- Previous Lecture:
  - Nesting `if`-statements
  - Logical operators short-circuit
  - Top-down design
- Today's Lecture:
  - Iteration using `for`
  - Watch MatTV episode "Troubleshooting for-loops"
- Announcements:
  - Discussion this week in the classrooms as listed in Student Center
  - Last call to register your clickers—use the link on the course website

Question

A stick of unit length is split into two pieces. The breakpoint is randomly selected. On average, how long is the shorter piece?

Physical experiment? ◆

Thought experiment? → analysis

Computational experiment! → simulation◆

◆Need to repeat many trials!

Question

A stick of unit length is split into two pieces. The breakpoint is randomly selected. On average, how long is the shorter piece?

A: .000001

B: .25

C: .333333

D: .499999

E: none of the above

Simulation:

use code to imitate the physical experiment

```
% one trial of the experiment
breakPt= rand;
if  breakPt<0.5
   shortPiece= breakPt;
else
   shortPiece= 1-breakPt;
end
```

```
% one trial of the experiment
breakPt= rand;
shortPiece= min(breakPt, 1-breakPt);
```

Want to do many trials, add up the lengths of the short pieces, and then divide by the number of trials to get the average length.

Repeat n times

```
% one trial of the experiment
breakPt= rand;
shortPiece= min(breakPt, 1-breakPt);
```

Take average

Print result

```
n= 10000;  % number of trials
total= 0;  % accumulated length so far

for  k= 1:n
    % one trial of the experiment
    breakPt= rand;
    shortPiece= min(breakPt, 1-breakPt);
    total= total + shortPiece;
end

aveLength= total/n;
fprintf('Average length is %f\n', ...
                                  aveLength)
```

Example: "Accumulate" a solution

```
% Average 10 numbers from user input

n= 10;      % number of data values

for k= 1:n
  % read and process input value
    num= input('Enter a number: ');
    total= total + num;
end
ave= total/n;  % average of n numbers
fprintf('Average is %f\n', ave)
```

How many passes through the loop will be completed?

A: 0

B: 1

C: 9

D: 10

E: 11

Remember to initialize

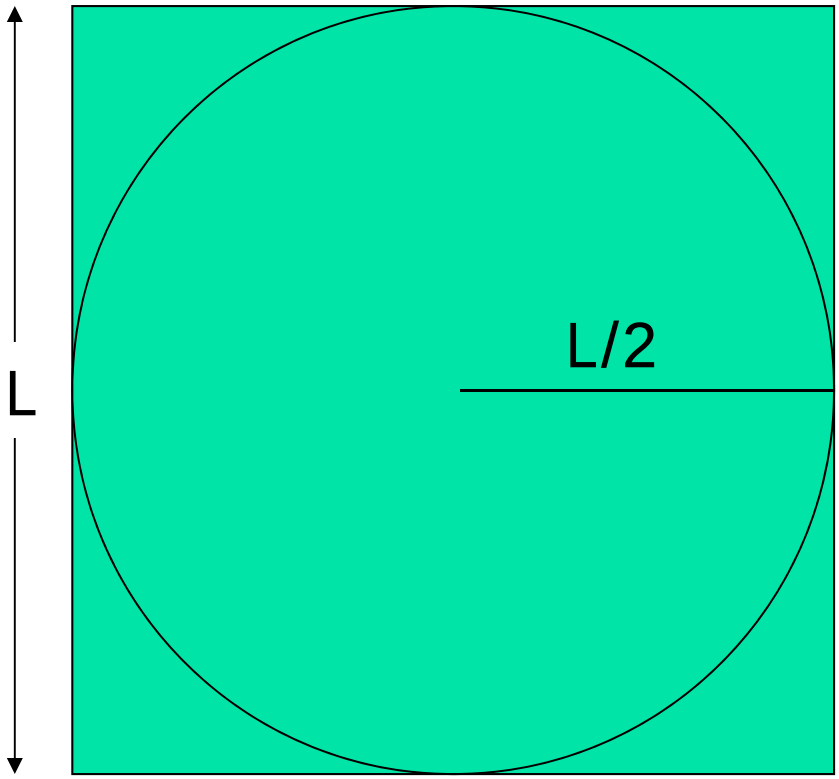
```
% Average 10 numbers from user input

n= 10;      % number of data values
total= 0;   % current sum (initialized to zero)
for k= 1:n
  % read and process input value
    num= input('Enter a number: ');
    total= total + num;
end
ave= total/n;  % average of n numbers
fprintf('Average is %f\n', ave)
```

Important Features of Iteration

- A task can be accomplished if some steps are repeated; these steps form the loop body
- Need a starting point
- Need to know when to stop
- Need to keep track of (and measure) progress—update

Monte Carlo Approximation of π



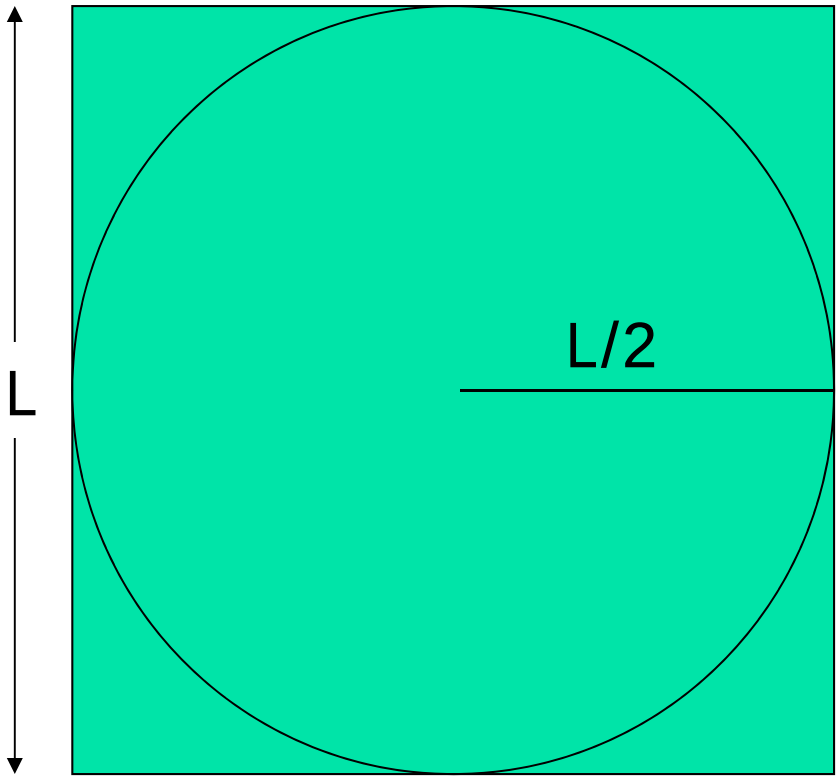
Throw N darts

Sq. area = $N = L \times L$

Circle area = N_{in}

$= \pi L^2 / 4$

Monte Carlo Approximation of π



Throw N darts

Sq. area = $\boldsymbol{N} = \boldsymbol{L} \times \boldsymbol{L}$

Circle area = $\boldsymbol{N_{in}}$

$= \pi \boldsymbol{L^2 / 4}$

$\pi = \boldsymbol{4\ N_{in} / N}$

Monte Carlo Approximation of π

For each of N trials

Throw a dart

If it lands in circle

add 1 to total # of hits

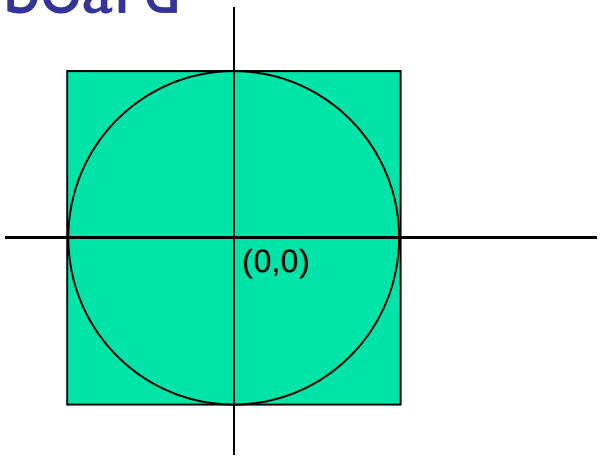
Pi is 4*hits/N

Monte Carlo π with N darts on L-by-L board

```
N=__;
for k = 1:N
```

```
end
myPi = 4*hits/N;
```

Monte Carlo π with N darts on L-by-L board



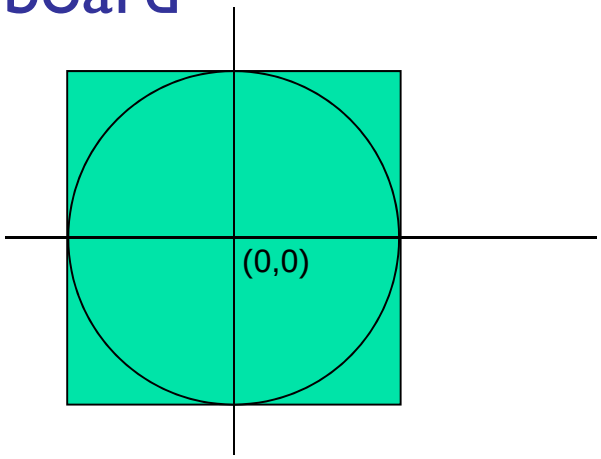

```
N=__;
for k = 1:N
    % Throw kth dart


    % Count it if it is in the circle



end
myPi = 4*hits/N;
```

Monte Carlo π with N darts on L-by-L board




```
N=__;
for k = 1:N
    % Throw kth dart
    x = rand*L – L/2;
    y = rand*L – L/2;
    % Count it if it is in the circle
    if sqrt(x^2+y^2) <= L/2
        hits = hits + 1;
    end
end
myPi = 4*hits/N;
```

Syntax of the `for` loop

```
for <var>= <start value>:<incr>:<end bound>
    statements to be executed repeatedly
end
```

Loop body

Loop header specifies all the values that the index variable will take on, one for each pass of the loop.

E.g, `k= 3:1:7` means `k` will take on the values 3, 4, 5, 6, 7, one at a time.

Pattern for doing something *n* times

```
n= _____
for k= 1:n

   % code to do
   % that something

end
```

Definite iteration

`for` loop examples

```
for k= 2:0.5:3
     disp(k)
end
```

k takes on the values _____

Non-integer increment is OK

```
for k= 1:4
     disp(k)
end
```

k takes on the values _____

Default increment is 1

```
for k= 0:-2:-6
     disp(k)
end
```

k takes on the values _____

"Increment" may be negative

```
for k= 0:-2:-7
     disp(k)
end
```

k takes on the values _____

Colon expression specifies *bounds*

```
for k= 5:2:1
     disp(k)
end
```

`for` loop examples

```
for k= 2:0.5:3
     disp(k)
end
```

k takes on the values 2,2.5,3

Non-integer increment is OK

```
for k= 1:4
     disp(k)
end
```

k takes on the values 1,2,3,4

Default increment is 1

```
for k= 0:-2:-6
     disp(k)
end
```

k takes on the values 0,-2,-4,-6

"Increment" may be negative

```
for k= 0:-2:-7
     disp(k)
end
```

k takes on the values 0,-2,-4,-6

Colon expression specifies *bounds*

```
for k= 5:2:1
     disp(k)
end
```

`for` loop examples

```
for k= 2:0.5:3
     disp(k)
end
```

k takes on the values 2,2.5,3

Non-integer increment is OK

```
for k= 1:4
     disp(k)
end
```

k takes on the values 1,2,3,4

Default increment is 1

```
for k= 0:-2:-6
     disp(k)
end
```

k takes on the values 0,-2,-4,-6

"Increment" may be negative

```
for k= 0:-2:-7
     disp(k)
end
```

k takes on the values 0,-2,-4,-6

Colon expression specifies *bounds*

```
for k= 5:2:1
     disp(k)
end
```

The set of values for k is the empty set: the loop body won't execute

```
% What will be printed?
for k= 1:2:6
    fprintf('%d ', k)
end
```

A: 1 2 3 4 5 6

B: 1 3 5 6

C: 1 3 5

D: *error (incorrect bounds)*