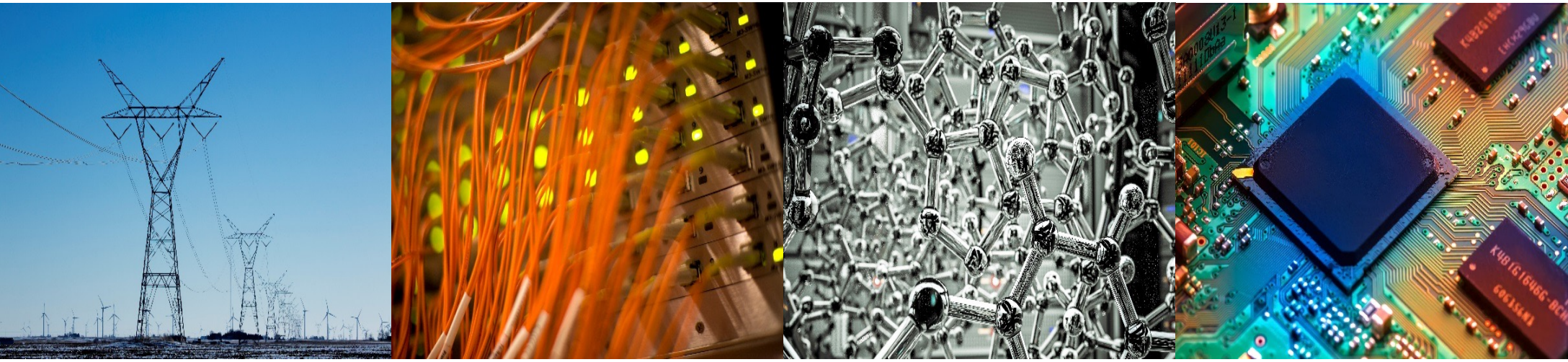
ECE 220 Computer Systems & Programming

Lecture 22 – Introduction to C++: Rule of Three & Templates

April 16, 2026



- **Quiz5 is next week**

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What we've learned so far in C++

1. Abstraction
2. Encapsulation
3. Inheritance
4. Polymorphism

- Class vs. Struct
- Dynamic Memory Allocation
- Basic I/O
- Pass by Value vs. Pass by Address (pointer) vs. Pass by Reference
- Function / Operator Overloading
- Base Class & Derived Class
- Virtual Function
- Abstract Class

Rule of Three (Big Three)

```
class demo{
public:
    demo(int x);                    //constructor
    demo();                         //default constructor
    demo(const demo &x);            //copy constructor
    ~demo();                        //destructor
    demo &operator=(const demo &x); //copy assignment operator
}
```

- These are called Rule of Three or **Big Three** (sometimes Big Five)
- When you are implementing one, you should be thinking about the others too

Shallow Copy vs. Deep Copy

```
class Person{
      char *name;
      int id;
  public:
      Person(){};
      Person(const char
*_name, int _id);
      Person(const Person &p);
      void ShowData();
      ~Person();
};
```

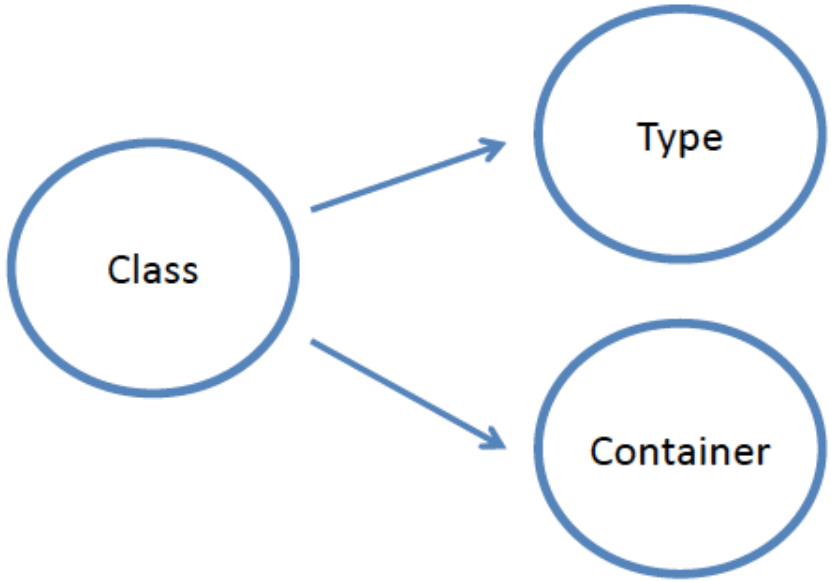
```
//default copy constructor will be
//inserted if it's not implemented
Person::Person(const Person &p){
      this->name = p.name;
      this->id = p.id;}
```

```
Person::Person(const char
*_name, int _id){
      name = new char[48];
      strcpy(this->name, _name);
      this->id = _id;
}

Person::~Person(){
      delete []name;
}
```

```
Person::Person(const Person &p){
    this->name = new char[48];
    strcpy(this->name, p.name);
    this->id = p.id;
}
```

Templates



- Separate type from the structure
- Type focuses on data values, basic operators
- Container focuses on data structure (stack, list, array, tree, etc…)

Function Template

```
//functions can have the same names (overload)
int getmin(int a, int b){
   return (a<b)?a:b;
}

double getmin(double a, double b){
   return (a<b)?a:b;
}

//define function with generic type instead!
template <typename T>
T getmin(T a, T b){
   return (T)(a<b)?a:b;
}
```

```
int main(){
   cout << getmin(5,7) << endl;
   cout << getmin(1.5,2.7) << endl;
   return 0;
}
```

Class Template

```
template <typename T>
class mypair {
   T a, b;
   public:
   mypair (T first, T second)
      {a=first; b=second;}
   T getmin ();
};

template <typename T>
T mypair<T>::getmin () {
   T retval = a<b?a:b;
   return retval;
}
```

```
int main () {
    mypair <int> myobject (100, 75);
    cout << myobject.getmax() << endl;
    return 0;
}
```

Friend Function and Class

- Allows outside function/class to access a class' private and protected members
- "Friendship" is one-way

C++ Standard Template Library (STL) Containers - Vector

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

int main() {
   // Create a vector containing integers
   vector<int> intVector {1,3,5,7};
   // Add two new elements at the end of vector
   intVector.push_back(9);
   intVector.push_back(11);
   // Iterate and print values of vector
   for(int i = 0; i < intVector.size(); i++) {
      cout << intVector[i] << endl;
   }
   return 0;
}
```

More on Vector

- Sequence container that encapsulates **dynamic size arrays** (container - an object that holds the same type of data)
- Can expand or shrink during run-time
- Similar to array, elements are stored in contiguous memory locations

Table 20.1 Some Useful Methods of the C++ STL Vector Class

	Description	Example
`size()`	return size of vector	`intVector.size();`
`resize()`	change size of vector	`intVector.resize(newSize);`
`insert()`	add elements to vector	`intVector.insert(where, value);`
`erase()`	remove elements from vector	`intVector.erase(where);`
`push_back()`	add new element at end of vector	`intVector.pushback(value);`
`front()`	access first element	`y = intVector.front() - 1;`
`back()`	access last element	`intVector.back() = 3;`

Other STL Containers

List

- Sequence container that encapsulates **a doubly linked list**
- Use when you need to insert and delete elements without moving existing elements
- Elements are individually allocated

Iterators

- Abstract way to represent traversing a collection
- Can be used for reading or writing (depending on iterator type)
- To use them, collection has begin() and end() class methods

List and Iterators Example

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

int main(){
    //Create a list containing floats
    list<float> l {2.1, 3.2, 4.5, 3.2, 5.6, 5.6};
    //Remove adjacent duplicate elements of list
    l.unique();
    //Remove all elements of list with the value ‘4.5'
    l.remove(4.5);
    for(auto it=l.begin(); it!=l.end(); it++){
            cout<<*it<<endl;}
    return 0;
}
```