how computers work (1)
more on representing information digitally

symbols represent information in many contexts
• dots and dashes in morse code
• raised dots are used to represent symbols in braille
• nucleotides (A,C,G,T) in our DNA encode our genetic makeup
• bits represent then information stored in a computer’s memory

why bits?
• electrical signals used to transmit information can be on or off
• data storage media such as disks have positions that are positively or negatively charged
• two possibilities – on/off, +ve/-ve – are represented as 0 and 1
• (there is nothing particularly special about 0 and 1, any pair of symbols would work just as well)

digitizing text, keyboard inputs
• text contains the symbols we see: letters, numbers, punctuation marks, spaces, and other symbols (e.g. for arithmetic, business)
• text also contains "nonprintable" characters: new-line, tab
• keyboards have yet more symbols on their keys, such as backspace, function keys

ASCII standard (American Standard Code for Information Interchange, 1960’s)
• the ASCII standard uses bit strings of length 8 to represent symbols
• see ASCII standard table in text, Chapter 8
• for example, “A” is represented as “01000001”, and the symbol “@” is represented as “01000000”
• how many symbols in total can be represented with 8 bits?
representing text in binary

<table>
<thead>
<tr>
<th>symbol</th>
<th>bit representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>01100001</td>
</tr>
<tr>
<td>b</td>
<td>01100010</td>
</tr>
<tr>
<td>c</td>
<td>01100011</td>
</tr>
<tr>
<td>d</td>
<td>01100100</td>
</tr>
</tbody>
</table>

- "bad" is represented as "01100010 011000101100100"  
- what does "01100011011000101100010" represent?

decimal digits in ASCII

- decimal digits also have ASCII representations
- for example, my office phone number, "822 1964", is represented as "00111000 00110010 00110010 00110001 00111001 00110110 00110100"
- decimal numbers embedded in text are represented in ASCII, *not* by converting to their binary representation

confusion with number representation

- when doing computer arithmetic, it is appropriate to represent numbers using binary notation
- when treating numbers as symbols (e.g., phone number), it is appropriate to represent the digits using ASCII notation

*When using numbers in a program, it can be important to know which representation is used!*

example: numbers in JavaScript

- suppose 'confuse' is declared as a variable:  
  ```javascript
  var confuse;
  ```
- depending on how 'confuse' is used in the code, it may store a number as a text string, or as an integer

numbers in JavaScript

- suppose `confuse` has value 1
- if `confuse` is a string, `confuse + 2 + 3` is the string “123”
- if `confuse` is an integer, then `confuse + 2 + 3` is 6!
- to help programmers, JavaScript provides ways to convert from text format to integer format
- if `confuse` is a string, then `parseInt(confuse) + 2 + 3` is 6

numbers in java

- Java syntax is designed to avoid any confusion about the representation of numbers
- the words `int` and `String` are used in variable declarations, to declare right from the start which type the variable has

*Examples:*
  ```java
  int width;
  String userName;
  ```
resources

- text chapter 8 (required reading)

- A Brief History of Character Codes, http://tronweb.super-nova.co.jp/characcodehist.html (useful additional reading)

- an on-line ASCII table + some additional information: www.jimprice.com/jim-asc.htm