A Balanced Introduction to Computer Science, 3/E

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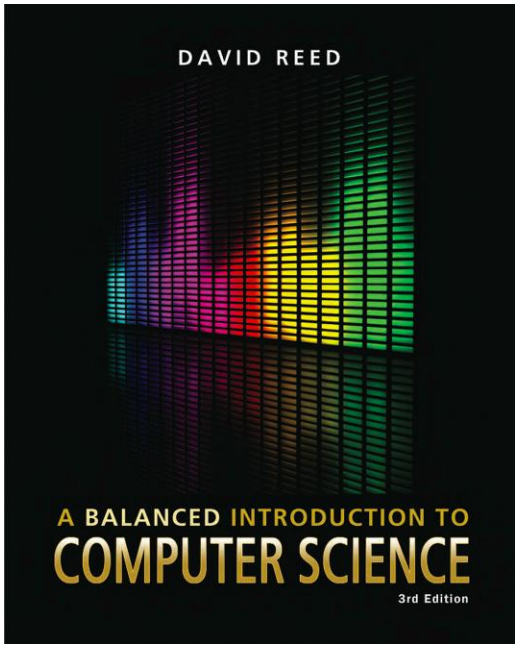


Chapter 5

JavaScript and User Interaction

Text Boxes

HTML event handlers enable the user to interact with the page

- e.g., move the mouse over an image to change it
- e.g., click on a button to display a text message in a page division

for greater control, the user must be able to enter information into the page

- e.g., enter words to complete a fill-in-the-blank story
- e.g., enter grades to calculate a course average

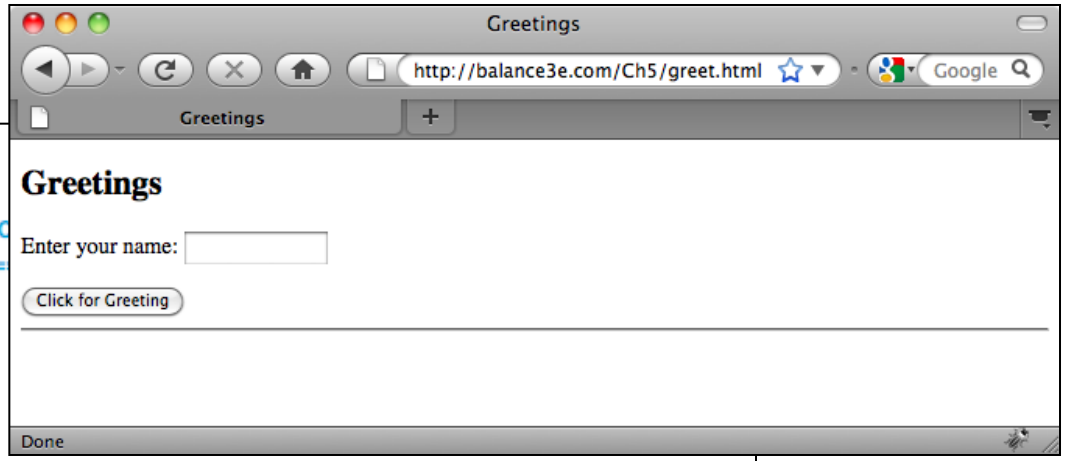
a *text box* is an HTML element that is embedded in the page

```
<input type="text" id="BOX_ID" size=NUM_CHARS value="INITIAL_CONTENTS">
```

- the user can enter text directly in the box
- a JavaScript statement can then access the contents of the text box by accessing its VALUE attribute

```
document.getElementById('BOX_ID').value
```

Greetings Page

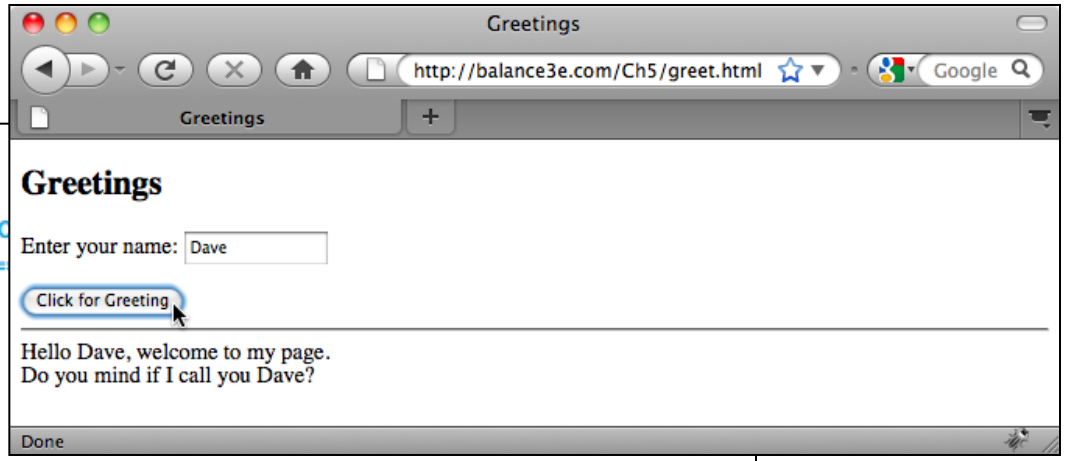



```
 1. <!doctype html>
 2. <!-- greet.html
 3. <!-- Web page that displays a perso
 4. <!-- ==============================
 5.
 6. <html>
 7.  <head>
 8.    <title> Greetings </title>
 9.  </head>
10.
11.  <body>
12.    <h2>Greetings</h2>
13.    <p>
14.      Enter your name: <input type="text" id="nameBox" size=12 value="">
15.    </p>
16.    <input type="button" value="Click for Greeting"
17.           onclick="document.getElementById('outputDiv').innerHTML=
18.                    'Hello' + document.getElementById('nameBox').value +
19.                    ', welcome to my page.<br>Do you mind if I call you' +
20.                    document.getElementById('nameBox').value + '?';">
21.    <hr>
22.    <div id="outputDiv"></div>
23.  </body>
24. </html>
```

since `value=""`, the text box is initially empty

the user can enter his/her name in the text box

Greetings Page




```
 1. <!doctype html>
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 4. <!-- ==============================
 5.
 6. <html>
 7.  <head>
 8.    <title> Greetings </title>
 9.  </head>
10.
11.  <body>
12.    <h2>Greetings</h2>
13.    <p>
14.      Enter your name: <input type="text" id="nameBox" size=12 value="">
15.    </p>
16.    <input type="button" value="Click for Greeting"
17.           onclick="document.getElementById('outputDiv').innerHTML=
18.                    'Hello' + document.getElementById('nameBox').value +
19.                    ', welcome to my page.<br>Do you mind if I call you' +
20.                    document.getElementById('nameBox').value + '?';">
21.    <hr>
22.    <div id="outputDiv"></div>
23.  </body>
24. </html>
```
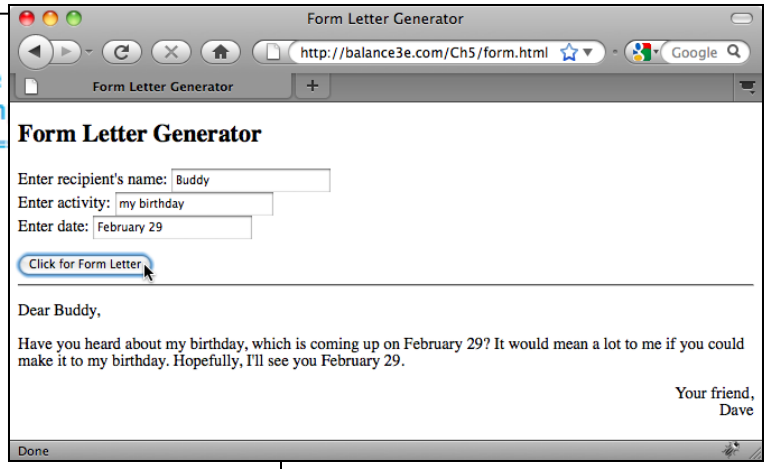

when the button is clicked, the text in the box is accessed and incorporated into the message

Form Letter Page

```
1.  <!doctype html>
2.  <!-- form.html                                                    Dave
3.  <!-- Web page that generates a form letter based on user in
4.  <!-- ============================================================
5.
6.  <html>
7.   <head>
8.     <title> Form Letter Generator </title>
9.   </head>
10.
11.  <body>
12.    <h2>Form Letter Generator</h2>
13.    <p>
14.      Enter recipient's name:
15.        <input type="text" id="recipientBox" size=20 value="Buddy"> <br>
16.      Enter activity:
17.        <input type="text" id="activityBox" size=20 value="my birthday"> <br>
18.      Enter date: <input type="text" id="dateBox" size=20 value="February 29">
19.    </p>
20.    <input type="button" value="Click for Form Letter"
21.          onclick="document.getElementById('outputDiv').innerHTML=
22.                  '<p>Dear ' + document.getElementById('recipientBox').value +
23.                  ',</p> <p>Have you heard about ' +
24.                  document.getElementById('activityBox').value +
25.                  ', which is coming up on ' +
26.                  document.getElementById('dateBox').value +
27.                  '? It would mean a lot to me if you could make it to ' +
28.                  document.getElementById('activityBox').value +
29.                  '. Hopefully, I\'ll see you ' +
30.                  document.getElementById('dateBox').value + '.</p>' +
31.                  '<p style=\'text-align:right\'>Your friend,<br> Dave</p>';">
32.    <hr>
33.    <div id="outputDiv"></div>
34.  </body>
35. </html>
```



a Web page can have numerous text boxes

- each must have a unique ID

text assigned to the VALUE attribute is automatically displayed

- useful whenever a default value is natural

Mixing Text & Expressions

when displaying a complex message involving text and box contents, special care must be taken

```
<input type="button" value="Click for Form Letter"
       onclick="document.getElementById('outputDiv').innerHTML=
                  '<p>Dear ' + document.getElementById('recipientBox').value +
                  ',</p> <p>Have you heard about ' +
                  document.getElementById('activityBox').value +
                  ', which is coming up on' +
                  document.getElementById('dateBox').value +
                  '?  It would mean a lot to me if you could make it to' +
                  document.getElementById('activityBox').value +
                  '. Hopefully, I\'ll see you ' +
                  document.getElementById('dateBox').value + '.</p>' +
                  '<p style=\'text-align:right\'>Your friend,<br> Dave</p>';">
```

- any part of the message enclosed in quotes is treated as plain text (including formatting tags)
- expressions that access the contents of a text box must be evaluated by the browser → cannot be enclosed in quotes

- all of the pieces of the message are concatenated together using '+'

JavaScript Variables

JavaScript assignments have been used to directly assign values to attributes

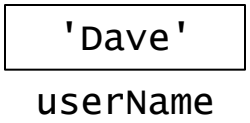
```
document.getElementById('mysteryImg').width = 100;
```

assignments can also be used for indirect actions via variables

a *variable* is a name used to symbolize a dynamic (changeable) value

- each variable is associated with a memory cell
- when a value is assigned to a variable, that value is stored in the corresponding memory cell

```
userName = 'Dave';
```



- any subsequent reference to a variable evaluates to the value stored in its memory cell

```
document.getElementById('outputDiv').innerHTML = 'Hi ' + userName;
```

Variable Names

a variable name can be any sequence of letters, digits and underscores, as long as it starts with a letter

- variable names should be chosen to be descriptive of its purpose

Reserved words that shouldn't be used as variable names because they are already used by JavaScript or the browser.

abstract	default	form	length	public	throw
all	delete	frame	link	reset	throws
anchor	do	function	location	return	top
area	document	goto	long	screen	transient
boolean	double	hidden	name	scroll	true
break	element	history	native	select	try
button	else	if	navigator	self	typeof
byte	enum	image	new	short	var
case	event	implements	null	static	void
catch	export	import	open	status	volatile
char	extends	in	option	submit	while
class	false	instanceof	package	super	window
const	final	int	parent	switch	with
continue	finally	interface	password	synchronized	
date	float	java	private	text	
debugger	for	layer	protected	this	

Variables for Reuse

variables can simplify code by giving a short name to a complex expression

- e.g., in greetings page, can assign the text box contents to a variable
- then, can use the variable repeatedly in the message

```
<input type="button" value="Click for Greeting"
       onclick="userName=document.getElementById('nameBox').value;
                document.getElementById('outputDiv').innerHTML =
                  'Hello ' + userName + ', welcome to my page.<br>' +
                  'Do you mind if I call you ' + userName + '?';">
```

example application: a fill-in-the-blank story page

- page contains text boxes with label such as Name, Color, Animal, Place
- the user enters word/phrase choices in these boxes
- those choices are inserted into a story and displayed in a page division

- because the words/phrases may be used several times in the story, it will make the code shorter (and less error prone) to first assign box contents to variables, then use the variables in the story

Common Pattern

many pages will follow the same basic pattern

- text boxes allow the user to enter words/phrases
- at the click of a button, the text box contents are accessed & stored in variables
- a message incorporating the variable values is displayed

the JavaScript code executed at the button click similarly follows a pattern

```
VAR1 = document.getElementById('BOX_ID1').value;
VAR2 = document.getElementById('BOX_ID2').value;
...
VARn = document.getElementById('BOX_IDn').value;

document.getElementById('outputDiv').innerHTML =
  MESSAGE_INTEGRATING_STRING_LITERALS_AND_VARIABLES;"
```

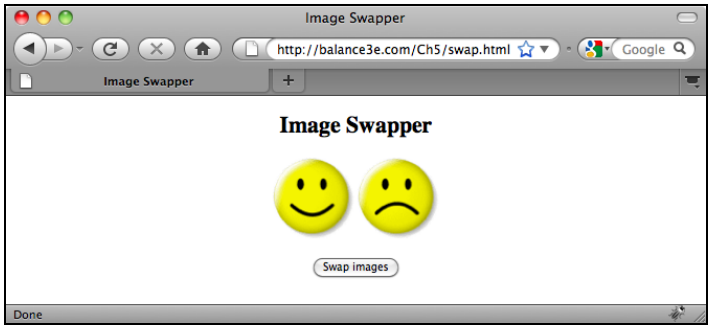
Variables for Temps

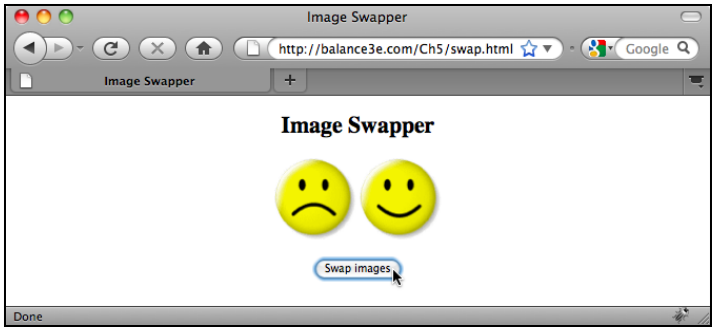
```
 1. <!doctype html>
 2. <!-- swap.html                                          Dave Reed  -->
 3. <!-- Web page that swaps two images at the click of a button.  -->
 4. <!-- ================================================  -->
 5.
 6. <html>
 7.  <head>
 8.    <title>Image Swapper</title>
 9.  </head>
10.
11.  <body>
12.    <div style="text-align:center">
13.      <h2>Image Swapper</h2>
14.      <p>
15.        <img id="leftImg" src="http://balance3e.com/Images/happy.gif">
16.        <img id="rightImg" src="http://balance3e.com/Images/sad.gif">
17.      </p>
18.      <input type="button" value="Swap images"
19.             onclick="saved=document.getElementById('leftImg').src;
20.                      document.getElementById('leftImg').src=
21.                        document.getElementById('rightImg').src;
22.                      document.getElementById('rightImg').src=saved;">
23.    </div>
24.  </body>
25. </html>
```

sometimes, a variable is needed to store a value so it is not lost

when the button is clicked, the IMG sources are swapped

- the `leftImg` source is saved in a variable
- then, can overwrite `leftImg` source with `rightImg` source
- finally, can assign stored value to `rightImg`





Data Types

each unit of information processed by a computer belongs to a general category or *data type*

- e.g., string, number, Boolean (either true or false)

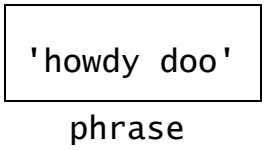
each data type is associated with a specific set of predefined operators that may be used by programmers to manipulate values of that type

- e.g., we have seen string concatenation via +
- similarly, standard operators are predefined for numbers
  - addition (+), subtraction (-), multiplication (*), division (/)

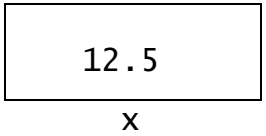
variables can be assigned various kinds of numerical values, including mathematical expressions formed by applying operators to numbers

- when an expression appears on the right-hand side, the expression is evaluated and the resulting value is assigned to the variable on the left-hand side

```
phrase = 'howdy' + ' doo';
```

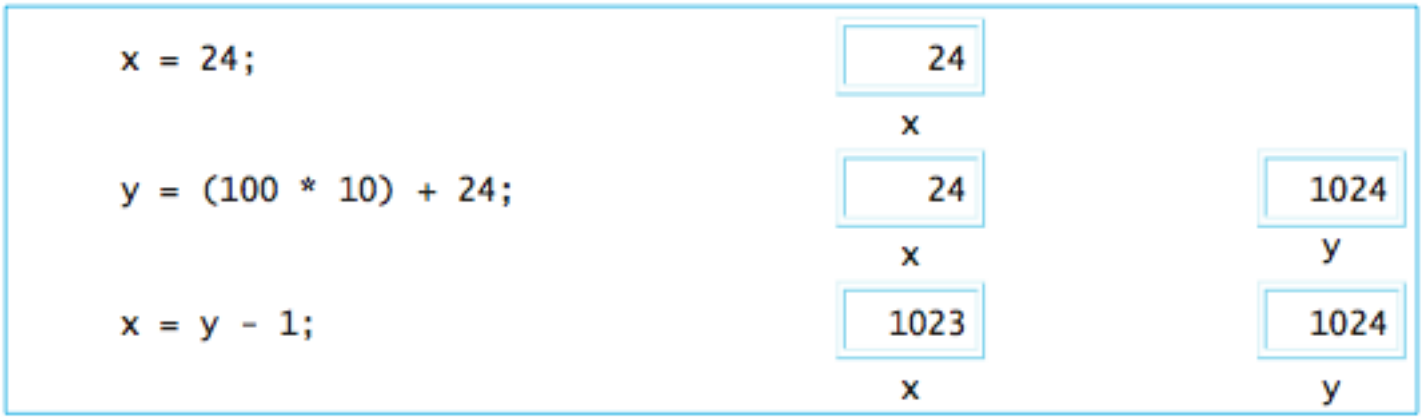



```
x = 50/4;
```



Variables and Expressions

if a variable appears in an expression, the value currently assigned to that variable is substituted



when you read an assignment statement, refrain from using *equals* for '='

- '=' does not represent equality, it represents assignment
- read it as *gets*

```
x = x + 1;        →        x gets x + 1;
```

Number Representation

useful facts about JavaScript numbers

- to improve readability, very large or very small number are displayed in *scientific notation:* `XeY` represents the value $X \times 10^Y$
  - e.g., `1e24` → 1×10^{24} → `1000000000000000000000000`

- JavaScript stores all numbers in memory cells of a fixed size (64 bits)
  - as a result, only a finite number of values can be represented
  - e.g., `1e308` can be represented, but `1e309` is treated as `Infinity`
    `1e-323` can be represented, but `1e-324` is treated as `0`

- even within the range 1e-323 . . . 1e309, not all numbers can be represented
  - note that between any two numbers lie infinitely more numbers!
  - JavaScript can represent approximately 17 significant digits
  - e.g.., `0.9999999999999999` can be represented exactly
    `0.99999999999999999` is rounded up to `1`

Text Boxes and Numbers

special care must be taken when accessing numbers from a text box

- the content of a text box is always accessed as a string (sequence of characters)
- e.g., if the user enters 500 in a box, then the value '500' is accessed

```
myNumber = document.getElementById('numBox').value;
alert('One more is ' + (myNumber + 1));
```

- if the user entered 12 in the box, what would be displayed?
- the alert message would be `One more is 121` WHY?
  - the box content is accessed as `'12'` which is stored in `myNumber`
  - the parenthesized sub-expression `(myNumber + 1)` is evaluated first
  - since this is a mixed expression, the number `1` is converted to `'1'` then concatenated
  - the result, `'121'`, is then concatenated to the end of `'One more is '`

what is needed is a mechanism for converting strings of digits into numbers

- e.g., '500' → 500, '1.314' → 1.314, …

parseFloat Function

in mathematics, a *function* is a mapping from inputs to a single output

- e.g., the absolute value function: |-5| → 5, |17.3| → 17.3

from a programmer's view, a function is a "unit of computational abstraction"

- there is some computation required to calculate the output given the input(s)
- a JavaScript function encapsulates that computation and hides the details
  - applying a function to inputs is known as *calling the function*
  - the output of a function call is known as the *return value*

```
contents1 = document.getElementById('userbox').value;
```

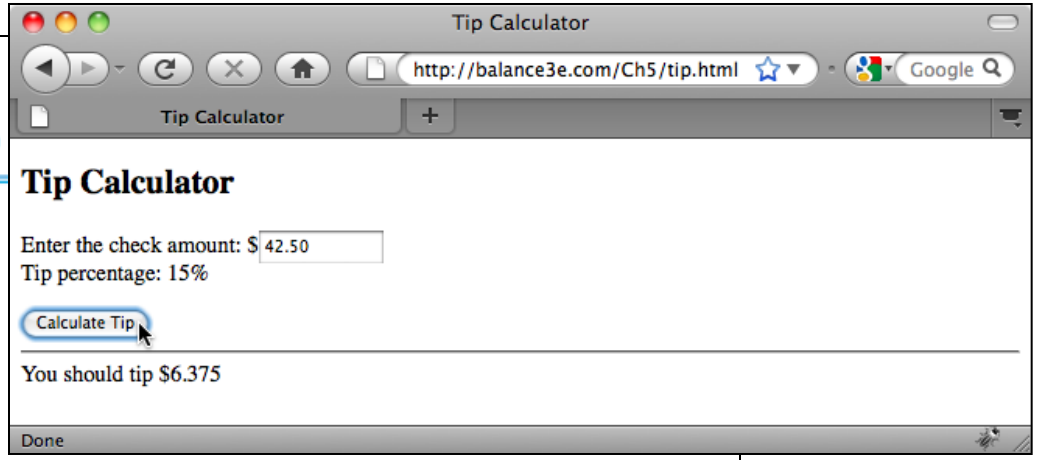
'123'
contents1

```
contents2 = parseFloat(document.getElementById('userbox').value;
```

123
contents2

Tip Calculator Page

```
 1. <!doctype html>
 2. <!-- tip.html
 3. <!-- Web page that calculates the tip
 4. <!-- ================================
 5.
 6. <html>
 7.  <head>
 8.    <title> Tip Calculator </title>
 9.  </head>
10.
11.  <body>
12.    <h2>Tip Calculator</h2>
13.    <p>
14.      Enter the check amount: $<input type="text" id="amountBox" size=10 value="">
15.      <br>
16.      Tip percentage: 15%
17.    </p>
18.    <input type="button" value="Calculate Tip"
19.        onclick="amount=parseFloat(document.getElementById('amountBox').value);
20.                 tip = amount * (15/100);
21.                 document.getElementById('outputDiv').innerHTML=
22.                   'You should tip $' + tip;">
23.    <hr>
24.    <div id="outputDiv"></div>
25.  </body>
26. </html>
```



calling the `parseFloat` function on the text in the box converts it to a number

this number is then assigned to `amount`

Common Pattern

similarly, Web pages that compute a value will follow the same basic pattern

- text boxes allow the user to enter numbers
- at the click of a button, the text box contents are accessed, `parseFloat` is applied to convert to numbers, and the numbers are stored in variables
- a computation involving those numbers is performed
- the result of the computation is displayed in the page

the JavaScript code executed at the button click similarly follows a pattern

```
VAR1 = parseFloat(document.getElementById('BOX_ID1').value);
VAR2 = parseFloat(document.getElementById('BOX_ID2').value);
...
VARn = parseFloat(document.getElementById('BOX_IDn').value);

RESULT = EXPRESSION_INVOLVING_VARIABLES;

document.getElementById('outputDiv').innerHTML =
  MESSAGE_INTEGRATING_STRING_LITERALS_AND_RESULT;
```

Errors and Debugging

in computer jargon, the term *bug* refers to an error in a program

- the process of systematically locating and fixing errors is *debugging*

three types of errors can occur

1. *syntax errors:* typographic errors
   - e.g., omitting a quote or misspelling a function name
   - since the browser catches these, they are usually "easy" to identify and fix
2. *run-time errors:* occur when operations are applied to illegal values
   - e.g., attempting to multiply a string or divide by zero
   - also caught by the browser, which either produces an error message or else returns a special value (string multiplication produces `NaN`, for "`Not a Number`"; division by zero produces `Infinity`)
3. *logic errors:* flaws in the design or implementation of a program
   - whenever your program produces the wrong result
   - since they are not caught by the browser (the program is legal, just not what you wanted), logic errors are hardest to identify

useful technique for identifying bugs: *diagnostic alert statements*

- at various intervals in the code, display the values of key variables using alert
- you can then isolate at what point the program is going wrong