Problem 1. Which ones (1..10), if any of the following data/function member declarations and definitions are incorrect? Explain clearly why (hint: there are 4 mistakes). [20%]

class X;
class Y {
public:
    void f1(X a) {a.f(*this);}    // 1
    void f2(X *a);                // 2
    void f3(Y a) {a.f4(*this);}   // 3
    void f4(Y &a);                // 4
private:
    X x1;                       // 5
    X &x2;                      // 6
    Y y1;                       // 7
    static Y y2;                // 8
};
class X {
public:
    void f(Y a) {a.f2(*this);}   // 9
};
void Y::f2(X *a) {a->f(*this); } // 10

Problem 2. Please draw the structure of the class diagram and identify the participants for the following design patterns: [20%]
(a) Strategy
(b) Template Method
(c) Adapter (class adapter)
(d) Command

Problem 3. Resource is often limited. Suppose that you have 12 resources of type XResource available to your application, which are shared by 50 clients of type XClient. A client is allowed to get and release an instance only by the following calls:

```cpp
XResource *px = XResource::getInstance(this);
if (px) {
    // do something with the obtained resource
    px->releaseInstance(this);
}
```

Note the client passes a pointer to itself (the this pointer) in getting and releasing a resource. Design and implement the class XResource. XResource must grant each client no more than 3 instances of the resource. [30%]

Problem 4. Suppose we would like to provide a GUI (Graphical User Interface) for our Petri Net simulation program so that networks can be constructed using GUI (instead of reading input files). This problem studies the support of the ability of grouping and ungrouping a set of objects (places, transitions, and links). The operations of grouping and ungrouping are similar to the drawing tools provided by PowerPoint. For simplicity, suppose that all of the objects are originally stored in an STL vector \( v \) (declared as `vector<object *> v`), and suppose that both regular and grouped objects can only be copied and moved. Please answer the following questions:

(a) Please provide a class diagram to describe the concept of your implementation. Note: you need to draw only the class diagrams that are related to grouping and ungrouping. [10%]

(b) Please describe how you maintain \( v \) for the grouping, and ungrouping operations? [10%]

(c) Please describe how you apply operations to a grouped object and how a grouped object responds to copy and move operations. [10%]