CS 162
Intro to Programming II

Polymorphism II
Virtual Functions

• Which is which, for changing the behavior of inherited functions?
  – Overriding refers to doing this change to a virtual function
  – Redefining refers to doing this change to a non-virtual function
  – Overloading refers to the definition of different functions within the same class with the same name and different parameter lists.
Abstract Classes

/* Shape.hpp */
class Shape {
public:
  Shape();
  virtual void print() = 0;
  virtual double getArea() = 0;
};

/* Shape.cpp */
Shape::Shape() {
}

/* Shape.hpp */
class Shape {
public:
  Shape();
  virtual void print() = 0;
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};

/* Shape.cpp */
Shape::Shape() {
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Abstract Classes

/* Shape.hpp */
class Shape {
public:
Shape();
virtual void print() = 0;
virtual double getArea() = 0;
};

• These are **pure** virtual functions
• Cannot create a shape object- abstract class
Abstract Classes

• Why abstract classes?
  – It has the common characteristics
  – Details are left to specific subclasses
  – In this case we want each shape to draw itself and compute its area
  – Details will vary for each shape
  – You do not even need to know what shapes may be used later!
Abstract Classes

• A derived class will also be abstract unless you:
  1. You provide definitions for the inherited pure virtual functions
  2. You do not add any pure virtual functions

• If these conditions are met you can create an object of the derived class
Abstract Classes

• How does this work?
• We will create a derived class for a Rectangle and a Triangle
• Both will define the pure virtual functions
• Both will add member variables and functions (but no pure virtual functions)
Abstract Classes

/* Rectangle.hpp */
class Rectangle : public Shape {
public:
    Rectangle(double height, double width);
    void print();
    double getArea();
private:
    double height;
    double width;
};
Abstract Classes

/* Inside Rectangle.cpp. Constructor omitted due of lack of space */

void Rectangle::print() {
    for( int i = 0; i < height; i++ ) {
        for( int j = 0; j < width; j++ ) {
            std::cout << "*";
        }
        std::cout << std::endl;
    }
}

double Rectangle::getArea() {
    return (height*width);
}
Abstract Classes

/* Triangle.hpp */
class Rectangle : public Shape {
public:
    Triangle(double height, double width);
    void print();
    double getArea();
private:
    double height;
    double width;
};
Abstract Classes

/* Inside Triangle.cpp. Constructor omitted due of lack of space */

void Triangle::print() {
    for( int i = 0; i < height; i++ ) {
        for( int j = 0; j <= i; j++ ) {
            std::cout << "*";
        }
        std::cout << std::endl;
    }
}

double Rectangle::getArea() {
    return (0.5*height*width);
}
Slicing Problem

/* In Bunny.hpp */

class Bunny {

public:
  Bunny(std::string);
  virtual ~Bunny();
  virtual void print() const;

private:
  std::string *name;

};
/* In MutantBunny.hpp */
class MutantBunny : public Bunny {
public:
    MutantBunny(std::string name);
    ~MutantBunny();
    void print() const;
    void addNameOfBunnyEaten(std::string name);
private:
    std::vector<std::string> *namesOfBunniesEaten;
};
Slicing Problem

/* In Bunny.cpp */
void Bunny::print() const {
    std::cout << "Name: " << name << std::endl;
}

/* In MutantBunny.cpp*/
void MutantBunny::print() const {
    Bunny::print();
    std::cout << "Bunnies eaten: " << std::endl;
    for( int i = 0; i < namesOfBunniesEaten->size();i++ ) {
        std::cout << "\t" << (*namesOfBunniesEaten)[i] << std::endl;
    }
}
MutantBunny mb("Fluffy");
Bunny b = mb;

• This assignment of objects works
• The copy does not include any variables in MutantBunny but not in Bunny
• It slices off those data members
• This code will not compile as b is a Bunny:
  b.addNameOfBunnyEaten("Bugs");
Slicing Problem

MutantBunny *mb = new MutantBunny("Fluffy");
mb->addNameOfBunnyEaten("Bugs");
Bunny *b = mb;
b->print();

• This assignment of pointers works
• print() calls the version in MutantBunny but not in Bunny
• The output is:
  Name: Fluffy
  Bunnies eaten: Bugs
Virtual Destructors

• In Bunny.hpp we had:
  virtual ~Bunny();

• The definitions look like this:
  
  /* In Bunny.cpp */
  Bunny::~Bunny() {
    delete name;
  }

  /* In MutantBunny.cpp */
  MutantBunny::~MutantBunny() {
    delete namesOfBunniesEaten;
  }
Virtual Destructors

• If the destructor is not virtual then this code:
  
  Bunny *b = new MutantBunny("Bob");
  delete b;

• Will clean up the name member in Bunny

• But not the namesOfBunniesEaten in MutantBunny

• If the base class destructor is virtual then all derived class destructors are virtual and will be called