



Module 08

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Das

Objectives &
Outline

Default
Parameter

Function
Overloading

Overload
Resolution

Default
Parameters in
Overloading

Summary

Module 08: Programming C++

Default Parameters & Function Overloading

Partha Pratim Das

Department of Computer Science and Engineering
Indian Institute of Technology, Kharagpur

ppd@cse.iitkgp.ernet.in

Tanwi Mallick
Srijoni Majumdar
Himadri B G S Bhuyan



Module Objectives

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Summary

- Understand default parameters
- Understand function overloading and Resolution



Module Outline

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Summary

- Default parameter
 - Motivation
 - Call function with default parameter
 - Highlighted Points
 - Restrictions
- Function overloading
 - Meaning & Motivation
 - Necessity of function overloading in Contrast with C
- Static Polymorphism
 - Meaning
 - Overloading function
- Overload Resolution
- Default parameters and Function Overloading



Module 08: Lecture 12

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Motivation: Example CreateWindow in MSDN

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Declaration of CreateWindow	Calling CreateWindow
<pre>HWND WINAPI CreateWindow(_In_opt_ LPCTSTR lpClassName, _In_opt_ LPCTSTR lpWindowName, _In_ DWORD dwStyle, _In_ int x, _In_ int y, _In_ int nWidth, _In_ int nHeight, _In_opt_ HWND hWndParent, _In_opt_ HMENU hMenu, _In_opt_ HINSTANCE hInstance, _In_opt_ LPVOID lpParam);</pre>	<pre>hWnd = CreateWindow(ClsName, WndName, WS_OVERLAPPEDWINDOW, CW_USEDEFAULT, CW_USEDEFAULT, CW_USEDEFAULT, CW_USEDEFAULT, NULL, NULL, hInstance, NULL);</pre>

- There are 11 Number of parameters in CreateWindow()
- Out of these 11, 7 parameters (4 are CWUSEDEFAULT and 3 are NULL) usually get fixed values in a call
- Instead of using these 7 fixed valued Parameters at the time of calling, we could have avoided those by assigning those value much earlier in function formal parameter
- C++ allows us to do so through the mechanism called **Default parameters**



Program 08.01: Function with a default parameter

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

int IdentityFunction(int a = 10) { // Default value for the parameter
    return (a);
}

int main() {
    int x = 5, y;

    y = IdentityFunction(x); // Usual function call
    cout << "y = " << y << endl;

    y = IdentityFunction(); // Uses default parameter
    cout << "y = " << y << endl;
}

-----
y = 5
y = 10
```



Program 08.02: Function with 2 default parameters

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

int Add(int a = 10, int b = 20) {
    return (a + b);
}

int main(){
    int x = 5, y = 6, z;

    z = Add(x, y); // Usual function call -- a = x = 5 & b = y = 6
    cout << "Sum = " << z << endl;

    z = Add(x);    // One parameter defaulted -- a = x = 5 & b = 20
    cout << "Sum = " << z << endl;

    z = Add();     // Both parameter defaulted -- a = 10 & b = 20
    cout << "Sum = " << z << endl;
}

-----
Sum = 11
Sum = 25
Sum = 30
```



Default Parameter: Highlighted Points

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Summary

- C++ allows programmer to assign default values to the function parameters
- Default values are specified while prototyping the function
- Default parameters are required while calling functions with fewer arguments or without any argument
- Better to use default value for less used parameters
- Default arguments may be expressions also



Restrictions on default parameters

- All parameters to the right of a parameter with default argument must have default arguments (function f)
- Default arguments cannot be re-defined (function g)
- All non-defaulted parameters needed in a call (call g())

```
#include <iostream>

void f(int, double = 0.0, char *);
// Error C2548: 'f': missing default parameter for parameter 3

void g(int, double = 0, char * = NULL); // OK
void g(int, double = 1, char * = NULL);
// Error C2572: 'g': redefinition of default parameter : parameter 3
// Error C2572: 'g': redefinition of default parameter : parameter 2

int main() {
    int i = 5; double d = 1.2; char c = 'b';

    g(); // Error C2660: 'g': function does not take 0 arguments
    g(i);
    g(i, d);
    g(i, d, &c);
    return 0;
}
```

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Module 08: End Of Lecture 12

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- Function overloading
 - Meaning & Motivation
 - Necessity of function overloading in Contrast with C
 - Restrictions on function overloading



Restrictions on default parameters

- Default parameters should be supplied only in a header file and not in the definition of a function

```
// Header file: myFunc.h
void g(int, double, char = 'a');
-----

// Source File: myFunc.cpp
#include <iostream>
using namespace std;
#include "myFunc.h"

void g(int i, double d, char c) {
    cout << i << ' ' << d << ' ' << c << endl;
}
-----

// Application File: Apps.cpp
#include <iostream>
#include "myFunc.h"
// void g(int, double, char = 'a');

void g(int i, double f = 0.0, char ch); // OK a new overload
void g(int i = 0, double f, char ch);  // OK a new overload
int main() {
    int i = 5; double d = 1.2; char c = 'b';

    g();           // Prints: 0 0 a
    g(i);          // Prints: 5 0 a
    g(i, d);       // Prints: 5 1.2 a
    g(i, d, c);    // Prints: 5 1.2 b
    return 0;
}
```



Function overloads: Matrix Multiplication in C

- Similar functions with different data types & algorithms

```
typedef struct { int data[10][10]; } Mat;    // 2D Matrix
typedef struct { int data[1][10]; } VecRow; // Row Vector
typedef struct { int data[10][1]; } VecCol; // Column Vector

void Multiply_M_M (Mat a,    Mat b,    Mat* c) { /* c = a * b */ }
void Multiply_M_VC (Mat a,    VecCol b, VecCol* c) { /* c = a * b */ }
void Multiply_VR_M (VecRow a, Mat b,    VecRow* c) { /* c = a * b */ }
void Multiply_VC_VR (VecCol a, VecRow b, Mat* c) { /* c = a * b */ }
void Multiply_VR_VC (VecRow a, VecCol b, int* c) { /* c = a * b */ }

int main() {
    Mat m1, m2, rm; VecRow rv, rrv; VecCol cv, rcv; int r;
    Multiply_M_M (m1, m2, &rm); // rm <-- m1 * m2
    Multiply_M_VC (m1, cv, &rcv); // rcv <-- m1 * cv
    Multiply_VR_M (rv, m2, &rrv); // rrv <-- rv * m2
    Multiply_VC_VR (cv, rv, &rm); // rm <-- cv * rv
    Multiply_VR_VC (rv, cv, &r); // r <-- rv * cv
    return 0;
}
```

- 5 multiplication functions share same functionality but different argument types
- C treats them as 5 separate functions
- C++ has an elegant solution



Function overloads: Matrix Multiplication in C++

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Summary

- Functions having similar functionality but different in details.

```
typedef struct { int data[10][10]; } Mat;    // 2D Matrix
typedef struct { int data[1][10]; } VecRow; // Row Vector
typedef struct { int data[10][1]; } VecCol; // Column Vector

void Multiply(const Mat& a,    const Mat& b,    Mat& c)    { /* c = a * b */ };
void Multiply(const Mat& a,    const VecCol& b, VecCol& c) { /* c = a * b */ };
void Multiply(const VecRow& a, const Mat& b,    VecRow& c) { /* c = a * b */ };
void Multiply(const VecCol& a, const VecRow& b, Mat& c)    { /* c = a * b */ };
void Multiply(const VecRow& a, const VecCol& b, int& c)    { /* c = a * b */ };

int main() {
    Mat m1, m2, rm; VecRow rv, rrv; VecCol cv, rcv; int r;
    Multiply(m1, m2, rm); // rm <-- m1 * m2
    Multiply(m1, cv, rcv); // rcv <-- m1 * cv
    Multiply(rv, m2, rrv); // rrv <-- rv * m2
    Multiply(cv, rv, rm); // rm <-- cv * rv
    Multiply(rv, cv, r); // r <-- rv * cv
    return 0;
}
```

- These 5 functions having different argument types are treated as one function (Multiply) in C++
- This is called **Function Overloading or Static Polymorphism**



Program 08.03/04: Function Overloading

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Summary

- Define multiple functions having the same name
- Binding happens at compile time

Same # of Parameters	Different # of Parameters
<pre> #include <iostream> using namespace std; int Add(int a, int b) { return (a + b); } double Add(double c, double d) { return (c + d); } int main() { int x = 5, y = 6, z; z = Add(x, y); // int Add(int, int) cout << "int sum = " << z; double s = 3.5, t = 4.25, u; u = Add(s, t); // double Add(double, double) cout << "double sum = " << u << endl; return 0; } </pre>	<pre> #include <iostream> using namespace std; int Area(int a, int b) { return (a * b); } int Area(int c) { return (c * c); } int main(){ int x = 10, y = 12, z = 5, t; t = Area(x, y); // int Add(int, int) cout << "Area of Rectangle = " << t; int z = 5, u; u = Area(z); // int Add(int) cout << " Area of Square = " << u << endl; return 0; } </pre>
int sum = 11 double sum = 7.75	Area of Rectangle = 12 Area of Square = 25
<ul style="list-style-type: none"> ● Same Add function ● Same # of parameters but different types 	<ul style="list-style-type: none"> ● Same Area function ● Different # of parameters



Program 08.05: Restrictions in Function Overloading

- Two functions having the same signature but different return types cannot be overloaded

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

int    Area(int a, int b) { return (a * b); }
double Area(int a, int b) { return (a * b); }
// Error C2556: 'double Area(int,int)': overloaded function differs only by return type
//           from 'int Area(int,int)'
// Error C2371: 'Area': redefinition; different basic types

int main() {
    int x = 10, y = 12, z = 5, t;
    double f;

    t = Area(x, y);
    // Error C2568: '=': unable to resolve function overload
    // Error C3861: 'Area': identifier not found

    cout << "Multiplication = " << t << endl;

    f = Area(y, z); // Errors C2568 and C3861 as above
    cout << "Multiplication = " << f << endl;

    return 0;
}
```




Module 08: End of Lecture 13

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- Default parameter Restrictions
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Summary

- Function overloading Rules
- Function Overload resolution
 - Exact match
 - Promotion & conversion
- Default parameter & function overloading



Function Overloading – Summary of Rules

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Summary

- The same function name may be used in several definitions
- Functions with the same name must have different number of formal parameters and/or different types of formal parameters
- Function selection is based on the number and the types of the actual parameters at the places of invocation
- Function selection (Overload Resolution) is performed by the compiler
- Two functions having the same signature but different return types will result in a compilation error due to *attempt to re-declare*
- Overloading allows **Static Polymorphism**



Overload Resolution

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Summary

- To resolve overloaded functions with one parameter
 - Identify the set of *Candidate Functions*
 - From the set of candidate functions identify the set of *Viable Functions*
 - Select the *Best viable function* through (*Order is important*)
 - Exact Match
 - Promotion
 - Standard type conversion
 - User defined type conversion



Overload Resolution: Exact Match

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Summary

- lvalue-to-rvalue conversion
 - Most common
- Array-to-pointer conversion
 - Definitions: `int ar[10];`
`void f(int *a);`
 - Call: `f(ar)`
- Function-to-pointer conversion
 - Definitions: `typedef int (*fp) (int);`
`void f(int, fp);`
`int g(int);`
 - Call: `f(5, g)`
- Qualification conversion
 - Converting pointer (only) to const pointer



Overload Resolution: Promotion & Conversion

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Summary

- Examples of Promotion
 - char to int; float to double
 - enum to int / short / unsigned int / ...
 - bool to int
- Examples of Standard Conversion
 - integral conversion
 - floating point conversion
 - floating point to integral conversion
 - The above 3 may be dangerous!**
 - pointer conversion
 - bool conversion



Example: Overload Resolution with one parameter

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Summary

- In the context of a list of function prototypes:

```
int g(double);           // F1
void f();                 // F2
void f(int);              // F3
double h(void);           // F4
int g(char, int);         // F5
void f(double, double = 3.4); // F6
void h(int, double);       // F7
void f(char, char *);     // F8
```

The call site to resolve is:

```
f(5.6);
```

- Resolution:
 - Candidate functions (by name): F2, F3, F6, F8
 - Viable functions (by # of parameters): F3, F6
 - Best viable function (by type double – Exact Match): F6



Example: Overload Resolution fails

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Summary

- Consider the overloaded function signatures:

```
int fun(float a) {...}           // Function 1
int fun(float a, int b) {...}    // Function 2
int fun(float x, int y = 5) {...} // Function 3
```

```
int main() {
    float p = 4.5, t = 10.5;
    int s = 30;

    fun(p, s); // CALL - 1
    fun(t);    // CALL - 2
    return 0;
}
```

- CALL - 1: Matches Function 2 & Function 3
- CALL - 2: Matches Function 1 & Function 3
- Results in ambiguity



Program 08.06/07: Default Parameter & Function Overload

- Compilers deal with default parameters as a special case of function overloading

Default Parameters	Function Overload
<pre>#include <iostream> using namespace std; int f(int a = 1, int b = 2); int main() { int x = 5, y = 6; f(); // a = 1, b = 2 f(x); // a = x = 5, b = 2 f(x, y); // a = x = 5, b = y = 6 return 0; }</pre>	<pre>#include <iostream> using namespace std; int f(); int f(int); int f(int, int); int main() { int x = 5, y = 6; f(); // int f(); f(x); // int f(int); f(x, y); // int f(int, int); return 0; }</pre>
<ul style="list-style-type: none">Function <code>f</code> has 2 parameters overloaded<code>f</code> can have 3 possible forms of call	<ul style="list-style-type: none">Function <code>f</code> is overloaded with up to 3 parameters<code>f</code> can have 3 possible forms of callNo overload here use default parameters



Program 08.08:

Default Parameter & Function Overload

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Summary

- Function overloading can use default parameter
- However, with default parameters, the overloaded functions should still be resolvable

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

int Area(int a, int b = 10) { return (a * b); }
double Area(double c, double d) { return (c * d); }

int main() {
    int x = 10, y = 12, t;
    double z = 20.5, u = 5.0, f;

    t = Area(x);    // Binds int Area(int, int = 10)
    cout << "Area = " << t << endl; // t = 100

    f = Area(z, u); // Binds double Area(double, double)
    cout << "Area = " << f << endl; // f = 102.5

    return 0;
}
```



Program 08.09: Default Parameter & Function Overload

- Function overloading with default parameters may fail

```
#include <iostream>
using namespace std;
int f();
int f(int = 0);
int f(int, int);

int main() {
    int x = 5, y = 6;

    f();          // Error C2668: 'f': ambiguous call to overloaded function
                  // More than one instance of overloaded function "f"
                  // matches the argument list:
                  //     function "f()"
                  //     function "f(int = 0)"

    f(x);         // int f(int);
    f(x, y);      // int f(int, int);

    return 0;
}
```



Module Summary

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Summary

- Introduced the notion of Default parameters and discussed several examples
- Identified the necessity of function overloading
- Introduced static Polymorphism and discussed examples and restrictions
- Discussed an outline for Overload resolution
- Discussed the mix of default Parameters and function overloading



Instructor and TAs

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Summary

Name	Mail	Mobile
Partha Pratim Das, <i>Instructor</i>	ppd@cse.iitkgp.ernet.in	9830030880
Tanwi Mallick, <i>TA</i>	tanwimallick@gmail.com	9674277774
Srijoni Majumdar, <i>TA</i>	majumdarsrijoni@gmail.com	9674474267
Himadri B G S Bhuyan, <i>TA</i>	himadribhuyan@gmail.com	9438911655