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

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

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

repeat n times

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)
Example: "Accumulate" a solution

```matlab
% 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

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 Estimation of \(\pi\)

- Throw \(N\) darts
- Sq. area = \(N = L \times L\)
- Circle area = \(\pi L^2 / 4\)
- \(\pi = 4 N_{\text{hit}} / N\)

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 \(4 \times \text{hits} / \text{N}\)

Monte Carlo Pi with \(N\) darts on \(L\)-by-\(L\) board

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

    % Is it in the circle?

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

Syntax of the **for** loop

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

Loop body
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.

Pattern for doing something `n` times

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

% 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)

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

A: error (incorrect bounds)
B: 10 (then error)
C: 10!
D: 14!
E: !

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

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