COMP1511 Week 2

Variables and if-Statements

Joanna Lin

Reminders

- Please log onto the course forum if you haven't already
- Respond to my welcome email titled 'Welcome to COMP1511'. If you can't find that email, please send me an email at joanna.lin@student.unsw.edu.au.
- Week 2 labs are due **Monday 8pm** in week 3.

What we'll cover today

variables and if-statements

- **Variables**
  - **Declaring** and **initialising** variables.
  - **Printing** and **scanning** in variables.
  - **Arithmetic operators**.
  - Difference between variables and `#defines`
- **if-statements**
  - Why do we need if-statements?
  - How do we structure if-statements?
  - **Logical operators**.

Variables

Declaring and Initialising

- Programs consist of two fundamental components: storing information and doing stuff with that information. Variables allow us to store information.
- Declaring a variable means informing the program that the variable exists.
  - In C, we must provide the type and variable name: `int width;`
  - The computer knows to assign a block of memory of size appropriate for that type.
  - Types: **`int`** (whole number e.g. **`5`**), **`double`** (decimal point e.g. **`5.1`**), **`char`** (single character e.g. **`'a'`**)
  - A character is stored as an integer representing the ASCII value of character. Use command **`ascii -d`** to see the numbers corresponding to each letter.
  - This means we can do arithmetic like **`'a' + 1`**, which sums together **`1`** and the ASCII value of **`'a'`** (which is conveniently **`'b'`**).
  - Style tip: the variable name should be descriptive where possible.
- Initialising a variable means giving it a value.
  - We can either initialise the variable on a line after declaration or on the same line as declaration:

```
int width;
width = 5;
```

OR

```
int height = 10;
```

Printing and Scanning Variables

- Printing and scanning variables requires format identifiers
  - `%d` to print integers (or ASCII value of characters) in base 10.
  - `%lf` to print doubles.
  - `%c` to print single characters
- When scanning, we accept input in a certain format, which are then assigned in order to the variables on the right.
- `&` indicates the address of the variable, so that `scanf` knows where to put the value

```
int width;
int height;
scanf("%d %d", &width, &height);
```

- When printing, the format identifiers within the double quotes are replaced in order by the list of values given after.

```
printf("Width: %d, Height: %d\n", width, height);
```

Variables

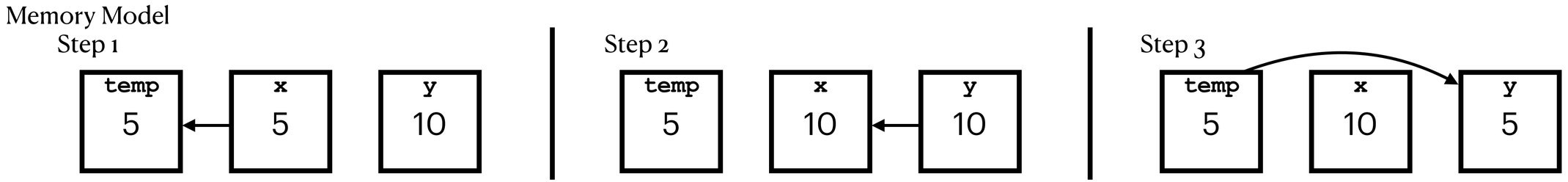
Changing their values

- The point of variables is that we can use and change their value.
- Think of = as an assignment operator, rather than ‘equals to’.
  - We’re evaluating the right and assigning that value to the variable on the left.

Step 1
Step 2
Step 3

```
// Swap x and y
int temp = x;
x = y;
y = temp;
```

Memory Model



Each box corresponds to the block of memory given to the variable upon declaration.
We’re assuming that variables `x` and `y` have been initialised to 5 and 10 respectively.

Arithmetic Operators

Doing quick maff

- Basic operations:
  - `+` addition
  - `-` subtraction
  - `*` multiplication
  - `/` division
  - `%` remainder

Basic examples

```c
int area = height * width;
int perimeter = 2 * (height + width);
```

Printing

```c
printf("Area: %d, Perimeter: %d\n", area, perimeter);
```

```c
printf("Area: %d, Perimeter: %d\n", height * width, 2 * (height + width));
```

Adding a variable to itself

```c
int perimeter = 0;
perimeter += 2 * height;
perimeter += 2 * width;
```

is shorthand for

```c
int perimeter = 0;
perimeter = perimeter + 2 * height;
perimeter = perimeter + 2 * width;
```

- Note that:
  - decimal part is ignored when dividing two integers (e.g. `2 / 3` evaluates to `0`)
  - the remainder operator is like modulo, but exhibits different behaviour when dealing with negatives

`#define`'d constants

What are they and how do they differ from variables?

- **`#define`**'d constants are important for making our code more readable.

```
#define MAX_LENGTH 45000
```

- They cannot change from the provided value, unlike a variable (hence 'constant')
- **`#define`** is a preprocessor directive.
  - A preprocessor directive is dealt with at the compilation stage. The compiler acts upon these directives, altering the C source code before machine code is produced.
  - In the case of **`#define`**, the compiler replaces every instance of the constant with its actual value.
  - This means that, when you actually run your program, a #define'd constant doesn't actually take up memory, unlike a variable

if-statements

Why do we need them and how do we write them?

- We don't want to always run the same piece of code. What if the user enters a negative side length, or if we want to safeguard against integer overflows?
  - We can use if-statements to run code only if a given condition is true.
- All if-statements must start with the **`if`** keyword, followed by a condition enclosed in brackets and a set of curly braces within which we write code. Optionally, we can add **`else if`**(s) and/or an **`else`** to account for other cases when needed.
- **Style tips**
  - code within curly braces are indented 4 spaces further into the line than the line containing the **`if`**
  - closing curly brackets are aligned with the line containing the **`if`**.
  - **`else if`** and **`else`** should be on the same line as the closing curly bracket corresponding to the previous **`if`** or **`else if`**

```
if (condition1) {
    // run if condition1 is true
} else if (condition2) {
    // run if condition2 is true
    // AND condition1 is false
} else {
    // run if condition1 and condition2
    // are false
}
```

`if`s vs `if`s and `else if`s

Important difference

When we have if-statements one after another, every condition is checked, regardless of whether the previous condition was true or false.

```
if (condition1) {
    // run if condition1 is true
}
if (condition2) {
    // run if condition2 is true
}
```

When we chain together **`if`** and **`else if`**s, only a maximum of one branch of the chain is run — the first whose condition is true. Once we find a true condition, the rest of the chain is skipped.

```
if (condition1) {
    // run if condition1 is true
} else if (condition2) {
    // run if condition2 is true
    // AND condition1 is false
}
```

Logical operators

Writing conditions

- `==`, `!=` equal to, not equal to
- `>`, `>=` greater than, greater than or equal to
- `<`, `<=` less than, less than or equal to
- `&&` logical and (true if left and right is true)
- `||` logical or (true if left or right is true)
- Conditions written with logical operators evaluate to either `0` or `1`, corresponding to false and true respectively.
- This means we can store a long condition inside an `int` variable, improving readability

Example use

```c
if (0 <= width && width <= MAX_LENGTH && 0 <= height && height <= MAX_LENGTH) {
    // User entered valid coordinates
    ...
} else {
    printf("Please enter positive lengths less than %d\n", MAX_LENGTH);
}
```

```c
int are_lengths_valid = 0 <= width && width <= MAX_LENGTH &&
                        0 <= height && height <= MAX_LENGTH;
if (are_lengths_valid) {
    // User entered valid coordinates
    ...
} else {
    printf("Please enter positive lengths less than %d\n", MAX_LENGTH);
}
```

Refactoring Logic

Error-checking first approach

- We often prefer to exit the program if we find any errors first.
  - This makes our code a lot less nested (less indented), so it's much neater.
  - We can get all the invalid (usually simpler) cases out of the way first, giving us a peace of mind when writing the rest of the program.

Original approach (okay)

```
if (are_lengths_valid) {
    // User entered valid coordinates
    ...
} else {
    printf("Please enter positive lengths less than %d\n", MAX_LENGTH);
}
```

Check for errors first (better!)

```
if (!are_lengths_valid) {
    printf("Please enter positive lengths less than %d\n", MAX_LENGTH);
    return 1;
}

// User entered valid coordinates
...
```