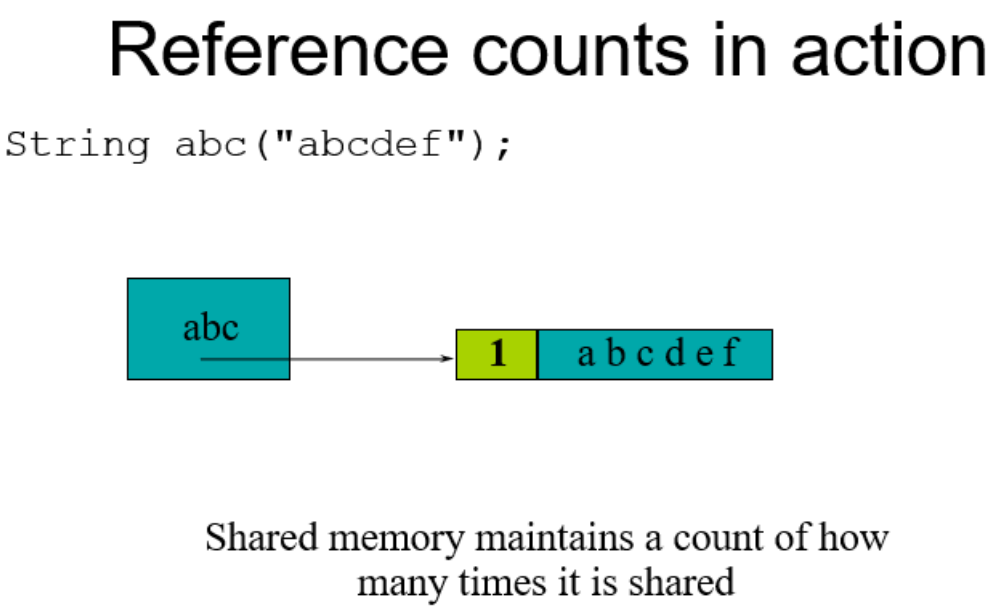
目录

第13章 SmartPointer

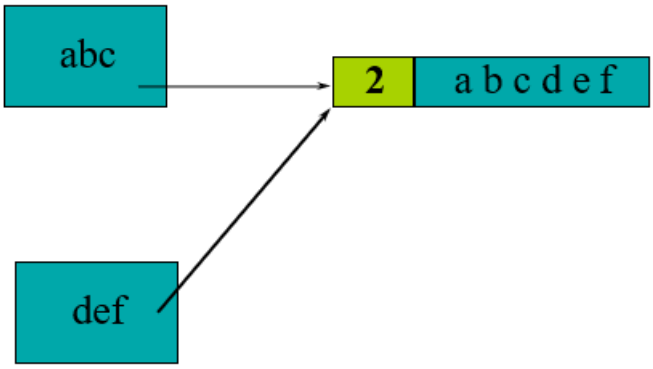
13.1 设计目标

1. 记录当前对象被引用了多少次 **reference count**
2. 类**UCObject**用来记录次数，use-counted object
3. 类**UCPointer**用来指向**UCObject**
    1. 智能指针是通过一个类定义的
    2. 使用模板实现
    3. 重载操作符->和*



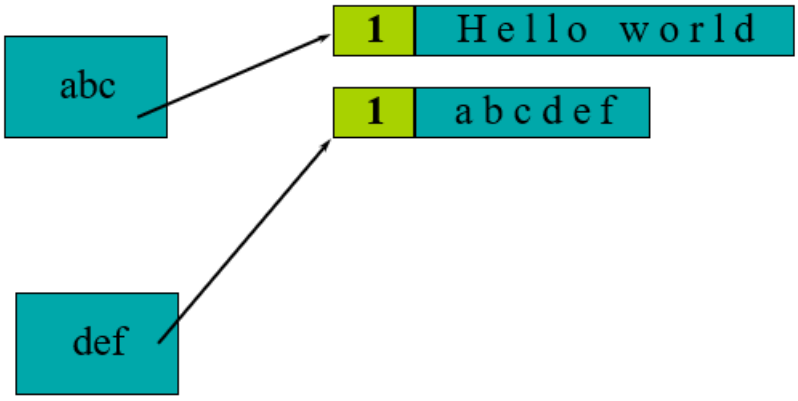
Reference counts in action

```
String abc("abcdef");
String def = abc; // shallow copy of abc
```



Reference counts in action

```
String abc("abcdef");
String  def = abc;          // shallow copy of abc
abc =  "Hello world";       // copy on write
```

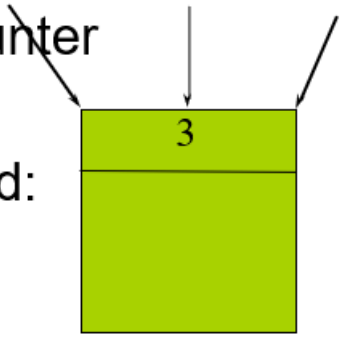


Reference counting

- Each sharable object has a counter
- Initial value is 0
- Whenever a pointer is assigned:

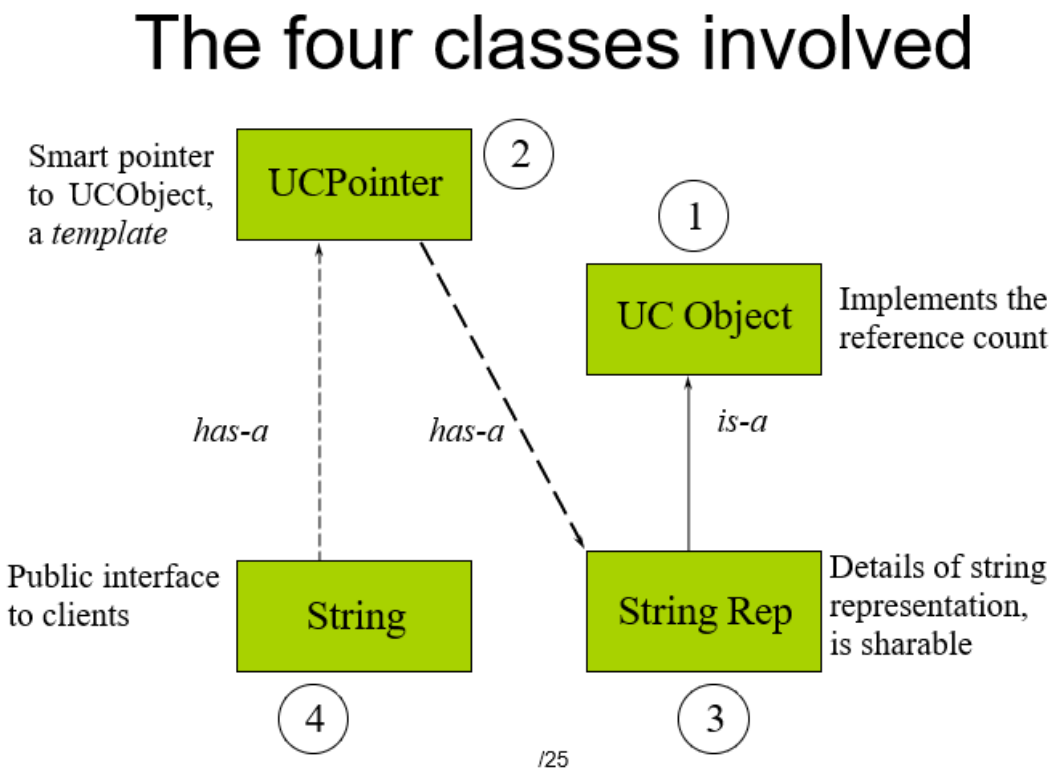
```
p  = q;
```

- Have to do the following




```
p->decrement(); // p's count will decrease
  p = q;
q->increment(); // q/p's count will increase
```

13.2 设计类及接口



1. **UCObject**：实现**reference count**
2. **UCPointer**：是一个类模板，支持指向任意一个类型的**UCObject**
3. **String Rep**：字符串表示的细节，是可共享的
4. **String**：再封装一层，提供给用户

13.3 实现细节

1. **UCObject**

```
#include <assert.h>
class UCObject {
private:
    int m_refCount;
public:
    UCObject() : m_refCount(0) { }
    UCObject(const UCObject&) : m_refCount(0) { }

    // 析构函数需要是virtual的,因为使用的时候,我们通常会使用父类指针指向子类,但是析构的时候要正确调用子类的析构函数
    virtual ~UCObject() {
        assert(m_refCount == 0);
    };

    // 接口不需要virtual, 因为所有子类的这些操作都是一样的
    void incr() {
        m_refCount++;
    }
    void decr() {
        m_refCount -= 1;
        if (m_refCount == 0)
            delete this;
    }
```

```
    int references() {
        return m_refCount;
    }
};
```

2. **UCPointer**

```
template <class T>
class UCPointer {
private:
    T* m_pObj;
    // 下列两个函数表明: T继承自UCObject, 否则调用incr(),decr()时编译器会报错
    // 因为UCPointer要像指针一样使用, 因此将这两个函数放入private中
    void increment() {
        if (m_pObj) m_pObj->incr();
    }
    void decrement() {
        if (m_pObj) m_pObj->decr();
    }
public:
    UCPointer(T* r = 0): m_pObj(r) {
        increment();
    }
    ~UCPointer() {
        decrement();
    };
    UCPointer(const UCPointer<T> & p){
        m_pObj = p.m_pObj;
        increment();
    }
    UCPointer& operator=(const UCPointer<T> &){
        if (m_pObj != p.m_Obj){
            decrement();
            m_pObj = p.m_pObj;
            increment();
        }
        return *this;
    }
    T* operator->() const{
        return m_pObj;
    }
    T& operator*() const {
        return *m_pObj;
    };
};

```

3. 使用实例：假设Shape继承自UCObject

```
Ellipse elly(200F, 300F);
UCPointer<Shape> p(&elly);
p->render(); // calls Ellipse::render() on  elly!
```

4. **String**

    1. **StringReq继承自UCObject**

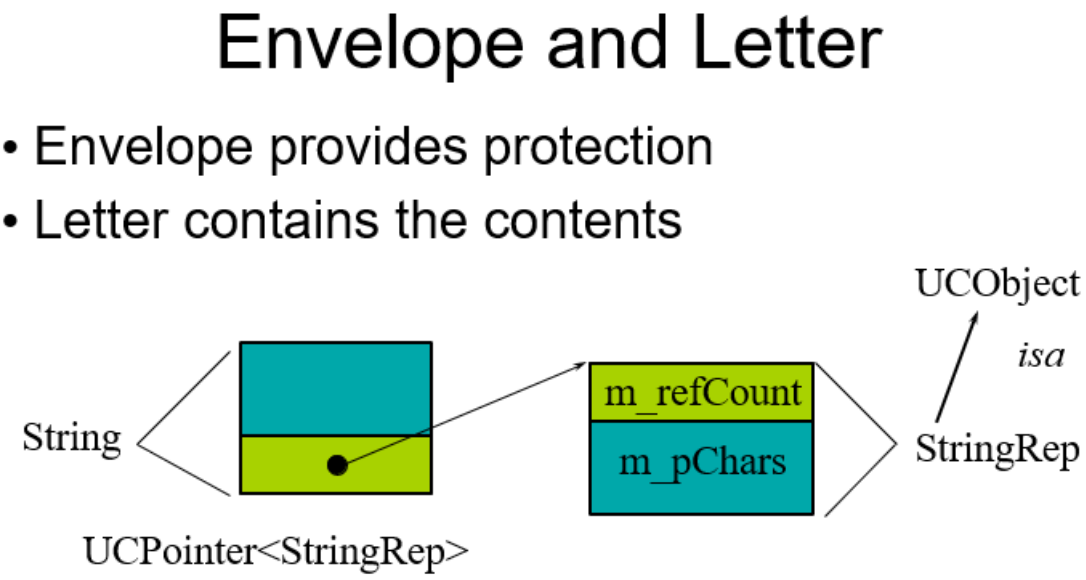
2. **String**提供用户使用的

```
class String {
public:
    String(const char *);
    ~String();
    String(const String&);
    String& operator=(const String&);
    int operator==(const String&) const;
    String operator+(const String&) const;
    int length() const;
    operator const char*() const;
private:
    UCPointer<StringRep> m_rep;
};
String::String(const char *s) : m_rep(0) {
    m_rep = new StringRep(s);
}

String::~String() {}

// Again, note constructor for rep in list.
String::String(const String& s) : m_rep(s.m_rep) {}

String& String::operator=(const String& s) {
    m_rep = s.m_rep; // let smart pointer do work!
    return *this;
}

int String::operator==(const String& s) const {
    // overloaded -> forwards to StringRep
    return m_rep->equal(*s.m_rep); // smart ptr *
}

int String::length() const {
    return m_rep->length();
}
```

5. **StringRep**

```
class StringRep : public UCObject {
public:
    StringRep(const char *);
    ~StringRep();
    StringRep(const StringRep&);
    int length() const{ return strlen(m_pChars); }
    int equal(const StringRep&) const;
private:
    char *m_pChars;
    // reference semantics -- no assignment op!
    void operator=(const StringRep&) { }
};
StringRep::StringRep(const char *s) {
    if (s) {
        int len = strlen(s) + 1;
        m_pChars = new char[len];
        strcpy(m_pChars , s);
```

```
    } else {
        m_pChars = new char[1];
        *m_pChars = '\0';
    }
}
StringRep::~StringRep() {
    delete [] m_pChars ;
}
StringRep::StringRep(const StringRep& sr) {
    int len = sr.length();
    m_pChars = new char[len + 1];
    strcpy(m_pChars , sr.m_pChars );
}

int StringRep::equal(const StringRep& sp) const {
    return (strcmp(m_pChars, sp.m_pChars) == 0);
}
```



13.4 细节

1. **UCPointer**维护了**reference counts**
2. **UCObject**隐藏了**count**的细节，使得**String**非常干净
3. **StringReq**只处理字符串的存储和操作
4. **UCObject**和**UCPointer**是可重用的
5. 当**UCPointer**的对象有环时，对象不会被**delete**