

CSC 211: Computer Programming

Introduction to C/C++

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Administrative notes

Administrative notes

- A00 Groups have been assigned
- Lab#01
- Are you on Piazza?
 - Get the app!
- Are you on Gradescope?
- Discussion sessions this week
- Communication Preference
 - Piazza Only

Algorithms and Programs

Problems, Algorithms and Programs

• Problem

- ✓ task to be performed (precisely defined)
- ✓ well-defined **inputs** and **outputs**
- ✓ may include constraints

• Algorithm

- ✓ set of concrete steps required to solve a problem
- ✓ properties:
 - it must be correct (must compute the desired function)
 - it is composed of a series of concrete and finite number steps
 - there can be no ambiguity as to which step will be performed next
 - it must terminate

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Problems, Algorithms and Programs

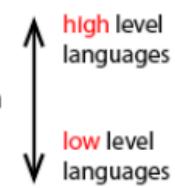
• Program

- ✓ instantiation of an algorithm using a programming language

Snap, Scheme, Prolog, Lisp

JavaScript, Python, Java, Alice, Scratch

C, C++



<https://bjc.edc.org/bjc-r/cur/programming/6-computers/1-abstraction/03-software-languages.html>

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Example

An Algorithm

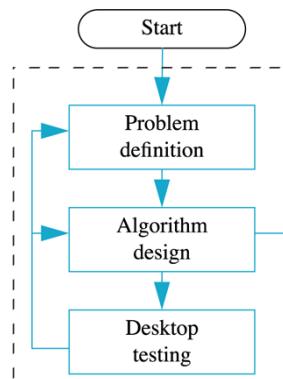
Algorithm that determines how many times a name occurs in a list of names:

from: Problem Solving with C++, 10th Edition, Walter Savitch

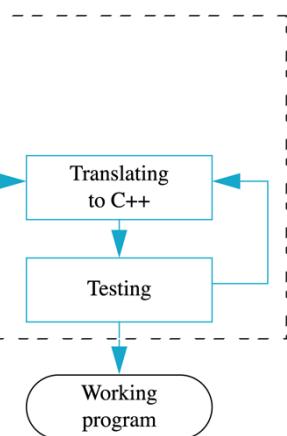
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Program Design Process

Problem-solving phase



Implementation phase



from: Problem Solving with C++, 10th Edition, Walter Savitch

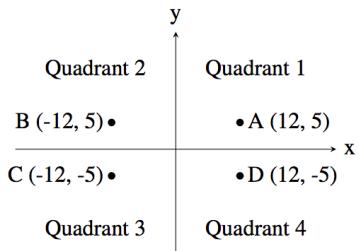
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Example

Read a point from user and determine the quadrant it is in. You can assume that neither of the two coordinates will be 0

```
read first number into x
read second number into y
if x and y are positives
    print "Quadrant 1"
else if x is positive and y is negative
    print "Quadrant 4"
else if x is negative and y is negative
    print "Quadrant 3"
else
    print "Quadrant 4"
```

<https://open.kattis.com/problems/quadrant>



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Example (program)

```
# read numbers
X = input('Enter first number: ')
y = input('Enter second number: ')

# perform selection
if x > 0 and y > 0:
    print('Quadrant 1')
else if x > 0 and y < 0:
    print('Quadrant 4')
else if x < 0 and y < 0:
    print('Quadrant 3')
else:
    print('Quadrant 2')
```

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Example (program)

```
#include <iostream>

int main() {
    // read numbers
    int x, y;
    std::cout << "Enter first number: ";
    std::cin >> x;
    std::cout << "Enter second number: ";
    std::cin >> y;
    // perform selection
    if (x > 0 && x > 0) {
        std::cout << "Quadrant 1\n";
    }
    else if (x > 0 && y < 0) {
        std::cout << "Quadrant 4\n";
    }
    else if (x < 0 && y < 0) {
        std::cout << "Quadrant 3\n";
    }
    else {
        std::cout << "Quadrant 2\n";
    }
}
```

<https://godbolt.org/z/oFwd6N>

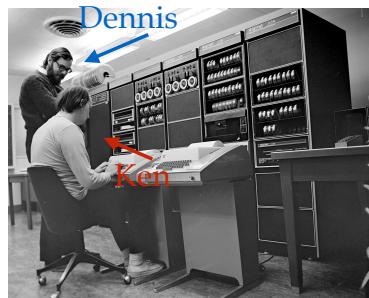
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C/C++

History

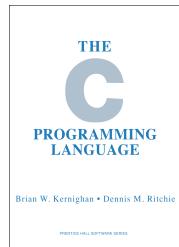
- ✓ Ken Thompson created the B language while developing UNIX (implemented in assembly) at Bell Labs [1970]

✓ slow and interpreted



- ✓ Dennis Ritchie began development of a compiler for B and could produce executable code [1972]

✓ became known as the C language
✓ Linux kernel reimplemented in C

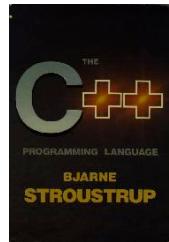
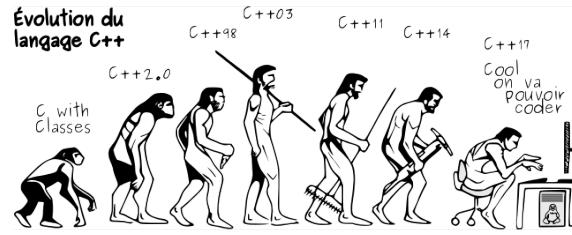
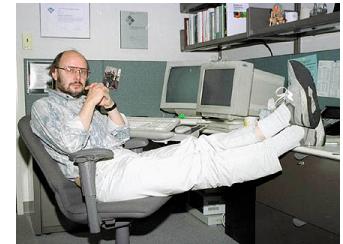


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History

- ✓ Bjarne Stroustrup began the development of C++ (also from Bell Labs) [1980]

✓ object oriented, generic, functional



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C++?

- ✓ Static type system
 - ✓ prevents unintended operations
 - ✓ optimized machine code (i.e. faster and/or using less memory)

- ✓ Object oriented language
 - ✓ improves maintainability

- ✓ When to use it?
 - ✓ performance matters
 - ✓ developing time is less important
 - ✓ specialized libraries require it

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C/C++?

Pros

- ✓ vast documentation freely available
- ✓ provides different levels of abstraction (from data structures to memory management)
- ✓ it is compiled
- ✓ high performance

Cons

- ✓ steep learning curve
- ✓ large language
- ✓ no automatic memory management (can be an advantage)
- ✓ requires attention to minor details
- ✓ GUIs only available through extensive libraries (less portable)

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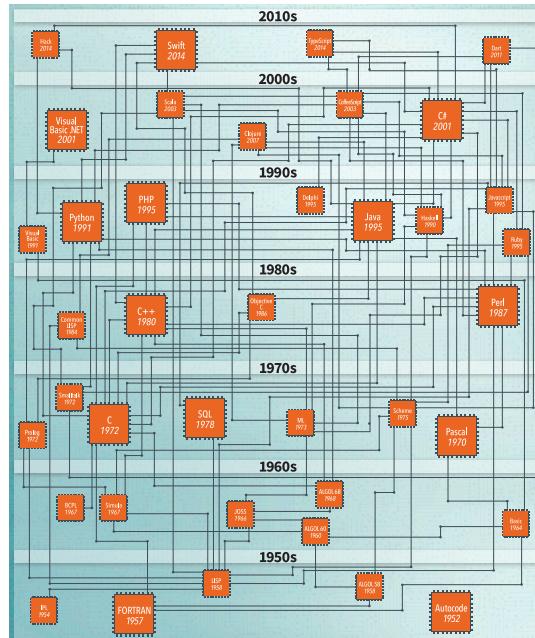
Console applications

The screenshot shows the CS50 IDE interface. At the top, there's a menu bar with File, Edit, Find, View, Go. Below it is a toolbar with icons for workspace, settings, share, collaborate, outline, and debugger. The main area displays a code editor with the file 'hello.c' containing the following code:

```
1 #include <stdio.h>
2
3 int main(void)
4 {
5     printf("hello, world\n");
6 }
```

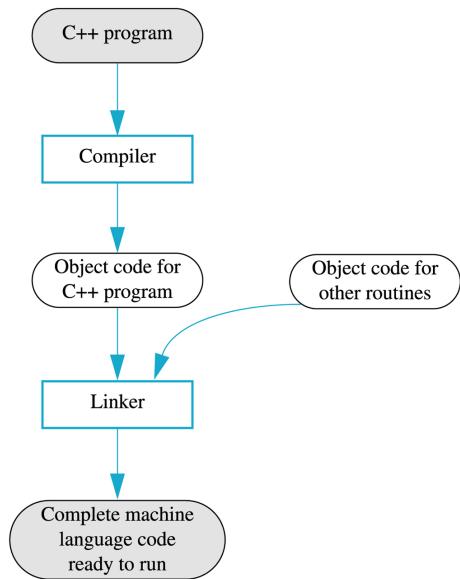
Below the code editor is a terminal window showing the command 'workspace/' followed by a dollar sign '\$'. On the right side of the IDE, there are tabs for Collaborate, Outline, and Debugger.

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Preparing a C++ Program for Running

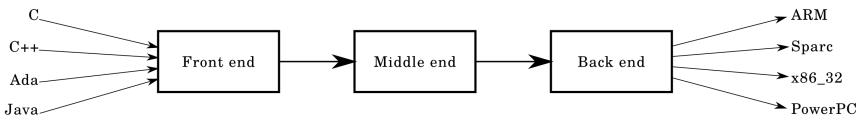


from: Problem Solving with C++, 10th Edition, Walter Savitch

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Compilers

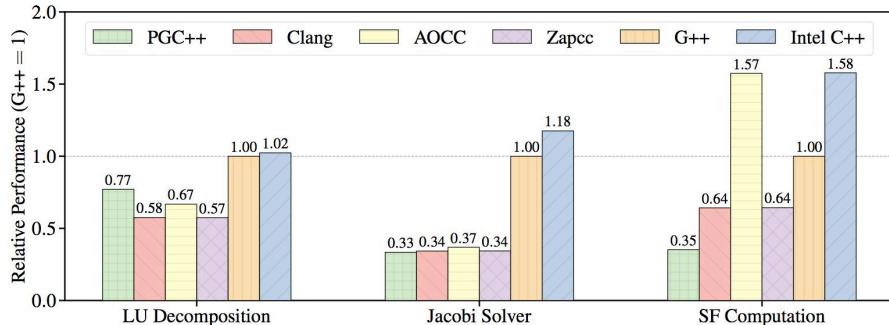
- A computer program that ...
 - ✓ translates source code from one programming language to another (usually from high-level to low-level languages)
 - ✓ performs code optimizations
 - ✓ provides error checking



Correctness is paramount. Compilers cannot afford to fail.

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C++ Compilers



single-threaded, higher is better

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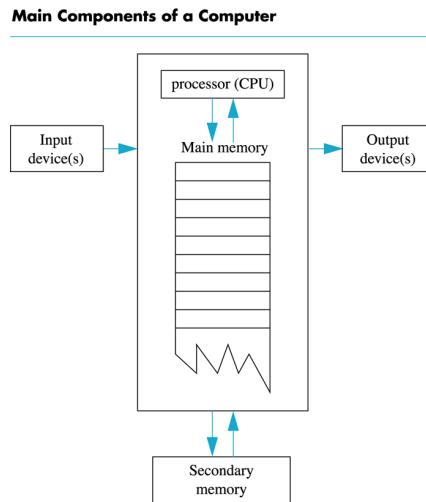
```
#include <iostream>

int main()
{
    std::cout << "Hello World!" << std::endl;
    return 0;
}
```

```
~/workspace/ $ g++ hello.cpp -o hello
~/workspace/ $ ls -l
total 16
-rwx----- 1 ubuntu ubuntu 9176 Sep 10 15:21 hello*
-rw------- 1 ubuntu ubuntu     91 Sep 10 15:20 hello.cpp
~/workspace/ $ ./hello
Hello World!
~/workspace/ $
```

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How programs run?



from: Problem Solving with C++, 10th Edition, Walter Savitch

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