CS 162, Lecture 18: Introduction to Polymorphism

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Polymorphism

• The ability to associate many meanings to one function name by means of a special mechanism known as a virtual function or late binding

• Virtual functions may be used before it is defined

• Late binding (dynamic binding): techniques of waiting until run time to determine the implementation of a procedure
How to Polymorph

- Have a virtual function in the base class declaration, don’t change anything else

```cpp
class Piece {
    protected:
        int r_pos;
        int c_pos;
        int color;
        char shape;
        bool captured;
    public:
        Piece();
        void move(int, int);
        //appropriate accessor and mutators here
        virtual bool check_valid(int r, int c);
};
```
How does it change what occurs here?

```cpp
void test_bishop(Bishop& p, int r, int c) {
    bool res = p.check_valid(r, c);
    if (res)
        p.move(r, c);
    else
        cout << "MOVE IS NOT VALID" << endl;
}
void test_piece(Piece& p, int r, int c) {
    bool res = p.check_valid(r, c);
    if (res)
        p.move(r, c);
    else
        cout << "MOVE IS NOT VALID" << endl;
}
Bishop b;
test_bishop(b, 3, 0); //Will these two function calls have the same result?
test_piece(b, 3, 0);
```
Best practices

• If the function is declared virtual in the base class, you do not need to redefine it in the derived class
  • But you should -> reminds the programmer which functions are virtual when working in a derived class

• Override: when you redefine a function in a derived class to be used in a polymorphic fashion

• Redefined: when you redefine a function in a derived class

• Why not make all functions virtual?
  • Increased storage overhead and slows the program down
The Return of Pointers

• We know that a base class type can take a child class type (upcasting)
• Slicing problem: lose some features of child class when assigned to the parent
• Fix with pointers, can maintain the child type

```cpp
Piece* p;
Pawn* sacrificial = new Pawn;
p = sacrificial;
p->get_num_moves();
//note: get_num_moves() needs to exist in Piece and must be virtual
```
Exercise

• How would you create a set of chess pieces for a player using polymorphism?
Example of Polymorphism Demo

Piece** pieces = new Piece*[16];
pieces[0] = new King(color, side);
pieces[1] = new Queen(color, side);
pieces[2] = new Rook(color, side, 0);
pieces[3] = new Rook(color, side, 7);
pieces[4] = new Knight(color, side, 1);
pieces[5] = new Knight(color, side, 6);
pieces[6] = new Bishop(color, side, 2);
pieces[7] = new Bishop(color, side, 5);
for(int i=8; i<16; i++) {
    pieces[i] = new Pawn(color, side, i-8);
}
Abstract Classes and Pure Virtual

• Sometimes the function in the base class does not need a definition if the primary purpose is to polymorph into a child
  • Make the function pure virtual in the base class
  • Ex. virtual bool check_valid(int, int) = 0;

• Abstract class: a class with one or more pure virtual functions.

• Can not have objects of an abstract class which do not polymorph
  • The class does not have complete set of definitions.

• Make destructors virtual, if you don’t then the child destructor won’t be called
How it works in the compiler

• If a class has one or more virtual functions, the compiler creates a virtual function table for that class.
• The table has a pointer for each virtual function to point to the appropriate code.
• If the definition did not change from the parent, it points to the parent.
• If the definition changed from the parent, it points to the child.