



Announcements

- CLUE Tutoring
 - Wednesday nights 7-8:30PM MGH 058
 - 2 extra-credit points for each session you attend from last week through the end of the quarter
 - Sign the attendance list to get credit!



Announcements

- Veteran's Day on Wednesday
 - Official UW holiday
 - CLUE Tutoring is on Monday night this week only
 - 7-8:30pm
 - If you have Wednesday lab section,
 - Attend a drop-in lab this week
 - Get 2 points extra credit for attending CLUE Tutoring—sign the attendance sheet



Announcements

- Tour of Living Computer Museum
 - Opens to the public in January
 - Our tours:
 - This week: Thursday, Friday
 - Next week: Monday, Tuesday
 - Signup on WebQ linked from Calendar by Tuesday 10pm
 - Directions on GoPost
 - SODO near Sears & Qwest Field





Announcements

- Due Tuesday night
 - Labs 6/7
 - Signup for museum tour



Announcements

- Labs 8/9
 - Thursday this week and Monday/Tuesday labs next week



Announcements

- The Museum Tour and Labs 8/9 are optional—for extra credit.
 - Choose one or the other



Announcements

- Repeat:
 - D.A.'s office hours have changed and moved to the drop-in lab
 - MGH 430 Tuesday nights 5-6pm
 - I'm always happy to answer questions after lecture, too.



Announcements

- Chapter 21 for today
- Handy references for lab
 - *The JavaScript Phrasebook*
 - W3 Schools JavaScript tutorial



Iterations, or Loops

Once is not Enough

D.A. Clements



Objectives

- Learn the syntax of loops
- Use loops to count down or count up
- Recognize the World-Famous Iteration
- Learn how to start, increment, and end a loop
- Describe the structure of nested loops



Play it again, Sam.

ITERATION



Definitions

- Iteration, or looping, is the process of repetition:
 - looping through a sequence of statements to repeat them



Major Types of Iterations

- For loop
 1. Baby
 2. Count up
 3. Count down
- While loop
 4. Count up
 5. Count down

**Try the examples in
Week 5 on the course
Web site!**



Repetition is good

FOR LOOPS



The `for` Loop Basic Syntax

```
for (<initialization>; <continuation>; <next iteration>)  
{  
    <statement list>  
}
```

- The whole sequence of statements in the statement list is performed for each iteration
 - Computer completes the whole statement sequence of the <statement list> before beginning the next iteration



Control specification

- The three operations in the parentheses of the **for** loop
 - Control the number of times the loop iterates
 - by using an *iteration variable* (must be declared)



How a `for` Loop Works

- Consider a computation on declared variables `j` and `text`

```
text = "She said ";  
for ( var j = 1; j <= 3; j = j + 1 )  
{  
    text = text + "Never! ";  
}  
alert(text);
```



How a for Loop Works

- Consider a computation on declared variables **j** and **text**

```
text = "She said ";
```

```
for ( var j = 1; j <= 3; j = j + 1 )
```

```
{
```

```
    text = text + "Never! ";
```

```
}
```

```
alert(text);
```

Control specification



How a for Loop Works

- Consider a computation on declared variables **j** and **text**

```
text = "She said ";  
for ( var j = 1; j <= 3; j = j + 1 )  
{  
    text = text + "Never! ";  
}  
alert(text);
```

Starting point



How a for Loop Works

- Consider a computation on declared variables **j** and **text**

```
text = "She said ";  
for ( var j = 1; j <= 3; j = j + 1 )  
{  
    text = text + "Never! ";  
}  
alert(text);
```

Continuation condition



How a for Loop Works

- Consider a computation on declared variables **j** and **text**

```
text = "She said ";  
for (var j = 1; j <= 3; j = j + 1 )  
{  
    text = text + "Never! ";  
}  
alert(text);
```

Step size or
increment



How a for Loop Works

- Demo:

```
text = "The two-year-old said ";  
for ( j = 1; j <= 3; j = j + 1 ) {  
    text = text + "No! ";  
    alert(text);  
}
```



Processing for loops

- Example:

```
for ( j = 1 ; j <= 3 ; j = j + 1 ) {  
    <statement list>  
}
```

- The first operation is the *<initialization>*
 - Sets the iteration variable's value for the first iteration of the loop. Done only once.
- The next operation is *<continuation>*
 - Test. If the test has a false outcome, the *<statement list>* is skipped and control passes to the next statement after the for loop
 - If the test has a true outcome, the *<statement list>* is performed. When the statements are complete, the
- *<next iteration>* operation is performed
 - Repeats with the continuation test, performs same sequence of steps.



The World-Famous Iteration

```
for ( j = 0; j < n; j++ ) { ... }
```

- Most frequently written **for** loop of all time
- Easy to see iteration count:
 - Always n times
 - When n is 3
 - 0 is first loop
 - 1 is second loop
 - 2 is third loop
 - 3 is fourth and it doesn't run.

Running through a for loop

Table 21.1 The sequence of operations on j from the for loop with control specification ($j=1$; $j \leq 3$; $j=j+1$)

Operation	Operation Result	Role
1 $j = 1$	j 's value is 1	Initialize iteration variable
$j \leq 3$	true, j is less than 3	First <continuation> test, continue
2 $j = j + 1$	j 's value is 2	First <next iteration> operation
$j \leq 3$	true, j is less than 3	Second <continuation> test, continue
3 $j = j + 1$	j 's value is 3	Second <next iteration> operation
$j \leq 3$	true, j is equal to 3	Third <continuation> test, continue
$j = j + 1$	j 's value is 4	Third <next iteration> operation
$j \leq 3$	false, j is greater than 3	Fourth <continuation> test, terminate



Rules: counter and start point

- The Iteration Variable: **j = 1;**
 - Must be declared, and follow rules for variable identifiers
 - i, j, and k are the most common choices
- The Starting Point
 - Iteration can begin anywhere, including negative numbers



Rules: Continuation & Step Size

- Continuation/Termination Test $j \leq 3$
 - *Test* is any expression resulting in a Boolean value (true/false)
 - Continuation must involve iteration variable to avoid infinite loop
- Step Size $j = j + 1$
 - Amount of change from one iteration to the next
 - Often called the *increment* or *decrement*
 - Increment: $j + 1$
 - Decrement: $j - 1$



Experiments with Flipping Coins

```
<html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
<head>
  <meta http-equiv="content-type"
    content="text/html; charset=utf-8" />
  <meta http-equiv="Content-Style-Type" content="text/css" />
  <title>For loop example with coin toss</title>
  <script type="text/javascript">
    var heads=0, tails=0;           //Counters
    var i;                          //Iteration variable
    for (i=0; i<100; i++ )
    {
      if (randNum(2) == 1)
        heads++;
      else
        tails++;
    }
    alert("Heads: " + heads + " and Tails: " + tails);
    function randNum(range)
    {
      return Math.floor(range*Math.random());
    }
  </script>
</head>
```



Experiments with Flipping Coins

```
<html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
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  <title>For loop example with coin toss</title>
  <script type="text/javascript">
    var heads=0, tails=0;           //Counters
    var i;                          //Iteration variable
    for (i=0; i<100; i++ )
    {
      if (randNum(2) == 1)
        heads++;
      else
        tails++;
    }
    alert("Heads: " + heads + " and Tails: " + tails);
    function randNum(range)
    {
      return Math.floor(range*Math.random());
    }
  </script>
</head>
```



Experiments with Flipping Coins

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<html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
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  <meta http-equiv="content-type"
    content="text/html; charset=utf-8" />
  <meta http-equiv="Content-Style-Type" content="text/css" />
  <title>For loop example with coin toss</title>
  <script type="text/javascript">
    var heads=0, tails=0;           //Counters
    var i;                          //Iteration variable
    for (i=0; i<100; i++ )
    {
      if (randNum(2) == 1)
        heads++;
      else
        tails++;
    }
    alert("Heads: " + heads + " and Tails: " + tails);
    function randNum(range)
    {
      return Math.floor(range*Math.random());
    }
  </script>
</head>
```



Experiments with Flipping Coins

```
<html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
<head>
  <meta http-equiv="content-type"
    content="text/html; charset=utf-8" />
  <meta http-equiv="Content-Style-Type" content="text/css" />
  <title>For loop example with coin toss</title>
  <script type="text/javascript">
    var heads=0, tails=0;           //Counters
    var i;                          //Iteration variable
    for (i=0; i<100; i++ )
    {
      if (randNum(2) == 1)
        heads++;
      else
        tails++;
    }
    alert("Heads: " + heads + " and Tails: " + tails);
    function randNum(range)
    {
      return Math.floor(range*Math.random());
    }
  </script>
</head>
```

$$\begin{array}{r} 0 = 1x \\ 99 = \underline{+99x} \\ \quad 100 \text{ times!} \end{array}$$



Experiments with Flipping Coins

```
<html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
<head>
  <meta http-equiv="content-type"
    content="text/html; charset=utf-8" />
  <meta http-equiv="Content-Style-Type" content="text/css" />
  <title>For loop example with coin toss</title>
  <script type="text/javascript">
    var heads=0, tails=0;           //Counters
    var i;                          //Iteration variable
    for (i=0; i<100; i++ )
    {
      if (randNum(2) == 1)
        heads++;
      else
        tails++;
    }
    alert("Heads: " + heads + " and Tails: " + tails);
    function randNum(range)
    {
      return Math.floor(range*Math.random());
    }
  </script>
</head>
```




Demo—100 coin tosses

- Try the Coin Toss
 - Example 6 in
Module 6 of our course Web site



Nested for Loop Basic Syntax

```
for (<initialization j >; <continuation j >; <next iteration j >)  
{  
    for (<initialization i >; <continuation i >; <next iteration i >)  
    {  
        <statement list>  
    }  
    <more statements>  
}
```



Experiment 2—with Five Trials

- A Nested Loop
 - To run several trials, consider the entire loop we just looked at as one Trial
 - Create another **for** loop containing this Trial unit, adding a couple of needed statements
 - We have a loop within a loop (*nested loop*) which causes the Trial loop (0-99) to run five times

Experiment 2—the original trial

```
4 <html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
5 <head>
6   <meta http-equiv="content-type"
7     content="text/html; charset=utf-8" />
8   <meta http-equiv="Content-Style-Type" content="text/css" />
9   <title>For loop example with coin toss</title>
10  <script type="text/javascript">
11    var heads = 0, tails = 0;
12    var i, j, text=''; //Iteration vars
13    for (j = 0; j < 5; j++) //Outer loop start
14    {
15      for (i=0; i<100; i++) //Trial line 1
16      {
17        if (randNum(2) == 1) //Trial line 2
18          heads++; //Trial line 3
19        else //Trial line 4
20          tails++; //Trial line 5
21      } //Trial line 6
22
23      text = text + 'Trial ' + j + ': '; //Add line to message that will print at end
24      for (i = 0; i < (Math.abs(heads-50)); i++)
25      {
26        text = text + '*'; //Add to message
27      }
28      text = text + '\n'; //Add line break (html <br /> cannot be used for alerts)
29      heads = 0; tails = 0; //Additional
30    } //Outer loop end
31    alert(text);
32    function randNum(range)
33    {
34      return Math.floor(range*Math.random());
35    }
36  </script>
37 </head>
```

Experiment 2—outer loop

```
4 <html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
5 <head>
6   <meta http-equiv="content-type"
7     content="text/html; charset=utf-8" />
8   <meta http-equiv="Content-Style-Type" content="text/css" />
9   <title>For loop example with coin toss</title>
10  <script type="text/javascript">
11    var heads = 0, tails = 0;
12    var i, j, text=''; //Iteration vars
13    for (j = 0; j < 5; j++) //Outer loop start
14    {
15      for (i=0; i<100; i++) //Trial line 1
16      {
17        if (randNum(2) == 1) //Trial line 2
18          heads++; //Trial line 3
19        else //Trial line 4
20          tails++; //Trial line 5
21      } //Trial line 6
22
23      text = text + 'Trial ' + j + ': '; //Add line to message that will print at end
24      for (i = 0; i < (Math.abs(heads-50)); i++)
25      {
26        text = text + '*'; //Add to message
27      }
28      text = text + '\n'; //Add line break (html <br /> cannot be used for alerts)
29      heads = 0; tails = 0; //Additional
30    } //Outer loop end
31    alert(text);
32    function randNum(range)
33    {
34      return Math.floor(range*Math.random());
35    }
36  </script>
37 </head>
```

Experiment 2—declare i and j

```
4 <html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
5 <head>
6   <meta http-equiv="content-type"
7     content="text/html;charset=utf-8" />
8   <meta http-equiv="Content-Style-Type" content="text/css" />
9   <title>For loop example with coin toss</title>
10  <script type="text/javascript">
11    var heads = 0, tails = 0;
12    var i, j, text=''; //Iteration vars
13    for (j = 0; j < 5; j++) //Outer loop start
14    {
15      for (i=0; i<100; i++) //Trial line 1
16      {
17        if (randNum(2) == 1) //Trial line 2
18          heads++; //Trial line 3
19        else //Trial line 4
20          tails++; //Trial line 5
21      } //Trial line 6
22
23      text = text + 'Trial ' + j + ': '; //Add line to message that will print at end
24      for (i = 0; i < (Math.abs(heads-50)); i++)
25      {
26        text = text + '*'; //Add to message
27      }
28      text = text + '\n'; //Add line break (html <br /> cannot be used for alerts)
29      heads = 0; tails = 0; //Additional
30    } //Outer loop end
31    alert(text);
32    function randNum(range)
33    {
34      return Math.floor(range*Math.random());
35    }
36  </script>
37 </head>
```

Experiment 2—set heads, tails to zero

```
4 <html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
5 <head>
6   <meta http-equiv="content-type"
7     content="text/html; charset=utf-8" />
8   <meta http-equiv="Content-Style-Type" content="text/css" />
9   <title>For loop example with coin toss</title>
10  <script type="text/javascript">
11    var heads = 0, tails = 0;
12    var i, j, text=''; //Iteration vars
13    for (j = 0; j < 5; j++) //Outer loop start
14    {
15      for (i=0; i<100; i++) //Trial line 1
16      {
17        if (randNum(2) == 1) //Trial line 2
18          heads++; //Trial line 3
19        else //Trial line 4
20          tails++; //Trial line 5
21      } //Trial line 6
22
23      text = text + 'Trial ' + j + ': '; //Add line to message that will print at end
24      for (i = 0; i < (Math.abs(heads-50)); i++)
25      {
26        text = text + '*'; //Add to message
27      }
28      text = text + '\n'; //Add line break (html <br /> cannot be used for alerts)
29      heads = 0; tails = 0; //Additional
30    } //Outer loop end
31    alert(text);
32    function randNum(range)
33    {
34      return Math.floor(range*Math.random());
35    }
36  </script>
37 </head>
```

Experiment 2—how far from 50%?

```
4 <html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
5 <head>
6   <meta http-equiv="content-type"
7     content="text/html;charset=utf-8" />
8   <meta http-equiv="Content-Style-Type" content="text/css" />
9   <title>For loop example with coin toss</title>
10  <script type="text/javascript">
11    var heads = 0, tails = 0;
12    var i, j, text='';           //Iteration vars
13    for (j = 0; j < 5; j++)     //Outer loop start
14    {
15      for (i=0; i<100; i++)     //Trial line 1
16      {
17        if (randNum(2) == 1)   //Trial line 2
18          heads++;             //Trial line 3
19        else                    //Trial line 4
20          tails++;             //Trial line 5
21      }                         //Trial line 6
22
23      text = text + 'Trial ' + j + ': '; //Add line to message that will print at end
24      for (i = 0; i < (Math.abs(heads-50)); i++)
25      {
26        text = text + '*';      //Add to message
27      }
28      text = text + '\n';      //Add line break (html <br /> cannot be used for alerts)
29      heads = 0; tails = 0;    //Additional
30    }                           //Outer loop end
31    alert(text);
32    function randNum(range)
33    {
34      return Math.floor(range*Math.random());
35    }
36  </script>
37 </head>
```




Demo—Five Trials

- Try the Five-Trial Coin Toss
 - Example 7 in
Module 6 of our course Web site



Summary

- Learn the syntax of loops
- Use loops to count down or count up
- Recognize the World-Famous Iteration
- Learn how to start, increment, and end a loop
- Describe the structure of nested loops



Quiz topics for next week

- For loops



End papers...

- A computer lets you make more mistakes faster than any invention in human history—with the possible exceptions of handguns and tequila.

~Mitche Ratcliffe