CS1003/1004: Intro to CS, Spring 2004

Lecture #4: Language concepts, data storage

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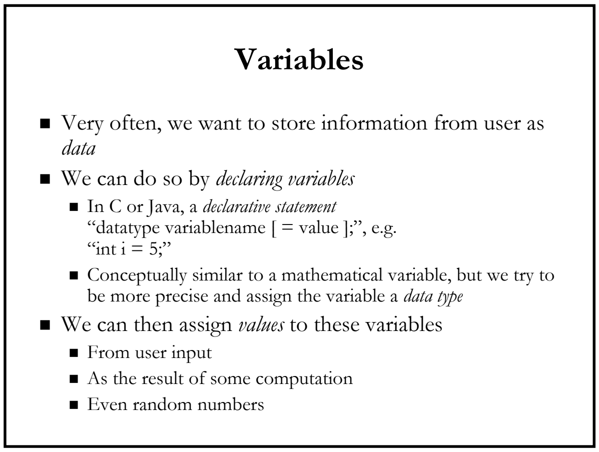
Administrivia

- HW#1 is out!
  - I hope you're checking the website frequently
  - Should know everything for the HW this week
  - Programming is about 5 lines of code, so don't worry too much
- Fourth TA: Rob Tobkes
  - Info on website
  - We now have office hours 5 days a week
- Labs update
  - How'd your first lab go?
  - *This week only:* Suhit's combining Thursday C labs to see what works best
- Register for the webboard, or else!
- Put books on reserve?

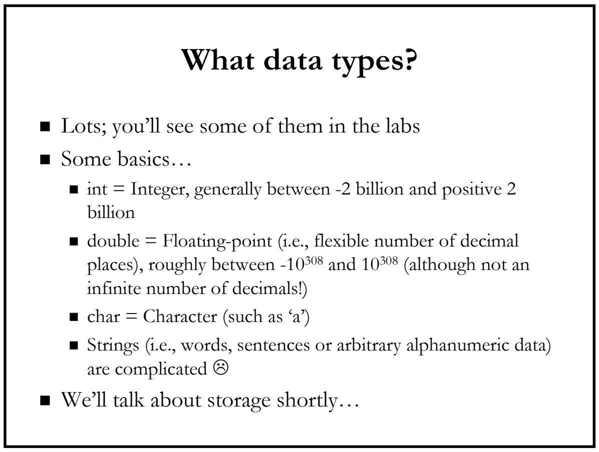
Agenda

- Finish up language intro
- Start data representation concepts
- Hopefully everything you need for the theory part of HW#1
  - If not, I'll trim the HW#1 theory a little bit
- Some overlap with labs…



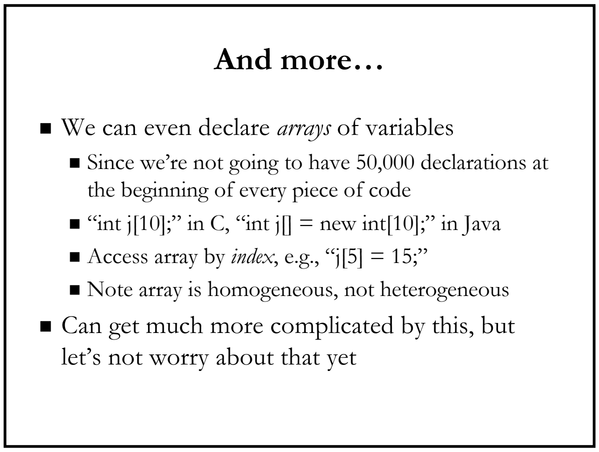
Variables

- Very often, we want to store information from user as *data*
- We can do so by *declaring variables*
  - In C or Java, a *declarative statement* “datatype variablename [= value];”, e.g. “int i = 5;”
  - Conceptually similar to a mathematical variable, but we try to be more precise and assign the variable a *data type*
- We can then assign *values* to these variables
  - From user input
  - As the result of some computation
  - Even random numbers



What data types?

- Lots; you’ll see some of them in the labs
- Some basics…
  - int = Integer, generally between -2 billion and positive 2 billion
  - double = Floating-point (i.e., flexible number of decimal places), roughly between -10^{308} and 10^{308} (although not an infinite number of decimals!)
  - char = Character (such as ‘a’)
  - Strings (i.e., words, sentences or arbitrary alphanumeric data) are complicated ☹
- We’ll talk about storage shortly…



And more…

- We can even declare *arrays* of variables
  - Since we’re not going to have 50,000 declarations at the beginning of every piece of code
  - “int j[10];” in C, “int j[] = new int[10];” in Java
  - Access array by *index*, e.g., “j[5] = 15;”
  - Note array is homogeneous, not heterogeneous
- Can get much more complicated by this, but let’s not worry about that yet

Constants and literals

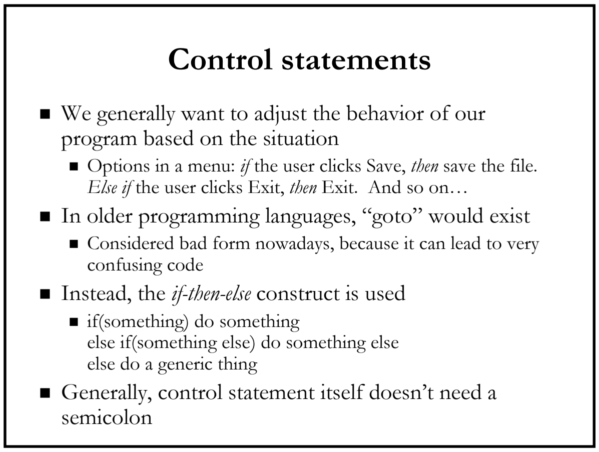
- We don't need to declare variables for everything; as we saw, we can just *literally* put numbers in place when we want to do things
  - e.g., print the sum of 10 and 15
- We can also declare that certain variables are *constants* for sanity's sake
  - "const double Pi = 3.141592654" in C
  - "final double Pi = 3.141592654" in Java

Assignments

- Once we've *declared* our variables, we might want to assign them values
  - x = 5;
- Can do this at declaration-time, too
  - int x = 5;
- Key concept: the above two statements are not functionally equivalent!
- *Operators* commonly used in assignments
  - * for multiply, + for add, - for subtract…
  - Operator precedence applies: use parentheses!

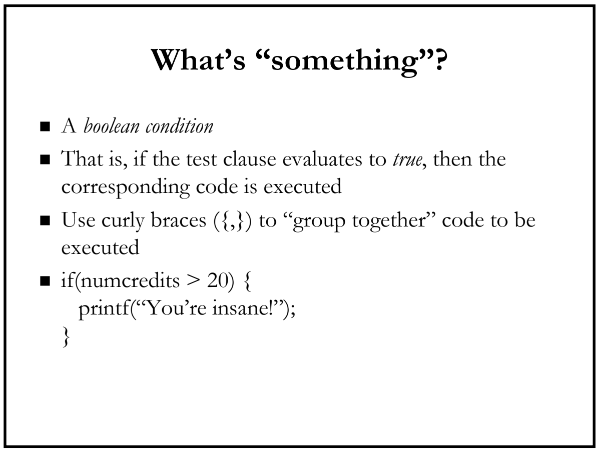
Comments

- As your code becomes more complex, you'll want to document it a little
- In C and Java, can use "/* comment */" notation
  - Can be multiple lines
- In Java, can also use "// comment" notation
  - Single-line only
  - Sometimes works in C too, but depends on age of compiler



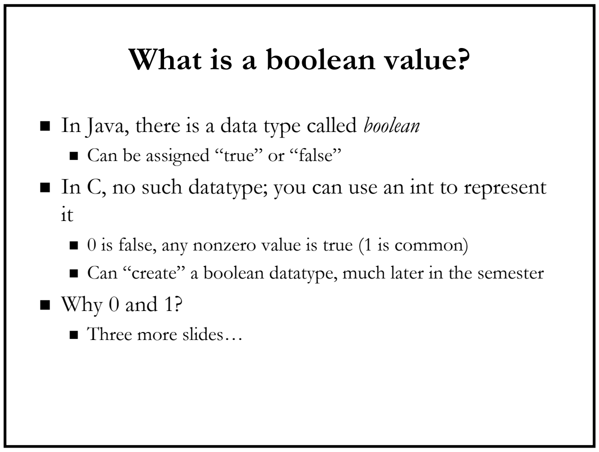
Control statements

- We generally want to adjust the behavior of our program based on the situation
  - Options in a menu: *if* the user clicks Save, *then* save the file. *Else if* the user clicks Exit, *then* Exit. And so on…
- In older programming languages, “goto” would exist
  - Considered bad form nowadays, because it can lead to very confusing code
- Instead, the *if-then-else* construct is used
  - if(something) do something
    else if(something else) do something else
    else do a generic thing
- Generally, control statement itself doesn’t need a semicolon



What’s “something”?

- A *boolean condition*
- That is, if the test clause evaluates to *true*, then the corresponding code is executed
- Use curly braces ({,}) to “group together” code to be executed
- if(numcredits > 20) {
    printf(“You’re insane!”);
  }



What is a boolean value?

- In Java, there is a data type called *boolean*
  - Can be assigned “true” or “false”
- In C, no such datatype; you can use an int to represent it
  - 0 is false, any nonzero value is true (1 is common)
  - Can “create” a boolean datatype, much later in the semester
- Why 0 and 1?
  - Three more slides…

What are boolean operators?

- A *logic operator* that takes one or two operands and produces a boolean result
- For numbers:
  - Equals: ==
  - Greater than: >
  - Less than: <
- Extremely important: "=" is not "=="
  - "=" is an **assignment operator**, while "==" is a **boolean test**
  - C programmers: *you will get burned by this at least once in your life*
  - Java programmers: the compiler will usually warn you

Combine boolean values?

- AND: &&
  - Only true if both operands are true
- OR: ||
  - Only false if both operands are false
- NOT: !
  - Takes single operand and reverses it
- We can draw "truth tables" for each of these
- Let's do a few examples…

Loops

- Instead of doing something *once*, can we do something *many times* until a boolean condition is satisfied?
  - Yes, we can
  - while(something is true) do something
  - Will keep on running (potentially forever)
  - How can we make an infinite loop (not that we'd want to)?
  - How can we make our loops non-infinite?
- for statement: more complex notation for loops
  - In labs…
- *Iteration* is the fancy term for such repetition

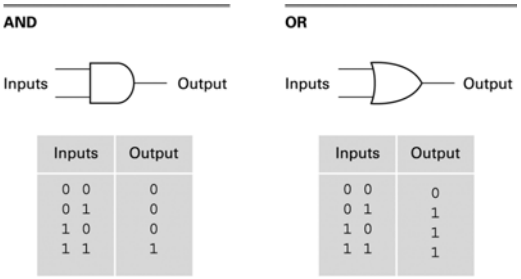
How is this information represented in the machine?

- *Bit* (binary digit): either 0 or 1
  - Why?
- What can we do with bits?
  - Combine them together into larger values
  - Base 2 representation of numbers…
    - Converting from decimal to binary: divide by 2 repeatedly and keep the remainder
    - Converting from binary to decimal: multiply the i^{th} digit by 2^i (with i starting at 0 for the ones' digit)

Binary representation, cont'd.

- We can also represent characters (in general) as a binary sequence
  - ASCII: American Standard Code for Information Interchange
  - Originally used 7 bits to represent a single character
  - Now, 8 bits used == *byte* in most computers today
  - Google for "ASCII table"
- Finally, we can apply *logic* operators to bit values
  - AND, OR, NOT, XOR are the four basics
    - Why XOR?
  - We've already seen the first two…

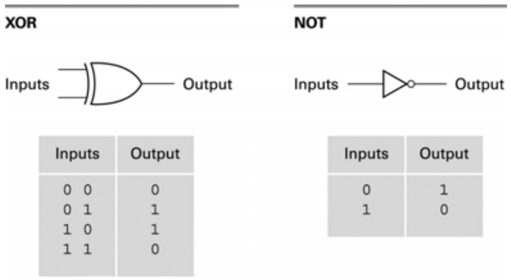
AND and OR



Inputs	Output
0 0	0
0 1	0
1 0	0
1 1	1

Inputs	Output
0 0	0
0 1	1
1 0	1
1 1	1

NOT and XOR



Inputs	Output
0 0	0
0 1	1
1 0	1
1 1	0

Inputs	Output
0	1
1	0

Logic diagrams

- Use those four building blocks to build increasingly complex logic operators, and ultimately devices
- Example: how would we diagram a AND b AND c?

Next time

- Finish up data storage
- Start talking about understanding algorithms using all our newfound information