L19. Two-Dimensional Arrays

Set-Up

Rows and Columns

Subscripting

Operations

Examples

Simple Set-Up Examples

```
>> A = [1 2 3; 4 5 6]
A =
     1     2     3
     4     5     6
```

Simple Set-Up Examples

```
>> A = zeros(3,4)
A =
     0     0     0     0
     0     0     0     0
     0     0     0     0
```

Simple Set-Up Examples

```
>> A = floor(100*rand(5,5))
A =
     95     76     61     40      5
     23     45     79     93     35
     60      1     92     91     81
     48     82     73     41      0
     89     44     17     89     13
```

Simple Set-Up Examples

```
>> A = [zeros(3,2) [1;2;3]]
A =
     0     0     1
     0     0     2
     0     0     3
```

Simple Set-Up Examples

```
>> A = [zeros(3,2) ; [1 2] ]
A =
     0     0
     0     0
     0     0
     1     2
```

Rows and Columns

A:

12	17	49	61
38	18	82	77
83	53	12	10

row 1
row 2
row 3

col 1 col 2 col 3 col 4

A is a 3-by-4 array: 3 rows 4 columns.

Subscripting

A:

12	17	49	61
38	18	82	77
83	53	12	10

Individual entries: **A(3,2)**

Subscripting

A:

12	17	49	61
38	18	82	77
83	53	12	10

An Entire Row: `A(2,:)`

Scaling a Row

A:

12	17	49	61
1	2	3	4
83	53	12	10

Before

A:

12	17	49	61
10	20	30	40
83	53	12	10

After

```
A(2,:) = 10*A(2,:)
```

Subscripting

A:

12	17	49	61
38	18	82	77
83	53	12	10

An Entire Column: `A(:,3)`

Incrementing the Values in a Column

A:

12	17	49	61
38	18	82	77
83	53	12	10

Before

A:

12	17	50	61
38	18	83	77
83	53	13	10

After

```
A(:,3) = A(:,3) + 1
```

Subscripting

A:

12	17	49	61
38	18	82	77
83	53	12	10

A General Subarray: **A(2:3,3:4)**

Zeroing a Subarray

A:

12	17	49	61
38	18	82	77
83	53	12	10

Before

A:

12	17	49	61
38	18	0	0
83	53	0	0

After

```
A(2:3,3:4) = zeros(2,2)
```

Classical Double Loop Set-Up

A:

11	21	31	41
12	22	32	42
13	23	33	43

```
for i=1:3
    for j=1:4
        A(i,j) = 10*j + i;
    end
end
```

Set-Up By Row

A:

11	21	31	41
12	22	32	42
13	23	33	43

```
A = [];
for i=1:3
    v = [10 20 30 40] + i;
    A = [A ; v]
end
```

Set-Up By Column

A:

11	21	31	41
12	22	32	42
13	23	33	43

```
A = [];
for j=1:4
    v = 10*j + [1;2;3];
    A = [A  v]
end
```

Question Time

```
A = [ 1 2 3; 4 5 6];
C = A(:,2);
```

What the value of A(2,2)?

A. 4 B. 5 C. 6

Question Time

```
A = [ 1 2 3; 4 5 6];
A = A(1:2,2:3)
```

What the value of A(2,2)?

A. 4 B. 5 C. 6

Largest Value

A:

12	17	49	61
38	18	82	77
83	53	12	10

m:

83	53	82	77

M:

83

m = max(*A*) ; M = max(m)

Functions and 2D Arrays

```
function  alpha = Ave(A)
% A is a 2D array.
% alpha is the average of its
% values.
```

```
10 20 30
40 50 60
```

-> (10+20+30+40+50+60)/6

Need Built-In Function `size`

```
function  alpha = Ave(A)
[m,n] = size(A);
```

Add up all the numbers in the array. Store in s.

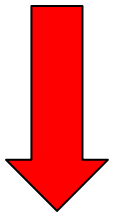
```
alpha = s/(m*n);
```

`size(A)` returns #rows and # columns

Refine…

```
function  alpha = Ave(A)
  [m,n] = size(A);
  s = 0;
  for i=1:m
    sRow = the sum of the values in A(i,:)
    s = s + sRow
  end
  alpha = s/(m*n);
```

```
sRow = the sum of the
       values in A(i,:)
```



```
sRow = 0;
for j=1:n
  sRow = sRow + A(i,j);
end
```

```
function  alpha = Ave(A)
[m,n] = size(A);
s = 0;
for i=1:m
      sRow = 0;
      for j=1:n
        sRow = sRow + A(i,j);
      end
      s = s + sRow
end
alpha = s/(m*n);
```

Now Some More Involved Examples

Random Web

N web pages

N-by-N Link Array A.

A(i,j) is 1 if there is a link
on webpage j to webpage i

Generate a random link array and display the connectivity.

Random Link Idea

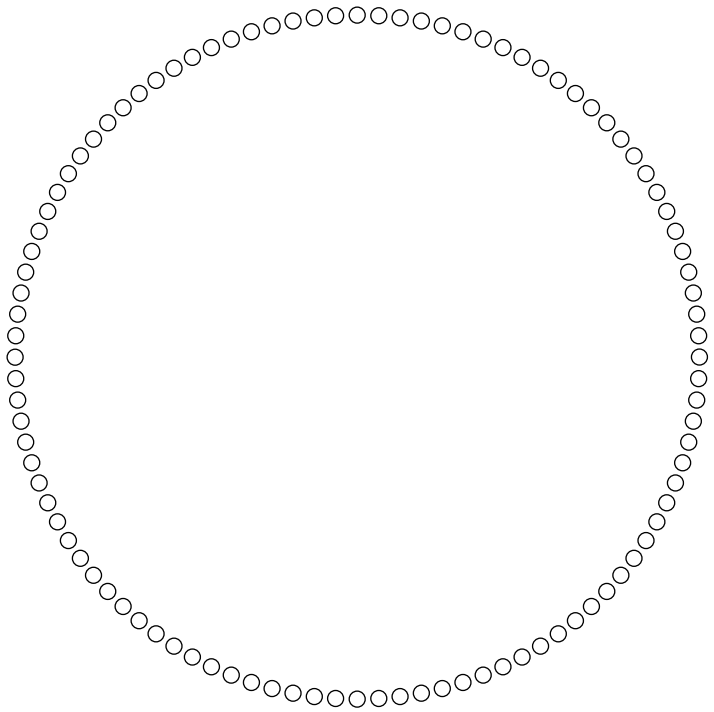
A(i,,j) = 1 with probability $\frac{1}{1+|i-j|}$

More likely to be a link
if i is close to j.

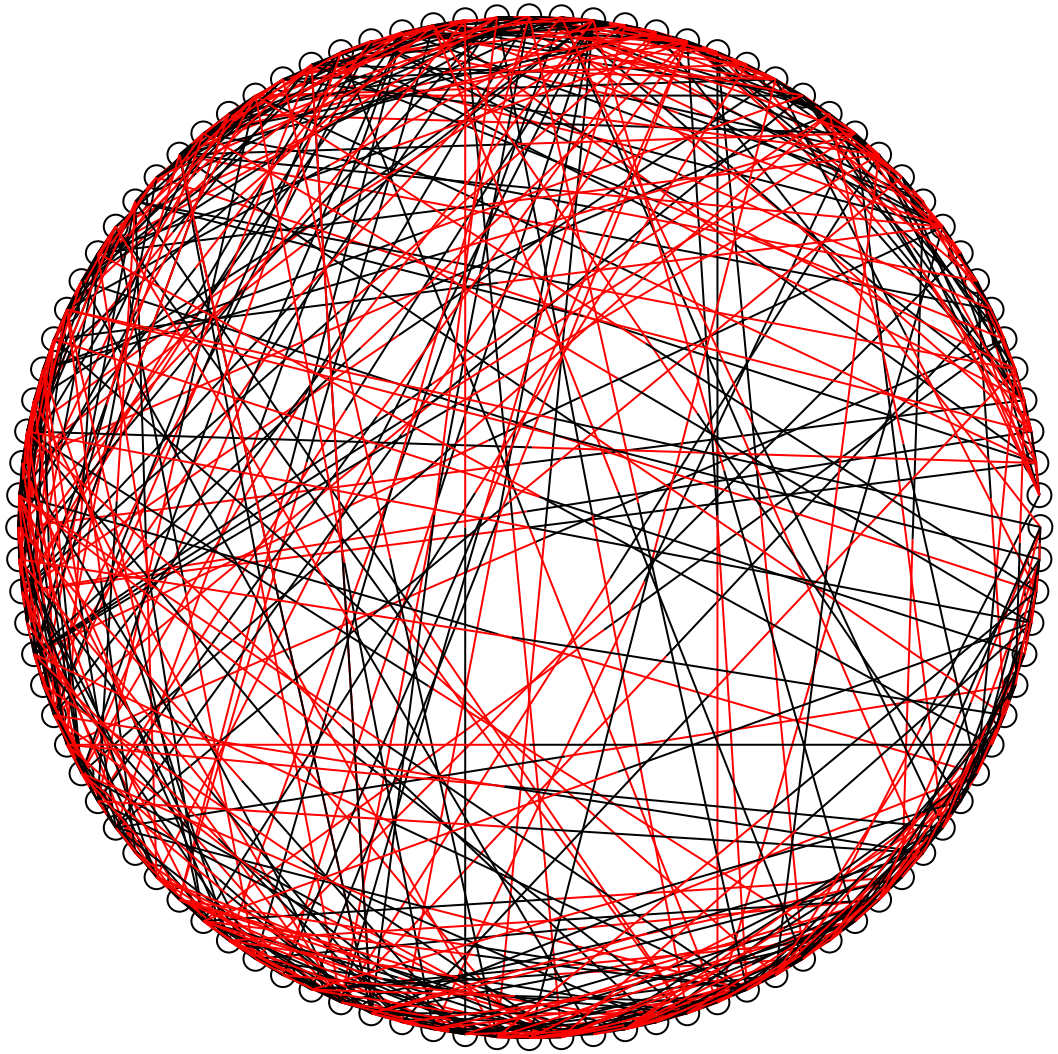
```
function A = RandomLinks(n)
A = zeros(n,n);
for i=1:n
  for j=1:n
    r = rand;
    if i~=j && r<= 1/(1 + abs(i-j));
        A(i,j) = 1;
    end
  end
end
```

N = 20

```
0 1 1 1 0 0 0 0 1 0 0 1 0 0 0 0 0 0
1 0 0 0 1 0 0 0 1 1 1 0 0 0 0 0 1 0 0
0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0
0 1 1 1 1 1 0 0 0 1 0 1 1 0 0 0 0 0 0
0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 1 1
0 1 0 0 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 0
0 0 0 0 0 0 0 1 1 0 1 0 0 0 0 0 0 0 1
0 0 0 0 0 0 1 0 0 0 0 0 1 1 0 0 0 0 0 0
0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 1
0 0 0 1 0 0 0 0 1 1 0 1 0 1 1 0 0 0 0 0
0 0 0 0 0 0 1 0 0 0 0 0 0 0 1 1 0 0 0 0
0 0 0 0 0 1 0 1 0 0 0 0 1 0 0 1 0 0 0 1
0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 1 0 1 0
0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 1 0 1 1 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 1
0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
```



100 Web pages. Now display the links….



Line black as it leaves page j, red when it arrives at page i.