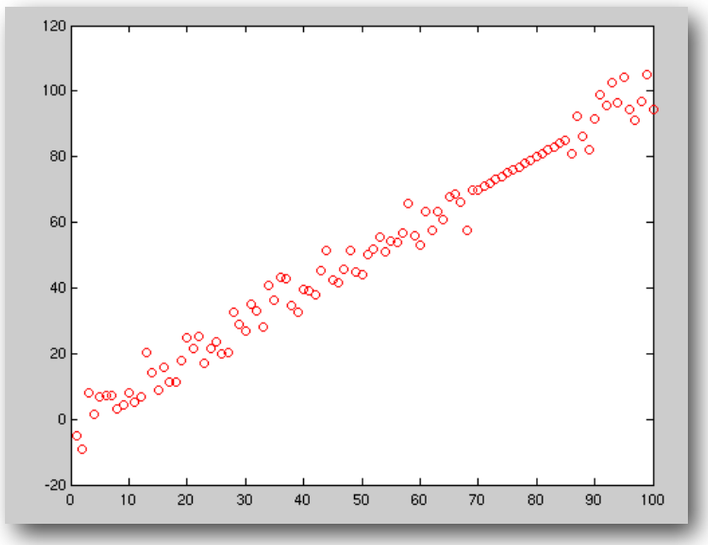
```
>> Sk=S(1:2,1:2);
>> Uk=U(:,1:2);
>> M = inv(Sk)*Uk';
>> Cc = M*C;
>> size(Uk)

ans =

     2     2

>> size(M)

ans =

     2     2

>> size(Cc)

ans =

     2   100
```

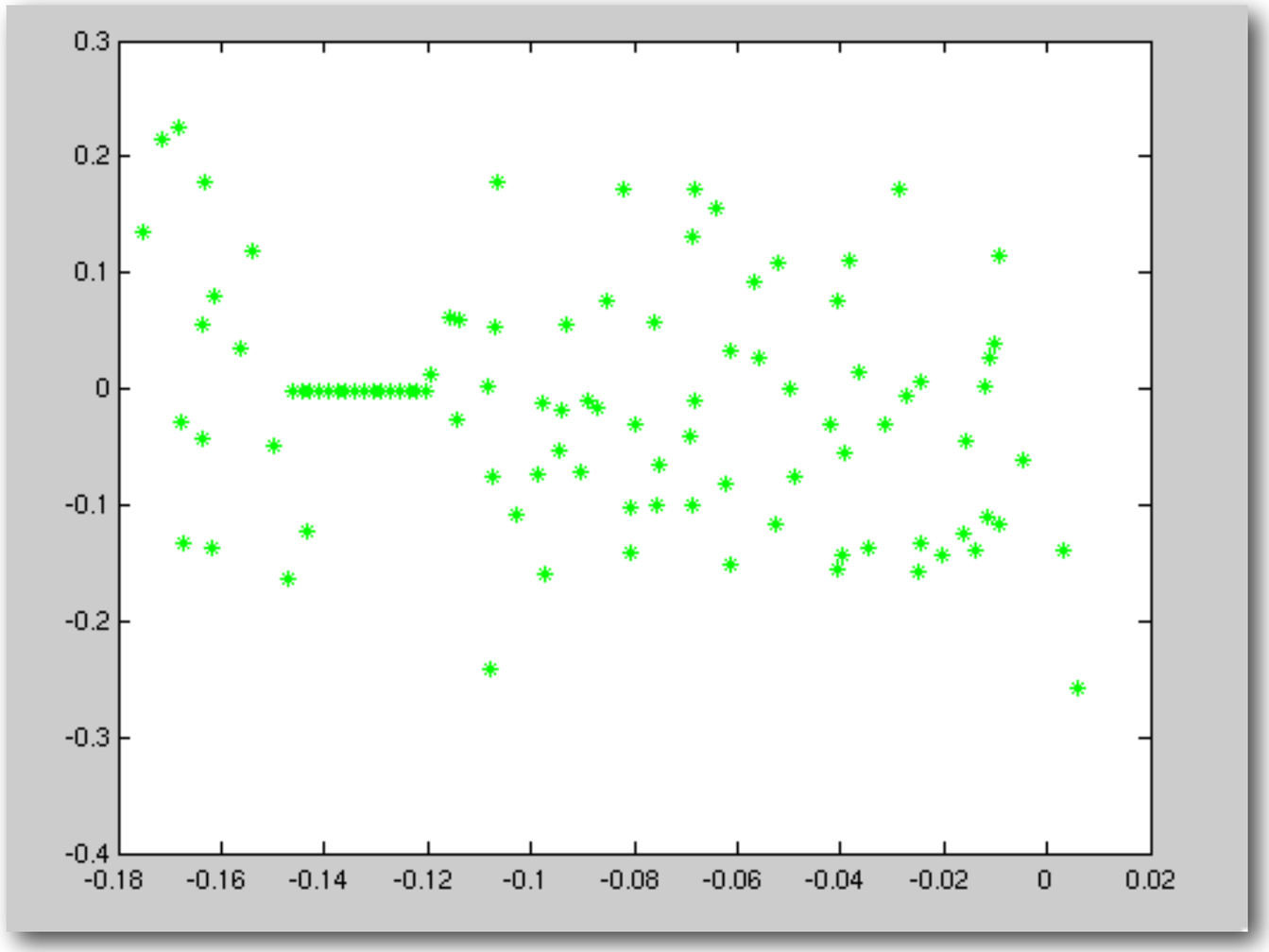


Demo

- Plot the new axes

```
>> plot(Cc(1,:),Cc(2,:),'g*')
```





Demo

- Calculate the TFIDF score
- Plot the documents on a two term axis
- Perform SVD decomposition
  - Validate decomposition
- Reduce rank of system
- Show “M”
  - Demonstrate what SVD is capturing
- Execute a query

Using MATLAB For LSA

Demo

- Calculate the TFIDF score

tf =

	wiki: baseballBat	wiki: bat	wiki: coffee	djp3 paper	starbucks	wiki:starbucks
ball	6	0	0	0	0	0
baseball	10	0	0	0	0	0
bat	24	5	0	0	0	0
California	0	0	0	6	0	0
coffee	0	0	21	0	0	10
company	0	0	0	0	0	8
encyclopedia	1	1	1	0	0	1
Irvine	0	0	0	6	0	0
run	5	0	0	0	0	0
species	0	3	2	0	0	0
starbucks	0	0	0	0	4	14
stores	0	0	0	0	0	7
university	0	0	0	6	0	0
users	0	0	0	5	0	0

df =

1
1
2
1
2
1
4
1
1
2
2
1
1
1

Demo

- Calculate the TFIDF score

```
>> !more computeTFIDF.m
c = 6;
tf =load('tf.txt','-ASCII');
df = load('df.txt','-ASCII');
tfidf = zeros(size(tf));

for i =1:size(tf,1)
for j = 1:size(tf,2)
if tf(i,j) == 0
        tfidf(i,j) = (0) * log2(c/df(i));
else
        tfidf(i,j) = (1+log2(tf(i,j))) * log2(c/df(i));
end
end
end
```

Using MATLAB For LSA

Demo

- Calculate the TFIDF score

	wiki: baseball Bat	wiki: bat	wiki: coffee	djp3 paper	starbucks	wiki:starbucks
ball	9.2670	0	0	0	0	0
baseball	11.1720	0	0	0	0	0
bat	8.8520	5.2651	0	0	0	0
California	0	0	0	9.2670	0	0
coffee	0	0	8.5466	0	0	6.8501
company	0	0	0	0	0	10.3399
encyclopedia	0.5850	0.5850	0.5850	0	0	0.5850
Irvine	0	0	0	9.2670	0	0
run	8.5871	0	0	0	0	0
species	0	4.0971	3.1699	0	0	0
starbucks	0	0	0	0	4.7549	7.6195
stores	0	0	0	0	0	9.8419
university	0	0	0	9.2670	0	0
users	0	0	0	8.5871	0	0

Using MATLAB For LSA

Demo

- Perform SVD decomposition
  - Validate decomposition

```
>> [U S V] = svd(tfidf);
>> size(U)

ans =

    14    14

>> size(S)

ans =

    14     6

>> size(V)

ans =

     6     6

>>
```

```
>> U*S*V'

ans =

    9.2670   -0.0000    0.0000    0.0000    0.0000   -0.0000
   11.1720   -0.0000    0.0000    0.0000    0.0000    0.0000
    8.8520    5.2651   -0.0000   -0.0000   -0.0000   -0.0000
   -0.0000    0.0000    0.0000    9.2670   -0.0000   -0.0000
    0.0000   -0.0000    8.5466   -0.0000    0.0000    6.8501
    0.0000   -0.0000   -0.0000   -0.0000    0.0000   10.3399
    0.5850    0.5850    0.5850   -0.0000    0.0000    0.5850
   -0.0000    0.0000    0.0000    9.2670   -0.0000   -0.0000
    8.5871   -0.0000    0.0000    0.0000    0.0000    0.0000
   -0.0000    4.0971    3.1699    0.0000    0.0000   -0.0000
    0.0000   -0.0000   -0.0000    0.0000    4.7549    7.6195
    0.0000   -0.0000   -0.0000   -0.0000    0.0000    9.8419
   -0.0000    0.0000    0.0000    9.2670   -0.0000   -0.0000
   -0.0000    0.0000    0.0000    8.5871   -0.0000   -0.0000
```

Using MATLAB For LSA

Demo

- Reduce rank of system

```
>> Sk = S(1:3,1:3)

Sk =

   19.2339         0         0
         0   18.2035         0
         0         0   18.1004

>> Uk = U(:,1:3)

Uk =

   -0.4767   -0.0000    0.0116
   -0.5747   -0.0000    0.0140
   -0.4946    0.0000    0.0086
    0.0000   -0.5091    0.0000
   -0.0119    0.0000   -0.4755
   -0.0102    0.0000   -0.5514
   -0.0354    0.0000   -0.0383
    0.0000   -0.5091    0.0000
   -0.4417   -0.0000    0.0107
   -0.0325   -0.0000   -0.0427
   -0.0080   -0.0000   -0.4365
   -0.0097    0.0000   -0.5249
    0.0000   -0.5091    0.0000
    0.0000   -0.4717    0.0000
```

Using MATLAB For LSA

Demo

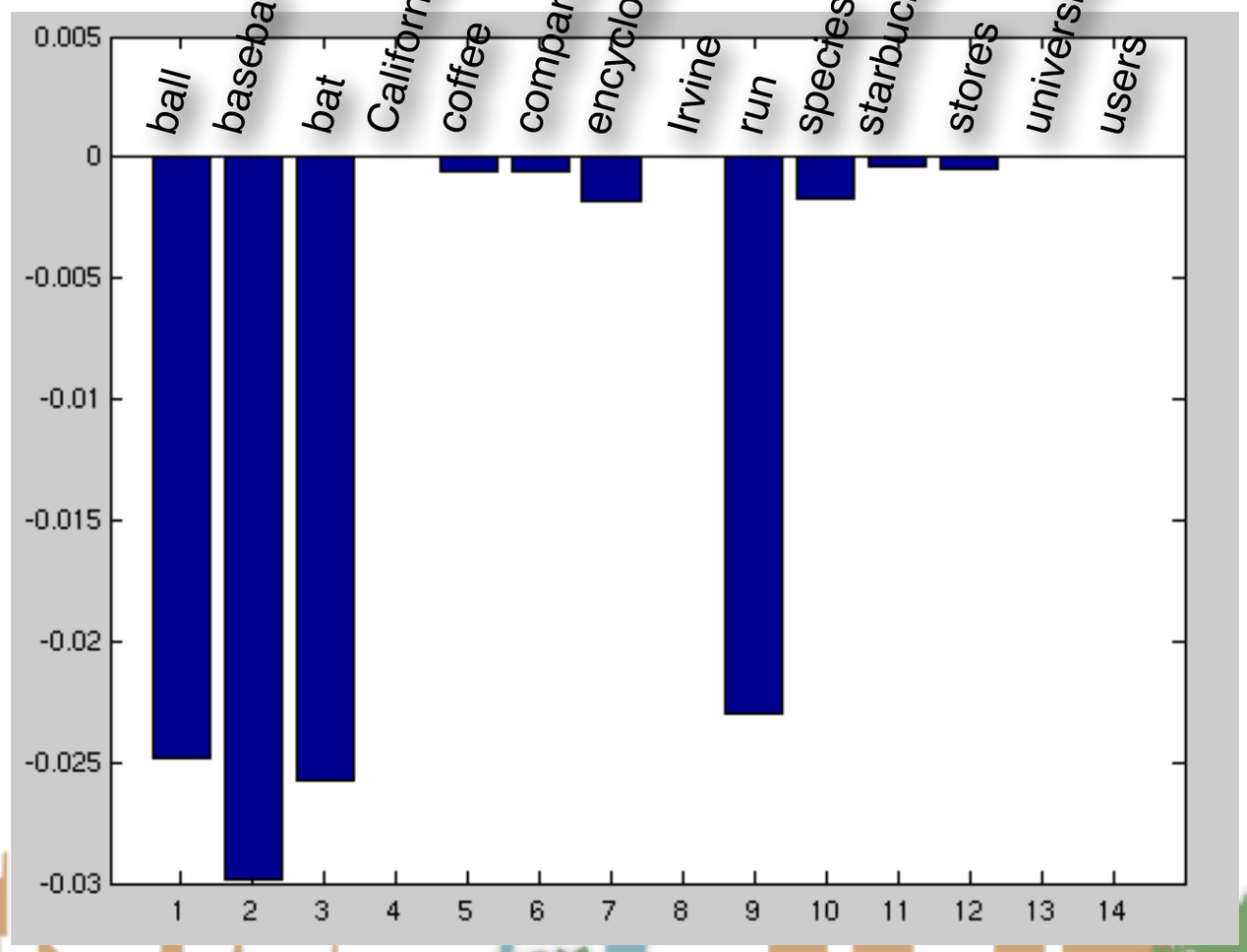
- Show “M”

```
>> M = inv(Sk)*Uk'

M =

  Columns 1 through 10

   -0.0248   -0.0299   -0.0257    0.0000   -0.0006   -0.0005   -0.0018    0.0000   -0.0230   -0.0017
   -0.0000   -0.0000    0.0000   -0.0280    0.0000    0.0000    0.0000   -0.0280   -0.0000   -0.0000
    0.0006    0.0008    0.0005    0.0000   -0.0263   -0.0305   -0.0021    0.0000    0.0006   -0.0024

  Columns 11 through 14

   -0.0004   -0.0005    0.0000    0.0000
   -0.0000    0.0000   -0.0280   -0.0259
   -0.0241   -0.0290    0.0000    0.0000
```

First concept is selecting for wikipedia?

Demo

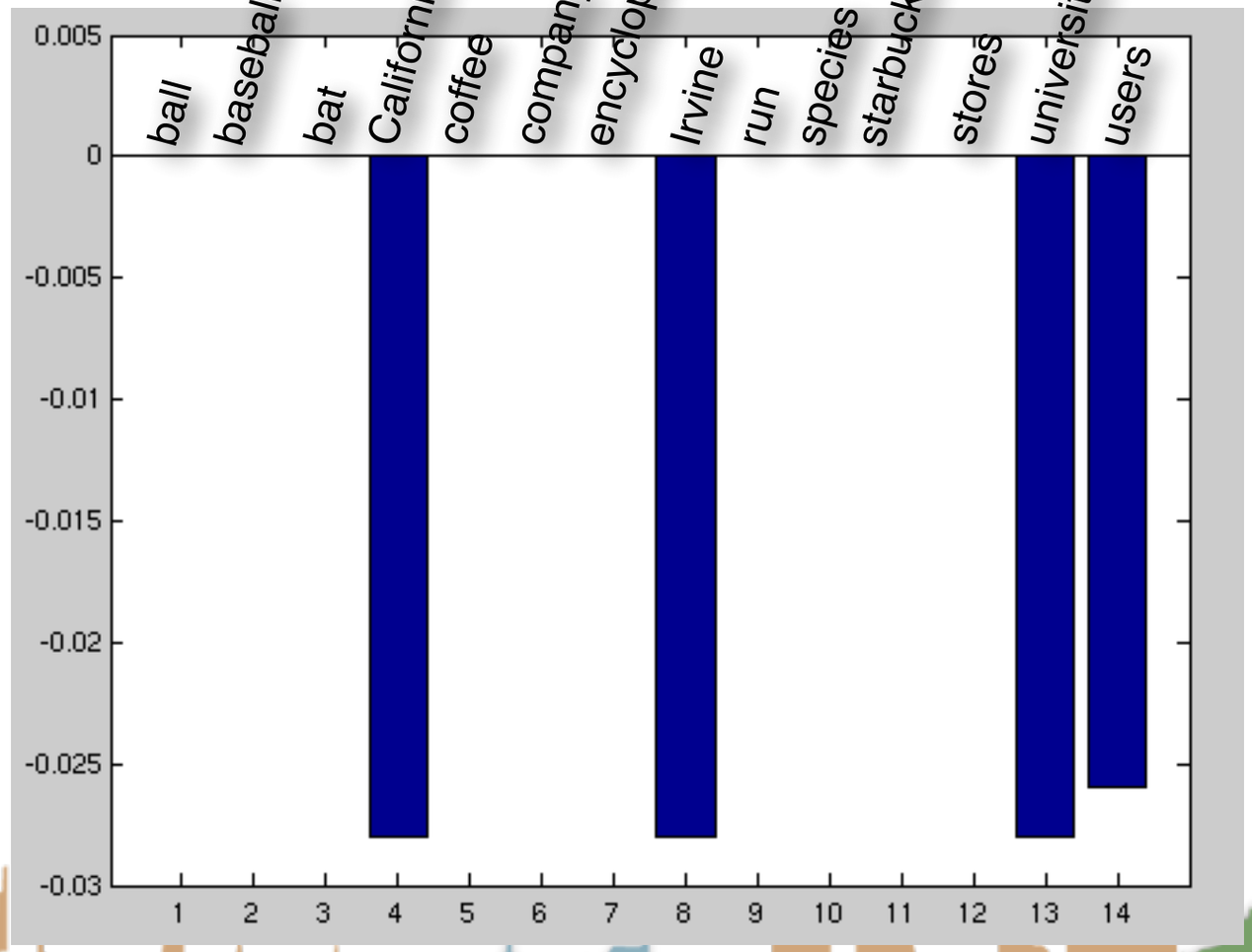
- Demonstrate what SVD is capturing
  - 1st concept (1st row of M)



First concept is selecting for baseball?

Demo

- Demonstrate what SVD is capturing
  - 2nd concept (2nd row of M)



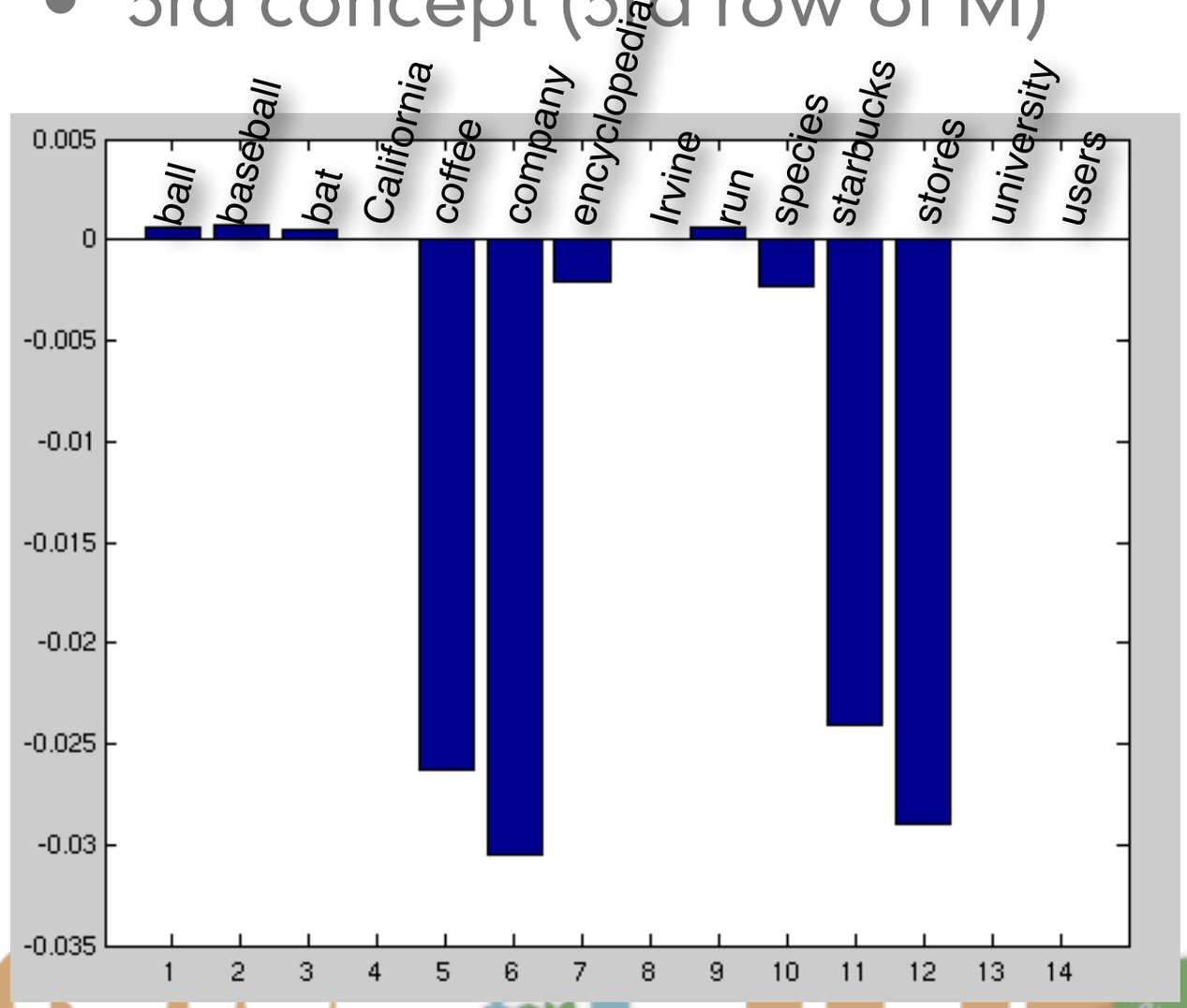
First concept is selecting for wikipedia?

Second concept is selecting for UCI?

First concept is selecting for wikipedia?

Demo

- Demonstrate what SVD is capturing
  - 3rd concept (3rd row of M)



Third concept is selecting for coffee?

Using MATLAB For LSA

Demo

- Execute a query “coffee stores”

ball baseball bat California coffee company encyclopedia Irvine run species starbucks stores university users

```
>> q=[ 0 0 0 0 (1+log2(1))*log2(c/df(5)) 0 0 0 0 0 0 (1+log(1))*log2(c/df(12)) 0 0]

q =

  Columns 1 through 10

         0         0         0         0    1.5850         0         0         0         0         0

  Columns 11 through 14

         0    2.5850         0         0

>> qc=M*q'

qc =

   -0.0023
    0.0000
   -0.1166
```

Using MATLAB For LSA

Demo

- Execute a query

$$sim(q, d_i) = \frac{\vec{V}(q) \cdot \vec{V}(d_i)}{|\vec{V}(q)||\vec{V}(d_i)|}$$

```
>> Cc = inv(Sk)*Uk'*tfidf

Cc =

   -0.9894   -0.1434   -0.0117    0.0000   -0.0020   -0.0189
    0.0000    0.0000    0.0000   -1.0000   -0.0000   -0.0000
    0.0227   -0.0084   -0.2332    0.0000   -0.1147   -0.9653

>> sim = qc'*Cc;
>> sim = sim ./ [norm(Cc(:,1)) norm(Cc(:,2)) norm(Cc(:,3)) norm(Cc(:,4)) norm(Cc(:,5)) norm(Cc(:,6))]

sim =

   -0.0004    0.0091    0.1166   -0.0000    0.1166    0.1166
```

wiki: baseballBat

wiki: bat

wiki: coffee

djp3 paper

starbucks

wiki:starbucks

Demo

- Execute a query “coffee stores”
  - Answer:
    - starbucks (0.1166)
    - wiki:starbucks(0.1166)
    - wiki:coffee (0.1166)
    - wiki:bat (0.0091)
    - djp3 paper (0.0)
    - wiki:baseballBat (-0.0004)

Using MATLAB For LSA

Demo

- Execute a query “baseball bat”

```
>> q=[(1+log2(1))*log2(c/df(1)) (1+log2(1))*log2(c/df(2)) 0 0 0 0 0 0 0 0 0 0 0 0]

q =

  Columns 1 through 10

    2.5850    2.5850         0         0         0         0         0         0         0         0

  Columns 11 through 14

         0         0         0         0

>> qc=M*q'

qc =

   -0.1413
   -0.0000
    0.0037
```

ball baseball bat California coffee company encyclopedia Irvine run species starbucks stores university users

Using MATLAB For LSA

Demo

- Execute a query

$$sim(q, d_i) = \frac{\vec{V}(q) \cdot \vec{V}(d_i)}{|\vec{V}(q)||\vec{V}(d_i)|}$$

```
>> Cc = inv(Sk)*Uk'*tfidf

Cc =

   -0.9894   -0.1434   -0.0117    0.0000   -0.0020   -0.0189
    0.0000    0.0000    0.0000   -1.0000   -0.0000   -0.0000
    0.0227   -0.0084   -0.2332    0.0000   -0.1147   -0.9653

>> sim = qc'*Cc;
>> sim = sim ./ [norm(Cc(:,1)) norm(Cc(:,2)) norm(Cc(:,3)) norm(Cc(:,4)) norm(Cc(:,5)) norm(Cc(:,6))]

sim =

    0.1414    0.1408    0.0035    0.0000   -0.0012   -0.0009
```

wiki: baseballBat

wiki: bat

wiki: coffee

djp3 paper

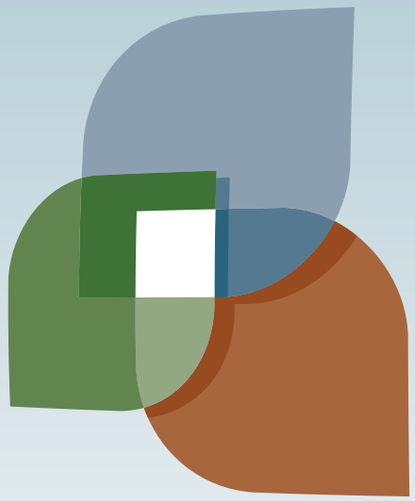
starbucks

wiki:starbucks

Using MATLAB For LSA

Demo

- Execute a query “baseball bat”
  - Answer:
    - wiki:baseballBat (0.1414)
    - wiki:bat (0.1408)
    - wiki:coffee (0.0035)
    - djp3 paper (0.000)
    - wiki:starbucks (-0.0009)
    - starbucks (-0.0012)



LUCI