IIT Bombay

Computer Programming

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Session: Advanced Operations with Inheritance

Recap

- Redefining member functions of the base class
- Access methods of base class using derived classes
- Constructors for derived classes
- Destructors
- Inheritance of assignment operators

Overview of This Lecture

- Objects of base and derived classes
- Objects of classes with pointers and references
- Inheritance
    - Multiple
    - Diamond

Acknowledgment

- Much of this lecture is motivated by the treatment in

  An Introduction to Programming Through C++

  by Abhiram G. Ranade

  McGraw Hill Education 2014

  Some examples used in this lecture are from the above book

Object of base and derived class

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Object of derived class can be assigned to object of base class

```
class base {
  public:
    int id;
    float balance;
};
```

```
class savings : public base {
  public:
    int age;
    long int ATM;
};
```

Object Slicing
(Loss of Information)

- ‘base’ class has ‘id’ and ‘balance’
- ‘savings’ class has ‘age’ and ‘ATM’, along with ‘id’ and ‘balance’ from base class
- Information of ‘age’ and ‘ATM’ is lost in base

Output

```
1, 15000
2, 67890
```

✓

```
2, 67890
2, 67890
```

```
int main() {
  base b;
  b.id = 1;   b.balance = 15000;

  savings s;
  s.id = 2;   s.balance = 67890;

  cout << b.id << ", " << b.balance << endl;

  cout << s.id << ", " << s.balance << endl;

  b = s;  //Assign object of derived to base

  cout << b.id << ", " << b.balance << endl;

  cout << s.id << ", " << s.balance << endl;

  return 0;
}
```

Object of base and derived class

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Can we assign object of base class to object of derived class ?

```
class base {
  public:
    int id;
    float balance;
};
```

```
class savings : public base {
  public:
    int age;
    long int ATM;
};
```

Compile time error

```
int main() {
  base b;
  b.id = 1;   b.balance = 15000;

  savings s;
  s.id = 2;   s.balance = 67890;

  cout << b.id << ", " << b.balance << endl;

  cout << s.id << ", " << s.balance << endl;

✗ s = b;  //Assign object of base to derived

  cout << b.id << ", " << b.balance << endl;

  cout << s.id << ", " << s.balance << endl;

  return 0;
}
```

Objects of classes with pointers and references

```
class base {
  public:
    int id;
    float balance;
    void print(){
      cout << "base called" ;
    }
};
```

```
class savings : public base {
  public:
    int age;
    long int ATM;
    void print(){
      cout << "savings called";
    }
};
```

```
int main() {
  base b;  savings s;
  b.id = 1;   b.balance = 15000;
  s.id = 2;   s.balance = 67000;   s.age = 20;   s.ATM = 240;
  b = s;
  cout << b.id << ", " << b.balance ;
  b.id = 3;   b.balance = 30000;
  s.id = 4;   s.balance = 40000;
  //s = b;
  base *bptr;
  savings *sptr;
  bptr = &s;
  cout << bptr->id << ", " << bptr->balance;
  //sptr = &b;
  base& bref = s;
  bref.print();
  return 0;
}
```

derived class can be assigned to object of base class, additional data members are sliced off, only members 'id' and 'balance' will be copied

```
2, 67000
```

error, cannot assign an object of superclass to variable of subclass

assigning subclass object to superclass pointer

```
4, 40000
```

error, cannot assign superclass object to subclass pointer

reference of type superclass to objects of subclass

```
base called
```

calls the 'print' in the base class and not in the savings class

Overloading assignment operator

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```
class base {
  public:
    int id; float balance;
    base(int x):id(x){ }
    base & operator=(base & a){
       id = a.id;
       cout << "base class operator\n" ;
       return *this;
    }
};
```

```
class savings : public base {
   public:
      int age; long int ATM;
      savings(int x, int y):base(x),age(y) { }
      savings & operator=(base &b) {
         base::operator=(b);
         return *this;
      }
};
```

assignment operator assigning base class to savings class object

```
int main() {
  base b1(10);
  savings s1(11,20), s2(12,30);
  s2 = s1;
  cout << s2.id << "," << s2.age << endl;
  b1 = s1;
  cout << b1.id << endl;
  b1.id = 50;
  s2 = b1;
  cout << s2.id << "," << s2.age << endl;
  return 0;
}
```

11,20

11

50,20

Inheriting assignment operator

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```
class base {
  public:
    int id; float balance;
    base(int x):id(x){ }
    base & operator=(base & a){
      id = a.id;
      cout << "base class operator\n" ;
      return *this;
    }
};
```

```
class savings : public base {
  public:
    int age; long int ATM;
    savings(int x, int y):base(x),age(y) { }
    using base::operator=;
};
```

```
int main() {
  base b1(10);
  savings s1(11,20), s2(12,30);
  s2 = s1;
  cout << s2.id << "," << s2.age << endl;
  b1 = s1;
  cout << b1.id << endl;
  b1.id = 50;
  s2 = b1;
  cout << s2.id << "," << s2.age << endl;
  return 0;
}
```

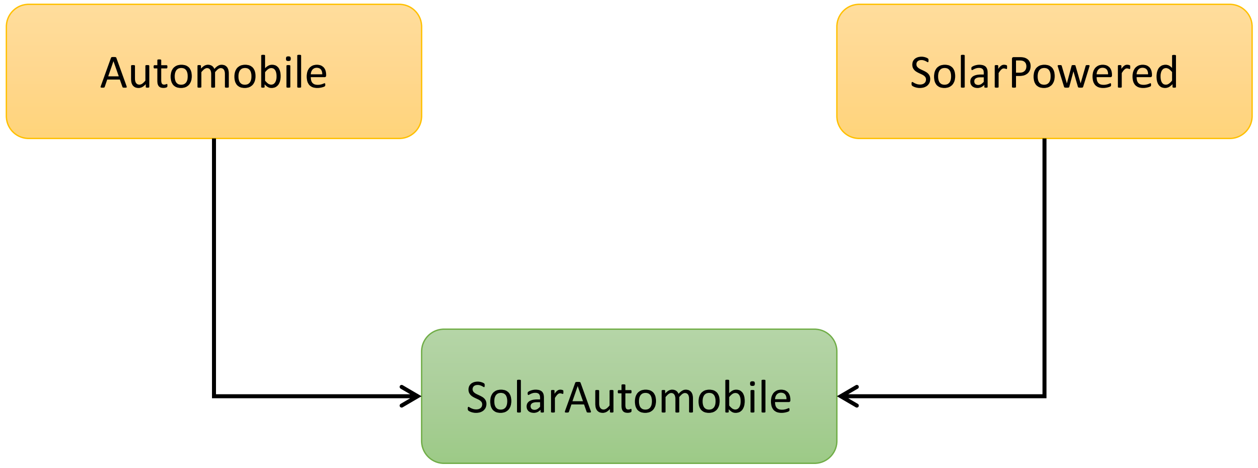
```
11,20
```

```
11
```

```
50,20
```

Multiple Inheritance

```
class Automobile{
    double mileage;
};
```



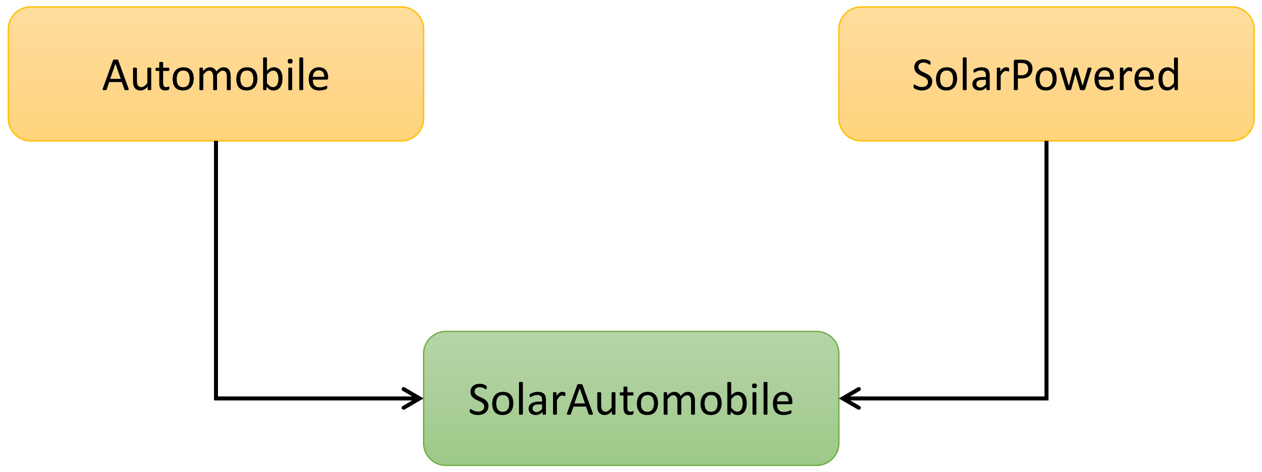
```
class SolarPowered {
    double cellEfficiency;
};
```

```
class SolarAutomobile  : public Automobile, public SolarPowered {
    int noOfSeats;
};
```

Multiple Inheritance

What if there are same member variables/functions in the base classes

```
class Automobile{
    double mileage;
    float price;
};
```



```
class SolarPowered {
    double cellEfficiency;
    float price;
};
```

```
class SolarAutomobile  : public Automobile, public SolarPowered {
    int noOfSeats;
};
```

Multiple Inheritance

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```
c
```

```
class SolarPowered {
```

```
class Sol
  int no(
  float t
  public:
    Solar
       /
    float
      ret
    }
};
```

```
int main() {
  double mileage = 20.5;
  float automobilePrice = 400000;
  double cellEfficiency = 60.5;
  float solarPrice = 100000;
  int seats = 4;
  SolarAutomobile s(mileage, automobilePrice, cellEfficiency, solarPrice, seats);
  cout << s.getTotalPrice();
  return 0;
}
```

Diamond Inheritance

```
class student{
  int rollNo;
  public :
    student(int a):rollNo(a) { }
    int getRollNo() {
      return rollNo;
    }
};
```

$$\begin{tikzcd}
 & \text{student} & \\
\text{midsem} \arrow[ur] & & \text{endsem} \arrow[ul] \\
 & \text{total} \arrow[ul] \arrow[ur] &
\end{tikzcd}$$

```
class endsem: public student{
  float endSemMarks;
  public :
    endsem(int a, float b) :
        student(a), endSemMarks(b) { }
    float getEndSemMarks() {
      return endSemMarks;
    }
};
```

```
class midsem: public student{
  float midSemMarks;
  public :
    midsem(int a, float b) :
       student(a), midSemMarks(b) { }
    float getMidSemMarks() {
      return midSemMarks;
    }
};
```

```
class total : public midsem, public endsem {
  float totalMarks;
  public:
    total(int a, float b, float c) :
      midsem(a,b), endsem(a,c) { }
    float getTotal() {
      return midsem::getMidSemMarks() +
           endsem::getEndSemMarks();
    }
};
```

Diamond Inheritance

```
class student{
  int rollNo;
  public :
    student(int a):rollNo(a) { }
    int getRollNo() {
      return rollNo;
    }
};
```

```
class midsem: public student{
  float midSemMarks;
  public :
    midsem(int a, float b) :
          student(a), midSemMarks(b) { }
    float getMidSemMarks() {
      return midSemMarks;
    }
};
```

```
class endsem: public student{
  float endSemMarks;
  public :
    endsem(int a, float b) :
          student(a), endSemMarks(b) { }
    float getEndSemMarks() {
      return endSemMarks;
    }
};
```

```
class total : public midsem, public endsem {
  float totalMarks;
  public:
    total(int a, float b, float c) :
         midsem(a,b), endsem(a,c) { }
    float getTotal() {
      return midsem::getMidSemMarks() +
           endsem::getEndSemMarks();
    }
};
```

```
int main() {
  int roll = 1001;
  float mMarks = 32.2, eMarks = 43.4;
  total student1(roll, mMarks, eMarks);
  cout << student1.getRollNo();  ✗
  cout << student1.getMidSemMarks();
  cout << student1.getEndSemMarks();
  cout << student1.getTotal() ;
  return 0;
}
```

Call to member function ‘getRollNo’ is ambiguous

Problems

- ‘total’ derives from both, ‘midsem’ and ‘endsem’.
- ‘midsem’ and ‘endsem’ have their own copy of the data members and methods of the student class.
- total object “student1" contains *two* subobjects of ‘*student’* base class.

Virtual Derivation

```
class student{
  int rollNo;
  public :
    student(int a):rollNo(a) { }
    int getRollNo() {
      return rollNo;
    }
};
```

```
class midsem: virtual public student{
  float midSemMarks;
  public :
    midsem(int a, float b) :
          student(a), midSemMarks(b) { }
    float getMidSemMarks() {
      return midSemMarks;
    }
};
```

```
class endsem: virtual public student{
  float endSemMarks;
  public :
    endsem(int a, float b) :
          student(a), endSemMarks(b) { }
    float getEndSemMarks() {
      return endSemMarks;
    }
};
```

```
class total : public midsem, public endsem {
  float totalMarks;
  public:
    total(int a, float b, float c) :
          student(a), midsem(a,b), endsem(a,c) { }
    float getTotal() {
      return midsem::getMidSemMarks() +
             endsem::getEndSemMarks();
    }
};
```

Only one subobject of the ‘student’ class is created for every ‘total’ object.

```
int main() {
  int roll = 1001;
  float mMarks = 32.2, eMarks = 43.4;
  total student1(roll, mMarks, eMarks);
  cout << student1.getRollNo() << endl;
  cout << student1.getMidSemMarks() << endl;
  cout << student1.getEndSemMarks() << endl;
  cout << student1.getTotal() << endl;
  return 0;
}
```

Output

```
1001
32.2
43.4
75.6
```

Summary

- Objects of base and derived classes
- Objects of classes with pointers and references
- Inheritance
  - Multiple
  - Diamond