EEE102

C++ Programming and Software Engineering II

Lecture 1 Introduction

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Room EE512/EE222

Course Structure of EEE102

- **Allocation of Time:**

Lectures	Seminar	Tutorials	Lab/Practice	Private Study	Total
11			22	42	75

- **Assessment:**

Assessment	75%
Final Project	25%

Class Rules

- 1. Attend all your lectures and lab sessions.
- 2. Submit all your course work (e-copy) on ICE.
- 3. Observe the deadline for your course work, university policy applied for late submission.
- 4. Collusions and plagiarism are absolutely forbidden. University policy applied once caught.
  - Students submitting the same or close to the same report for the assessment will be awarded “ZERO” and reported to Registry for record.
- 5. If failed, resit will be a class room examination.

Course Materials

- Reference books:
  - H.M.Deitel and P.J.Deitel, “Small C++ How to program”, Prentice Hall, 2006.
  - S. Prata, “C++ Primer Plus, 5th ed.”, SAMS, 2005.
  - B. Eckel, “Thinking in C++, 2nd ed.”, Prentice Hall, 2002.
- Online resources:
  - The C++ Resources
    - http://www.cplusplus.com/
  - C++ tutorial for C users:
    - http://www.4p8.com/eric.brasseur/cppcen.html

What we will learn in this module?

- Software Engineering
- From C to C++
- Introduction to Classes and Objects
  - Functions, arrays and pointers with objects
- Advanced topics on classes
  - Class composition
  - Dynamic memory allocation
  - Operator overloading
  - Inheritance
  - Polymorphism
- Stream I/O in C++

Lecture 1 Introduction - Outline

- What is software engineering?
  - Software as an Engineering Product
  - The design model of software engineering – waterfall model
- Basic Principles for Software Design
  - Abstraction
  - Modularity
  - Information hiding
- C++ Programming Language and Object Oriented Programming
  - History of C and C++
  - What is object oriented programming (OOP)
  - A simple C++ program
  - Compilation process
  - Typical Structure of the Source Code

1.1 Introduction – Software Engineering

- SOFTWARE
  - Basically, **A set of instructions to a computer** to perform specified computation, operation or control.
  - A piece of software may consist of a number of programme modules.

- SOFTWARE ENGINEERING
  - The establishment and use of sound engineering principles to cost effectively design and produce software that is reliable and works efficiently on real machines.

Introduction – Software Engineering

- Software as an Engineering Product ---- Business

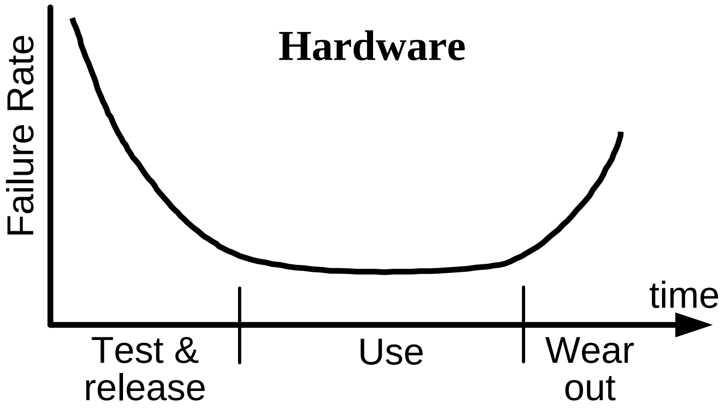
  Need to use a set of tools, methods and techniques for the design of a software product.

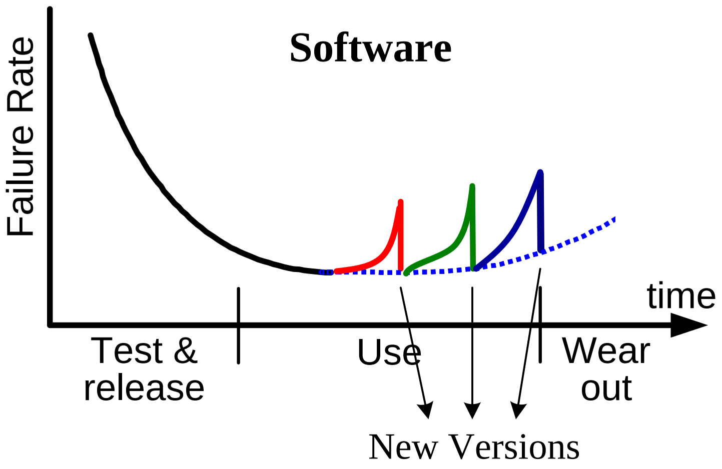
  - Pre-planned (specifications)
  - Designed (away from computer)
  - Constructed (coding)
  - Tested
  - User manual for information and maintenance

Introduction – Software Engineering

- Important to Engineering Students ?
  - Simulation and Modelling
    - Final year project, research project in future for optimum design and simulation of complex systems.
  - Design of embedded systems
    - Multimedia systems or control systems.
  - Development of Commercial Software
    - Where there is a computer, there must be software
  - Job aspects ---- Lots of advertisement requires knowledge in C/C++

Lifecycle and characteristics of engineered products

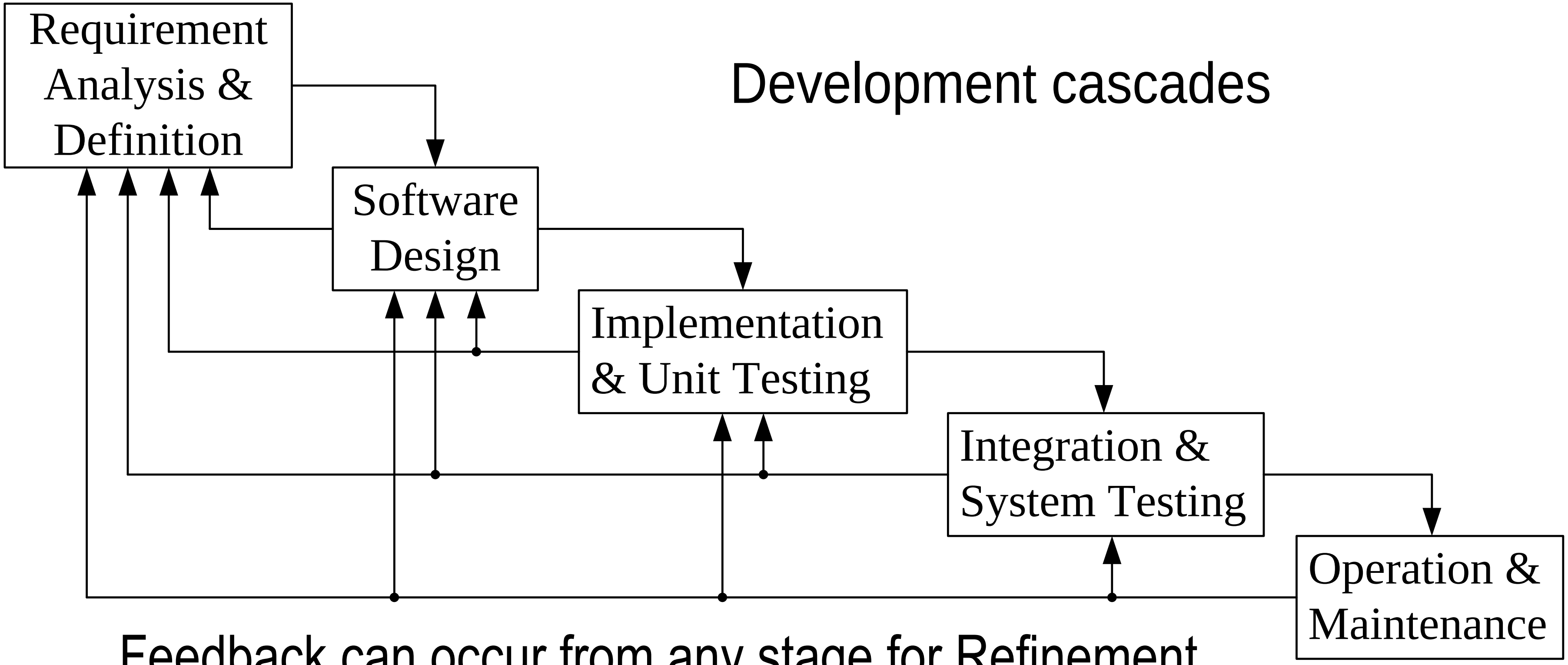




- Product
- Manufactured
- Physical system
- Ware out
- Spare part to replace
- Instructions for use

•Product
•Developed
•Logical system
•Does not ware out
•No spare part to replace
•Instructions for installation and use

1.2 The Waterfall model of software design


Requirement Analysis & Definition
Software Design
Implementation & Unit Testing
Integration & System Testing
Operation & Maintenance

Development cascades

Feedback can occur from any stage for Refinement

2. Basic Principles for Software Design

- Abstraction
  - Important for structured programming
- Modularity
  - For efficient management and test
- Information hiding (coupling and cohesion)
  - To reduce the interference between modules

2.1 Abstraction

When a program becomes big, it is more difficult to handle it.

- Problem:
  - It is important to understand the whole problem for which you are going to produce a software package; However, human brains can only understand part of a complicated system at one time.
- Solution:
  - Use of Structured programming where we divide the whole software package into smaller pieces (modules). Each time we concentrate on a specific part of the programme.
- How to divide?

Top Level of Abstraction

Always start from the customer's requirements -- Describe the major actions that a programme needs to perform, just forget all the details associated with each major job.

- Example:
  - A programme will read information of all employees in an organisation from a disk file, sort the names in alphabetic order and display the information on the screen. It also outputs the sorted information into a disk file with another file name.

Second Level of Abstraction

Then progressing into the major tasks and produce a list

- Major Tasks:
  - Read in information from file
  - Sort names
  - Display information on monitor
  - Write sorted information to another file

Tips: Regard each of the tasks as a black box.

Lower Level of Abstraction

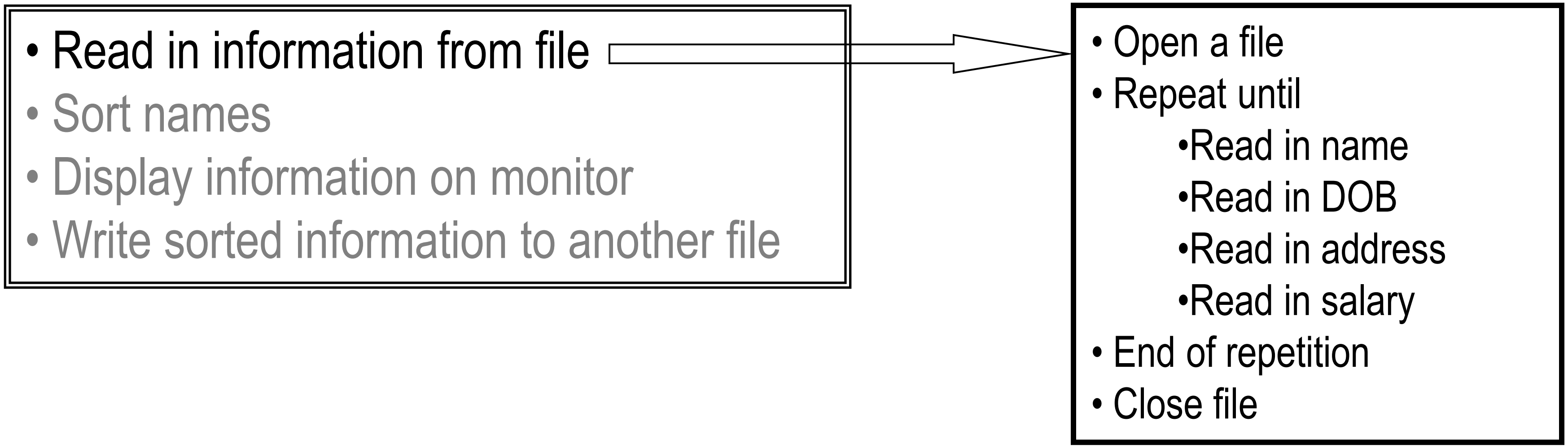
Progressing into more details that how a specific task should be done. You may need to break a major task into several smaller ones depending on the problem you are working on

- Task 1: Read in information from file
  - Open a file
  - Repeating the following for each employee
    - Read in name
    - Read in DOB
    - Read in address
    - Read in salary
  - Until information read for all staff
  - Close file

2.2 Modularity and Information Hiding

A programme (piece of software) consists of a number of sub-programmes (modules).

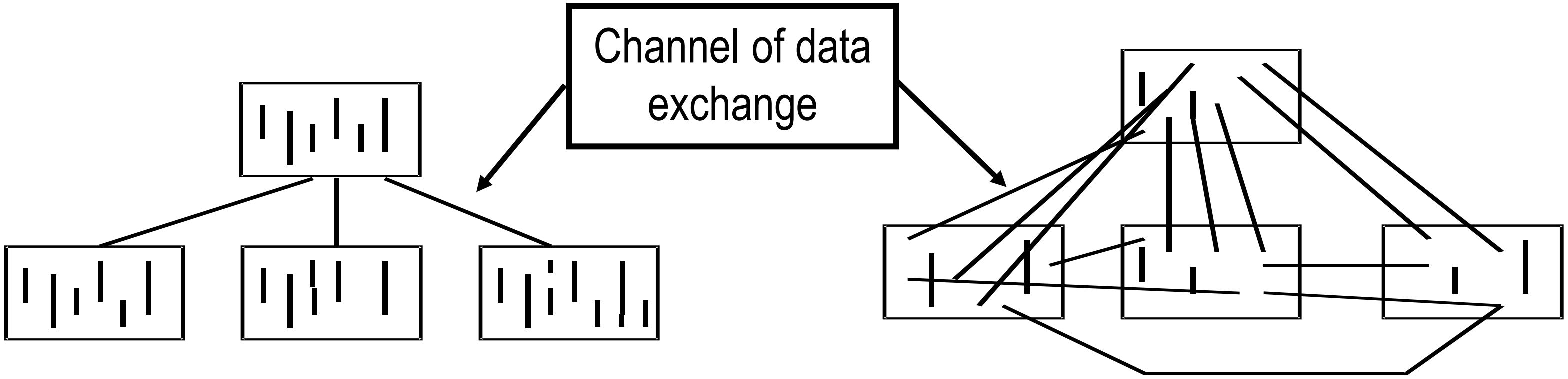
- ✓ Ideally, Each module perform only one simple task.
- ✓ Modules should be reusable when needed.
- ✓ Information contained in a module should not be accessed from another module. It can only be exchanged through module interface.



- Read in information from file
- Sort names
- Display information on monitor
- Write sorted information to another file

- Open a file
- Repeat until
    - Read in name
    - Read in DOB
    - Read in address
    - Read in salary
- End of repetition
- Close file

Module Content and Communication between Modules



Channel of data exchange

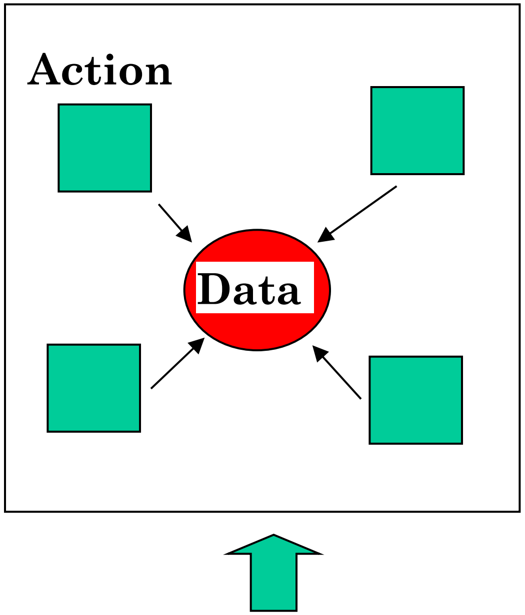
Weak coupling
Strong cohesion
Easy to change

Strong coupling
Weak cohesion
Difficult to change

- **Coupling:**
  - Is a measure of the amount of interaction between modules. Less is better.
- **Cohesion:**
  - Is a measure of the amount of interaction between action and information within a module. More is better

Types of cohesion

- Coincidental (undesirable):
- Logical: Example: Output text to screen for user
  Output line to printer
  Output data to file
- Temporal: Example: Clear screen
  Read data from a file
  Display on screen



- Communicational: Actions acting on common data are grouped together.

  Example: Convert and print the price in British pounds

- Functional (desirable):

  A module performs a well-defined action on a group of data.

Types of cohesion

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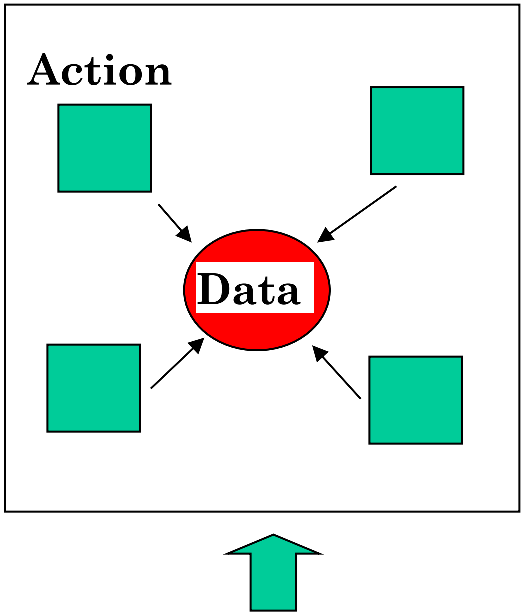


- Communicational: Actions acting on common data are grouped together.

  Example: Convert and print the price in British pounds
- Functional (desirable):

  A module performs a well-defined action on a group of data.

3. C++ Programming Language

- What is Programming?
- Why do we learn Programming?
- Programming languages
  - Low-level: Assembly & Machine Languages – are specific to machine architectures; closer to machines than “problems”
  - High-level: They are used to write programs that are independent of the machine architectures on which they will be executed.
  - Examples of high-level languages are Fortran, C, C++ and Java.
- C and C++

3.1 History of C and C++

- C
  - Designed by Dennis Ritchie at Bell Labs 1972
  - ANSI C standard adopted in 1989.
  - ISO C (C90) standard adopted in 1990 (same as ANSI C).
  - Joint ANSI/ISO committee revised the standard (C99)

- C++
  - Bjarne Stroustrup of Bell Labs develops C++ in 1979 (C with Classes).
  - In 1983, the name of the language was changed from C with Classes to C++
  - ISO/IEC 14882:1998 (C++98) published in 1998
  - A corrected version ISO/IEC 14882:2003 published in 2003.

3.2 C++ and Object Oriented Programming

- C++ is developed from C
  - Introduce object-oriented programming (OOP) features to C.
  - It offers classes, which provide the features commonly present in OOP languages: abstraction, encapsulation, modularity, inheritance, and polymorphism

- Object Oriented Programming
  - Object – a data structure consisting of data fields and methods together with their interactions – to design applications and computer programs.
  - Object Oriented Programming Languages – C++, JAVA, C#
  - Procedure Oriented Programming – C, BASIC

3.3 A simple program

The first program – print “Hello world” to the standard output

- C - Hello world

```
#include <stdio.h>

int main(void)
{
    printf(“Hello world\n");
    return 0;
}
```

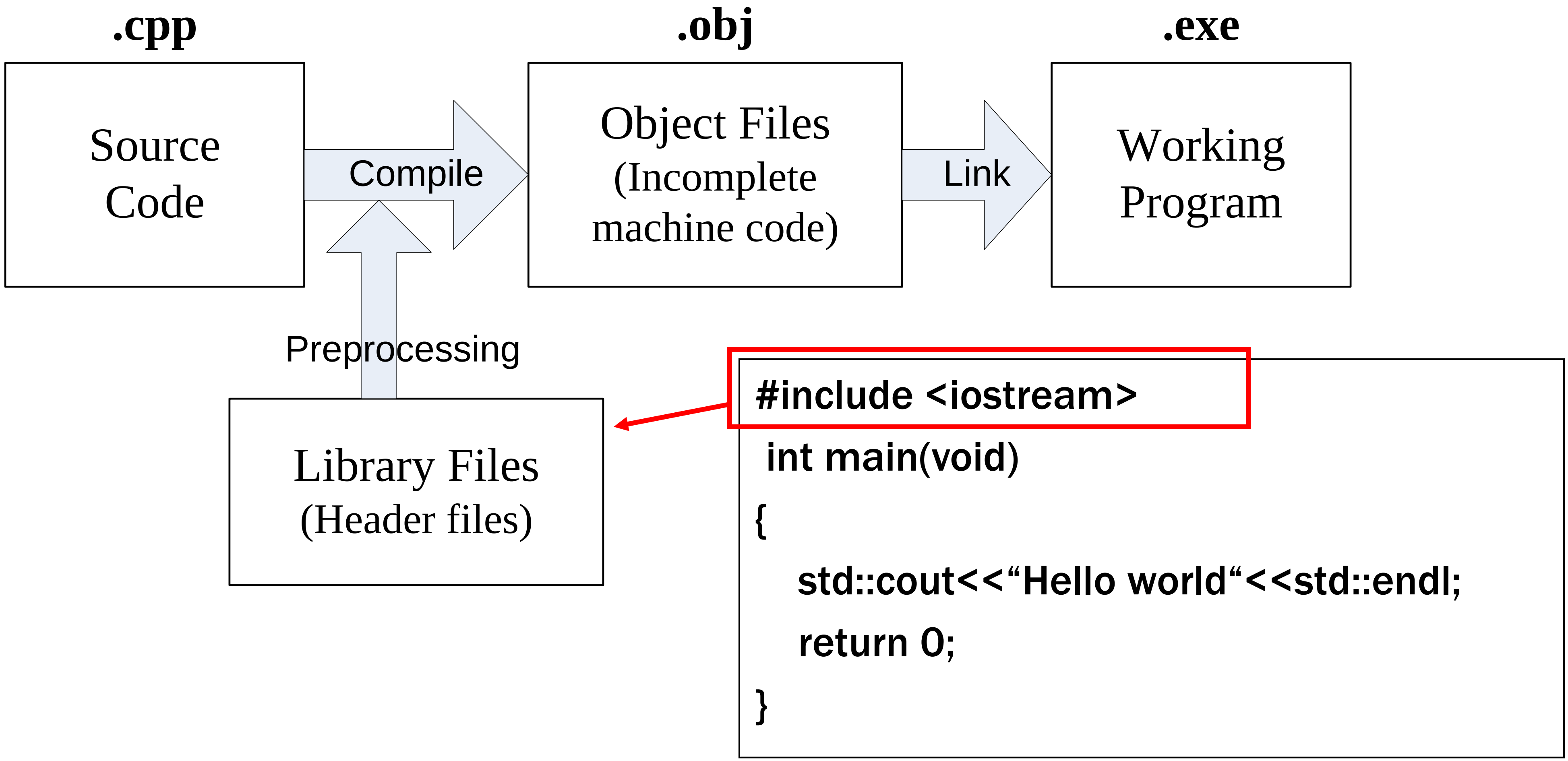
- C++ - Hello world

```
#include <iostream>

int main(void)
{
    std::cout<<“Hello world“<<std::endl;
    return 0;
}
```

Compilation process

From C++ Source Code to Working Programme


.cpp
Source Code
Compile
.obj
Object Files (Incomplete machine code)
Link
.exe
Working Program
Preprocessing
Library Files (Header files)

```
#include <iostream>
 int main(void)
{
   std::cout<<“Hello world“<<std::endl;
   return 0;
}
```

3.4 Typical Structure of the Source Code

of a C++ Main Function

Comment

```
// Comment on a single line
// 2010-Jan-01 by Z.Wang
/* Comment on multiple lines
   A programme to output information to screen*/
```

Preprocessor directive

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

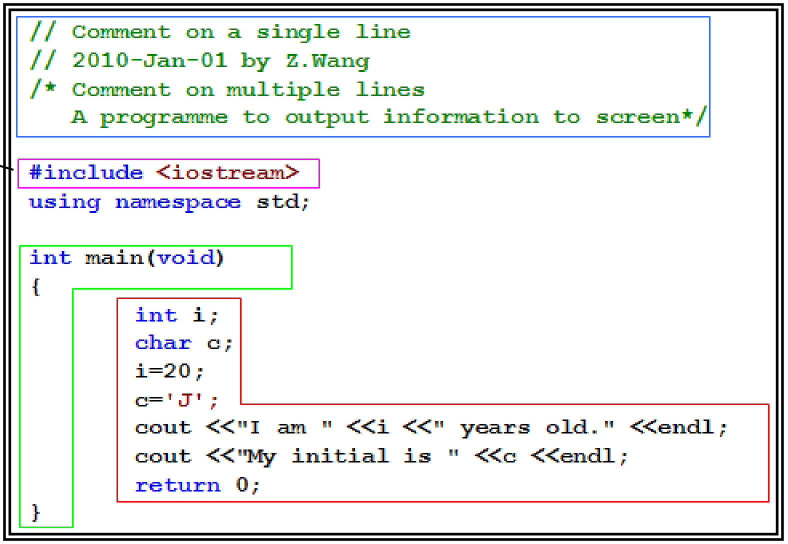
Function body

```
int main(void)
{
        int i;
        char c;
        i=20;
        c='J';
        cout <<"I am " <<i <<" years old." <<endl;
        cout <<"My initial is " <<c <<endl;
        return 0;
}
```

Statements

Header File

```
#include <iostream>
#include “myheaderfile.h”
```



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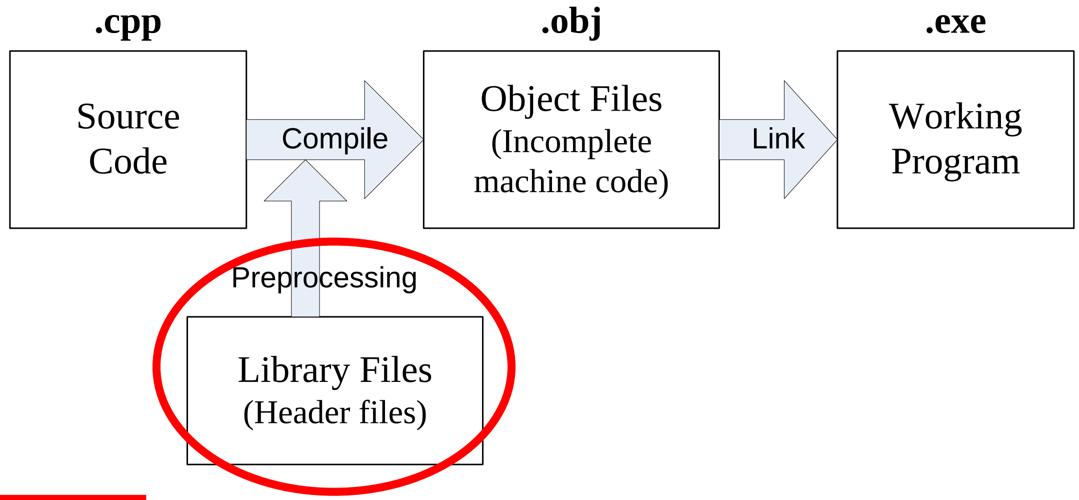
#include <iostream>
using namespace std;

int main(void)
{
        int i;
        char c;
        i=20;
        c='J';
        cout <<"I am " <<i <<" years old." <<endl;
        cout <<"My initial is " <<c <<endl;
        return 0;
}
```

- Pre-processor lines
- Always start with a **#**
- No semi-colon (;) at the end of this line
- This line will logically be replaced by the codes contained in the header file when the source code is compiled.
- A lot of pre-defined actions (functions) can be carried out without the user writing the source codes. The user only need to call the name of that particular function.

Pre-processing


.cpp
Source Code
Compile
.obj
Object Files (Incomplete machine code)
Link
.exe
Working Program
Preprocessing
Library Files (Header files)

Source file

```
// File hello.cpp
#include "pre_io.h"
void main()
{
   cout << "Hello!";
}
```

Header file

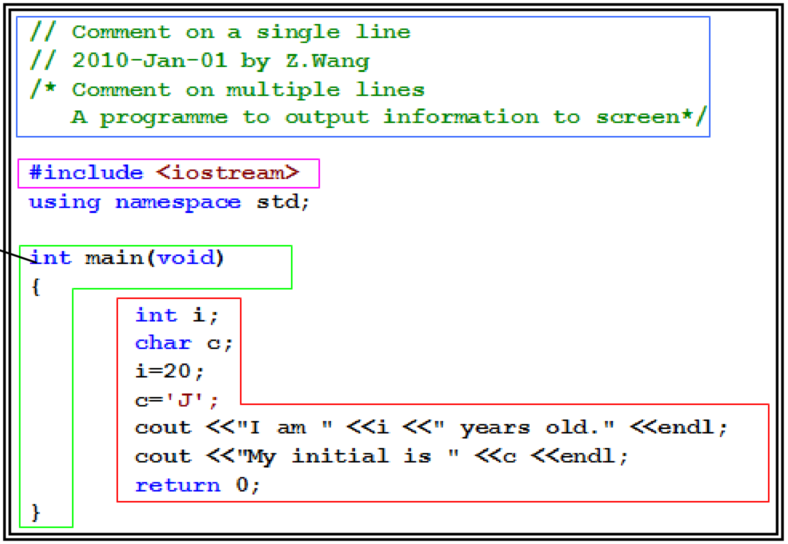
```
// File pre_io.h
#include <iostream>
using namespace std;
```

```
// File hello.cpp
#include <iostream>
using namespace std;

void main()
{
   cout << "Hello!";
}
```

Main function

```
int main(void)
{
   ...... // code here
  return 0;
}
```



```
// Comment on a single line
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#include <iostream>
using namespace std;

int main(void)
{
        int i;
        char c;
        i=20;
        c='J';
        cout <<"I am " <<i <<" years old." <<endl;
        cout <<"My initial is " <<c <<endl;
        return 0;
}
```

- Every C++ source code must have and can only have one main function.
- The **`int`** is a return type, the **`void`** means no input parameters passed into the main function, **`return 0`** means successfully finished the program.
- **`main`** is a keyword in C++ which you cannot use for other purposes, such as a variable name.

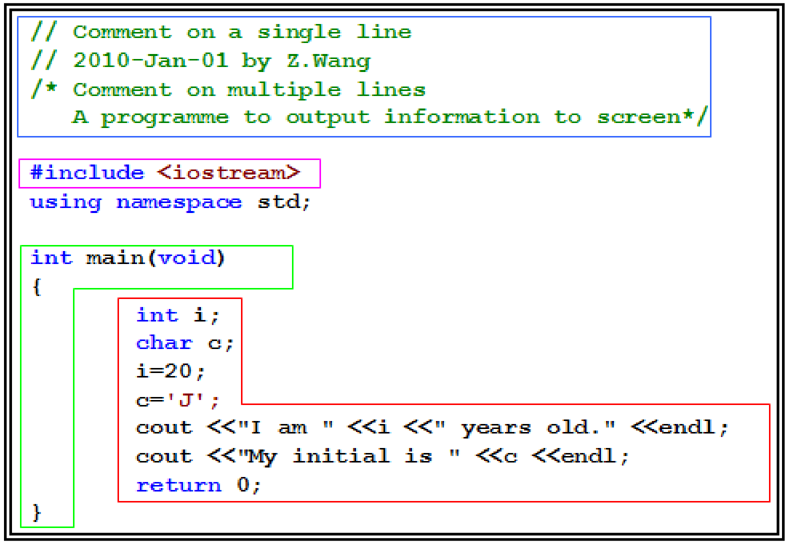
Statements

One statement each line

```
int n;
n=5;
```

Two statements on one line

```
int n ; n=5;
```



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#include <iostream>
using namespace std;

int main(void)
{
        int i;
        char c;
        i=20;
        c='J';
        cout <<"I am " <<i <<" years old." <<endl;
        cout <<"My initial is " <<c <<endl;
        return 0;
}
```

One statement on more than one lines

```
cout<<"This statement to output information on the
  screen is too long to be placed on a single
  line";
```

Labs and assessments

- Labs

- Assessments
  - 5 assessments, each takes 15% in final marks
  - Submitted to ICE online (soft copy only!).