- Previous topic:
  - Branching
  - Boolean expressions
- Now:
  - Introduction to **for**-loop

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!

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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

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

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Repeat n times

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

Take average

Print result

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

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

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

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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

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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

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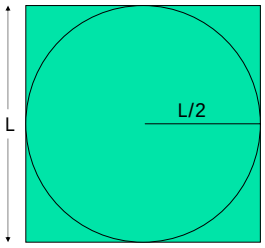
Monte Carlo Estimation of π



Throw *N* darts

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

Circle area = N_{in}
$= \pi L^2 / 4$

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

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Monte Carlo Approximation of Pi

For each of N trials
  Throw a dart
  If it lands in circle
    add 1 to total # of hits

Pi is 4*hits/N

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

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


   % Is it in the circle?



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

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Syntax of the `for` loop

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

Loop body

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Syntax of the `for` loop

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

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.

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Pattern for doing something *n* times

```
n= _____
for k= 1:n
    % code to do
    % that something
end
```

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```
% 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)*

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`for` loop examples

```
for k= 2:0.5:3
    disp(k)
end
for k= 1:4
    disp(k)
end
for k= 0:-2:-6
    disp(k)
end
for k= 0:-2:-7
    disp(k)
end
for k= 5:2:1
    disp(k)
end
```

`k` takes on the values _____
Non-integer increment is OK

`k` takes on the values _____
Default increment is 1

`k` takes on the values _____
"Increment" may be negative

`k` takes on the values _____
Colon expression specifies a *bound*

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```
% What will be printed?
for k= 10:-1:14
    fprintf('%d ', k)
end
fprintf('!')
```

A: *error (incorrect bounds)*

B: 10 *(then error)*

C: 10 !

D: 14 !

E: !

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In the loop body, never change the value of the loop variable

```
n= _____
for k= 1:n
    % code to do
    % that something
end
```

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