Announcements

Put the hardcopy of Project 2a on the table

Once Is Not Enough

Repeating instructions is the source of great power in computing

Iteration

"Iteration" is another term for "repeat"

- Iteration doesn't suffer from the question of whether the first item is counted … in iteration it always is. (*Use "repeat" and "iterate" interchangeably unless it matters.*)
- Iterating is usually called "looping" in programming
- Programming languages have many kinds of statements to help program loops
- In JS we will use the **`for`**-statement

Anatomy of `for`

The **`for`**-statement syntax

`for` **(** *<initialize>*; *<continue test>*; *<next iteration>*) {

<statement list>

}

`for`'s 3 control specifications -- the "control trio" -- are connected by an iteration variable

<initialize> -- gives iteration variable its first value

<continue test> -- this test is performed before starting each cycle of loop; if false, quit

<next iteration> -- the change to the iteration variable after each cycle

An Iteration

Iterations can count ...

```
<html><head><title>Test Page</title></head> <body>
  <script language="JavaScript">
      var i, text = "";  // Initialize text to empty string
      for (i=1; i<=5; i=i+1) {
        text = text + "Iteration no.: " + i + "\n";
      }
      alert(text);
  </script></body>
</html>
```

Newline in JS

Iterations Control Actions

Iterations can replicate other things...

```
<html><head><title>Test Page</title></head> <body>
  <script language="JavaScript">
      var i, text="It's funny!";
      for (i=1; i<=3; i=i+1) {
        text = text + " Ha!";
      }
      alert(text);
  </script></body>
</html>
```

It is possible to make it a lot funnier by changing the limit variable to, say, i<=1000

Key Points of Loops

The most important features of loops:

- The starting value of the iteration variable
- The ending value of the iteration variable
- The amount the iteration variable changes

∗ *As explained in the book, it is possible to completely control these features by properly setting the "control trio," but programmers have gotten in the habit of writing a single kind of iteration: WFI*

World Famous Iteration

To loop *n* times the WFI has this form

```
for ( i=0; i<n;  i++) {
  <statement list>
}
```

Same as i=i+1

WFI starts at 0, steps by 1, stops (before) n
0, 1, 2, …, n-1

Advantages:

- Fast to type
- The number of iterations is the number after **<**
- 0-origin makes it handy for most computations

"Off By 1" Error

The most common error when working with iterations is to miscount by 1

- Everyone makes this mistake
- A common place where the "off by 1" error matters is in how many times a loop loops
- The importance of the WFI is it tells exactly

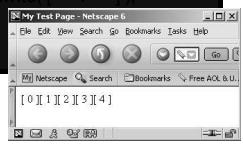
Number of iterations

```
for ( i=0; i<n;  i++) {
  <statement list>
}
```

Using Iteration In JS

Print out a row of things

```
<html><head><title>Test Page</title></head> <body>
  <script language="JavaScript">
        var i;
        for (i=0; i<5; i++) {
          document.write('[ ' + i + ' ]');
        }
  </script></body>
</html>
```

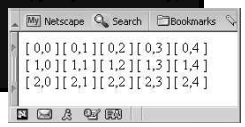


Doubly Nested Loop

A loop within a loop repeats repetitions

```
<html><head><title>Test Page</title></head> <body>
  <script language="JavaScript">
        var i, j;
        for (j=0; j<3; j++) {
          for (i=0; i<5; i++) {
            document.write('[ ' + j + ',' + i + ' ]');
          }
        }
  </script></body>
</html>
```

The new code is shown in white



Arrays and Indexes

We know about names with multiple instances: *Rocky* 3, QE 2, John Paul 2

- The number is called the name's *index*
- The least index is called the index *origin*
- In programming, variables that can be indexed are called *arrays*
- Declare arrays in JavaScript:

var <*identifier*> = new Array (<*num elements*>);

- JavaScript arrays are 0-origin
- Reference array elements w/ brackets: A[0]

Arrays and Loops

Loops and arrays work together

- Declare an array and initialize elements to 4

```
var j, A = new Array(5);
for (j=0; j<5; i++) {
  A[i] = 4;
}
```

Five elements: A[0], A[1], A[2], A[3] & A[4]

WFI and array's indices both start at 0

Notice what would change to have 1000 elements -- arrays and loops give power

Summary

Iteration is very powerful because a small amount of code specifies a lot of computation

- **`for`** gives full range of looping limits, steps
- Use any form of **`for`** that works, but using the WFI is a good habit to adopt
- In a doubly nested loop one iteration has another iteration as its *<statement list>*
- Arrays are variables with many elements that are referred to by their index