Control Statements and Functions

EECS 211

Winter 2018

Agenda

- Computation
  - What is computable? How best to compute it?
  - Abstractions, algorithms, heuristics, data structures
- Language constructs and ideas
  - Sequential order of execution
  - Expressions and statements
  - Selection
  - Iteration
  - Functional abstraction
- How to talk about syntax

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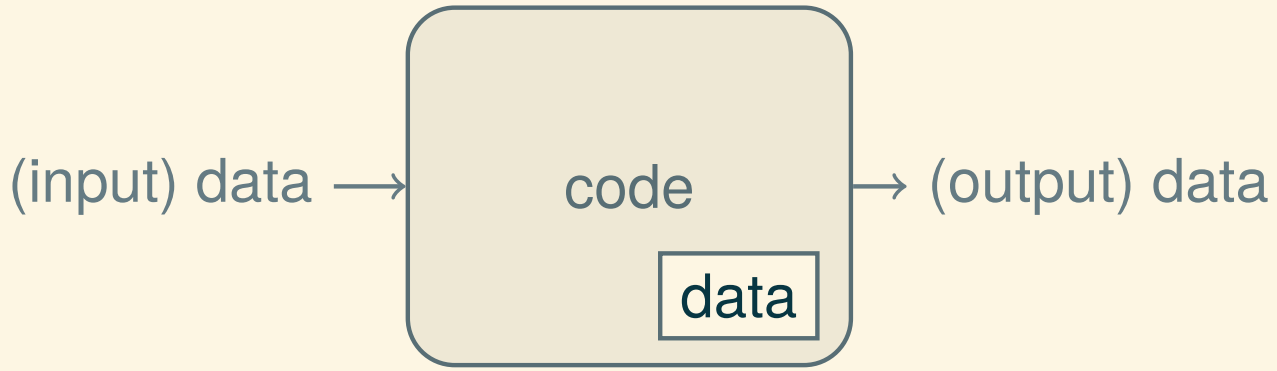
So what I’ll be showing you is mainly syntax for things you already know.

Computation: the big picture



- Input: from keyboard, files, mouse, other input devices, the network, other programs
- Code: consumes the input and does something to produce the output
- Output: to the screen, files, printer, other output devices, the network, other programs

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- Data organization (often key to good code)
  - Input/output formats
  - Communication protocols
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Note the emphasis is on structure and organization

Programming language features

Each language feature exists to express a fundamental idea:

$+$	addition
$*$	multiplication
{ *stm stm* ... }	sequencing
if (*expr*) *stm* else *stm*	selection
while (*expr*) *stm*	iteration
f(x);	function call

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The meaning of each feature is simple, but we combine them into programs of arbitrary complexity.

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`a * b + c / d` means `(a * b) + (c / d)`, not `((a * b) + c) / d`

When in doubt, parenthesize (but don't overdo it)

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Some common operators:

Operator(s)	Meaning	bool	int	double
+, −, ∗, /	arithmetic		Yes	Yes
%	remainder		Yes	
==	equal	Yes	Yes	Yes
!=	not equal	Yes	Yes	Yes
<, <=, >, >=	comparisons		Yes	Yes
&&, ||	and, or	Yes		

Concise operators

For many binary operators, there are (roughly) equivalent more concise versions:

a $+=$ c	means	a $=$ a $+$ c
a $*=$ scale	means	a $=$ a $*$ scale
$++$a	means	a $+=$ 1
	or	a $=$ a $+$ 1

Use them when they make your code clearer

Syntax of Expressions

In BNF:

⟨*expr*⟩ := ⟪*numeric-literal*⟫
| ⟪*string-literal*⟫
| ⟪*variable*⟫
| ⟨*expr*⟩ ⟪*op*⟫ ⟨*expr*⟩
| ⟨*expr*⟩ (⟨*expr-list*⟩)
| (⟨*expr*⟩)

⟨*expr-list*⟩ :=
| ⟨*expr*⟩ ⟨*expr-cont*⟩

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Statements

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Examples:

- `a = b;`
- `double d2 = 2.5;`
- `if (x == 2) y = 4;`
- `while (cin >> number) numbers.push_back(number);`
- `int average = (length + width) / 2;`
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I don't expect you to recognize all of these…yet.

Syntax of Statements

⟨*type*⟩ := `int` | `double` | `string` | ···

⟨*decl*⟩ := ⟨*type*⟩ ⟨⟨*variable*⟩⟩ `=` ⟨*expr*⟩
| ⟨*type*⟩ ⟨⟨*variable*⟩⟩

⟨*stmt*⟩ := ⟨*expr*⟩ `;`
| ⟨*decl*⟩ `;`
| `if (` ⟨*expr*⟩ `)` ⟨*stmt*⟩ `else` ⟨*stmt*⟩
| `if (` ⟨*expr*⟩ `)` ⟨*stmt*⟩
| `while (` ⟨*expr*⟩ `)` ⟨*stmt*⟩
| `for (` ⟨*decl*⟩ `;` ⟨*expr*⟩ `;` ⟨*expr*⟩ `)` ⟨*stmt*⟩
| `return` ⟨*expr*⟩ `;`
| `{` ⟨*stmt-list*⟩ `}`

⟨*stmt-list*⟩ :=
| ⟨*stmt*⟩ ⟨*stmt-list*⟩

Selection

Sometimes we must choose between alternatives.

For example, suppose we want to identify the larger of two numbers. We can use an if statement:

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if (a < b)
    max = b;
else
    max = a;
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The syntax is

⟨*stmt*⟩ := `if (` ⟨*expr*⟩ `)` ⟨*stmt*⟩ `else` ⟨*stmt*⟩

Sequencing

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Use a compound statement:

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}
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⟨*stmt*⟩ := { ⟨*stmt-list*⟩ }

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Iteration (while)

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int i = 0;

while (i < 100) {
        cout << i << '\t' << square(i) << '\n';
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Iteration (for)

```
int i = 0;          // initialization

while (i < 100) {
        cout << i << '\t' << square(i) << '\n';
        ++i;        // step
}
```

This pattern—a loop with initialization and step—is so common that there's special syntax for it:

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for (int i = 0; i < 100; ++i)
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for loops are the idiomatic way to count in C++

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for (*init-decl*; *cond-expr*; *step-expr*)
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init-decl;
while (*cond-expr*) {
    body-stm
    step-expr;
}

Functions

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A call to the function square(int), which might be defined like

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⟨*fun-decl*⟩ := ⟨*type*⟩ ⟪*variable*⟫ (⟨*args*⟩) { ⟨*stmt-list*⟩ }

⟨*args*⟩ :=

| ⟨*type*⟩ ⟪*variable*⟫ ⟨*more-args*⟩

⟨*more-args*⟩ :=

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- …is logically separate.
- …make the program clearer.
- …can be reused.
- …eases testing, distribution of labor, and maintenance.

A function example

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int square(int n) {
        return n * n;
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int main () {
        cout << sqrt(square(3) + square(4)) << '\n';
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double sqrt(double);
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