Module 30: Programming in C++

Dynamic Binding (Polymorphism): Part 5

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Module Objectives

- Understand design with class hierarchy

Module Outline

- Staff Salary Processing
  - C Solution
  - C++ Solution
    - Non-Polymorphic Hierarchy
    - Polymorphic Hierarchy
    - Polymorphic Hierarchy (Flexible)

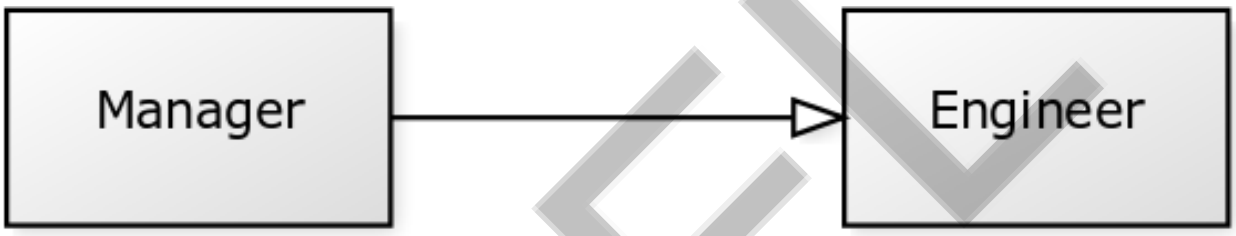
Staff Salary Processing: Problem Statement: RECAP (Module 29)

- An organization needs to develop a salary processing application for its staff
- At present it has an engineering division only where Engineers and Managers work. Every Engineer reports to some Manager. Every Manager can also work like an Engineer
- The logic for processing salary for Engineers and Managers are different as they have different salary heads
- In future, it may add Directors to the team. Then every Manager will report to some Director. Every Director could also work like a Manager
- The logic for processing salary for Directors will also be distinct
- Further, in future it may open other divisions, like Sales division, and expand the workforce
- **Make a suitable extensible design**

C Solution: Engineer + Manager: RECAP (Module 29)

- How to represent Engineers and Managers?
  - `struct`
- How to initialize objects?
  - Initialization functions
- How to have a collection of mixed objects?
  - Array of `union`
- How to model variations in salary processing algorithms?
  - `struct`-specific functions
- How to invoke the correct algorithm for a correct employee type?
  - Function switch
  - Function pointers

C++ Solution: Non-Polymorphic Hierarchy Engineer + Manager



- How to represent Engineers and Managers?
  - Non-Polymorphic `class` hierarchy
- How to initialize objects?
  - Constructor / Destructor
- How to have a collection of mixed objects?
  - `array` of base class pointers
- How to model variations in salary processing algorithms?
  - Member functions
- How to invoke the correct algorithm for a correct employee type?
  - Function switch
  - Function pointers

C++ Solution: Non-Polymorphic Hierarchy
Engineer + Manager


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

typedef enum E_TYPE { Er, Mgr };
class Engineer { protected: string name_; E_TYPE type_;
public: Engineer(const string& name, E_TYPE e = Er) : name_(name), type_(e) {}
    E_TYPE GetType() { return type_; }
    void ProcessSalary() { cout << name_ << ": Process Salary for Engineer" << endl; }
};
class Manager : public Engineer { Engineer *reports_[10];
public: Manager(const string& name, E_TYPE e = Mgr) : Engineer(name, e) {}
    void ProcessSalary() { cout << name_ << ": Process Salary for Manager" << endl; }
};
int main() { Engineer e1("Rohit"), e2("Kavita"), e3("Shambhu");
    Manager m1("Kamala"), m2("Rajib");
    Engineer *staff[] = { &e1, &m1, &m2, &e2, &e3 };

    for (int i = 0; i < sizeof(staff) / sizeof(Engineer*); ++i) {
        E_TYPE t = staff[i]->GetType();
        if (t == Er) staff[i]->ProcessSalary();
        else if (t == Mgr) ((Manager *)staff[i])->ProcessSalary();
        else cout << "Invalid Staff Type" << endl;
    }
    return 0;
}
```

C++ Solution: Non-Polymorphic Hierarchy Engineer + Manager


```
    Engineer e1("Rohit"), e2("Kavita"), e3("Shambhu");
    Manager m1("Kamala"), m2("Rajib");
    Engineer *staff[] = { &e1, &m1, &m2, &e2, &e3 };

Output:
Rohit: Process Salary for Engineer
Kamala: Process Salary for Manager
Rajib: Process Salary for Manager
Kavita: Process Salary for Engineer
Shambhu: Process Salary for Engineer
```

C++ Solution: Non-Polymorphic Hierarchy Engineer + Manager + Director

- How to represent Engineers, Managers, and Directors?
  - Non-Polymorphic `class` hierarchy
- How to initialize objects?
  - Constructor / Destructor
- How to have a collection of mixed objects?
  - `array` of base class pointers
- How to model variations in salary processing algorithms?
  - Member functions
- How to invoke the correct algorithm for a correct employee type?
  - Function switch
  - Function pointers

C++ Solution: Non-Polymorphic Hierarchy
Engineer + Manager + Director


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

typedef enum E_TYPE { Er, Mgr, Dir };
class Engineer { protected: string name_; E_TYPE type_;
public: Engineer(const string& name, E_TYPE e = Er) : name_(name), type_(e) {}
    E_TYPE GetType() { return type_; }
    void ProcessSalary() { cout << name_ << ": Process Salary for Engineer" << endl; }
};
class Manager : public Engineer { Engineer *reports_[10];
public: Manager(const string& name, E_TYPE e = Mgr) : Engineer(name, e) {}
    void ProcessSalary() { cout << name_ << ": Process Salary for Manager" << endl; }
};
class Director : public Manager { Manager *reports_[10];
public: Director(const string& name) : Manager(name, Dir) {}
    void ProcessSalary() { cout << name_ << ": Process Salary for Director" << endl; }
};
int main() { Engineer e1("Rohit"), e2("Kavita"), e3("Shambhu");
    Manager m1("Kamala"), m2("Rajib"); Director d("Ranjana");
    Engineer *staff[] = { &e1, &m1, &m2, &e2, &e3, &d };

    for (int i = 0; i < sizeof(staff) / sizeof(Engineer*); ++i) {
        E_TYPE t = staff[i]->GetType();
        if (t == Er) staff[i]->ProcessSalary();
        else if (t == Mgr) ((Manager *)staff[i])->ProcessSalary();
        else if (t == Dir) ((Director *)staff[i])->ProcessSalary();
        else cout << "Invalid Staff Type" << endl;
    }
    return 0;
}
```

C++ Solution: Non-Polymorphic Hierarchy Engineer + Manager + Director


```
    Engineer e1("Rohit"), e2("Kavita"), e3("Shambhu");
    Manager m1("Kamala"), m2("Rajib"); Director d("Ranjana");
    Engineer *staff[] = { &e1, &m1, &m2, &e2, &e3, &d };
```

```
Output:
Rohit: Process Salary for Engineer
Kamala: Process Salary for Manager
Rajib: Process Salary for Manager
Kavita: Process Salary for Engineer
Shambhu: Process Salary for Engineer
Ranjana: Process Salary for Director
```

C++ Solution: Polymorphic Hierarchy
Engineer + Manager + Director

- How to represent Engineers, Managers, and Directors?
  - Polymorphic `class` hierarchy
- How to initialize objects?
  - Constructor / Destructor
- How to have a collection of mixed objects?
  - `array` of base class pointers
- How to model variations in salary processing algorithms?
  - Member functions
- How to invoke the correct algorithm for a correct employee type?
  - Virtual Functions

C++ Solution: Polymorphic Hierarchy
Engineer + Manager + Director

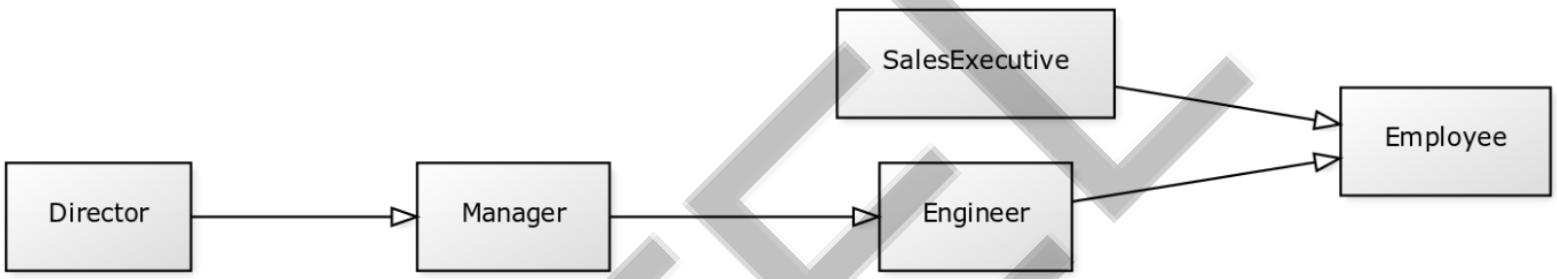

```
#include <iostream>
#include <string>
using namespace std;

class Engineer { protected: string name_;
public: Engineer(const string& name) : name_(name) {}
    virtual void ProcessSalary() { cout << name_ << ": Process Salary for Engineer" << endl; }
};
class Manager : public Engineer { Engineer *reports_[10];
public: Manager(const string& name) : Engineer(name) {}
    void ProcessSalary() { cout << name_ << ": Process Salary for Manager" << endl; }
};
class Director : public Manager { Manager *reports_[10];
public: Director(const string& name) : Manager(name) {}
    void ProcessSalary() { cout << name_ << ": Process Salary for Director" << endl; }
};
int main() { Engineer e1("Rohit"), e2("Kavita"), e3("Shambhu");
    Manager m1("Kamala"), m2("Rajib"); Director d("Ranjana");
    Engineer *staff[] = { &e1, &m1, &m2, &e2, &e3, &d };

    for (int i = 0; i < sizeof(staff) / sizeof(Engineer*); ++i) staff[i]->ProcessSalary();

    return 0;
}
```

C++ Solution: Polymorphic Hierarchy
Engineer + Manager + Director


```
    Engineer e1("Rohit"), e2("Kavita"), e3("Shambhu");
    Manager m1("Kamala"), m2("Rajib"); Director d("Ranjana");
    Engineer *staff[] = { &e1, &m1, &m2, &e2, &e3, &d };
```

```
Output:
Rohit: Process Salary for Engineer
Kamala: Process Salary for Manager
Rajib: Process Salary for Manager
Kavita: Process Salary for Engineer
Shambhu: Process Salary for Engineer
Ranjana: Process Salary for Director
```

C++ Solution: Polymorphic Hierarchy (Flexible) Engineer + Manager + Director + Others



- How to represent Engineers, Managers, Directors, etc.?
  - Polymorphic `class` hierarchy with an Abstract Base Employee
- How to initialize objects?
  - Constructor / Destructor
- How to have a collection of mixed objects?
  - `array` of base class pointers
- How to model variations in salary processing algorithms?
  - Member functions
- How to invoke the correct algorithm for a correct employee type?
  - Virtual Functions (Pure in Employee)

C++ Solution: Polymorphic Hierarchy (Flexible) Engineer + Manager + Director + Others


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

class Employee { protected: string name_;
public: virtual void ProcessSalary() = 0;
};
class Engineer: public Employee { public: Engineer(const string& name) { name_ = name; }
    void ProcessSalary() { cout << name_ << ": Process Salary for Engineer" << endl; }
};
class Manager : public Engineer { Engineer *reports_[10];
public: Manager(const string& name) : Engineer(name) {}
    void ProcessSalary() { cout << name_ << ": Process Salary for Manager" << endl; }
};
class Director : public Manager { Manager *reports_[10];
public: Director(const string& name) : Manager(name) {}
    void ProcessSalary() { cout << name_ << ": Process Salary for Director" << endl; }
};
class SalesExecutive : public Employee { public:
    SalesExecutive(const string& name) { name_ = name; }
    void ProcessSalary() { cout << name_ << ": Process Salary for Sales Executive" << endl; }
};
int main() {
    Engineer e1("Rohit"), e2("Kavita"), e3("Shambhu");
    Manager m1("Kamala"), m2("Rajib");   SalesExecutive s1("Hari"), s2("Bishnu");
    Director d("Ranjana");
    Employee *staff[] = { &e1, &m1, &m2, &e2, &s1, &e3, &d, &s2 };

    for (int i = 0; i < sizeof(staff) / sizeof(Employee*); ++i) staff[i]->ProcessSalary();
    return 0;
}
```

C++ Solution: Polymorphic Hierarchy (Flexible) Engineer + Manager + Director + Others


```
    Engineer e1("Rohit"), e2("Kavita"), e3("Shambhu");
    Manager m1("Kamala"), m2("Rajib"); SalesExecutive s1("Hari"), s2("Bishnu");
    Director d("Ranjana");
    Employee *staff[] = { &e1, &m1, &m2, &e2, &s1, &e3, &d, &s2 };
```

Output:

```
Rohit: Process Salary for Engineer
Kamala: Process Salary for Manager
Rajib: Process Salary for Manager
Kavita: Process Salary for Engineer
Hari: Process Salary for Sales Executive
Shambhu: Process Salary for Engineer
Ranjana: Process Salary for Director
Bishnu: Process Salary for Sales Executive
```

Module Summary

- Completed design for a staff salary problem using hierarchy and worked out extensible C++ solution

Instructor and TAs

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