Shallow Copy

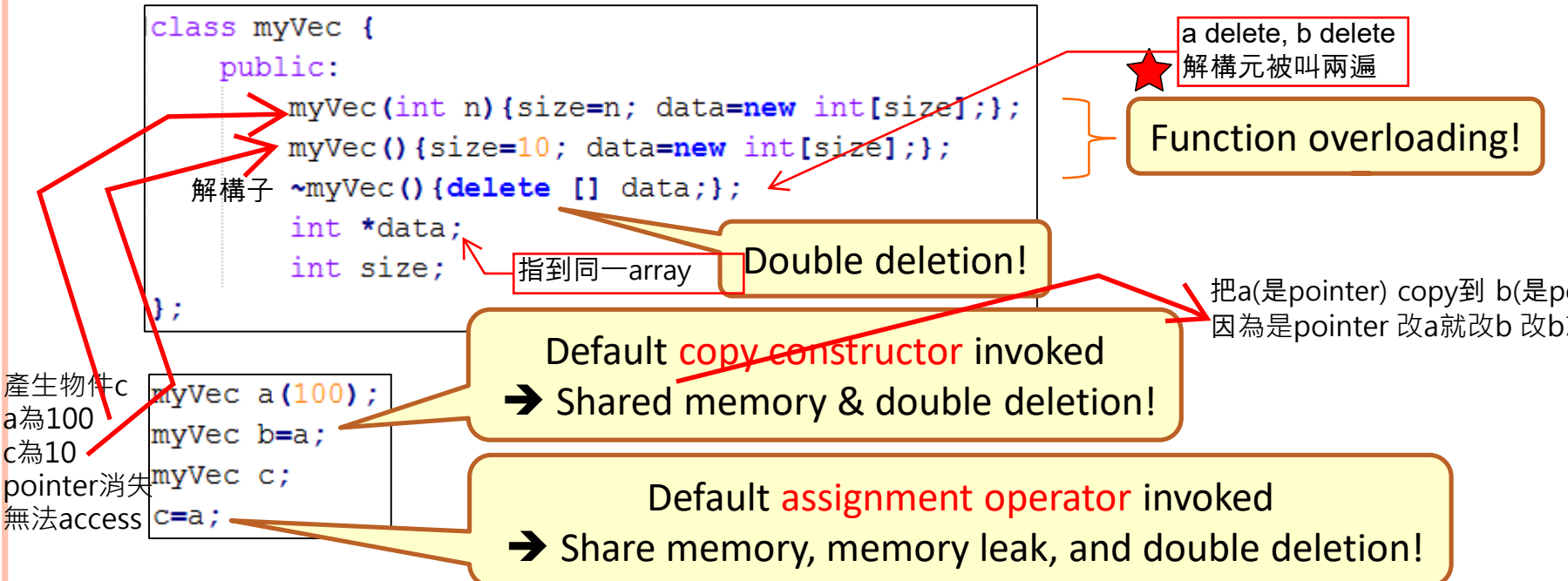
產生memory leak 的情況之一

Jyh-Shing Roger Jang (張智星)

CSIE Dept, National Taiwan University

Memory Allocation in Classes

- Common programming errors when using “new” for memory allocation in classes
  - Default copy constructor and assignment operator are based on “shallow copy”, which leads to errors easily.
  - We need to design our own constructor/operator.



How to Fix “Shallow Copy”?

- To fix the problem of “shallow copy”
  - Define our own copy constructor
  - Define our own assignment operator

a = b
a.operator = (b)
兩個意義是一樣的

```
// Copy constructor
myVec::myVec(const myVec& a) {   // copy constructor from a
    size = a.size;               // copy sizes
    data = new int[size];        // allocate new array
    for (int i=0; i<size; i++)   // copy the vector contents
        data[i]=a.data[i];
}

// Assignment operator
myVec& myVec::operator=(const myVec& a) {    // assignment operator from a
    if (this != &a) {                        // avoid self-assignment
        delete [] data;                      // delete old array
        size = a.size;                       // set new size
        data = new int[size];                // allocate new array
        for (int i=0; i<size; i++)           // copy the vector contents
            data[i]=a.data[i];
    }
    return *this;
}
```

Avoid memory leak

送進來的物件

將來要回傳的物件

Examples Which Fix “Shallow Copy”

- Examples
  - shallowCopy00.cpp: Demo of shallow copy
  - deepCopy00.cpp: Use new copy constructor only
  - deepCopy01.cpp: Use new assignment operator only
  - deepCopy02.cpp: Use both
- Lesson learned
  - If a class allocates memory via “new” (or the likes, such as “malloc” or “calloc”), we should provide a new copy constructor and a new assignment operator to allocate new memory for the created copy.

Q & A

- Questions
  - How to avoid the error message (due to double deletion) in shallowCopy00.cpp?
  - If we use STL vectors, do we still the problem of “shallow copy”? ➔ Please give examples and post to FB.
- Further studies
  - How to check memory leak?
    - Tools: Purify (Windows), Valgrind (Unix/Linux), Dr. Memory (both)
    - Please post on FB if you know other good tools to identify memory leak.
  - How to avoid memory leak?
    - Use STL (standard template library)

Quiz

- A program is used to record each student's quiz scores
  - Class definition:

```
class student {
    public:
        student(int n=3){count=n; score=new int[count];};
        ~student(){delete [] score;};
        int *score, count;
        string name;
};
```

如果沒送值
default n = 3

  - Main program:

```
int main(){
    student a(3);
    a.name="John"; a.score[0]=70; a.score[1]=80;
    student b=a;
    b.name="Mary"; b.score[2]=90;
}
```

直接copy所以
a.score[2] = 90

  - Quiz:
    - What are the contents of a and b?
    - What are the two potential problems of this program?
      - Shared memory & double deletion