A <Basic> C++ Course

8 – Object-oriented programming 2

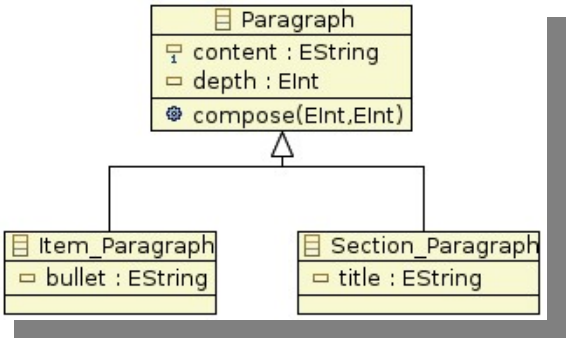
Julien Deantoni

Outline

- Dynamic Typing
- Truncature
- Cast

Variants of class `Paragraph` Definition of derived classes (1)

- We wish to have several sorts of paragraphs
  - titles, sections, enumerations, items…
- We want to share as much as possible the common properties
  - contents as a string
  - possibility to compose (crude lay out)
- But specific properties should be possible
  - numbering, bullets…
  - page layout

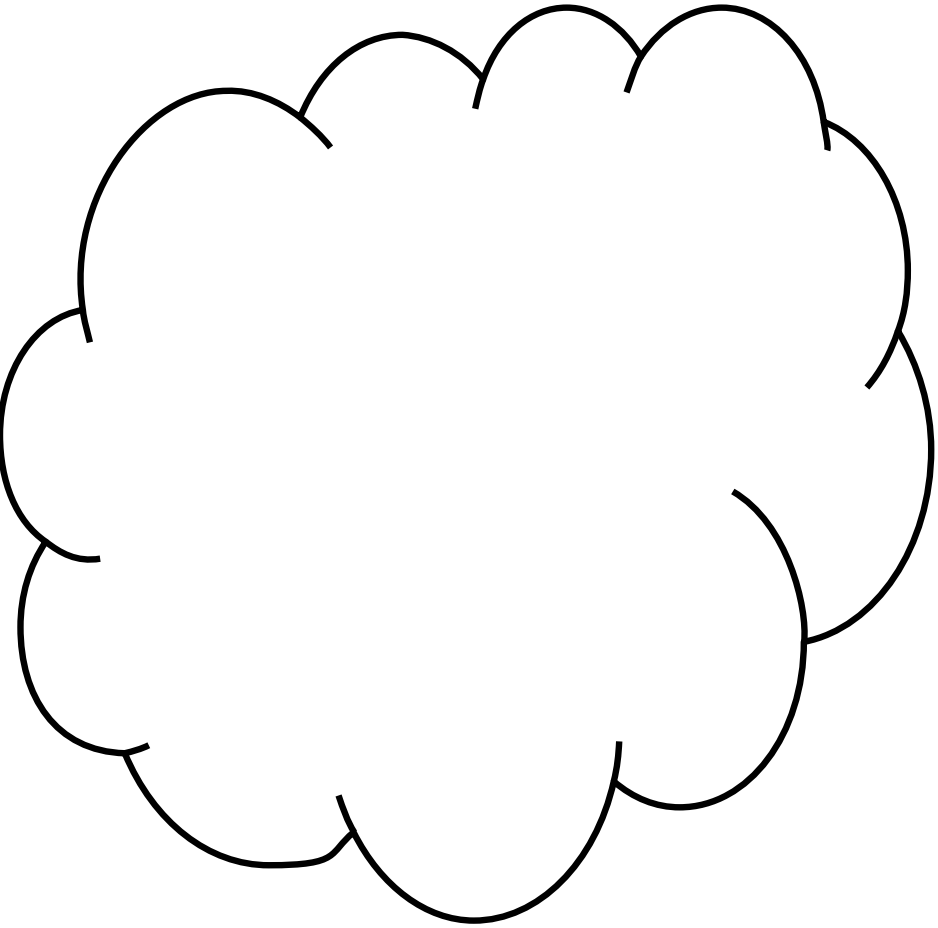


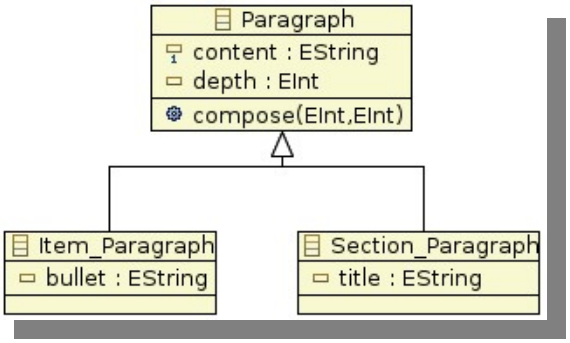
Variants of class `Paragraph` Definition of derived classes (5)

- A derived class may add new properties
  - data members
  - member-functions
  - friend functions
- A derived class may redefine (override) some inherited member-functions
- Derivation depth is unlimited
- Single and multiple inheritance
  - Single: only one base class
  - Multiple: several *distinct* base classes

What happens in memory (at least conceptually)

If `compose(int, int)` is NON virtual



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Paragraph p("test",2);
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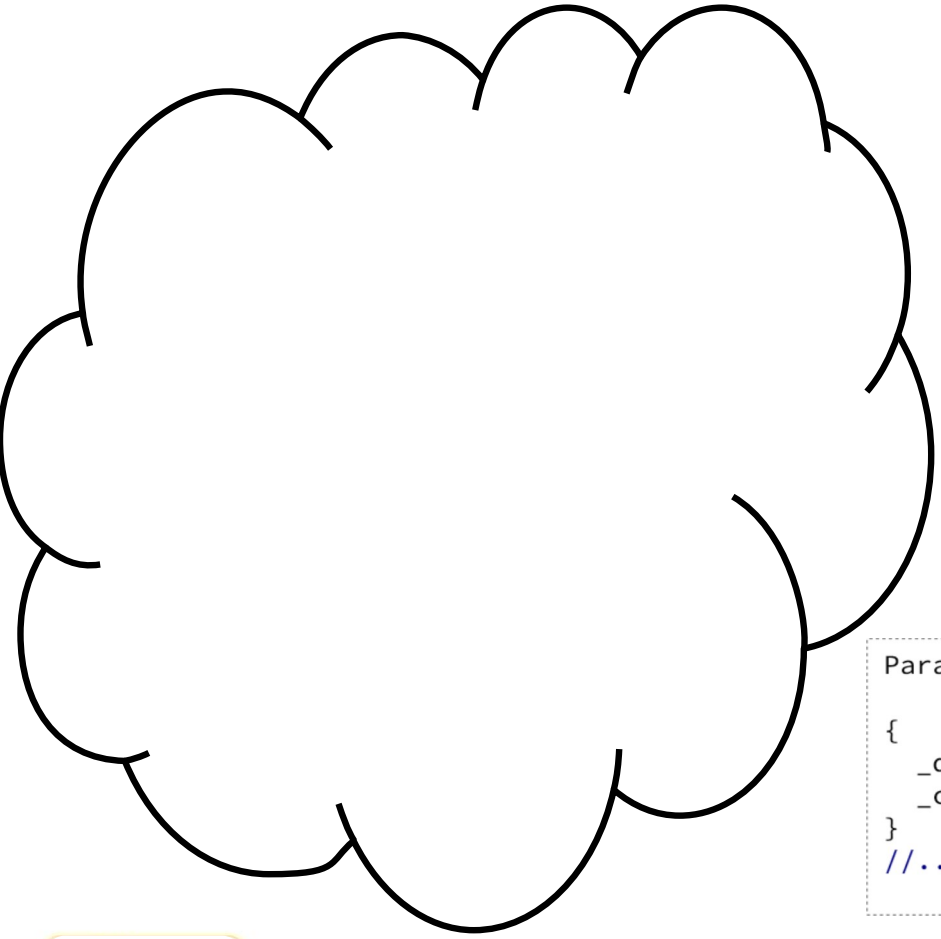

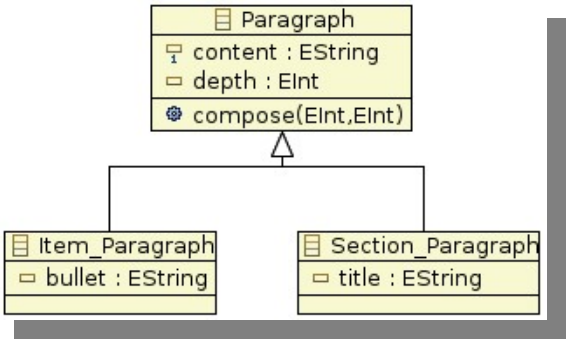


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//...
Paragraph p("test",2);
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```
Paragraph::Paragraph(std::string content
                     int depth)
{
  _depth = depth;
  _content = content;
}
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```

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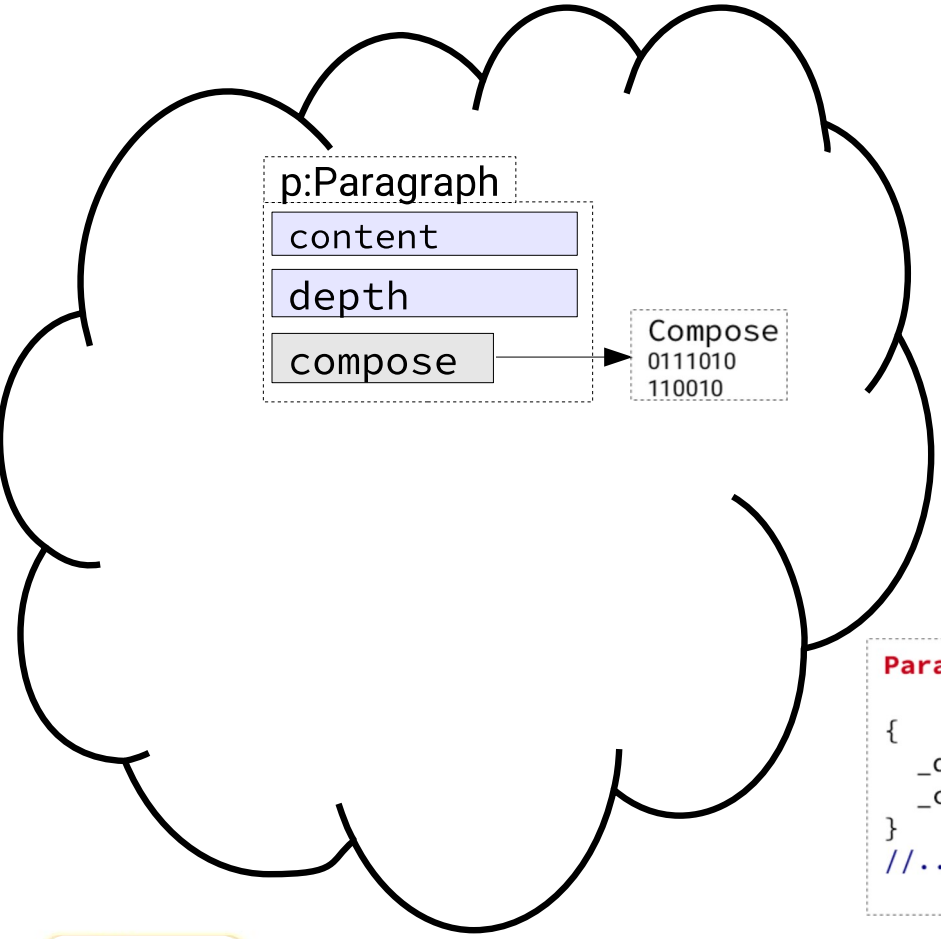

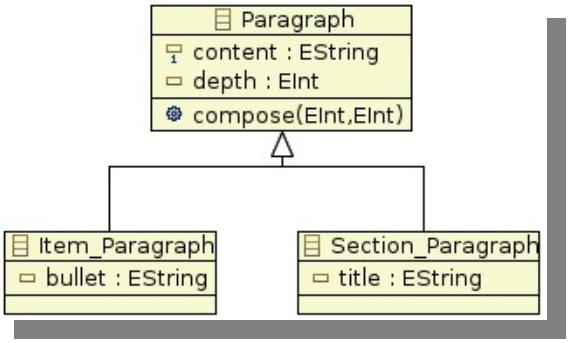


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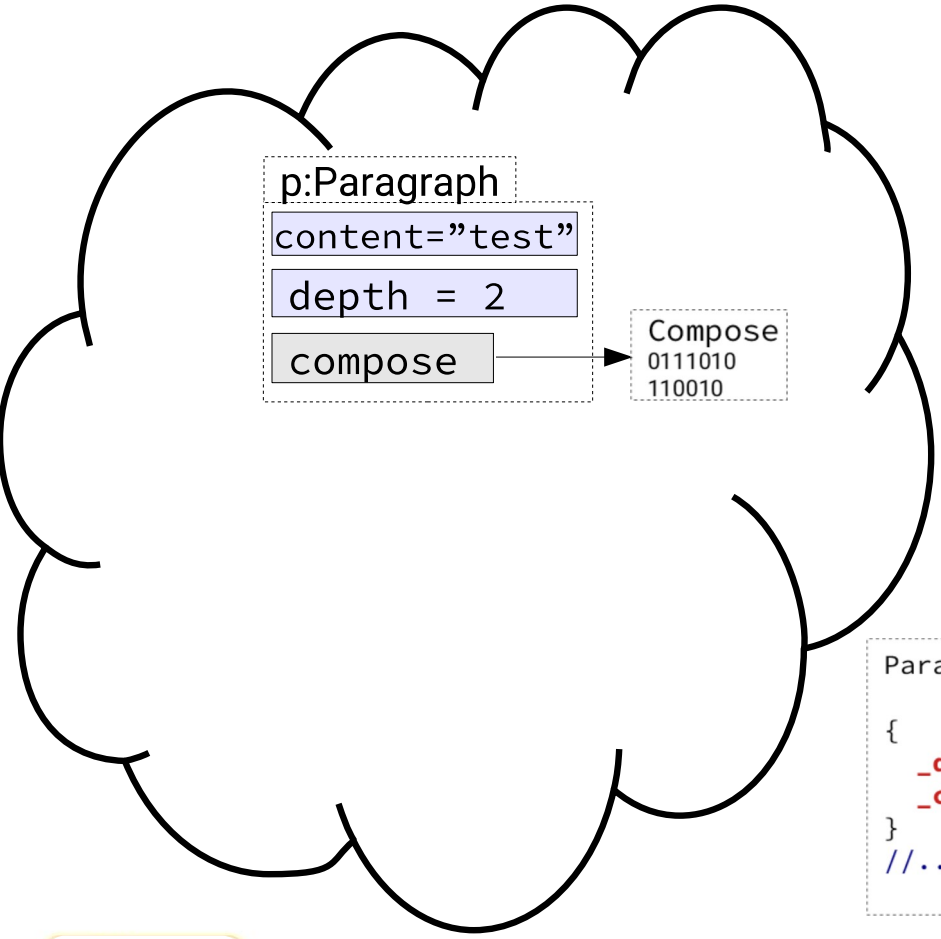

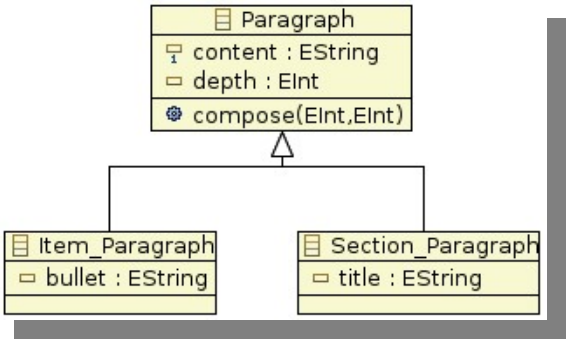


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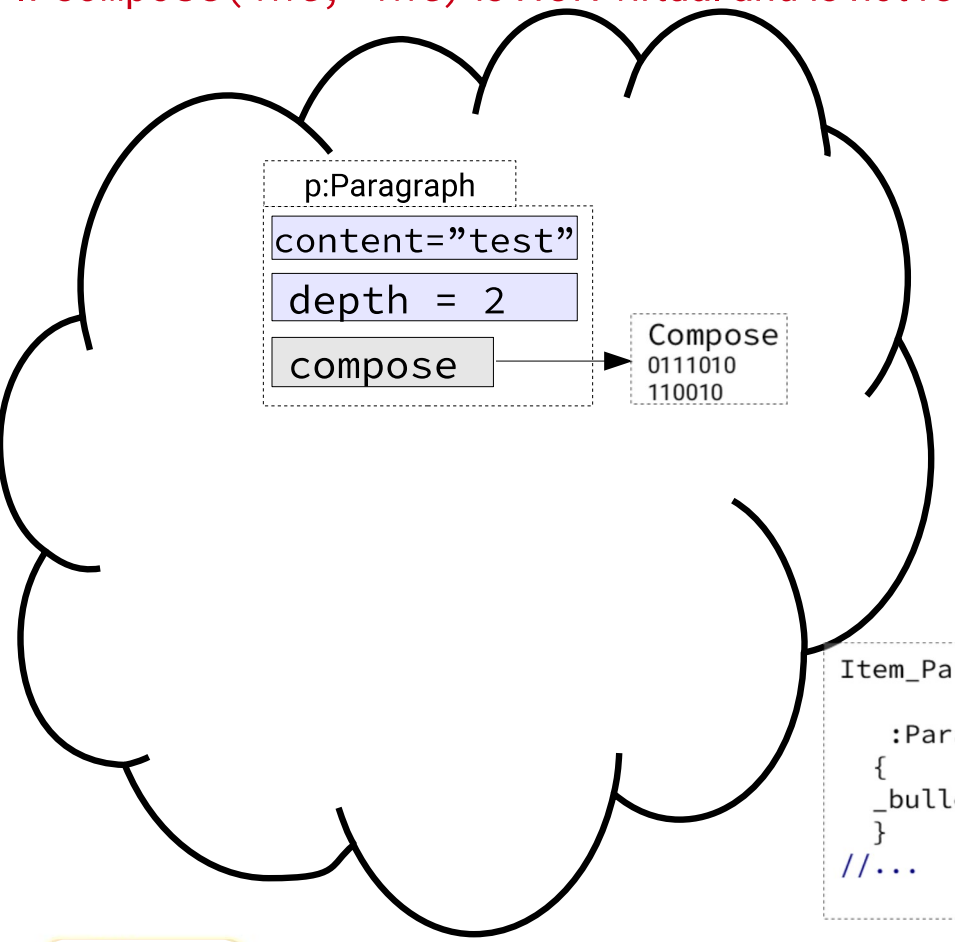
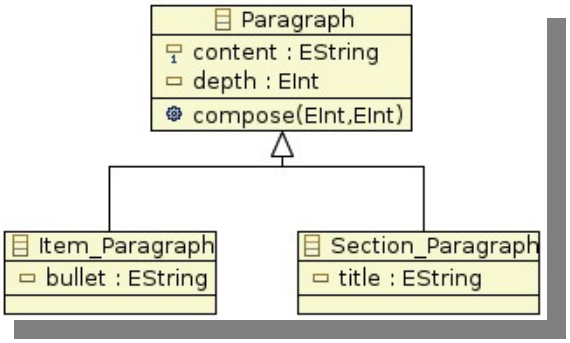
What happens in memory (at least conceptually)

If `compose(int, int)` is NON virtual and is not redefined in Item_Paragraph






```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');
```

```
Item_Paragraph::Item_Paragraph(string content,
                               int depth, char b)
   :Paragraph(content, depth)
  {
  _bullet = b;
  }
//...
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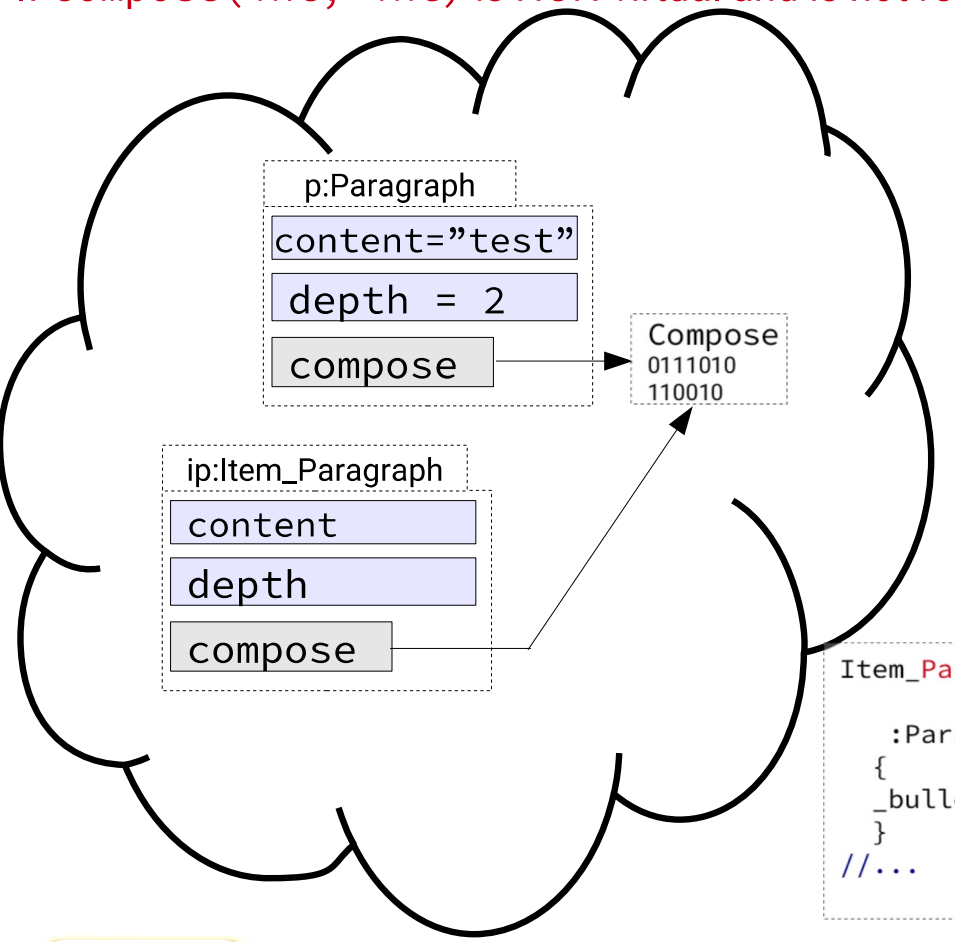

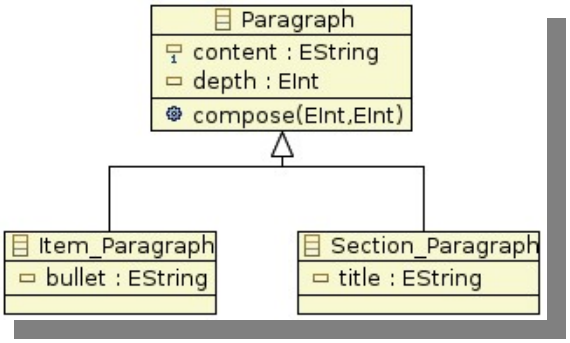


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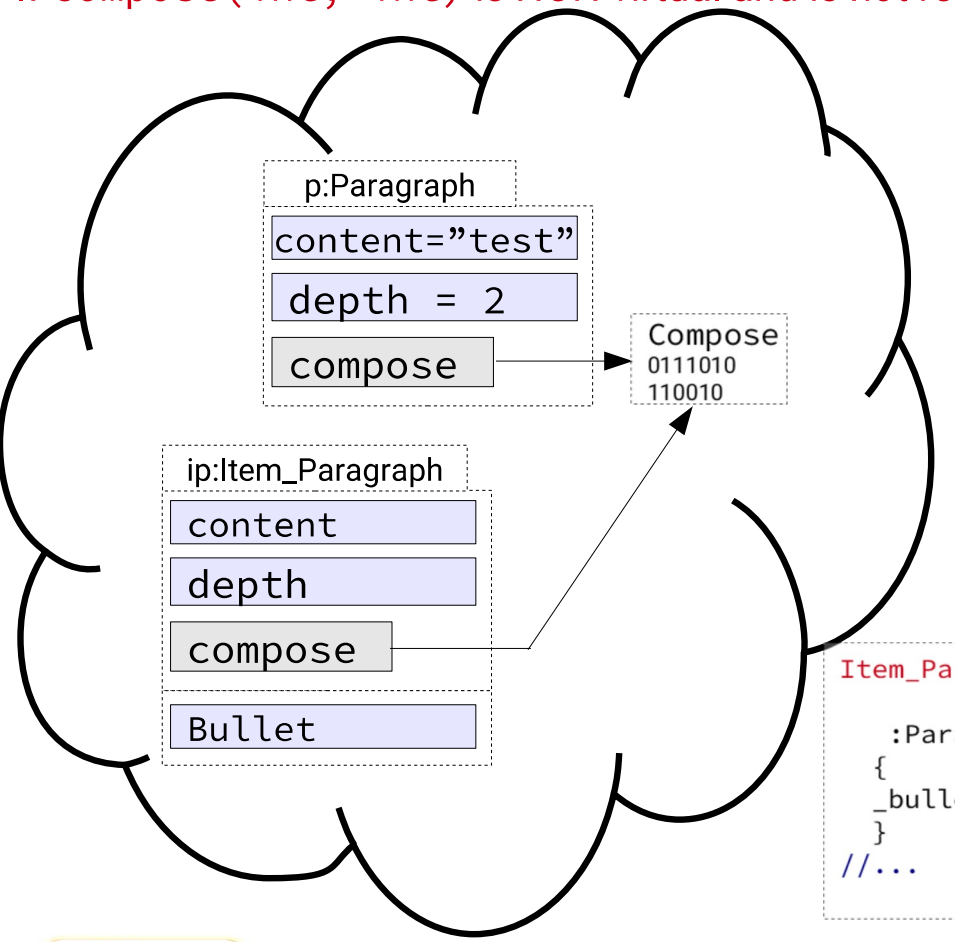

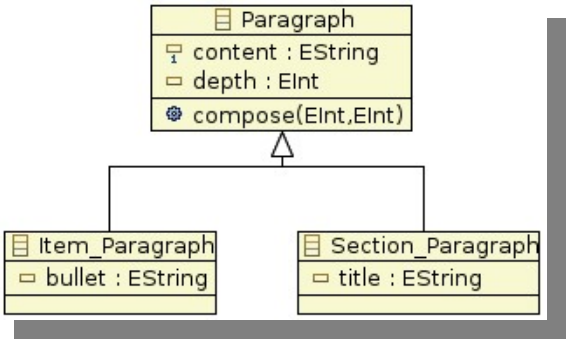


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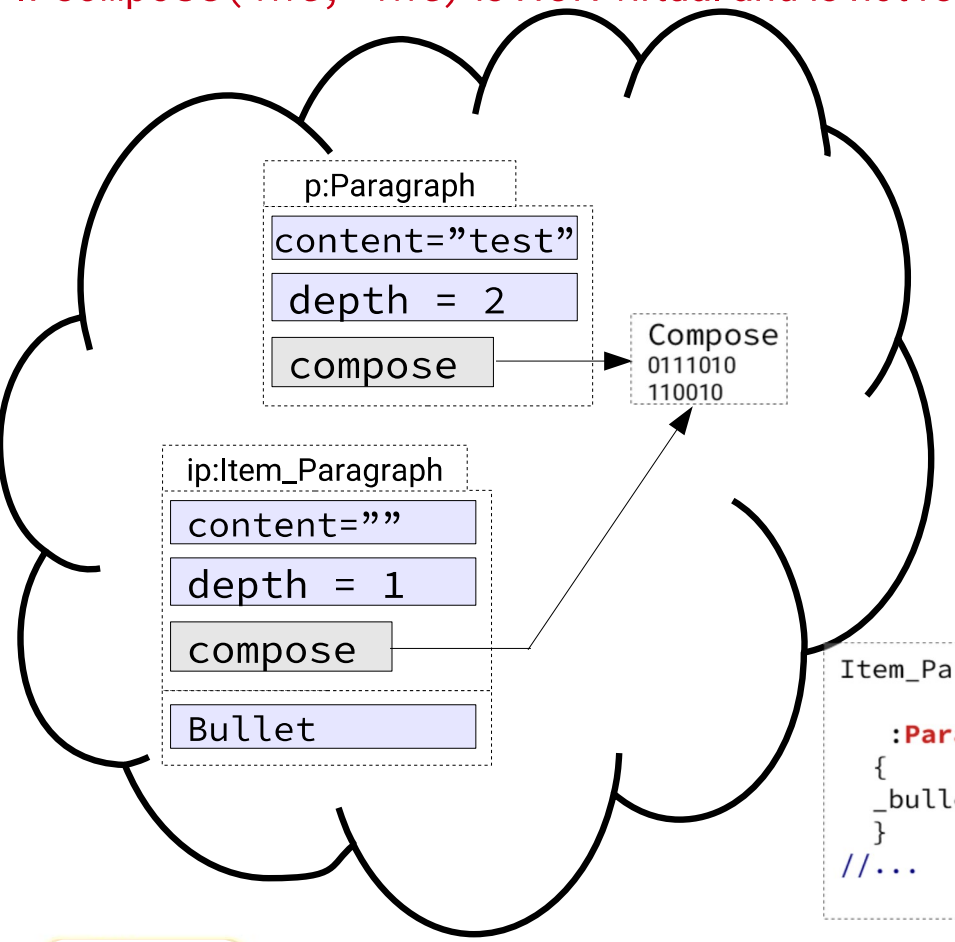

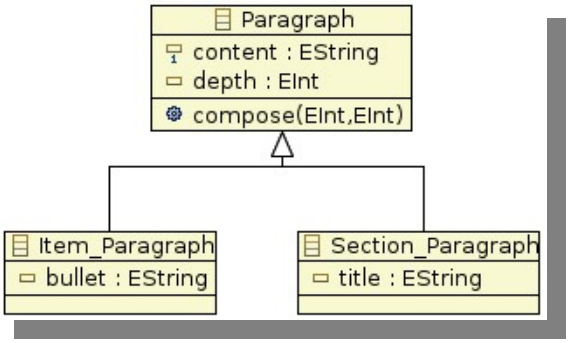


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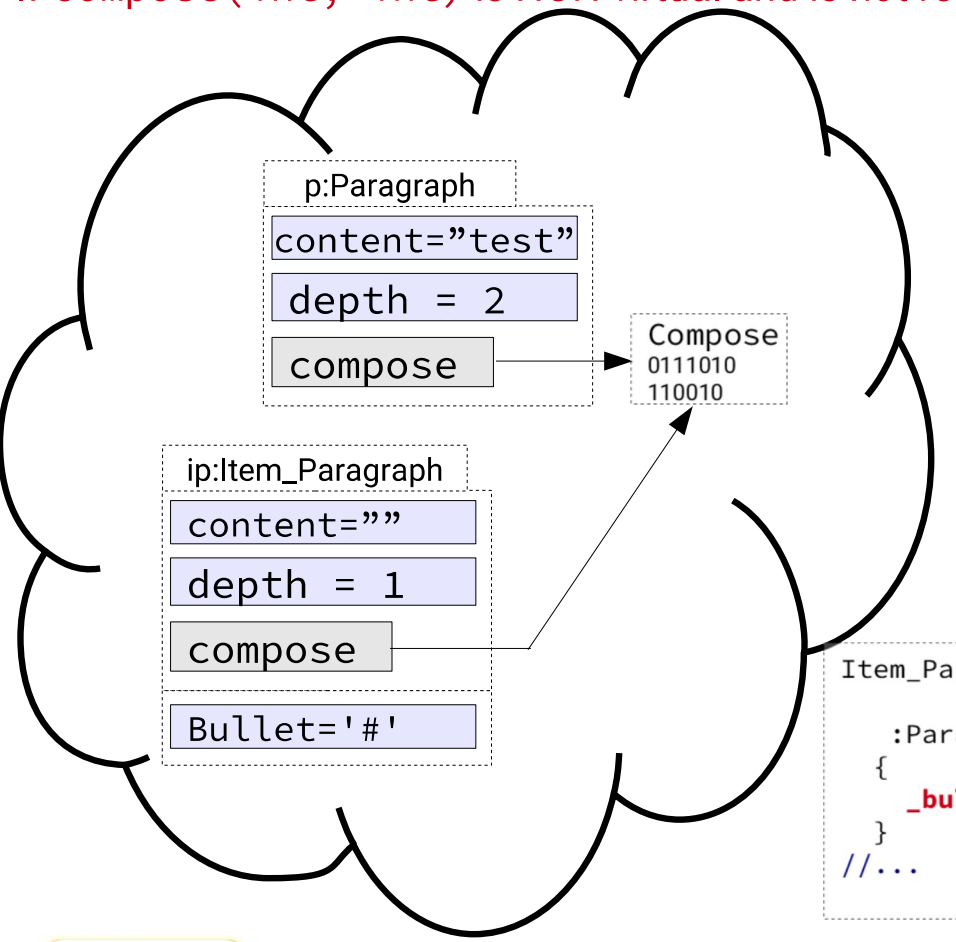

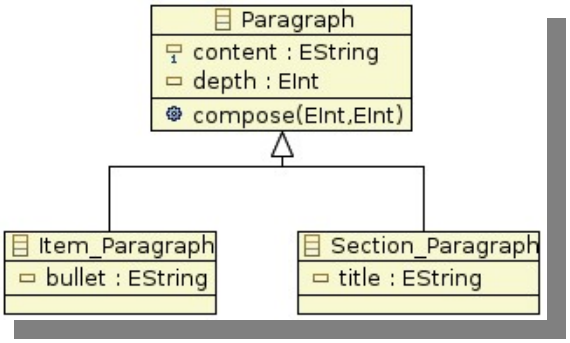


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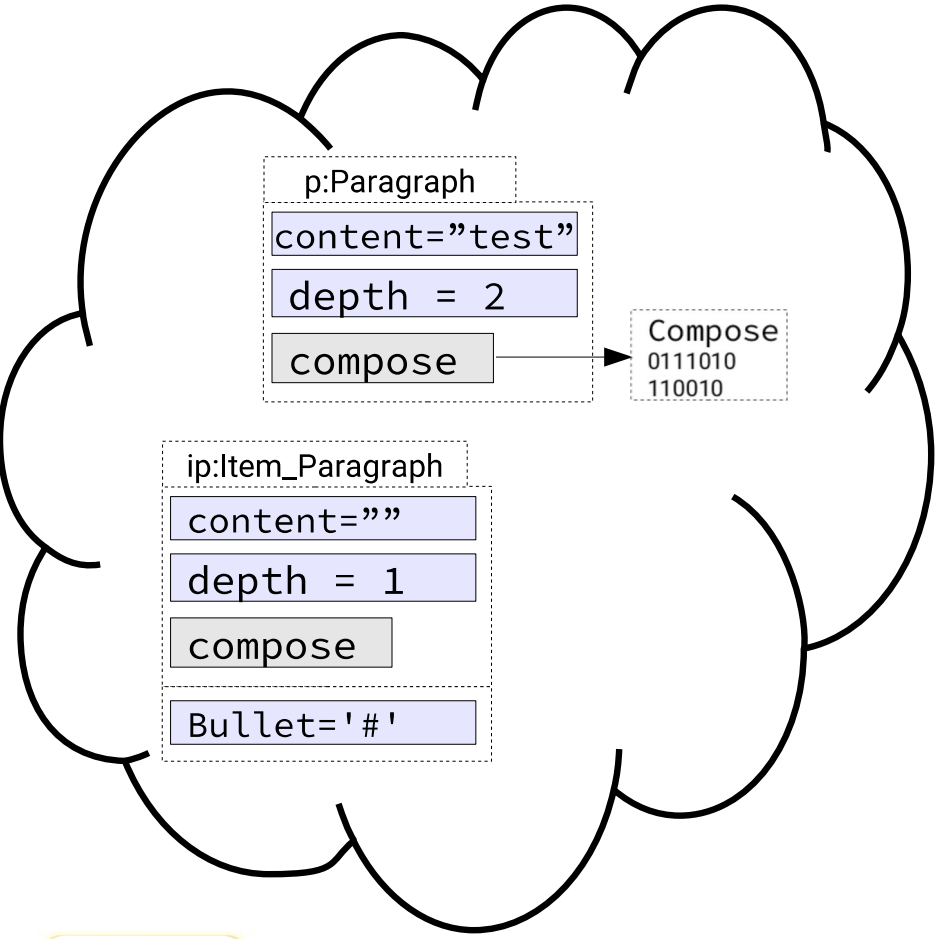

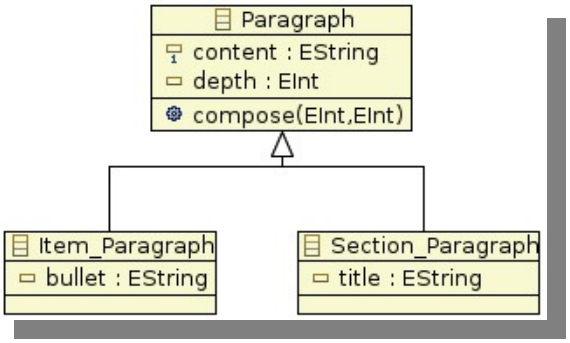


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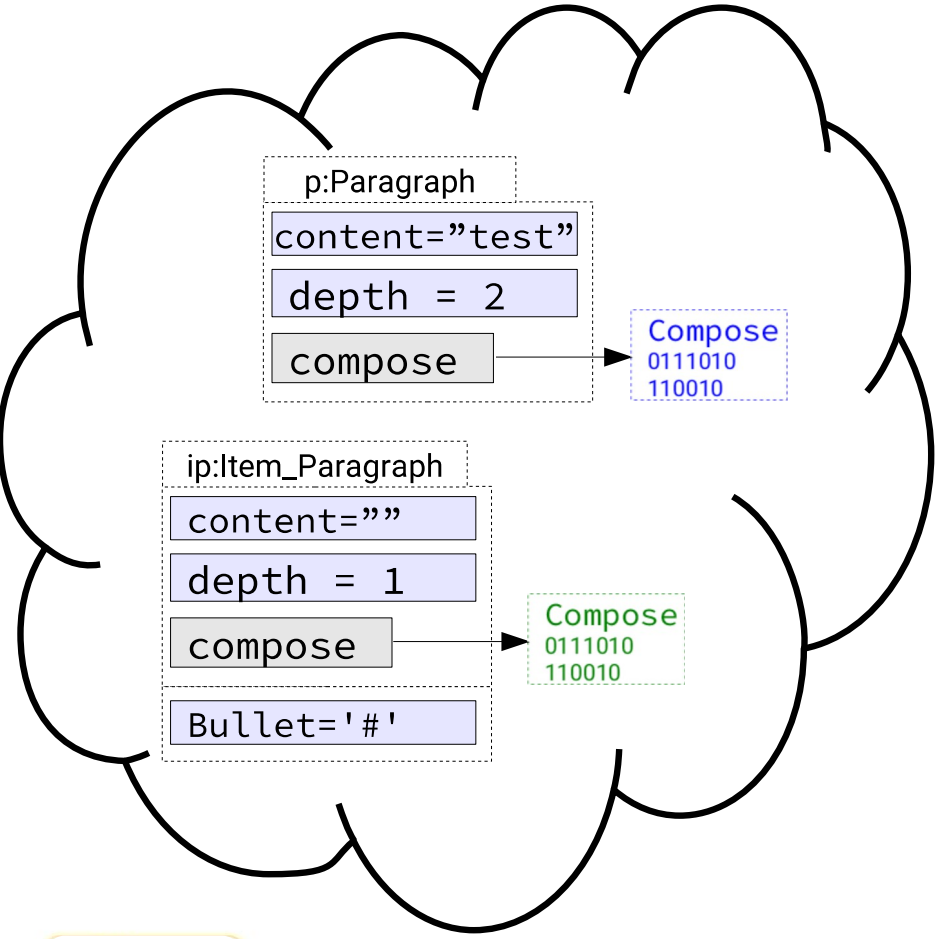

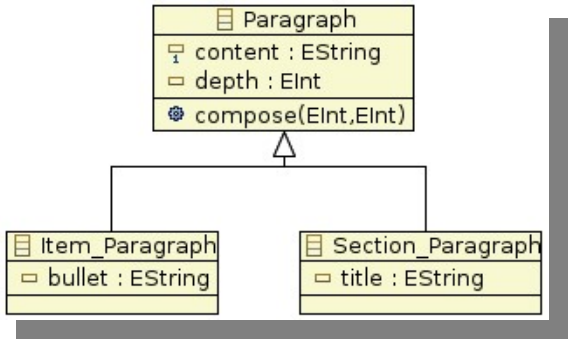


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Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

p.compose();
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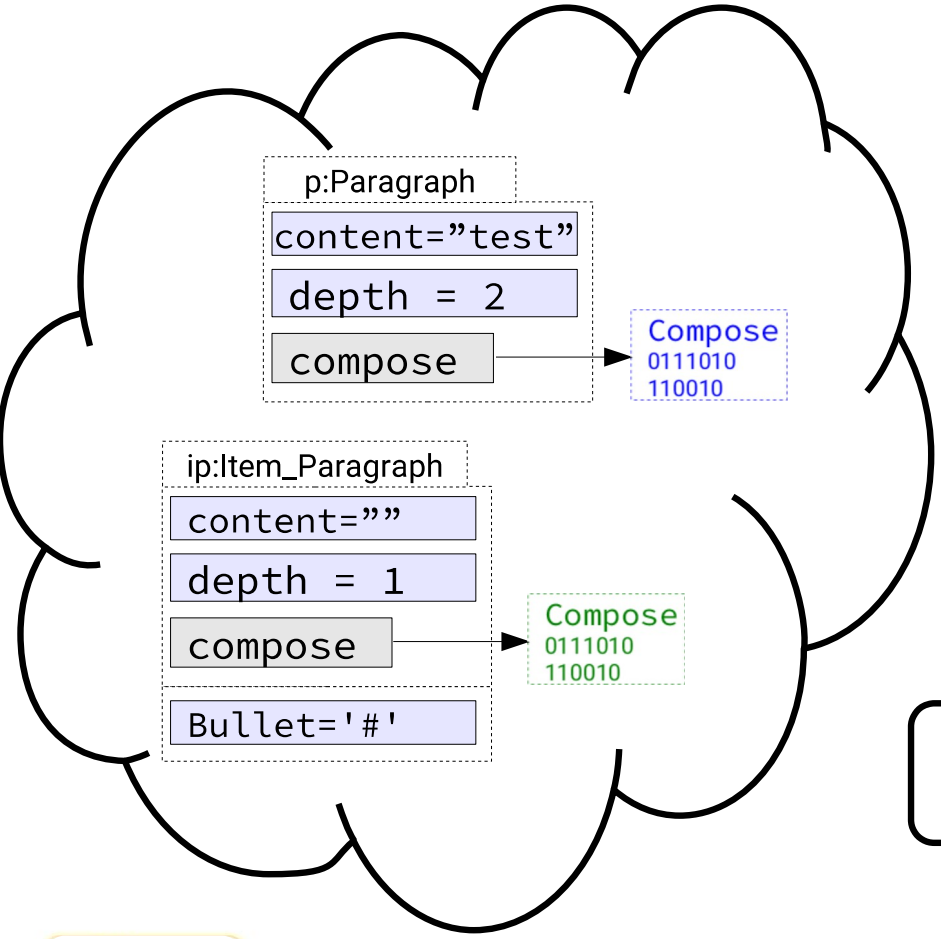

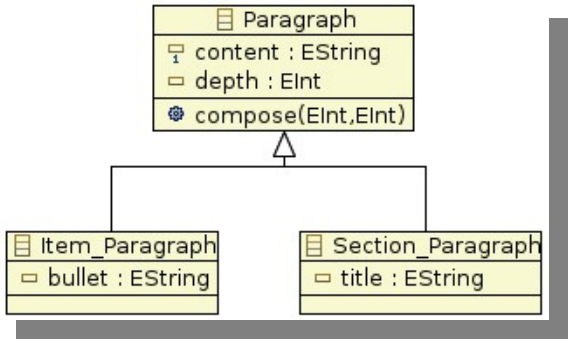


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//...
Paragraph p("test",2);
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What if we create a vector of Paragraphs ??

What happens in memory (at least conceptually)

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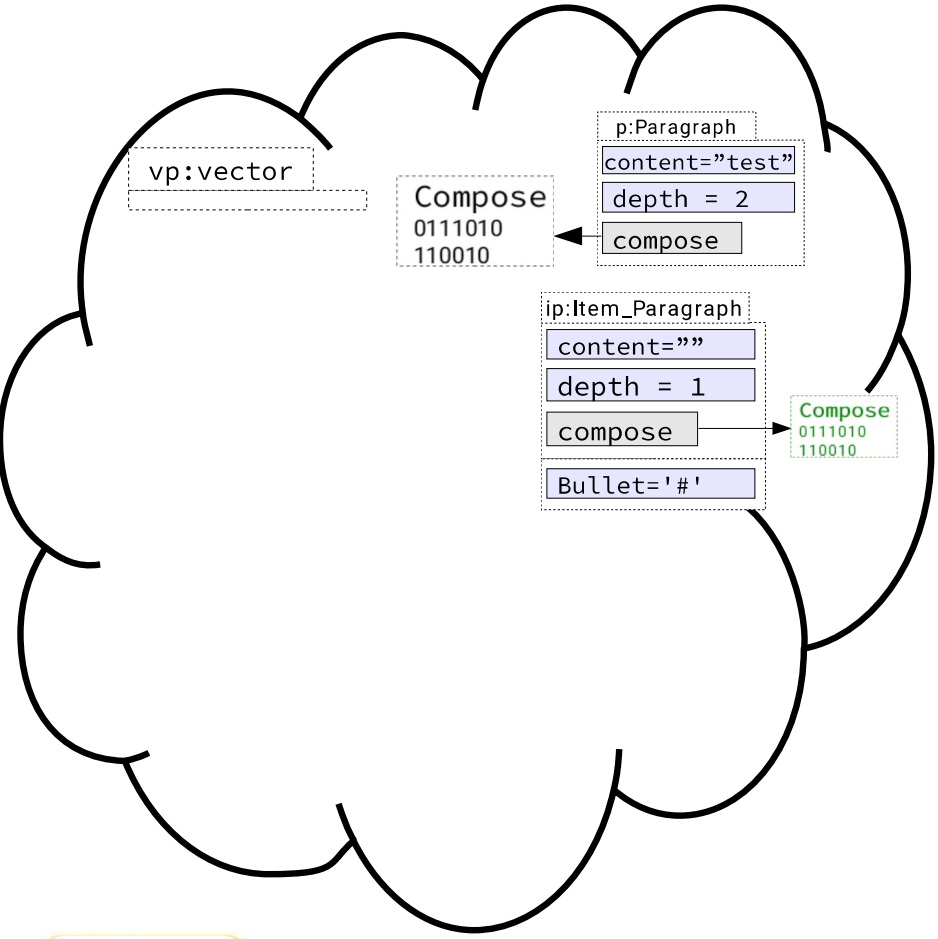

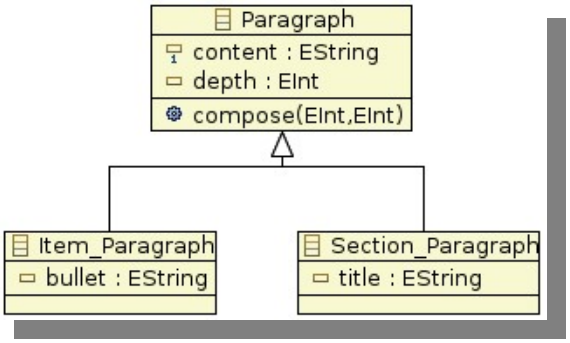


```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<Paragraph> vp;
```

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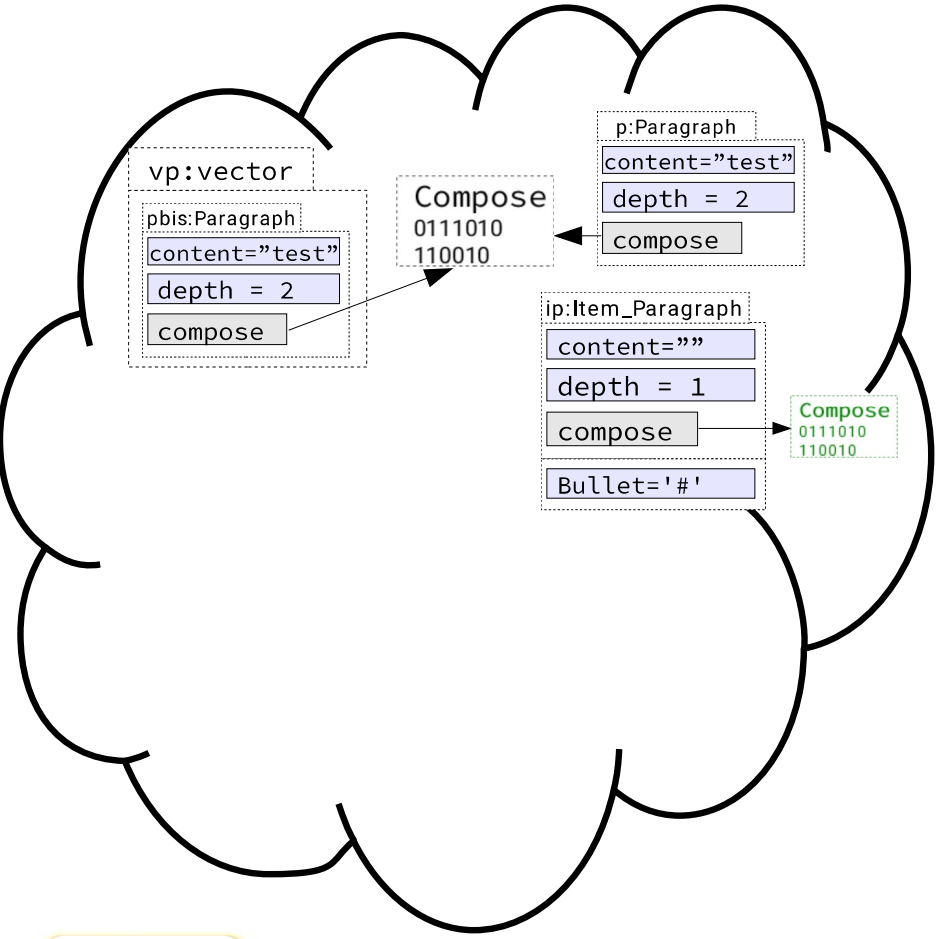

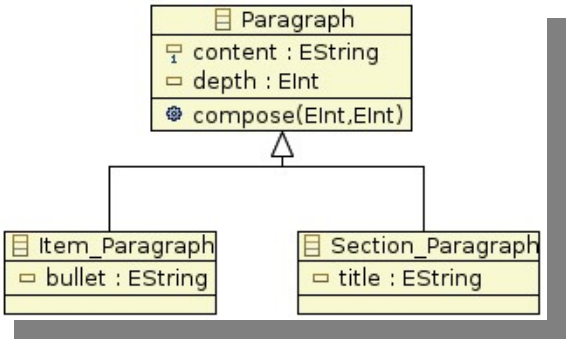


```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<Paragraph> vp;
vp.push_back(p);
```

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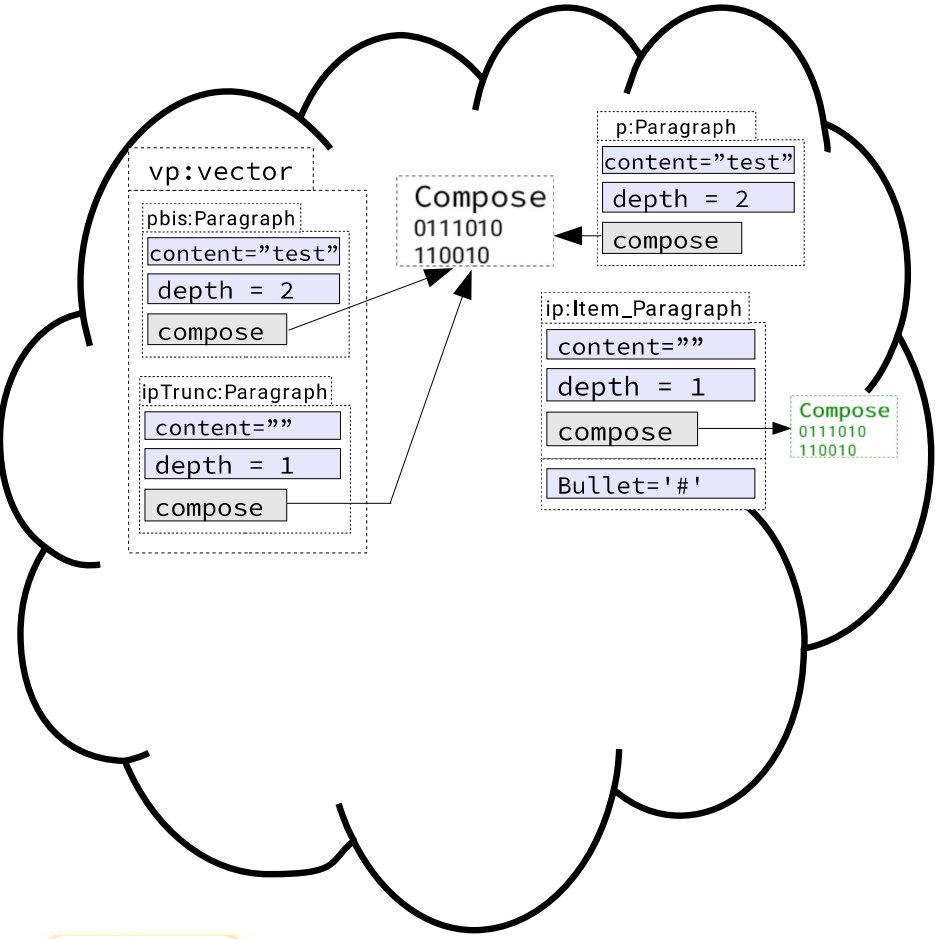
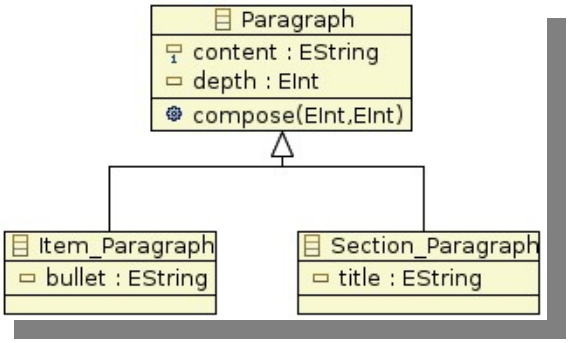
If `compose(int, int)` is NON virtual and is **REDEFINED** in Item_Paragraph



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```

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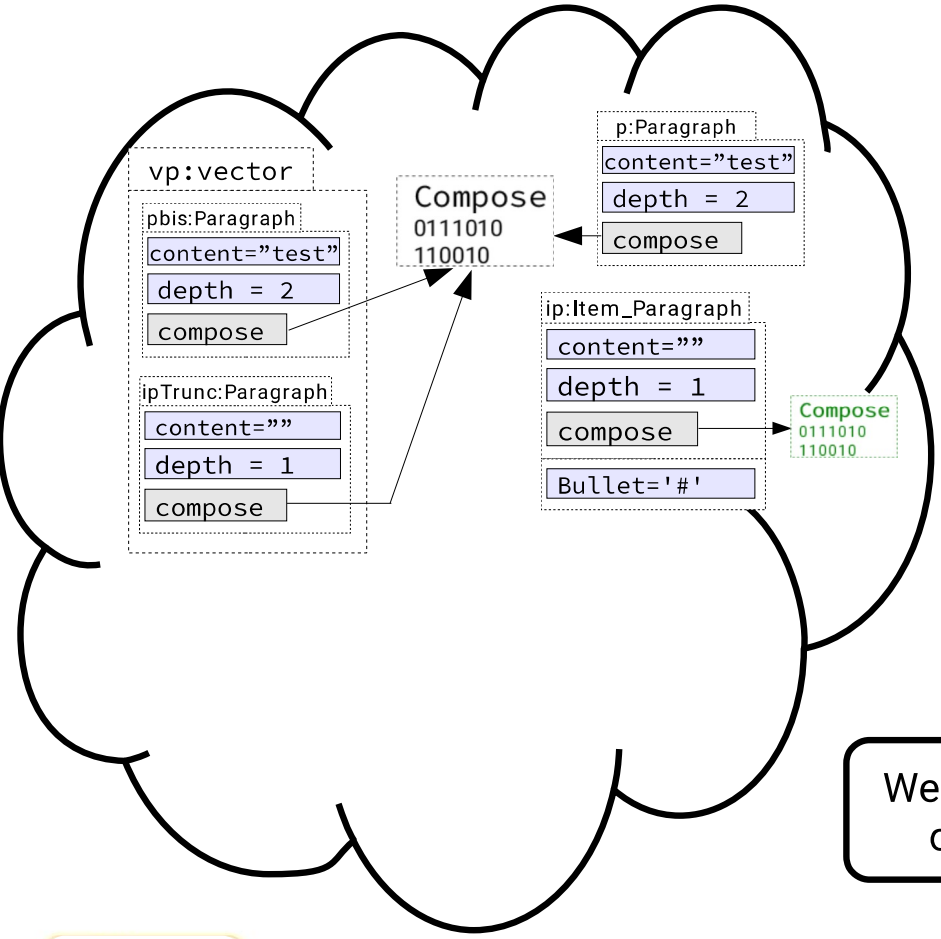

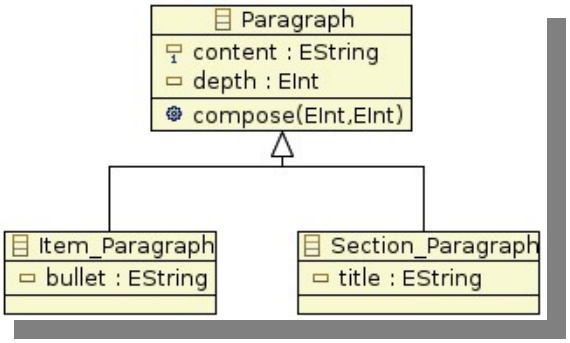


```
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Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<Paragraph> vp;
vp.push_back(p);
vp.push_back(ip);
```

We lost the specificities of Item_Paragraph

What happens in memory (at least conceptually)

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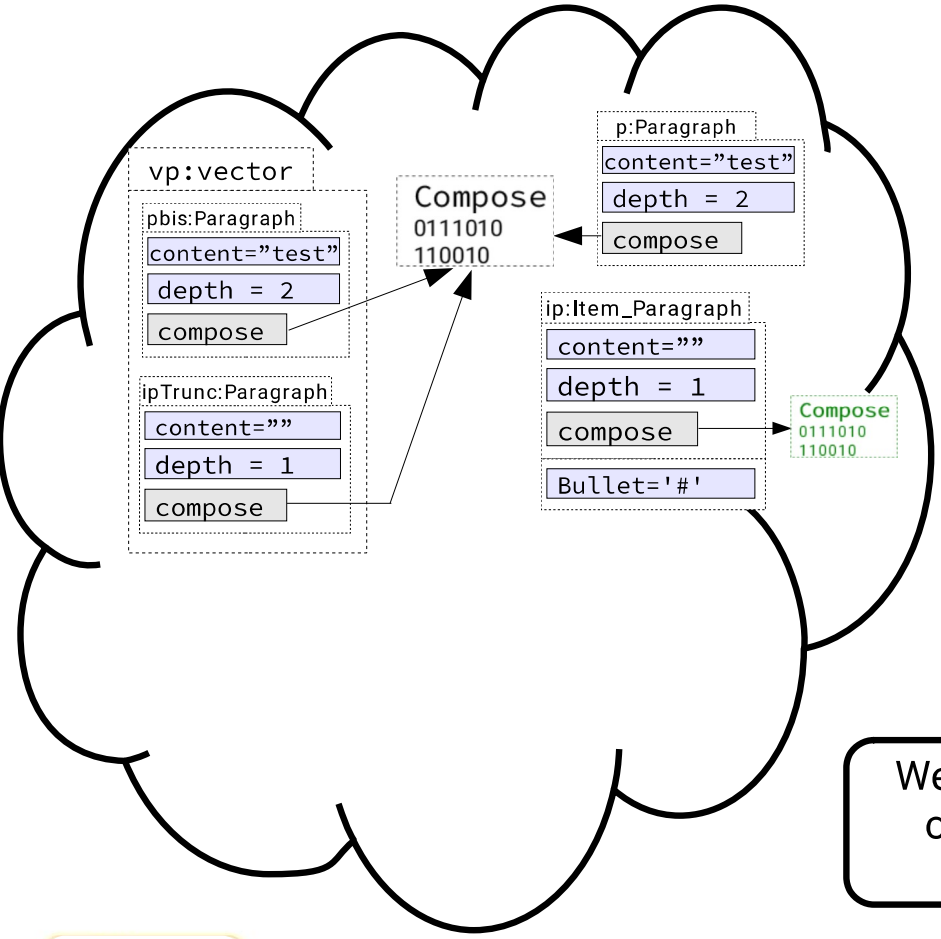

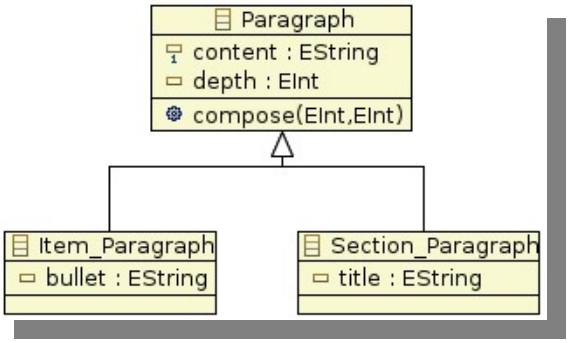


```
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vector<Paragraph> vp;
vp.push_back(p);
vp.push_back(ip);
```

We lost the specificities of Item_Paragraph...
Forever !

What happens in memory (at least conceptually)

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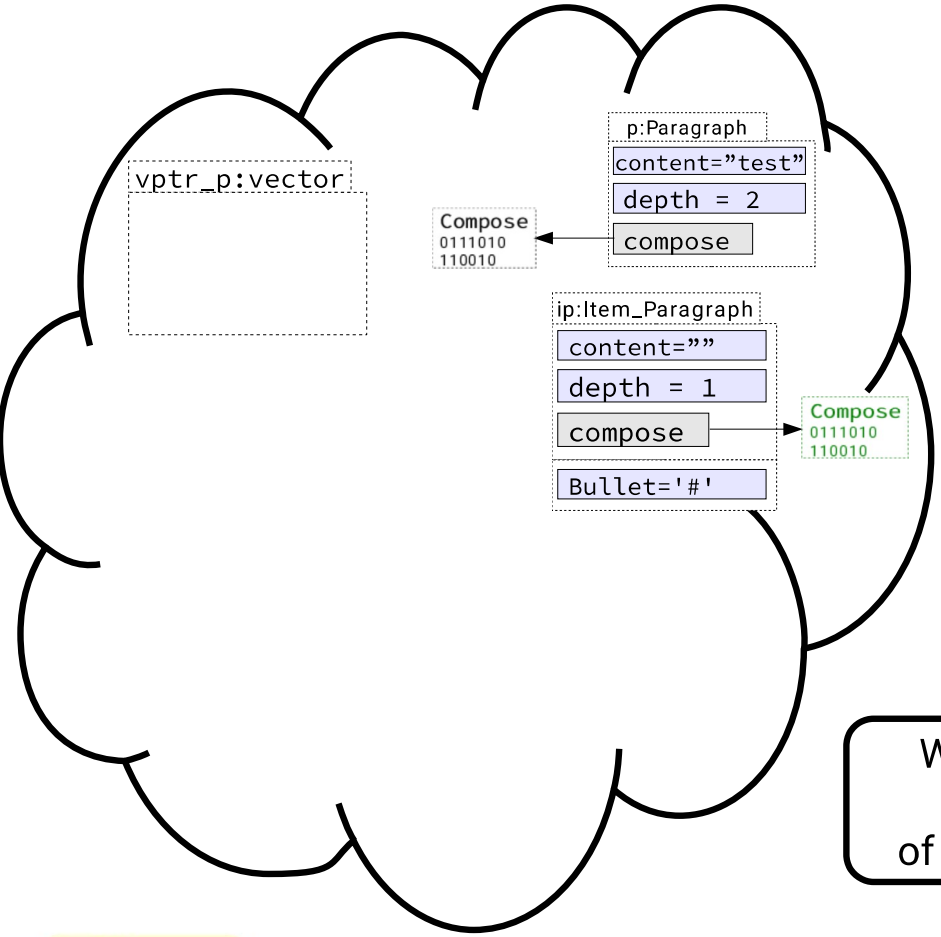

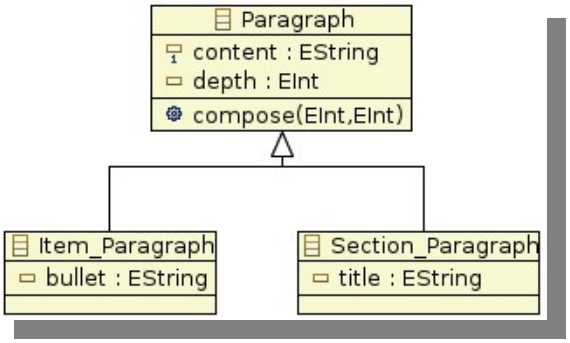


```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<paragraph*> vptr_p
```

What happens if we create a vector of paragraph pointer ?

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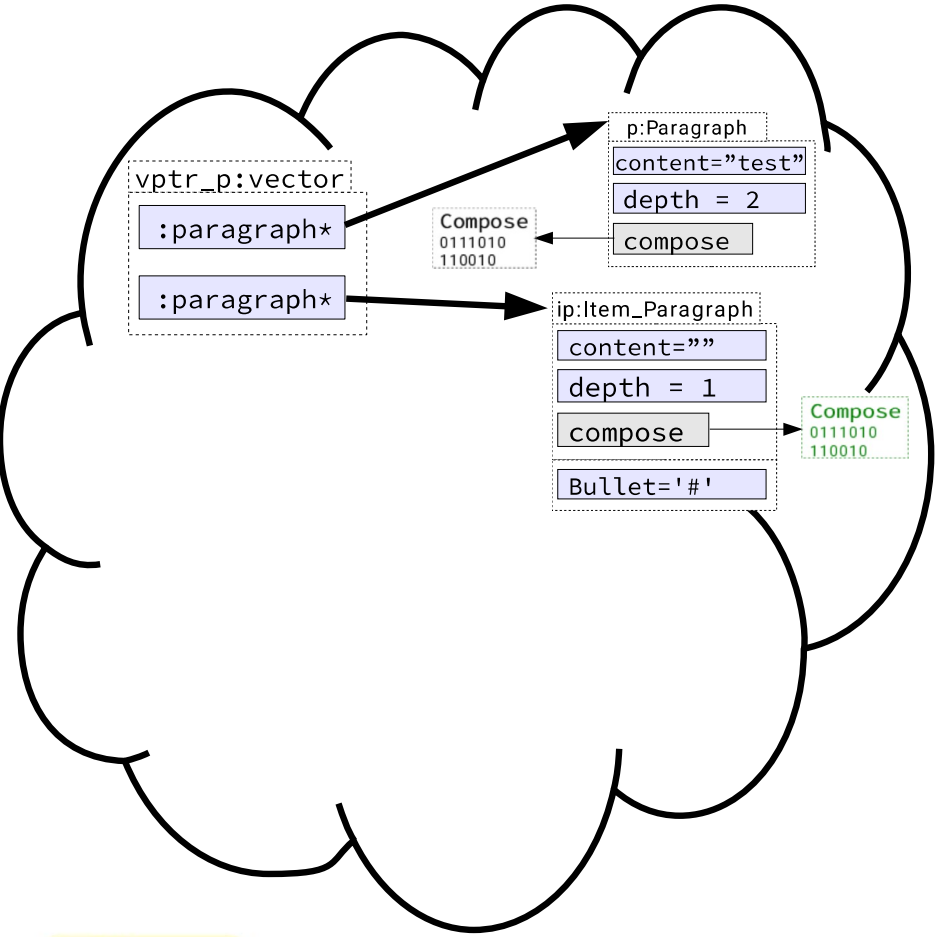
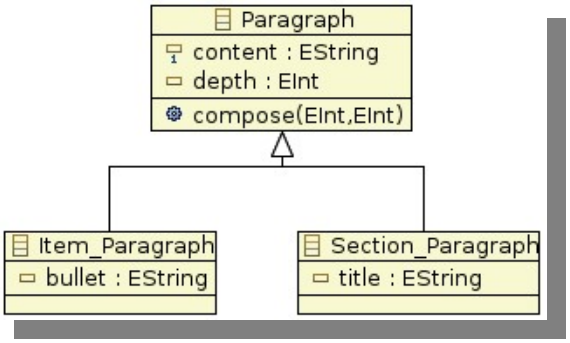
If `compose(int, int)` is NON virtual and is **REDEFINED** in Item_Paragraph

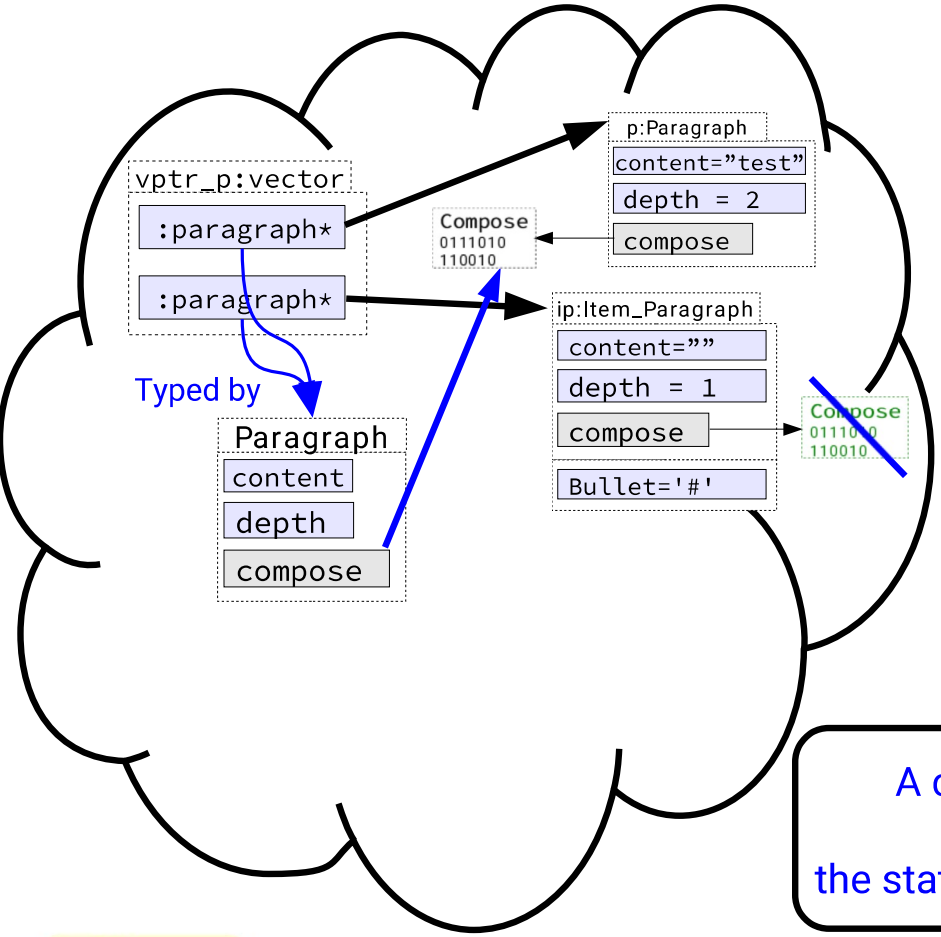


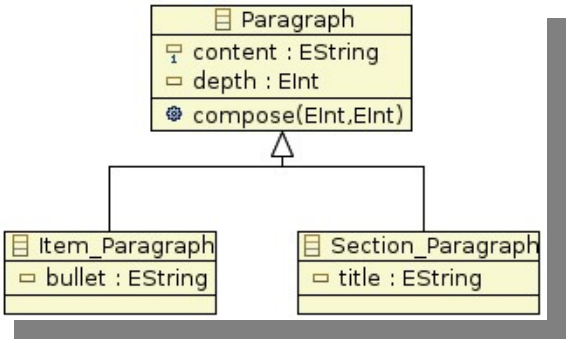



```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<paragraph*> vptr_p
vptr_p.push_back(&p);
vptr_p.push_back(&ip);
```

What happens in memory (at least conceptually)

If `compose(int, int)` is NON virtual and is **REDEFINED** in Item_Paragraph



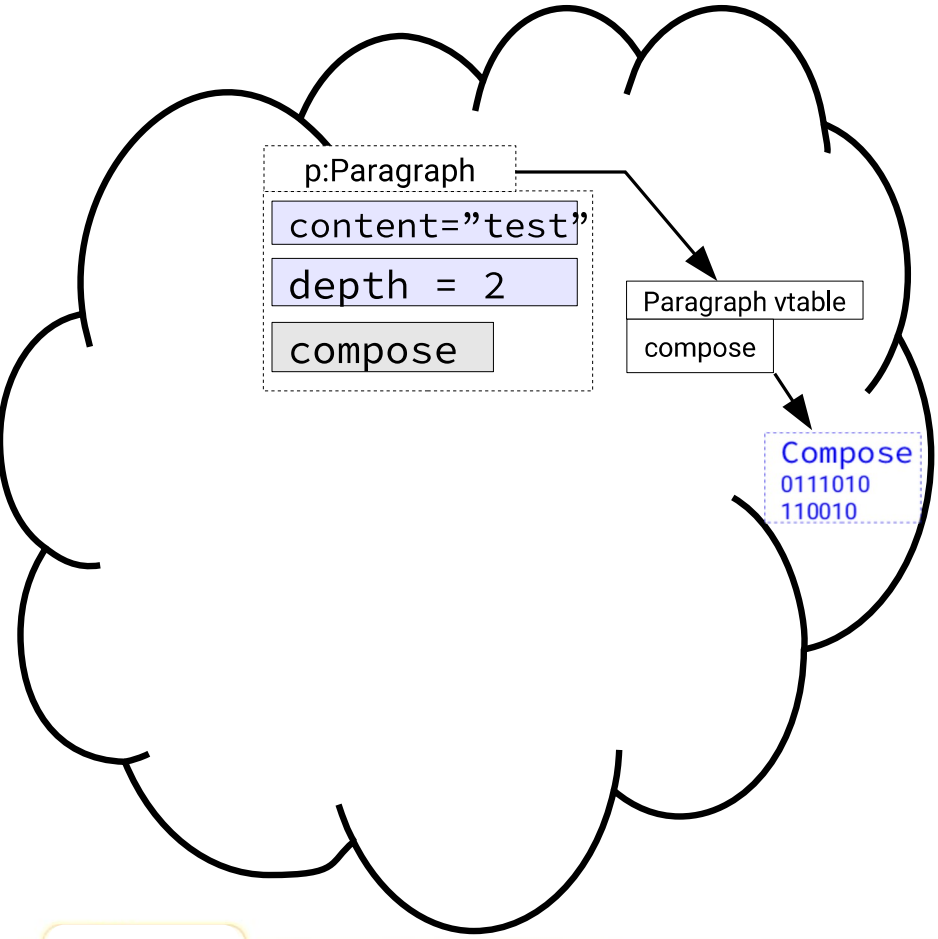


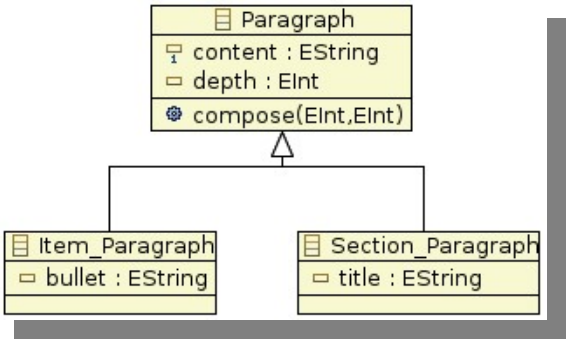

```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<paragraph*> vptr_p
vptr_p.push_back(&p);
vptr_p.push_back(&ip);
```

A call to a non-virtual function
is resolved according to
the static type of the hidden parameter

What happens in memory (at least conceptually)

If `compose(int, int)` is **VIRTUAL** and is **REDEFINED** in Item_Paragraph

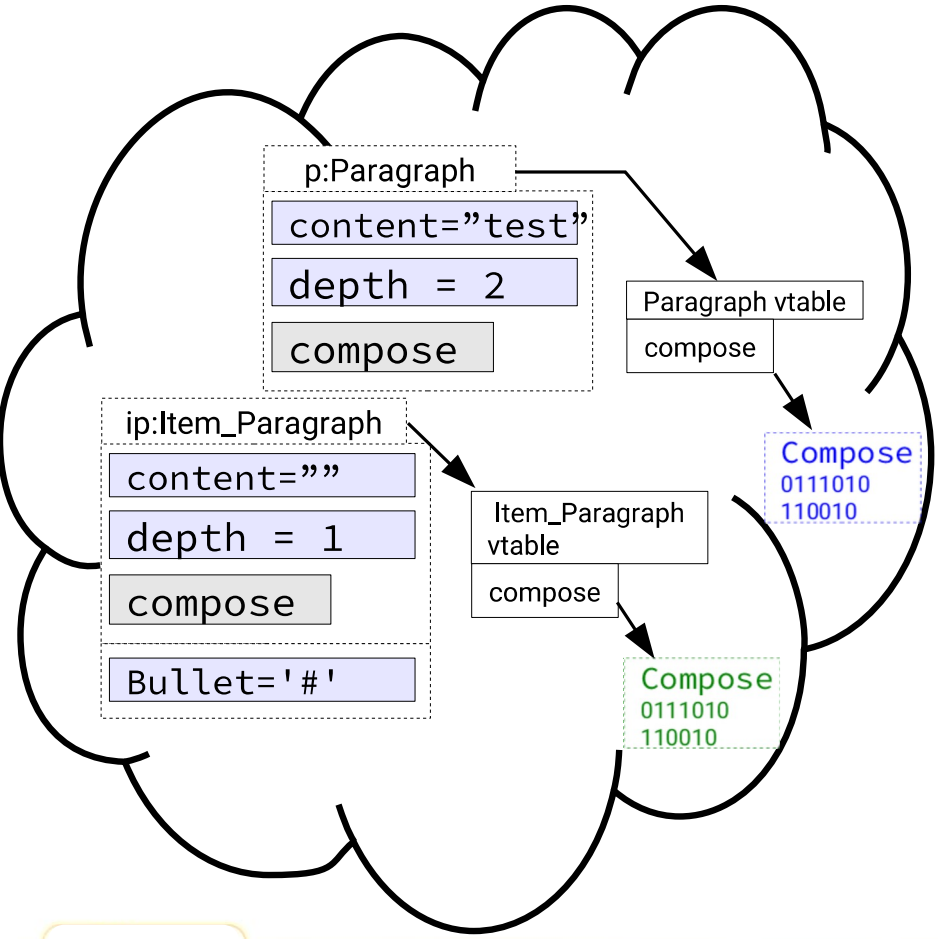


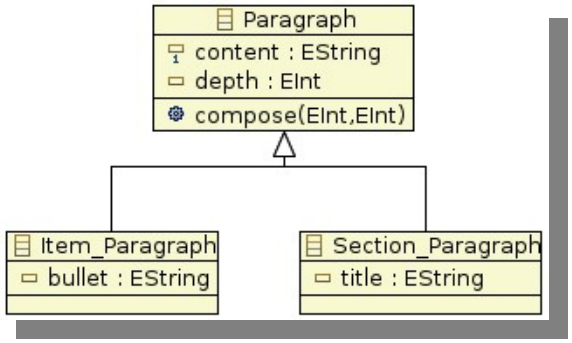



```
//...
Paragraph p("test",2);
p.compose();
```

What happens in memory (at least conceptually)

If `compose(int, int)` is **VIRTUAL** and is **REDEFINED** in Item_Paragraph

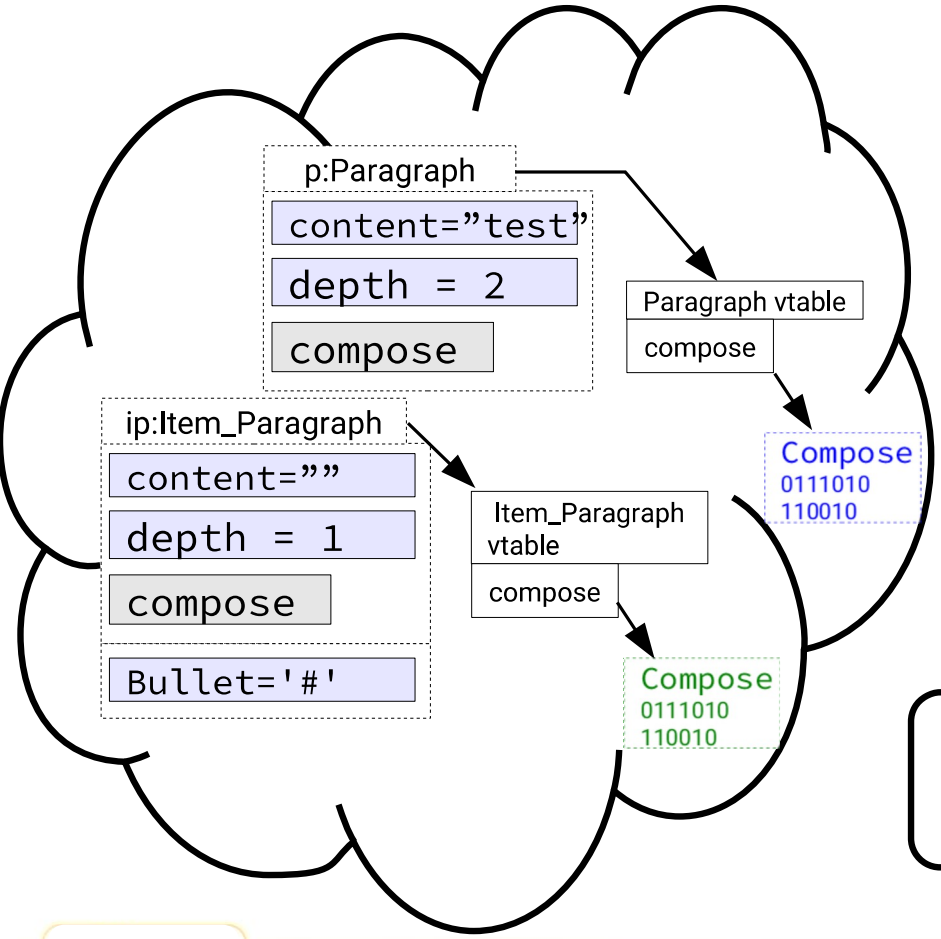


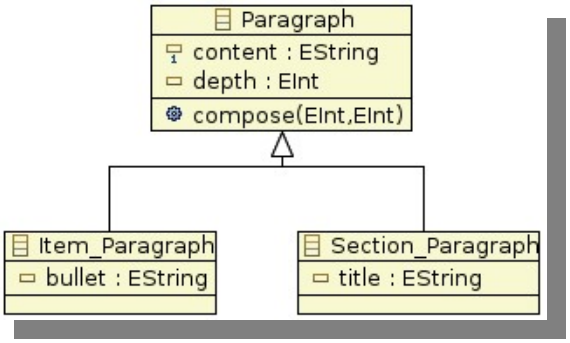



```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

p.compose();
ip.compose();
```

What happens in memory (at least conceptually)

If `compose(int, int)` is **VIRTUAL** and is **REDEFINED** in Item_Paragraph



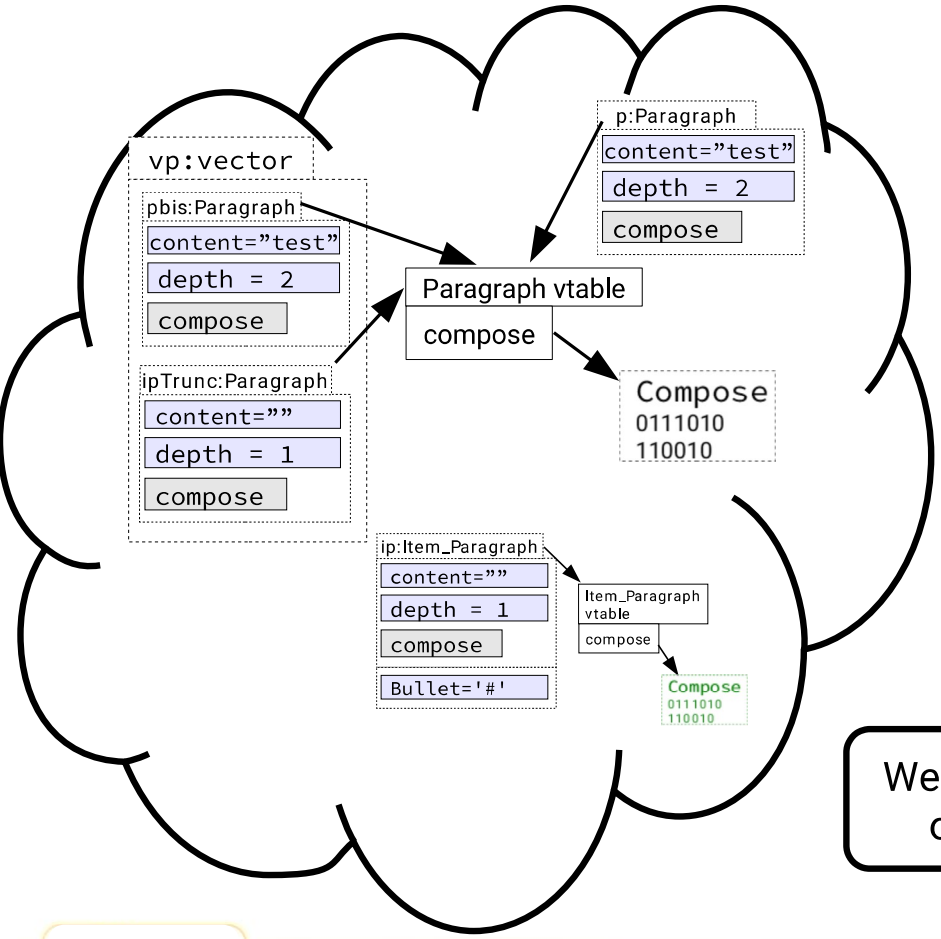


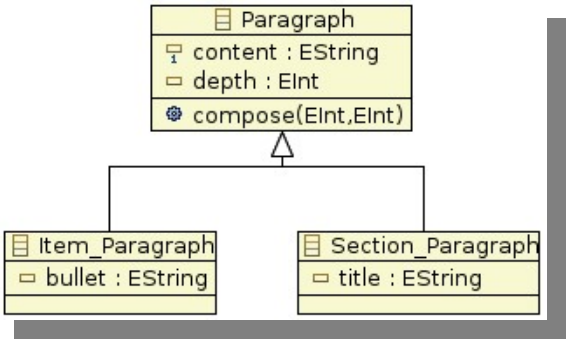

```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

p.compose();
ip.compose();
```

What happens if we create a vector of Paragraphs ??

What happens in memory (at least conceptually)

If `compose(int, int)` is **VIRTUAL** and is **REDEFINED** in Item_Paragraph



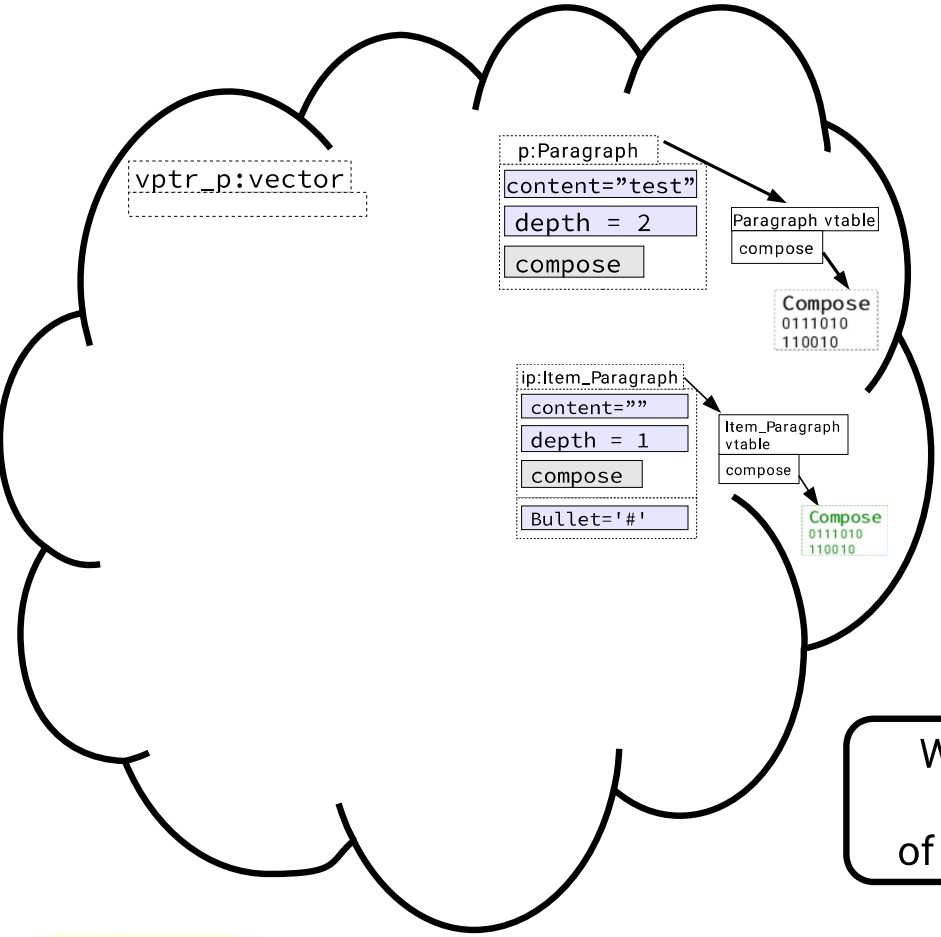


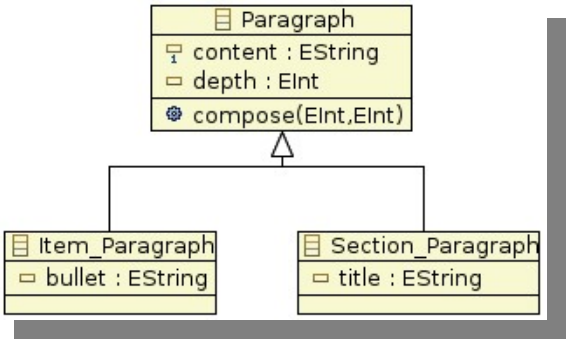

```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<Paragraph> vp;
vp.push_back(p);
vp.push_back(ip);
```

We lost the specificities of Item_Paragraph

What happens in memory (at least conceptually)

If `compose(int, int)` is **VIRTUAL** and is **REDEFINED** in Item_Paragraph



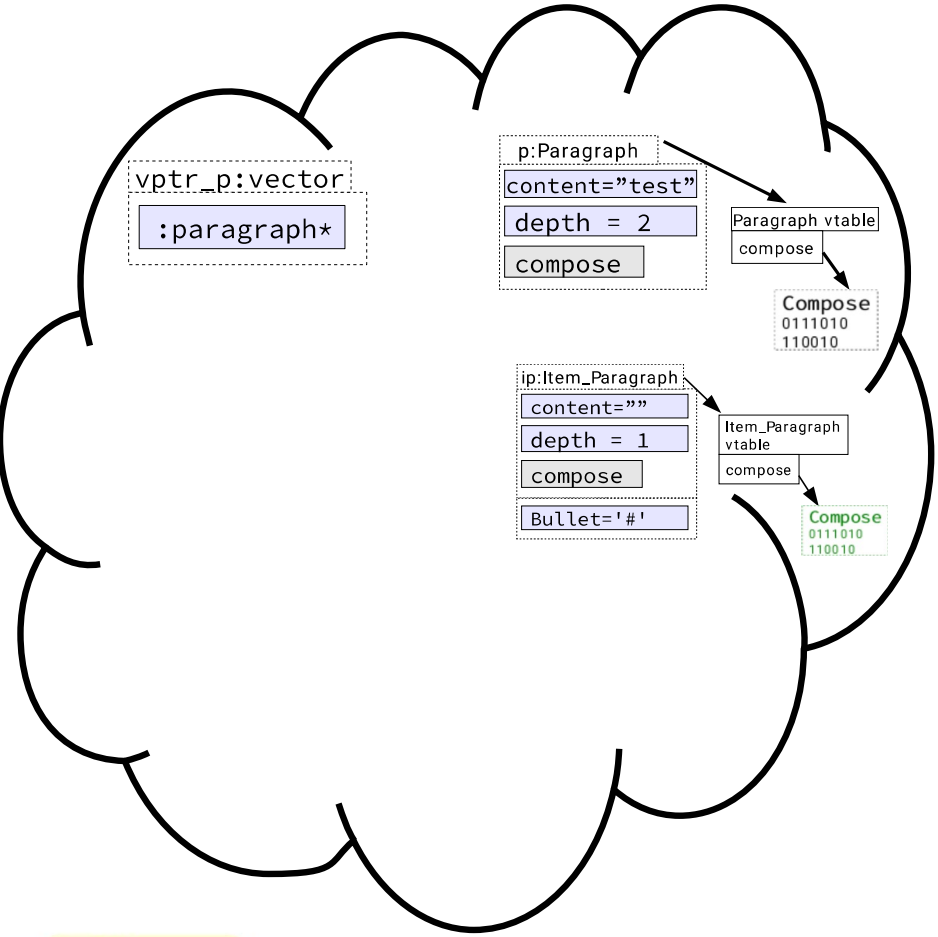


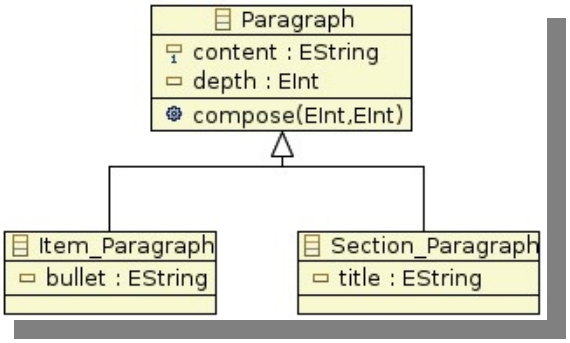

```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<paragraph*> vptr_p
```

What happens if we create a vector of paragraph pointer ?

What happens in memory (at least conceptually)

If `compose(int, int)` is **VIRTUAL** and is **REDEFINED** in Item_Paragraph

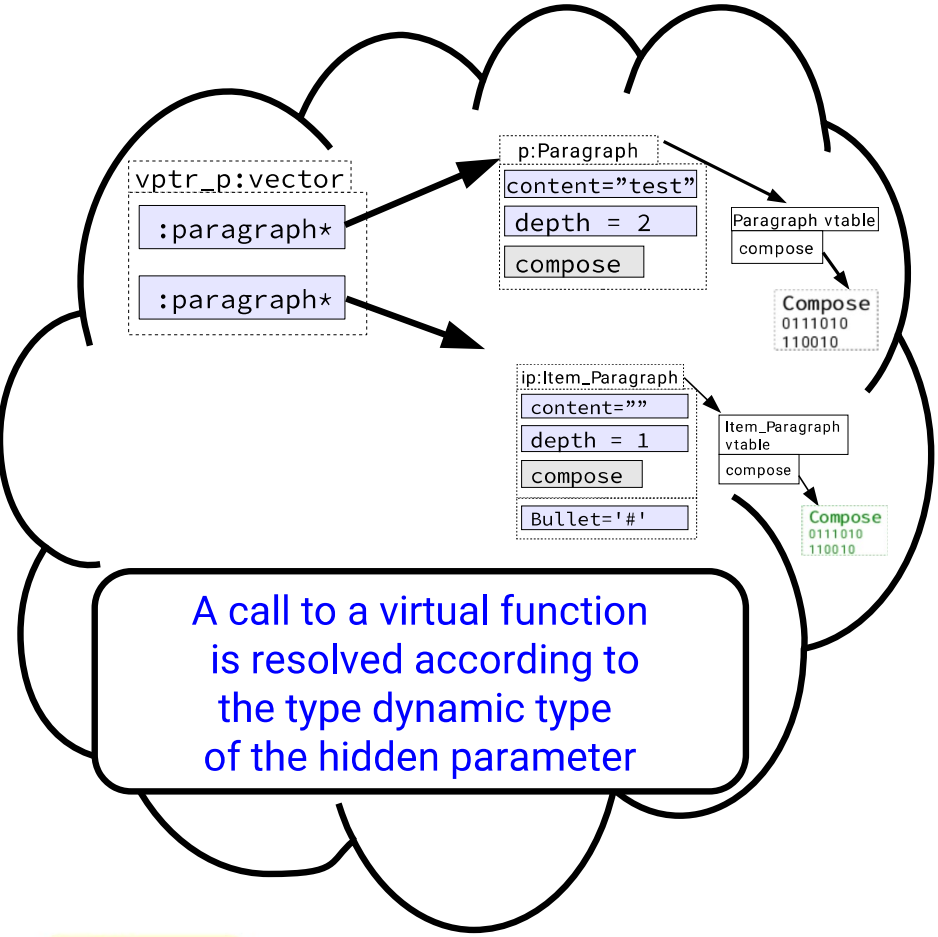


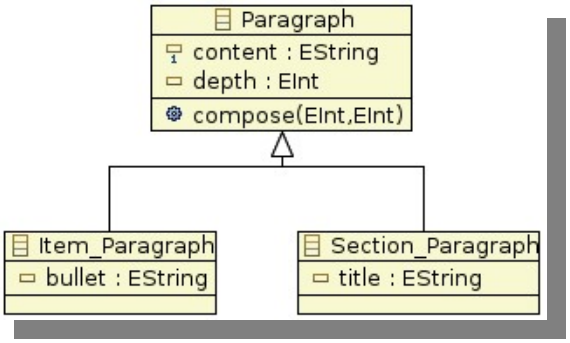



```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<paragraph*> vptr_p
vptr_p.push_back(&p);
```

What happens in memory (at least conceptually)

If `compose(int, int)` is **VIRTUAL** and is **REDEFINED** in Item_Paragraph

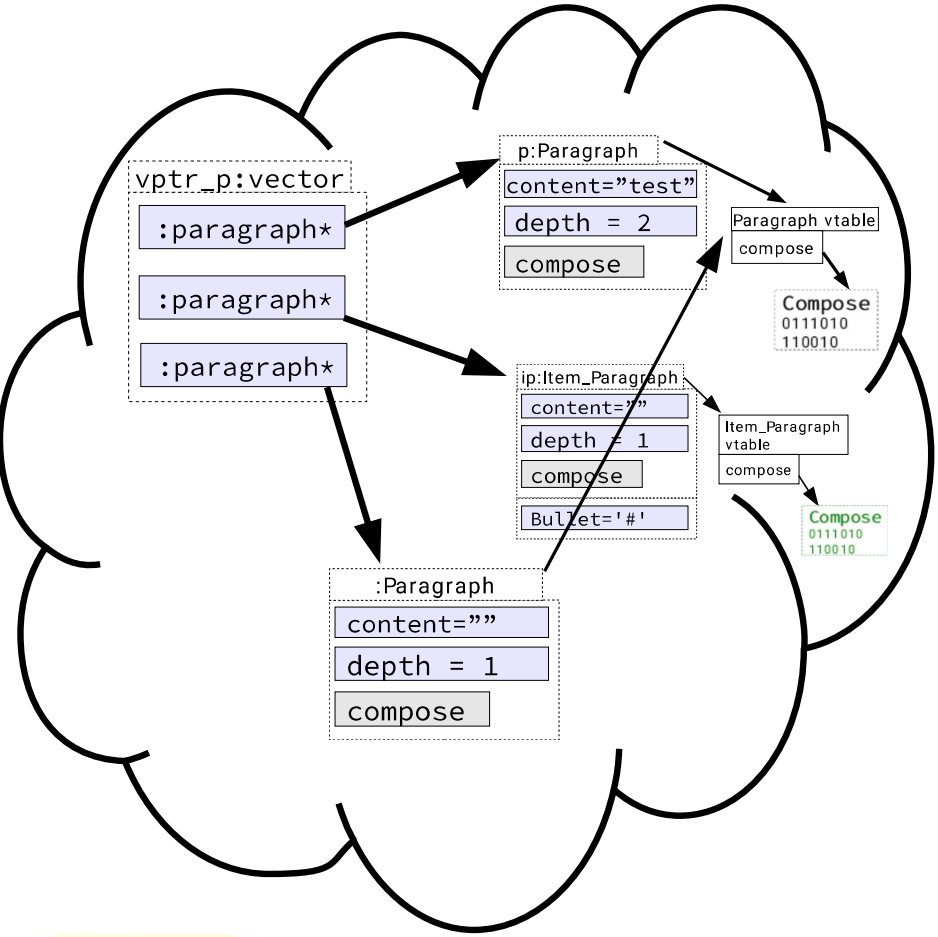


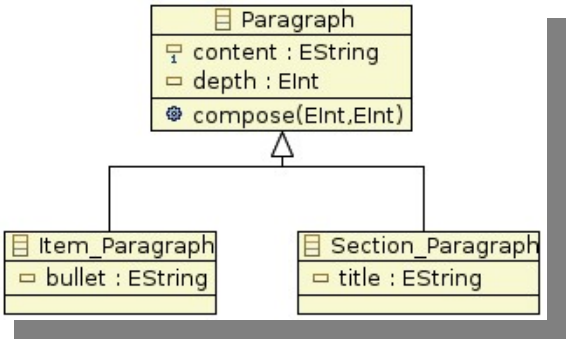



```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<paragraph*> vptr_p
vptr_p.push_back(&p);
vptr_p.push_back(&ip);
```

What happens in memory (at least conceptually)

If `compose(int, int)` is **VIRTUAL** and is **REDEFINED** in Item_Paragraph

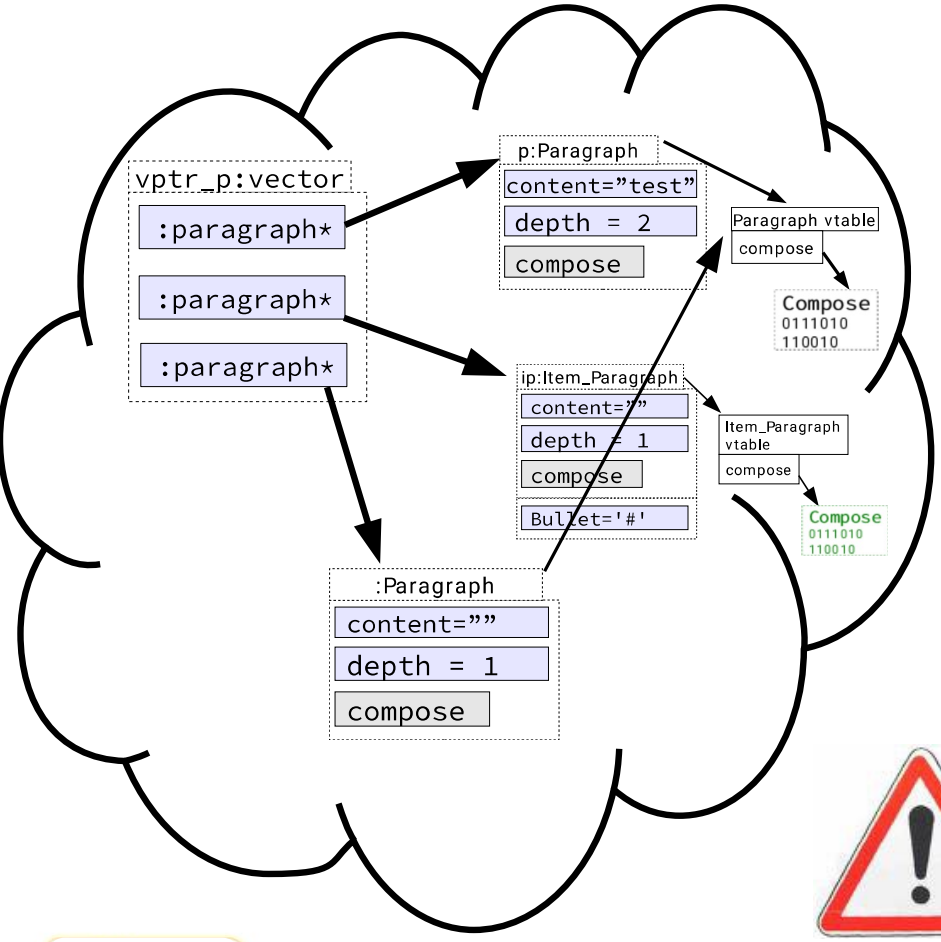


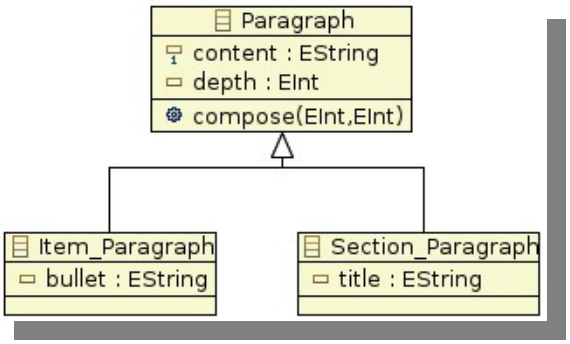



```
//...
Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<paragraph*> vptr_p
vptr_p.push_back(&p);
vptr_p.push_back(&ip);
vptr_p.push_back(new Paragraph(ip));
```

What happens in memory (at least conceptually)

If `compose(int, int)` is **VIRTUAL** and is **REDEFINED** in Item_Paragraph






```
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Paragraph p("test",2);
Item_Paragraph ip("",1,'#');

vector<paragraph*> vptr_p
vptr_p.push_back(&p);
vptr_p.push_back(&ip);
vptr_p.push_back(new Paragraph(ip));
```
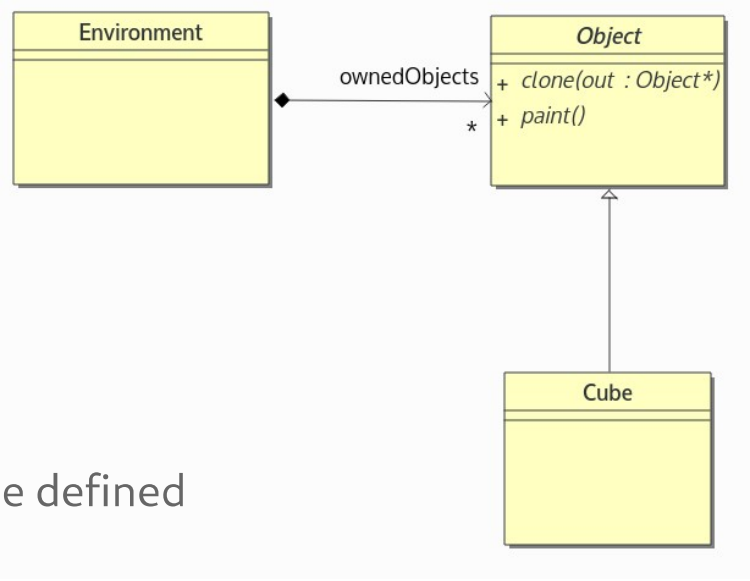


You have to use the `clone()` virtual function
(course 7-OO.pdf)

Abstract classes and pure virtual functions

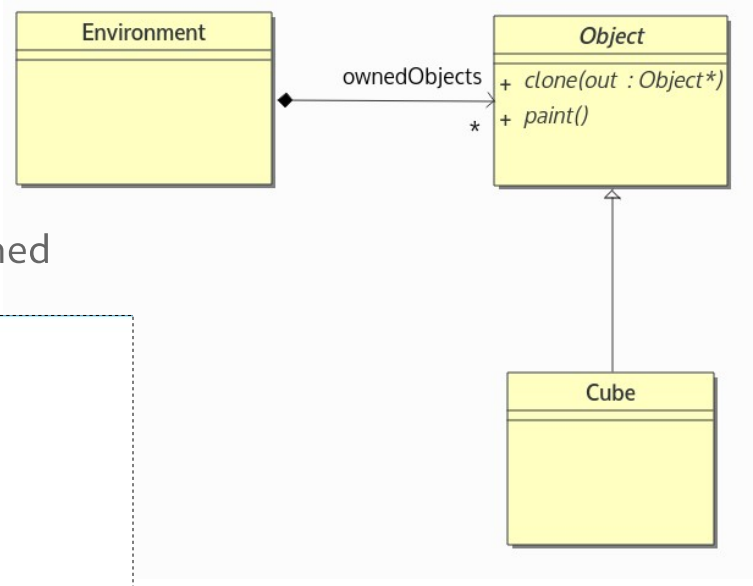


- Object is abstract
  - It cannot be instantiated
  - Some of its behaviors cannot be defined

→ at least one of its member function is a pure virtual function

Abstract classes and pure virtual functions

- Object is abstract
  - It cannot be instantiated
  - Some of its behaviors cannot be defined




```
#ifndef _OBJECT_H
#define _OBJECT_H


class Object
{
    public:
//[...]
        virtual Object* clone() const=0;
        virtual void paint()=0;
        virtual ~Object();
};

#endif // _OBJECT_H
```

} pure virtual functions

Safe downward cast (1)

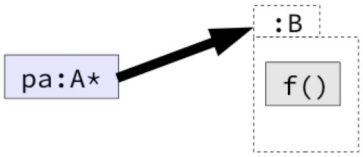
- Downward cast may be dangerous

```
class A { ... };
class B : public A {
   void f() { ... }      // f() not defined in A
};
```

Safe downward cast (1)

- Downward cast may be dangerous

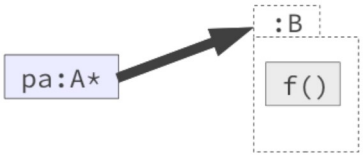
```
class A { ... };
class B : public A {
   void f() { ... }        // f() not defined in A
};

A* pa = new B();           // OK
```



Safe downward cast (1)

- Downward cast may be dangerous

```
class A { ... };
class B : public A {
   void f() { ... }        // f() not defined in A
};

A* pa = new B();           // OK
pa->f();                   // KO
```



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class A { ... };
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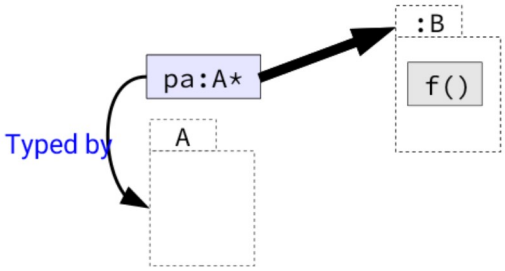
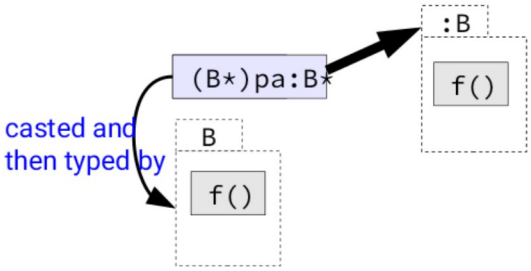


Safe downward cast (1)

- Downward cast may be dangerous

```
class A { ... };
class B : public A {
   void f() { ... }        // f() not defined in A
};

A* pa = new B();           // OK
pa->f();                   // KO
((B*)pa)->f();             // OK
```

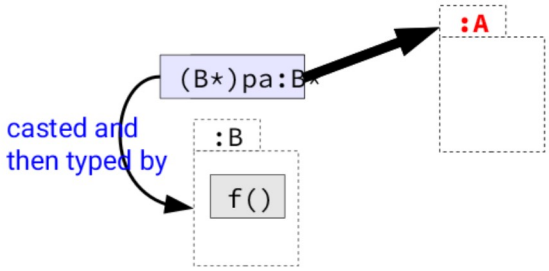


Safe downward cast (1)

- Downward cast may be dangerous

```
class A { ... };
class B : public A {
   void f() { ... }        // f() not defined in A
};

A* pa = new A();           // OK
pa->f();                   // KO
((B*)pa)->f();             // OK
```



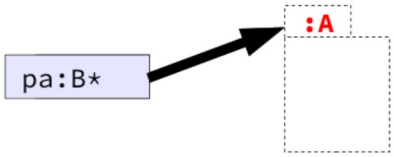
Unsafe !!

Safe downward cast (1)

- Downward cast may be dangerous

```
class A { ... };
class B : public A {
   void f() { ... }        // f() not defined in A
};

B* pa = new A();           // KO
```

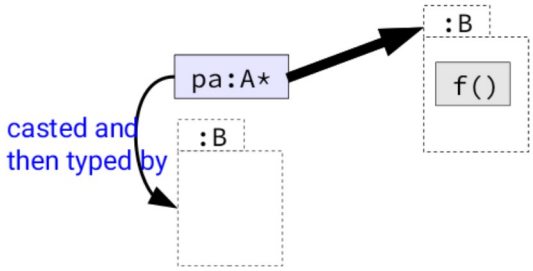


Safe downward cast (1)

- Downward cast may be dangerous

```
class A { ... };
class B : public A {
   void f() { ... }        // f() not defined in A
};

A* pa = new B();           // OK
pa->f();                   // KO
((B*)pa)->f();             // OK
static_cast<B*>(pa)->f();// OK
```



Unsafe !!

Safe downward cast (2)

- Operator `dynamic_cast`

```
B *pb = dynamic_cast<B*>(pa);
if (pb != nullptr)
{
  pb->f();        // OK and safe
}
```

Safe downward cast (2)

- Operator `dynamic_cast`

```
B *pb = dynamic_cast<B*>(pa);
if (pb != nullptr)
  pb->f(); // OK and safe

try {
  dynamic_cast<B*>(pa)->f();
} catch(bad_cast) {
  cerr << "bad conversion" << endl;
}
```

Safe downward cast (3)

- Limitation of `dynamic_cast`
  - Work only on classes with virtual functions (polymorphic types)
- Invoking `dynamic_cast` from a constructor or a destructor
  - **`dynamic_cast`** behaves like a virtual function
  - it is statically bound in a constructor or a destructor