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Programming

- Why is programming fun?
  - First is the sheer joy of making things. As the child delights in his mud pie, so the adult enjoys building things, especially things of his own design. I think this delight must be an image of God's delight in making things, a delight shown in the distinctness and newness of each leaf and each snowflake.

Source: Frederick P. Brooks, Jr. *The Mythical Man-Month: Essays on Software Engineering.*

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Homework

- By today you should have read
  - Chapters 20 and 21 in *Fluency*

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Once is Not Enough

Iteration Principles

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Iteration: *Play It Again, Sam*

- The process of repetition:
  - looping through a series of statements to repeat them

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Again and again, and again

Repetition is good

FOR LOOPS

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The for Loop Basic Syntax

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

- Text that is not in *metabrackets* <> must be given literally
- 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

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The Iteration Variable

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- *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)

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JavaScript Rules for `for` Loops (cont'd)

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- The World-Famous Iteration
  - JavaScript uses the same `for` loop statement as other programming languages, so thousands of loops with this structure are written every day:

```
for ( j = 0; j < n; j++ ) {…}
```

  - Most frequently written `for` loop of all time
  - Easy to see iteration count:
    - Always *n* times

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The Iteration Variable (cont'd)

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- Example:

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

- Here's what happens:
  - 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.
    - 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.

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

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

How a `for` Loop Works

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

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

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How a `for` Loop Works

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

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

Starting point

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How a for Loop Works

- Consider a computation on declared variables j and text

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

Stop condition

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How a for Loop Works

- Consider a computation on declared variables j and text

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

Step size or increment

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How a for Loop Works

- Demo:

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

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JavaScript Rules for for Loops

- 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

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JavaScript Rules for for Loops (cont'd)

- Continuation/Termination Test **`j <= 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*

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Experiments with Flipping Coins

- To practice for loops, we experiment with flipping electronic coins
- We can use the function randNum(2), which returns either 0 (tails) or 1 (heads)
- Set up an iteration in which our randNum() function is performed 100 times, and statistics gathered

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Experiments with Flipping Coins (cont'd)

```
<html><head><title>Coin Flips</title></head>
<body><script language='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></body></html>
```

- Demo...

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Experiments with Flipping Coins (cont'd)

- `i` ranges from 0 to 99, so the loop iterates 100 times
- Conditional statement checks and records the outcome of random number generation
- When random number is 1, count of heads is increased by 1 (`heads++;`)
- When random number is 0, count of tails is increased by 1 (`tails++;`)

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Experiments with Flipping Coins (cont'd)

- 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

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Experiments with Flipping Coins (cont'd)

```
var heads = 0, tails = 0;
var i, j;                                  //Iteration vars
for (j = 0; j < 5; j++){                   //Outer loop start
   for (i=0; i<100; i++){                     //Trial line 1
      if (randNum(2) == 1)                    //Trial line 2
         heads++;                             //Trial line 3
      else                                    //Trial line 4
         tails++;                             //Trial line 5
   }                                          //Trial line 6
   alert("Heads: "+heads+" and Tails: "+tails);
                                              //Trial line 7
   heads = 0; tails = 0;                   //Additional
}                                          //Outer loop end
```

- Demo....

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Experiments with Flipping Coins (cont'd)

- A Diagram of Results
  - To show how far off a perfect 50-50 score a trial is, display with diagram
  - Compute the distance from 50-50 and show that number using asterisks

```
text = text + 'Trial ' + j + ': ';
for (i = 0; i < (Math.abs(heads-50)); i++) {
   text = text + '*';
}
text = text + '\n';
alert(text);
```

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Creating and using lists, or arrays

INDEXING

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Indexing

- Process of creating a sequence of names by associating a base name with a number (like Apollo 13 or Henry VIII)
  - Each indexed item is called an element of the base-named sequence
- Index Syntax
  - index number is enclosed in square brackets [ ]
- Iterations can be used to refer to all elements of a name
  - `A[j]` for successive iterations over `j` referring to different elements of A

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Indexing (cont'd)

- *Index* ***Origin***
  - The point at which indexing begins (the least index)
  - In life, the first element may begin with 1, or have no number (Queen Elizabeth)
  - JavaScript *always* uses index origin 0

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Rules for Arrays

- Arrays are normal variables initialized by
  `new Array (<number of elements>);`
- <number of elements> is number of items in array
- Array indexing begins at 0
- Greatest index is <number of elements> - 1
- Number of elements is array length
- Index values range from 0 to (length – 1)

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Array Reference Syntax

- Array reference is array name together with index enclosed in brackets (non-negative integer or expression or variable that resolves to non-negative integer)

  `array[i]`
- World-Famous Iteration, or 0-origin loop iteration, is perfect for arrays

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JavaScript Rules for `for` Loops (cont'd)

- The World-Famous Iteration for looping through an array:

```
for ( i = 0; i < fruits.length; i++ )
{
      alert(fruits[i]);
}
```

- `.length` is a built-in JavaScript property that always gives you the length of an array.

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Reflections

- Write for 10 minutes on this topic:
  - First describe and then compare and contrast
    - Dante and
    - The Students server
  - Be sure to answer these questions:
    - How are they connected?
    - How do you access each one?

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Homework

- Read *Fluency* chapter 22 for Friday!
- Quiz 4 Thursday and Friday
  - See email for details on what to review