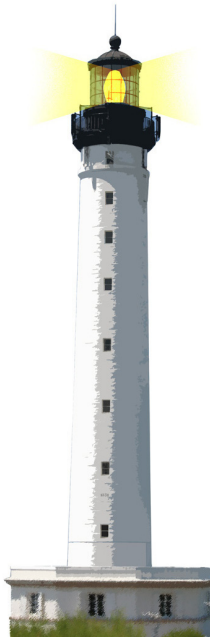
About type and method lookup



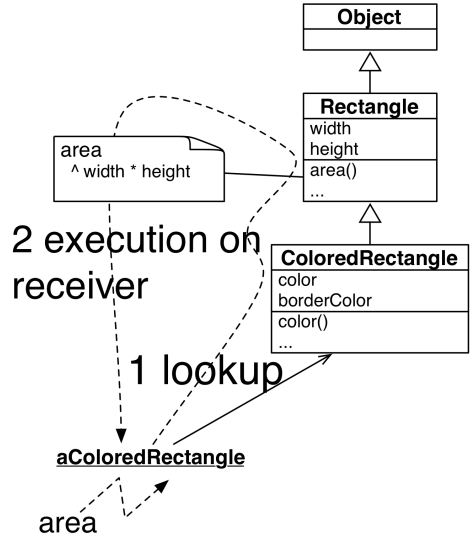
Outline

- Lookup (remember)
- Static type vs Dynamic type
- Type checker
- Method lookup

Message Sending

Sending a **message** is a two-step process:

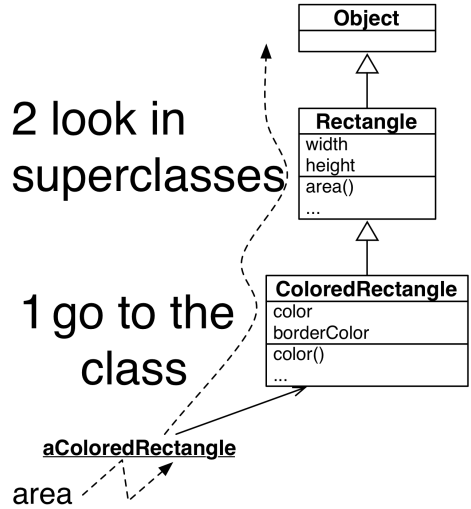
1. **look up** the **method** matching the message
2. execute this method on the **receiver**



Method lookup

The lookup starts in the **class** of the **receiver** then:

- if the method is defined in the class, it is returned
- otherwise the search continues in the superclass



It was the essence

Questions:

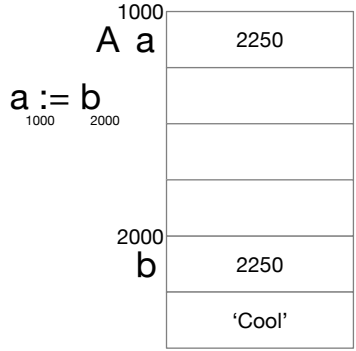
- How types influence (polute) this beautiful model?
- Static types, dynamic types, overloading

The type of a variable

Let us a simple program model:

- a variable is a box with a label: its type.
- a variable contains a reference to objects.

A variable type indicates the kind of object the variable can refer to
`A a`: we can put reference to objects of the class `A` (and subclasses)



Type checker

During compilation

- A type checker is a tool that tries to make sure that correct objects are put in variables
- Using type information the type checker avoids that an unknown message is sent to an object

Static vs. Dynamic Types

```
A a = new B();
```

- The static type of variable a is A i.e., the declared label of the box.
  - The static type never changes.
- The dynamic type of a is B i.e., the class of the object currently bound to a.
  - The dynamic type may change throughout the program.

```
a = new A();
```

Now the dynamic type is also A!

Static and dynamic types can be different

Consider:

```
A a = new B();
```

- The static type of variable a is A.
- The dynamic type of a is B

Static types

Pay attention method signatures also define static types

```
foo (A a){

}

foo(new B());
```

static type of a is A, dynamic type of a is B

How do static and dynamic types interact?

```
class A {
  void m(A a) { println("A.m(A)"); }}
class B extends A {
  void m(B b) { println("B.m(B)"); }}
```

```
B b = new B(); A a = b;
```

What are the results of the invocations?

```
a.m(a);
a.m(b);
b.m(a);
b.m(b);
```

How do static and dynamic types interact?

```
class A {
  void m(A a) { println("A.m(A)"); }}
class B extends A {
  void m(B b) { println("B.m(B)"); }}
```

```
B b = new B(); A a = b;
```

What are the results of the invocations?

```
a.m(a);  A.m(A)
a.m(b);  A.m(A)
b.m(a);  A.m(A)
b.m(b);  B.m(B)
```

- Static types determine which message is sent.
- Dynamic types determine which method is called.

Compilation vs. execution

At compilation:

- First, the **static** type of the receiver determines which class we consider
- Second, does the class **define** the method?
- Third, does the static type of the arguments **fit** the static type of the parameter?
- Fourth, find the best fit

At execution:

- the lookup starts in the class of the receiver

a.m(a)

```
class A {void m(A a) { println("A.m(A)"); }}
class B extends A {void m(B b) { println("B.m(B)"); }}
B b = new B(); A a = b;
```

- Step 1: receiver static type is A: we look in A
- Step 2: there is a method m
- Step 3: static type of a matches A a we will look for m(A a)

The dynamic type of a is B.

- The lookup starts in class B but looks for m(A a)
- > A.m(A)

b.m(a)

```
class A {void m(A a) { println("A.m(A)"); }}
class B extends A {void m(B b) { println("B.m(B)"); }}
B b = new B(); A a = b;
```

- Step 1: the static type of b is B, so we look in B and its superclass A
- Step 2: There is a method m (in fact two m(A a) and m(B b))
- Step 3: the static type of a is A we will look for m(A a)

The dynamic type of b is B.

- The lookup starts in class B and looks for m(A a)
- > A.m(A)

b.m(b)

```
class A {void m(A a) { println("A.m(A)"); }}
class B extends A {void m(B b) { println("B.m(B)"); }}
B b = new B(); A a = b;
```

- Step 1: b static type is B, so we look in B and its superclass A
- Step 2: There is a method m (in fact two m(A a) and m(B b))
- Step 3: the static type of b is B we will look for m(B b)
- The lookup starts in class B and looks for m(B b)
- > B.m(B)

a.m(b)

```
class A {void m(A a) { println("A.m(A)"); }}
class B extends A {void m(B b) { println("B.m(B)"); }}
B b = new B(); A a = b;
```

- Step 1: receiver static type is A: we only look in A
- Step 2: there is a method m
- Step 3: the static type of b is B but since A is a supertype of B this is ok we will look for m(A a)

The dynamic type of a is B

- The lookup starts in class B and looks form(A a)
- > A.m(A)

a.m(c)

```
class A {void m(A a) { println("A.m(A)"); }}
class B extends A {void m(B b) { println("B.m(B)"); }}
B b = new B(); A a = b; C c = new C;
```

- Step 1: We look only in A
- Step 2: there is a method m
- Step 3: C the static type of c does not match A there is no subtype relations

Does not compile!

Conclusion

- Examples used so far were simple
- By careful with static types, it can get tricky
- Check lecture on overloading
- Check lectures on interfaces

A course by

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