Chapter 7
Functions and Randomness
Predefined Functions

recall: in mathematics, a function is a mapping from inputs to a single output
- e.g., the absolute value function: \(|-5| \rightarrow 5, \quad |17.3| \rightarrow 17.3\)

in JavaScript, a function is applied to inputs via a function call
- specify the function name, followed by inputs in parentheses

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JavaScript has
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```

in addition to parseFloat, JavaScript has numerous predefined mathematical functions

the functest.html page allows you to explore these
Math Functions

Math.sqrt determines the square root

Math.sqrt(9) → $\sqrt{9} = 3$
Math.sqrt(12.25) → $\sqrt{12.25} = 3.5$

Math.max determines the maximum of two values

Math.max(12, 8.5) → 12
Math.max(-3, -8) → -3

Math.pow raises a number to a power

Math.pow(2, 10) → $2^{10} = 1024$
Math.pow(2, -1) → $2^{-1} = 0.5$
Math.pow(9, 0.5) → $9^{0.5} = 3$

Math.min, Math.abs, Math.round, Math.ceil, Math.floor, …
Rounding Page

1. `<!doctype html>`
2. `<!-- round.html -->`
3. `<!-- Web page that rounds a number to 1 digit -->`
4. `<!-- == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == =

```html
<!doctype html>
<!-- round.html -->
<!-- Web page that rounds a number to 1 digit -->
<!-- == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == == =
text
id='numberBox'
siz=12
value=3.14159

<input type='button' value='Round It'
onclick='number=parseFloat(document.getElementById('numberBox').value);
rounded=Math.round(number*10)/10;
document.getElementById('outputDiv').innerHTML=
number + ' rounded to one decimal place is ' + rounded;'></text
id='outputDiv'></text
}`

uses the Math.round function to round a number to 1 digit

Math.round(3.14159*10)/10 \rightarrow Math.round(31.4159)/10 \rightarrow 31/10 \rightarrow 3.1
Math.random generates a pseudo-random number in the range [0...1)

- pseudo-random refers to the fact that the numbers appear randomly distributed, but are in fact generated by a complex algorithm
- note: this function has no inputs; it returns a different number each call

Math.random() \rightarrow 0.33008525626748814
Math.random() \rightarrow 0.213335955823927
Math.random() \rightarrow 0.8975001737758223
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```
Math.random() → 0.33008525626748814
Math.random() → 0.213335955823927
Math.random() → 0.8975001737758223
```

a call to Math.random can be placed in an expression to affect the range

```
2*Math.random() → [0...2)
Math.random() + 1 → [1...2)
9*Math.random() + 1 → [1...10)
Math.floor(9*Math.random()+1) → 1, 2, 3, ..., 9
```
Lucky Number Page

1. <!doctype html>
2. <!-- lucky1.html
3. <!-- Web page that generates a lucky number
4. <!-- ---------------------------------------------
5. 
6. <html>
7. <head>
8. <title> Lucky Number </title>
9. </head>
10. 
11. <body>
12. <h2>Lucky Number</h2>
13. <p>
14. Numbers are selected between <input type="text" id="minBox" size=3 value=0>
15. and <input type="text" id="maxBox" size=3 value=9>.
16. </p>
17. <input type="button" value="Generate Lucky Number"
18. onclick="min=parseFloat(document.getElementById('minBox').value);
19. max=parseFloat(document.getElementById('maxBox').value);
20. number=Math.floor(Math.random()*(max-min+1))+min;
21. document.getElementById('outputDiv').innerHTML=
22. 'Your lucky number is ' + number;">
23. <hr>
24. <div id="outputDiv"></div>
25. </body>
26. </html>

displays a random number from the range specified by the text boxes
Simplifying buttons

consider the button from lucky1.html:

```html
<input type="button" value="Generate Lucky Number"
onclick="min=parseFloat(document.getElementById('minBox').value);
max=parseFloat(document.getElementById('maxBox').value);
number=Math.floor(Math.random()*(max-min+1))+min;
document.getElementById('outputDiv').innerHTML=
'Your lucky number is ' + number;">
```

- the size of ONCLICK attribute makes the button complex and difficult to read
- plus, must be careful with nested quotes ("...") vs. '...')
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'Your lucky number is ' + number;">
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functions provide a mechanism for simplifying complex buttons such as this recall:

- functions minimize the amount of detail that has to be considered
  - e.g., can use \texttt{Math.sqrt} without worrying about how it works
- functions reduce the length and complexity of code
  - e.g., a single call to \texttt{Math.sqrt} replaces the underlying complex algorithm
Simple user-defined functions

In addition to JavaScript's predefined functions, the user can define new functions in the HEAD section and call them within the page.

We will explore user-defined functions fully in Chapter 9.

- For now, the following simple form suffices for simplifying buttons:

```javascript
function FUNCTION_NAME()
// Assumes: DESCRIPTION OF ANY ASSUMPTIONS ABOUT THE PAGE
// Results: DESCRIPTION OF THE ACTION PERFORMED BY THE FUNCTION
{
    STATEMENTS_TO_BE_EXECUTED
}
```

- A function definition begins with the word `function` followed by its name and `()`
  - A function name should be descriptive of the task being performed.
- Lines beginning with `//` are comments that describe the function's behavior.
  - Comments are ignored by the interpreter, but make code more user-readable.
- The statements to be executed when the function is called are placed between the curly braces.
Lucky Number Revisited

```html
1. <!doctype html>
2. <!-- lucky2.html
3. <!-- Web page that generates a lucky number from a range. -->
4. <!-- ------------------------------- -->
5. 
6. <html>
7.  <head>
8.   <title> Lucky Number </title>
9.   <script type="text/javascript">
10.    function GenerateNumber()
11.     // Assumes: minBox and maxBox define the range for the value
12.     // Results: picks a random number and displays it in outputDiv
13.     {
14.        min=parseFloat(document.getElementById('minBox').value);
15.        max=parseFloat(document.getElementById('maxBox').value);
16.        number=Math.floor(Math.random()*(max-min+1))+min;
17.        document.getElementById('outputDiv').innerHTML=
18.        'Your lucky number is ' + number;
19.     }
20.   </script>
21.  </head>
22. 
23.  <body>
24.   <h2>Lucky Number</h2>
25.   <p>
26.    Numbers are selected between
27.    <input type="text" id="minBox" size=3 value=0>
28.    and <input type="text" id="maxBox" size=3 value=9>.
29.   </p>
30.   <input type="button" value="Generate Lucky Number"
31.      onclick="GenerateNumber();">'
32.   <hr>
33.   <div id="outputDiv"></div>
34. </body>
35. </html>
```

the code from the button is moved to the user-defined GenerateNumber function

SCRIPT tags enclose the function definition in the HEAD

as a result, the button is greatly simplified

GENERAL ADVICE: if more than one statement is to be associated with a button, define a separate function
Example: Dice Simulation

suppose we wanted to simulate the roll of a 6-sided die

- at the click of a button, see a randomly selected roll of a die

```javascript
roll = Math.floor(Math.random()*6) + 1;
```

Example: Dice Simulation

```html
<!doctype html>
<!-- dice.html
<!-- This page simulates and displays...
<!-- ==-------------------------------

<html>
<head>
  <title>Die Rolls</title>
  <script type="text/javascript">
    function SelectImage() {
      // Assumes: die images are in balance3e.com/Images
      // Results: displays a randomly selected image of a 6-sided die
      roll=Math.floor(Math.random()*6) + 1;
      imgName='http://balance3e.com/Images/die' + roll + '.gif';
      document.getElementById('dieImg').src = imgName;
    }
  </script>
</head>
<body>
  <div style="text-align:center">
    <p>
      <img id="dieImg" alt="die image"
           src="http://balance3e.com/Images/die1.gif">
    </p>
    <input type="button" value="Click to Roll" onclick="SelectImage();">```

the desired die image can be selected using the roll variable

'.../die' + roll + '.gif'
the dice simulation page can be generalized into a random slide show
  - name the slide images using a consistent naming scheme

     slide1.jpg, slide2.jpg, slide3.jpg, ...

each time the button is clicked, the SelectImage function is called to randomly change the image

to select a random slide at the start, make use of the ONLOAD attribute of the BODY tag

<body onload="CODE_TO_EXECUTE_AFTER_PAGE_LOADS">

here, call SelectImage after the page loads in order to start with a random image

<body onload="SelectImage();">
Example: Banner Ads

the random slide show page can be generalized into random banner ads

- name the ad images using a consistent naming scheme
  
ad0.jpg, ad1.jpg, ad2.jpg, ...

the SelectAd function changes the ad to a random image

instead of calling the function at the click of a button, can automate using the predefined setInterval function

```
setInterval('JAVASCRIPT_FUNCTION_CALL', INTERVAL_IN_MSEC)
```

sets a timer and repeatedly executes the specified function at set intervals

```
<body onload="setInterval('SelectAd()', 5000);">
Example: Banner Ads

1. `<!doctype html>
2. <! -- bannerads.html
3. <! -- This page displays banner ads that
4. <! -- are displayed randomly.
5. 
6. <html>
7. <head>
8.   <title> Random Banner Ads </title>
9.   <script type="text/javascript">
10.    function SelectAd()
11.    // Assumes: the banners ad0.gif, ad1.gif, ad2.gif, and ad3.gif are
12.    // stored in http://balance3e.com/Images
13.    // Results: displays the next banner ad image in the page
14.    {
15.        adNum = Math.floor(4*Math.random());
16.        document.getElementById('adImg').src=
17.           'http://balance3e.com/Images/ad' + adNum + '.gif';
18.    }
19.   </script>
20. </head>
21. <body onload="setInterval('SelectAd()', 5000);">
22.   <div style="text-align:center">
23.       <img id="adImg" alt="banner ad"
24.           src="http://balance3e.com/Images/ad0.gif">
25.   </div>
26. </p>
27. <p>
28.    Contents of the page.
29. </p>
30. </body>
31. </html>"