Lecture 1: Introduction to C++ Programming

Curtin FIRST Robotics Club (FRC) Pre-season Training

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Programming

What is a Computer Program?

A computer program is a collection of instructions that performs a specific task when executed by a computer. A computer requires programs to function, and typically executes the program's instructions in a central processing unit.

A part of a computer program that performs a well-defined task is known as an algorithm. A collection of computer programs, libraries and related data are referred to as software.

Problem Solving

Recipe to writing programs:

1. Understand the problem.

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Recipe to writing programs:

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   You may use diagrams or plain English to do this.
4. Translate your solution into a program.

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Recipe to writing programs:

1. Understand the problem.
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   You may use diagrams or plain English to do this.
4. Translate your solution into a program.
5. Run your program and see if it works.

Problem Solving

Recipe to writing programs:

1. Understand the problem.
2. Think of a solution.
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4. Translate your solution into a program.
5. Run your program and see if it works.
   - Yes? Hurray! Victory!

Problem Solving

Recipe to writing programs:

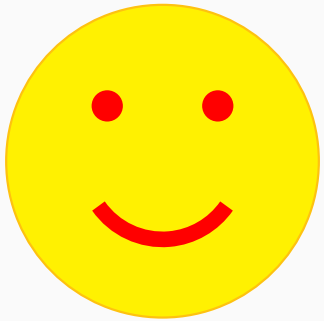
1. Understand the problem.
2. Think of a solution.
3. Describe the solution in as much detail as possible.
   You may use diagrams or plain English to do this.
4. Translate your solution into a program.
5. Run your program and see if it works.
   - Yes? Hurray! Victory!
   - No? Go back to 1

Example

Think like a computer!

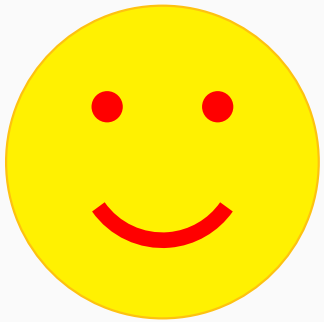
What steps do you need to take to draw a smiley face?

Example



Example Code Appreciation

Lets just take a minute to appreciate what it took to make that smiley face



```
{center}
\begin{tikzpicture}
\path[fill=yellow,
        draw=yellow!75!red]
        (0,0) circle (1cm);
\fill[red] (45:5mm) circle (1mm);
\fill[red] (135:5mm) circle
  ↪  (1mm);
\draw[line width=1mm,red]
  ↪  (215:5mm) arc
  ↪  (215:325:5mm);
\end{tikzpicture}
\end{center}
```

And act like it totally didn't take me like ... 2 hours to figure out how to do it.

C++

The C++ Programming Language

C++ is a general-purpose programming language with a bias towards systems programming that:

- Is a better C,
- Supports data abstraction,
- Supports object-oriented programming, and
- Supports generic programming.

The Pervasiveness of C++

Why choose C++

Brief History of C++

The C++ programming language is an extension of C that was developed by (the god himself) Bjarne Stroustrup in the early 1980s at Bell Laboratories.

Example C++ Program (Hello World)

```cpp
#include <iostream>

int main()
{
    cout << "Hello World!";
    return 0;
}

```

```
[user@pc]$  Hello World!
```

Environment Setup

Setup and Installation

C++ Editors

Compiling

Editing, Compiling, and Execution

A Simple Program to Add Two Numbers

The following is an example of a simple program written in C++.

```
1  #include <iostream>
2  using namespace std;
3
4  int main()
5  {
6      int num1, num2, total;
7
8      cout << "Enter integers to be added:" << endl;
9      cin >> num1 >> num2;
10     total = num1 + num2;
11     cout << "The sum is " << total << endl;
12
13     return 0;
14 }
```

I double dare you to guess what this program does.

A Simple Program to Add Two Numbers

The following is an example of a simple program written in C++.

```cpp
#include <iostream>
using namespace std;

int main()
{
    int num1, num2, total;

    cout << "Enter integers to be added:" << endl;
    cin >> num1 >> num2;
    total = num1 + num2;
    cout << "The sum is " << total << endl;

    return 0;
}
```

This program is designed to read two numbers typed by the user at the keyboard; Compute their sum and display the result on the screen.

A Simple Program to Add Two Numbers

The following is an example of a simple program written in C++.

```cpp
#include <iostream>
using namespace std;

int main()
{
    int num1, num2, total;

    cout << "Enter integers to be added:" << endl;
    cin >> num1 >> num2;
    total = num1 + num2;
    cout << "The sum is " << total << endl;

    return 0;
}
```

What could we do to make understanding this program easier?

A Simple Program with Comments

Add comments!

```cpp
// Program to add two integers typed by user at keyboard
#include <iostream>
using namespace std;

int main()
{
    int num1, num2, total;

    cout << "Enter integers to be added:" << endl;
    cin >> num1 >> num2;
    total = num1 + num2;
    cout << "The sum is " << total << endl;

    return 0;
}
```

A Not So Simple Program Because OMG whoever wrote this is an ass

Or hey, if you want to guarantee yourself a job

```
#include <iostream>
using namespace std;
int main(){
    int n,b,memes = 42;
cout<<"gimmie:" <<endl;
        cin>>n>>b;
    memes=n+b;
cout<<"got em" <<memes+1-1<<endl;
    return (pow(meme, 0) - 1);}
```

Program Structure and Syntax

C++ uses notation that may appear strange to non-programmers (and me).
The notation is part of the programming language `syntax`.

Syntax Formal rules that specify the structure of a legal program.

Program Structure and Syntax

The notation and explanations which follow will appear strange if you have never written a computer program.

Don’t worry about them or how the program works. This will be explained in more detail later.

The following is an overview.

Program Structure and Syntax

Every C++ program consists of a header and a main body and has the following structure:

```
1  // Comment statements which are ignored by computer
2  /* Also a comment */
3  #include < header file name >
4
5  int main()
6  {
7      declaration of variables;
8      statements;
9
10     return 0;
11 }
```

Program Structure and Syntax

```
1  // Program to add two integers typed by user at keyboard
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7      int num1, num2, total;
8
9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Line 1

- Lines beginning with // indicate that the rest of the line is a **comment**.
- Comments are inserted by programmers to help people read and understand the program.
- Can be placed anywhere in a program.

Program Structure and Syntax

```
1  // Program to add two integers typed by user at keyboard
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7      int num1, num2, total;
8
9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Line 2

- Lines beginning with # are instructions to the compiler's preprocessor.
- The **include** instruction says "what follows is a file name, find that file and insert its contents right here".
- Here the file iostream contains the definitions of **cin**, **cout**.

Program Structure and Syntax

```
1  // Program to add two integers typed by user at keyboard
2  #include <iostream>
3  using namespace std;
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5  int main()
6  {
7      int num1, num2, total;
8
9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Line 3

- Specifies that names used in the program (ie. **cin** and **cout**) are defined in the standard libraries.
- This is used to avoid problems with other libraries which may also use these names.

Program Structure and Syntax

```
1  // Program to add two integers typed by user at keyboard
2  #include <iostream>
3  using namespace std;
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5  int main()
6  {
7      int num1, num2, total;
8
9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
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14     return 0;
15 }
```

Line 5

- When the program is executed the instructions will be executed in the oder they appear in the main body of the program.
- The main body is delimited by main() and the curly braces { }.
- This line also specifies that main() will return a value of type integer (int) on its completion (see line 14).

Program Structure and Syntax

```
1  // Program to add two integers typed by user at keyboard
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7      int num1, num2, total;
8
9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Line 6

- The opening (left) brace marks the beginning of the main body of the program.
- The main body consists of instructions which are **declarations** defining the data or **statements** on how the data should be processed.
- All C++ declarations and statements must end with a semicolon;

Program Structure and Syntax

```
1  // Program to add two integers typed by user at keyboard
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7      int num1, num2, total;
8
9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Line 7

- This is a declaration. The words num1 and num2 are the names of **variables**.
- A variable is a location in the computer's memory where a value can be stored for use by a program.
- The declaration also specifies the variable **type**

Program Structure and Syntax

```
1  // Program to add two integers typed by user at keyboard
2  #include <iostream>
3  using namespace std;
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6  {
7      int num1, num2, total;
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9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Line 9

- This statement instructs the computer to output the `string` of characters contained between the quotation marks, followed by a new line **endl**.
- The location of the output is denoted by **cout** which in this case will be the terminal screen.

```
1  // Program to add two integers typed by user at keyboard
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3  using namespace std;
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5  int main()
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7      int num1, num2, total;
8
9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Line 10

- This statement instructs the computer to read data typed in at the keyboard (standard input), denoted by **cin**.
- These values are **`assigned to`** (stored in) variables num1 and num2.

```
1  // Program to add two integers typed by user at keyboard
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7      int num1, num2, total;
8
9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Line 11

- This statement is an **arithmetic expression** which assigns the value of the expression num1 + num2 (sum of integer values stored at num1 and num2) to the variable total.

```
1  // Program to add two integers typed by user at keyboard
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7      int num1, num2, total;
8
9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Line 12

- Instructs the computer to display the value of the variable total.

Program Structure and Syntax

```
1  // Program to add two integers typed by user at keyboard
2  #include <iostream>
3  using namespace std;
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5  int main()
6  {
7      int num1, num2, total;
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9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Line 14

- The last instruction of every program is the return statement.
- The return statement with the int value 0 (zero) indicates to the operating system that the program has terminated successfully.

Program Structure and Syntax

```
1  // Program to add two integers typed by user at keyboard
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3  using namespace std;
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5  int main()
6  {
7      int num1, num2, total;
8
9      cout << "Enter integers to be added:" << endl;
10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Line 15

- The closing (right) brace marks the end of the main body of the program.

Program Structure and Syntax

```
1  // Program to add two integers typed by user at keyboard
2  #include <iostream>
3  using namespace std;
4
5  int main()
6  {
7      int num1, num2, total;
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10     cin >> num1 >> num2;
11     total = num1 + num2;
12     cout << "The sum is " << total << endl;
13
14     return 0;
15 }
```

Blank lines

- Lines 4, 8 and 13 are used to make the program more readable.
- They will be ignore by the compiler.
- **Whitespace** (spaces, tabs and newlines) are also ignored (unless within quotation marks).

Program Structure and Syntax

```cpp
// Program to add two integers typed by user at keyboard
#include <iostream>
using namespace std;

int main()
{
    int num1, num2, total;

    cout << "Enter integers to be added:" << endl;
    cin >> num1 >> num2;
    total = num1 + num2;
    cout << "The sum is " << total << endl;

    return 0;
}
```

Indentation

- It does not matter where you place statements, either on the same line or on separate lines.

Development Environment & Development Cycle

C++ programs go through 3 main phases during development:

Editing Writing the program,

Compiling Translating the program to executable code and detecting syntax errors, and

Debugging Running the program and checking for logical errors.