

## how computers work (1)

more on representing information digitally

## overview

- already seen: decimal numbers, pictures can be represented using bits (0's and 1's)
- today:
  - using bits to represent text, keyboard inputs
  - subtleties of number representation

## 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 the 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, +voltage/-voltage – 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, 1960s)

- 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

symbol	bit representation
a	01100001
b	01100010
c	01100011
d	01100100

- “bad” is represented as “01100010 011000101100100”.
- What does “011000110110000101100010” represent?

## decimal digits in ASCII

- Decimal digits also have ASCII representations.
- For example, the CS department's phone number, “822-3061”, is represented as “00111000 00110010 00110010 00101101 00110011 00110000 00110110 00110001”. (Even the dash has an ASCII code!)
- 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 ‘number’ is declared as a variable:  
**var number;**
- Depending on how ‘number’ is used in the code, it may store a number as a text string, or as an integer.

## numbers in JavaScript

- Suppose **number** has value **1**.
- If **number** is a string, **number + 2 + 3** is the string “**123**”.
- If **number** is an integer, then **number + 2 + 3** is **6**!
- To help programmers, JavaScript provides ways to convert from text format to integer format.
- If **number** is a string, then **parseInt(number) + 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:*

**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](http://www.jimprice.com/jim-asc.htm)
- an on-line ASCII converter:  
<http://nickciske.com/tools/binary.php>