



Module 16

Partha Pratim
Das

Objectives &
Outline

static data
member

Print Task

static
Member
function

Print Task

Singleton
Class

Summary

Module 16: Programming in C++

static Members

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Module Objectives

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Objectives & Outline

static data
member

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Summary

- Understand `static` data member and member function



Module Outline

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static data
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function
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Summary

- static data member
 - Print Task
- static member function
 - Print Task
- Singleton Class



static Data Member

A **static** data member

- is associated with class not with object
- is shared by all the objects of a class
- needs to be defined outside the class scope (in addition to the declaration within the class scope) to avoid linker error
- must be initialized in a source file
- is constructed before `main()` starts and destructed after `main()` ends
- can be private / public type
- can be accessed
 - with the class-name followed by the scope resolution operator (`::`)
 - as a member of any object of the class
- virtually eliminates any need for global variables in OOPs environment

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Program 16.01: static Data Member

A Simple Case

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Non static Data Member

```
#include<iostream>
using namespace std;
class MyClass { int x; // Non-static
public:
    void get() { x = 15; }
    void print() {
        x = x + 10;
        cout << "x =" << x << endl ;
    }
};

int main() {
    MyClass obj1, obj2;
    obj1.get(); obj2.get();

    obj1.print(); obj2.print();
    return 0 ;
}
---
```

- x is a non-static data member
- x cannot be shared between obj1 & obj2
- Non-static data members do not need separate definitions - instantiated with the object
- Non-static data members are initialized during object construction

static Data Member

```
#include<iostream>
using namespace std;
class MyClass { static int x; // Declare static
public:
    void get() { x = 15; }
    void print() {
        x = x + 10;
        cout << "x =" << x << endl;
    }
};

int MyClass::x = 0; // Define static data member
int main() {
    MyClass obj1, obj2;
    obj1.get(); obj2.get();

    obj1.print(); obj2.print();
    return 0;
}
---
```

- x is static data member
- x is shared by all MyClass objects including obj1 & obj2
- static data members must be defined in the global scope
- static data members are initialized during program start-up



Program 16.02: static Data Member Print Task

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```
#include <iostream>
using namespace std;
class PrintJobs { int nPages_; // # of pages in current job
public:
    static int nTrayPages_; // # of pages remaining in the tray
    static int nJobs_; // # of print jobs executing
    PrintJobs(int nP): nPages_(nP) {
        ++nJobs_;
        cout << "Printing " << nP << " pages" << endl;
        nTrayPages_ = nTrayPages_ - nP;
    }
    ~PrintJobs() { --nJobs_; }
};

int PrintJobs::nTrayPages_ = 500; // Definition and initialization -- load paper
int PrintJobs::nJobs_ = 0; // Definition and initialization -- no job to start with
int main() {
    cout << "Jobs = " << PrintJobs::nJobs_ << endl;
    cout << "Pages= " << PrintJobs::nTrayPages_ << endl;
    PrintJobs job1(10);
    cout << "Jobs = " << PrintJobs::nJobs_ << endl;
    cout << "Pages= " << PrintJobs::nTrayPages_ << endl;
    {
        PrintJobs job1(30), job2(20);
        cout << "Jobs = " << PrintJobs::nJobs_ << endl;
        cout << "Pages= " << PrintJobs::nTrayPages_ << endl;
        PrintJobs::nTrayPages_ += 100; // Load 100 more pages
    }
    cout << "Jobs = " << PrintJobs::nJobs_ << endl;
    cout << "Pages= " << PrintJobs::nTrayPages_ << endl;
    return 0;
}
```

Output:

```
Jobs = 0
Pages= 500
Printing 10 pages
Jobs = 1
Pages= 490
Printing 30 pages
Printing 20 pages
Jobs = 3
Pages= 440
Jobs = 1
Pages= 540
```



static Member Function

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A **static** member function

- does not have `this` pointer – not associated with any object
- cannot access non-static data members
- cannot invoke non-static member functions
- can be accessed
 - with the class-name followed by the scope resolution operator (`::`)
 - as a member of any object of the class
- is needed to read / write static data members
 - Again, for encapsulation static data members should be private
 - `get()-set()` idiom is built for access (static member functions in public)
- may initialize static data members even before any object creation
- cannot co-exist with a non-static version of the same function
- cannot be declared as `const`



Program 16.03: static Data & Member Function Print Task (safe)

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```
#include <iostream>
using namespace std;
class PrintJobs { int nPages_; // # of pages in current job
    static int nTrayPages_;    // # of pages remaining in the tray
    static int nJobs_;         // # of print jobs executing
public: PrintJobs(int nP) : nPages_(nP) { ++nJobs_;
    cout << "Printing " << nP << " pages" << endl;
    nTrayPages_ = nTrayPages_ - nP;
    }
    ~PrintJobs() { --nJobs_; }
    static int getJobs() { return nJobs_; }
    static int checkPages() { return nTrayPages_; }
    static void loadPages(int nP) { nTrayPages_ += nP; }
};
int PrintJobs::nTrayPages_ = 500; // Definition and initialization -- load paper
int PrintJobs::nJobs_ = 0;        // Definition and initialization -- no job to start with
int main() {
    cout << "Jobs = " << PrintJobs::getJobs() << endl;
    cout << "Pages= " << PrintJobs::checkPages() << endl;
    PrintJobs job1(10);
    cout << "Jobs = " << PrintJobs::getJobs() << endl;
    cout << "Pages= " << PrintJobs::checkPages() << endl;
    { PrintJobs job1(30), job2(20);
        cout << "Jobs = " << PrintJobs::getJobs() << endl;
        cout << "Pages= " << PrintJobs::checkPages() << endl;
        PrintJobs::loadPages(100);
    }
    cout << "Jobs = " << PrintJobs::getJobs() << endl;
    cout << "Pages= " << PrintJobs::checkPages() << endl;
    return 0;
}
```

Output:

```
Jobs = 0
Pages= 500
Printing 10 pages
Jobs = 1
Pages= 490
Printing 30 pages
Printing 20 pages
Jobs = 3
Pages= 440
Jobs = 1
Pages= 540
```




Singleton Class

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Summary

- A class is called a Singleton if it can have *only* one instance
- Many classes are singleton:
 - President of India
 - Prime Minister of India
 - Director of IIT Kharagpur
 - ...
- How to implement a Singleton Class?
- How to restrict that user can created *only one* instance?



Program 16.04: static Data & Member Function Singleton Printer

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Summary

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

class Printer {          /* THIS IS A SINGLETON PRINTER -- ONLY ONE INSTANCE */
    bool blackAndWhite_, bothSided_;

    Printer(bool bw = false, bool bs = false) : blackAndWhite_(bw), bothSided_(bs)
    { cout << "Printer constructed" << endl; } // Private -- Printer cannot be constructed!

    static Printer *myPrinter_; // Pointer to the Instance of the Singleton Printer

public:
    ~Printer() { cout << "Printer destructed" << endl; }

    static const Printer& printer(bool bw = false, bool bs = false) { // Access the Printer
        if (!myPrinter_) myPrinter_ = new Printer(bw, bs); // Constructed for first call
        return *myPrinter_;                                // Reused from next time
    }

    void print(int nP) const { cout << "Printing " << nP << " pages" << endl; }
};

Printer *Printer::myPrinter_ = 0;

int main() {
    Printer::printer().print(10);
    Printer::printer().print(20);

    delete &Printer::printer();
    return 0;
}
```

Output:

```
Printer constructed
Printing 10 pages
Printing 20 pages
Printer destructed
```

In the recorded video the destructor was directly called by `Printer::printer().~Printer();` This is wrong and will leak memory. It is corrected here with `delete &Printer::printer();`



Program 16.05: Using function-local static Data Singleton Printer

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Summary

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

class Printer { /* THIS IS A SINGLETON PRINTER -- ONLY ONE INSTANCE */
    bool blackAndWhite_, bothSided_;

    Printer(bool bw = false, bool bs = false) : blackAndWhite_(bw), bothSided_(bs)
    { cout << "Printer constructed" << endl; }

    ~Printer() { cout << "Printer destructed" << endl; }

public:

    static const Printer& printer(bool bw = false, bool bs = false) {
        static Printer myPrinter(bw, bs); // The Singleton -- constructed the first time

        return myPrinter;
    }

    void print(int nP) const {
        cout << "Printing " << nP << " pages" << endl;
    }
};

int main() {
    Printer::printer().print(10);
    Printer::printer().print(20);

    return 0;
}
```

Output:

```
Printer constructed
Printing 10 pages
Printing 20 pages
Printer destructed
```

- Function local static object is used
- No memory management overhead – so destructor too get private
- This is called *Meyer's Singleton*



Module Summary

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Summary

- Introduced `static` data member
- Introduced `static` member function
- Exposed to use of static members
- Singleton Class discussed



Instructor and TAs

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Summary

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