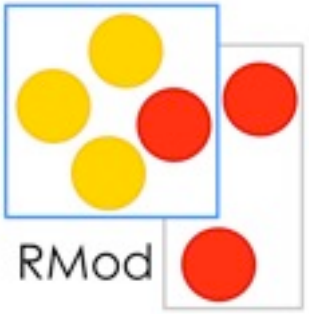

Read-Only Execution for Dynamic Languages

Jean Baptiste Arnaud, Marcus Denker, Stephane Ducasse,
Damien Pollet, Alexandre Bergel and Mathieu Suen

http://rmod.lille.inria.fr

Example

```
if (this.precondition())
{
    this.doSomething();
}
```

- Precondition might or might not make a side effect

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if (this.precondition())
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should ***only*** check the precondition

- Precondition might or might not make a side effect

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if (this.precondition())
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}
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should ***only*** check the precondition

Shouldn't

- Precondition ~~might or might not~~ make a side effect

The problem

- Dynamic language
  - No Static analysis
  - Not Freeze the object
  - Propagation through object graph

- Related work
  - Dynamic Object Ownership (Noble, J)
  - Object-Oriented Encapsulation (Schärli, N)

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Ownership imposed by object graph

The problem

- Dynamic language
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  - Not Freeze the object
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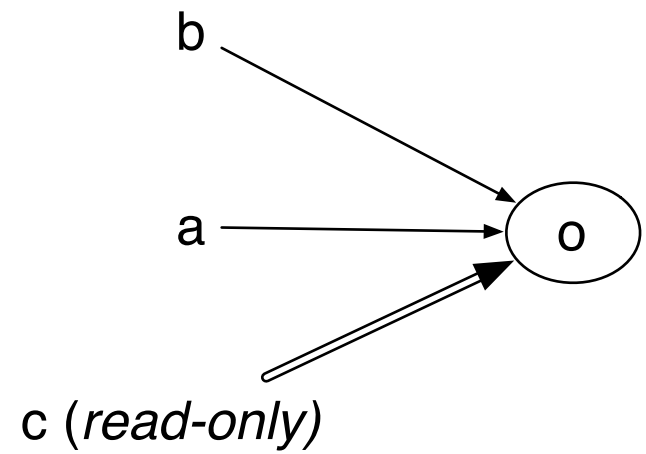
  - Object-Oriented Encapsulation (Schärli, N)

Restrict the interface

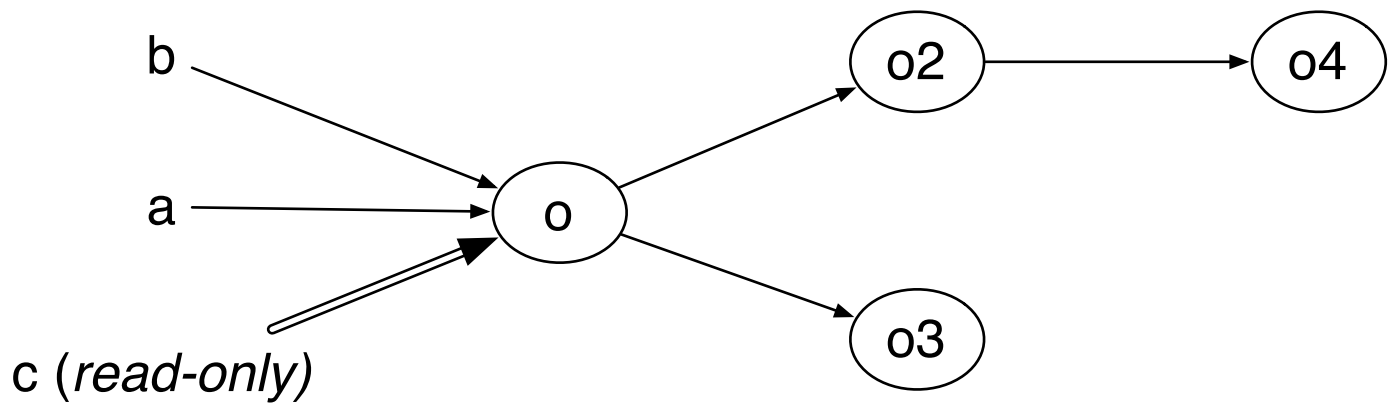
Read-only references



Read-only reference,
via a Handle (transparent proxy)

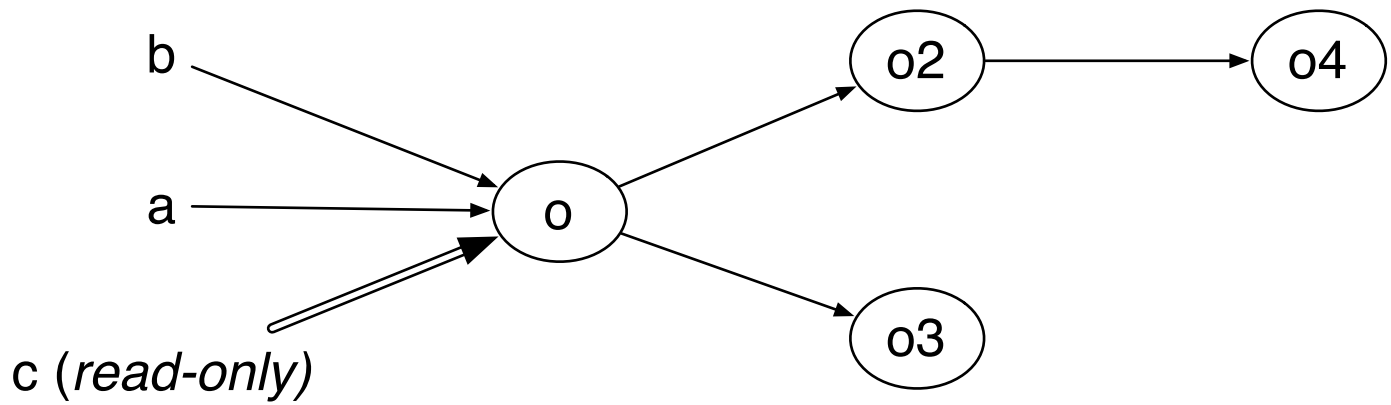
Principle of the Handle

Follow the execution flow



Principle of the Handle

The read-only mode propagates with execution



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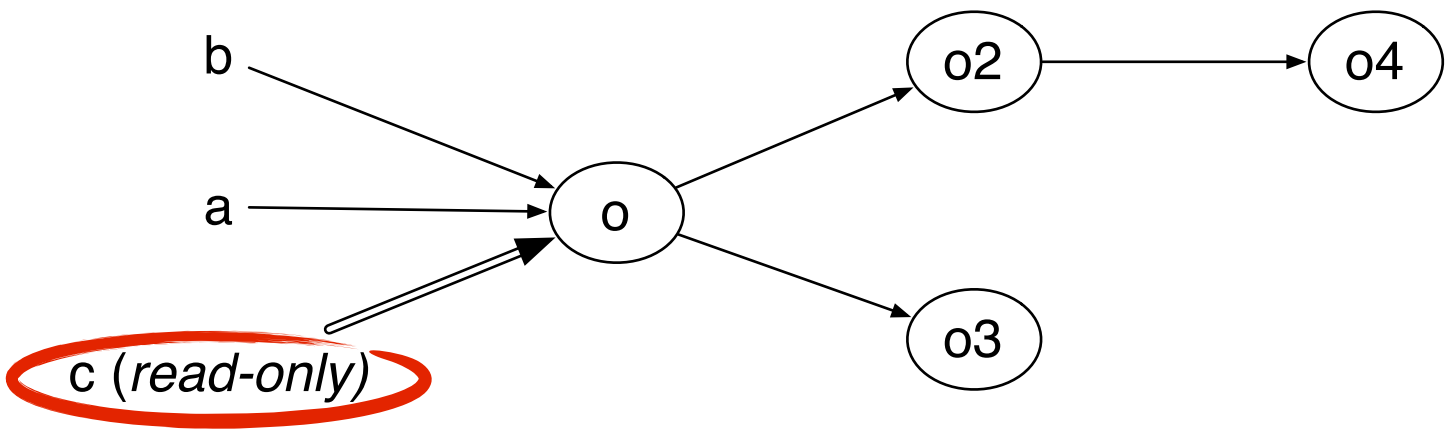

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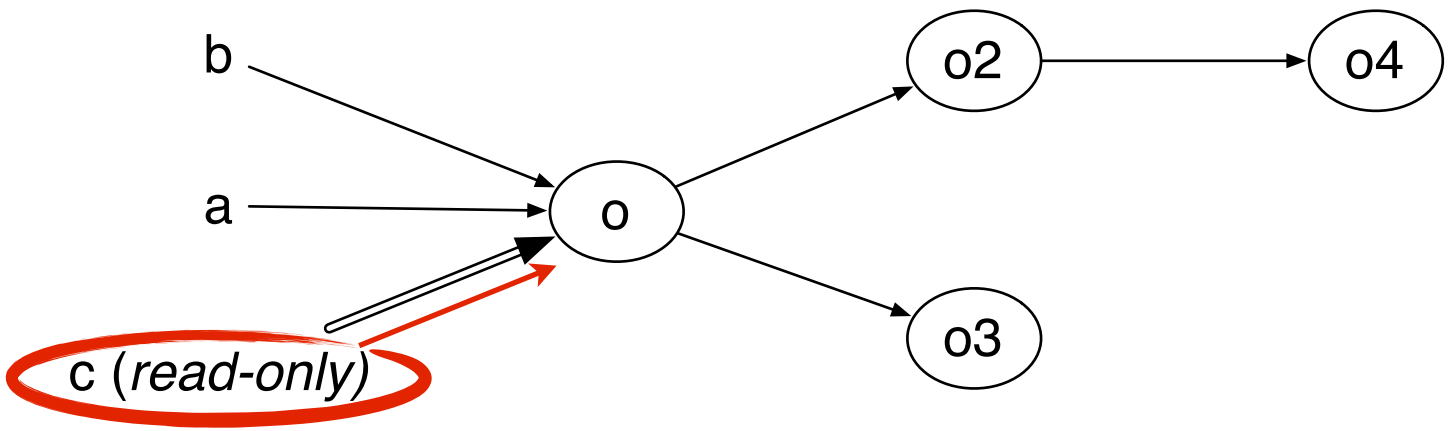

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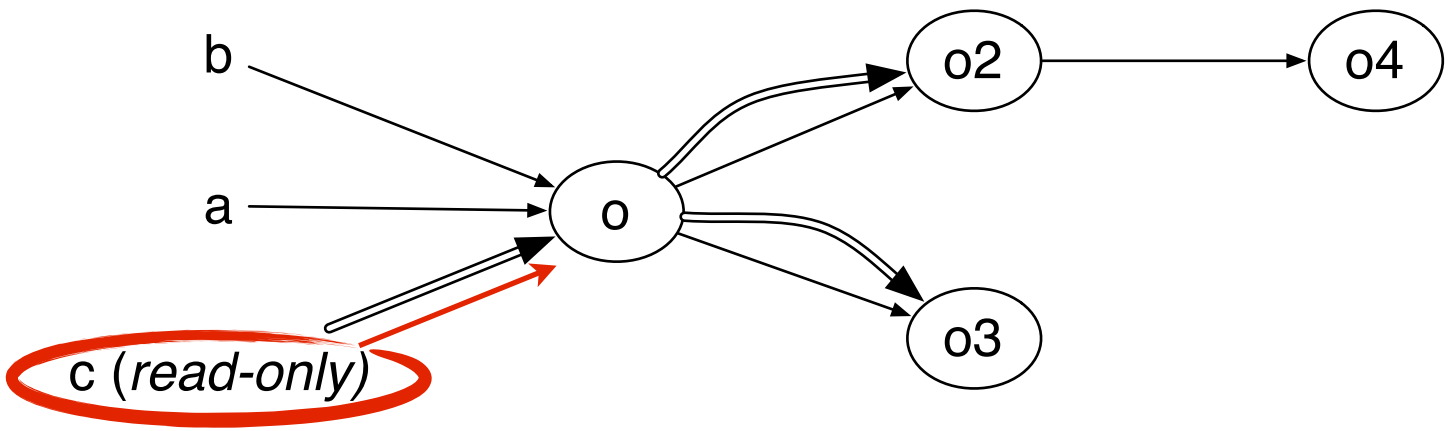
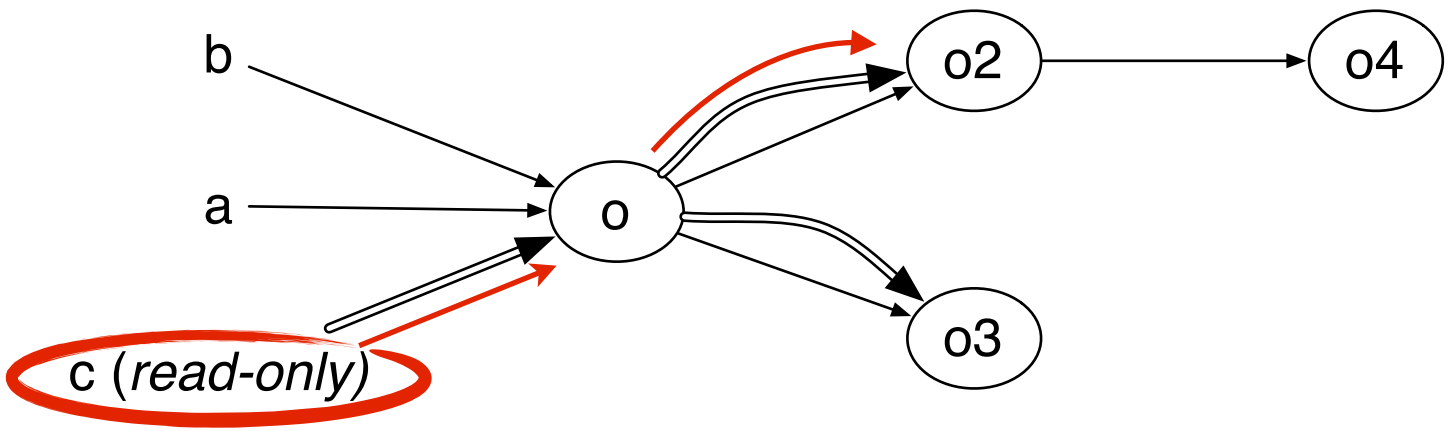


Principle of the Handle

The read-only mode propagates with execution



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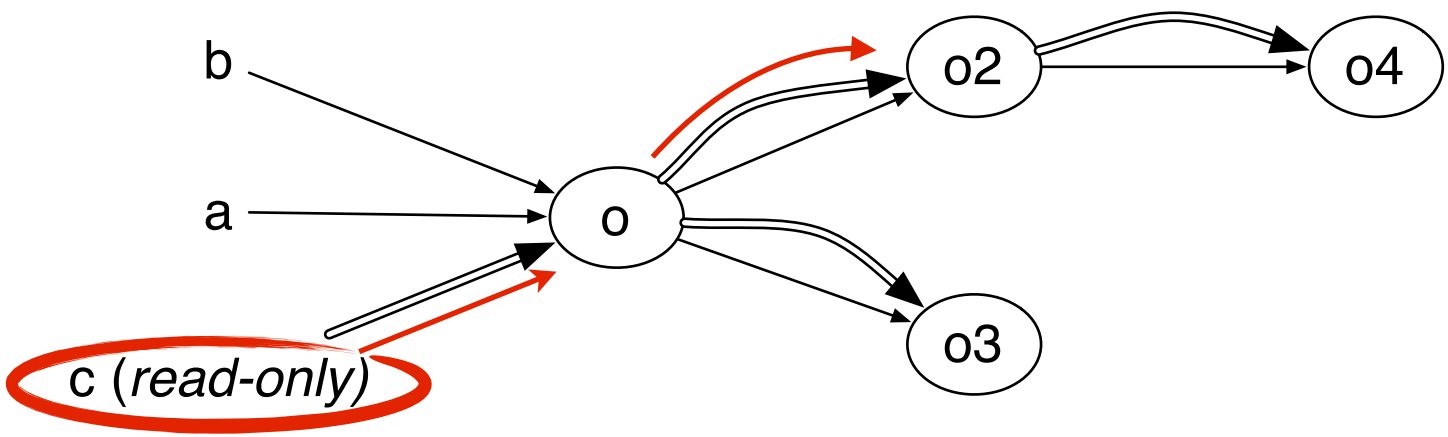
The read-only mode propagates with execution



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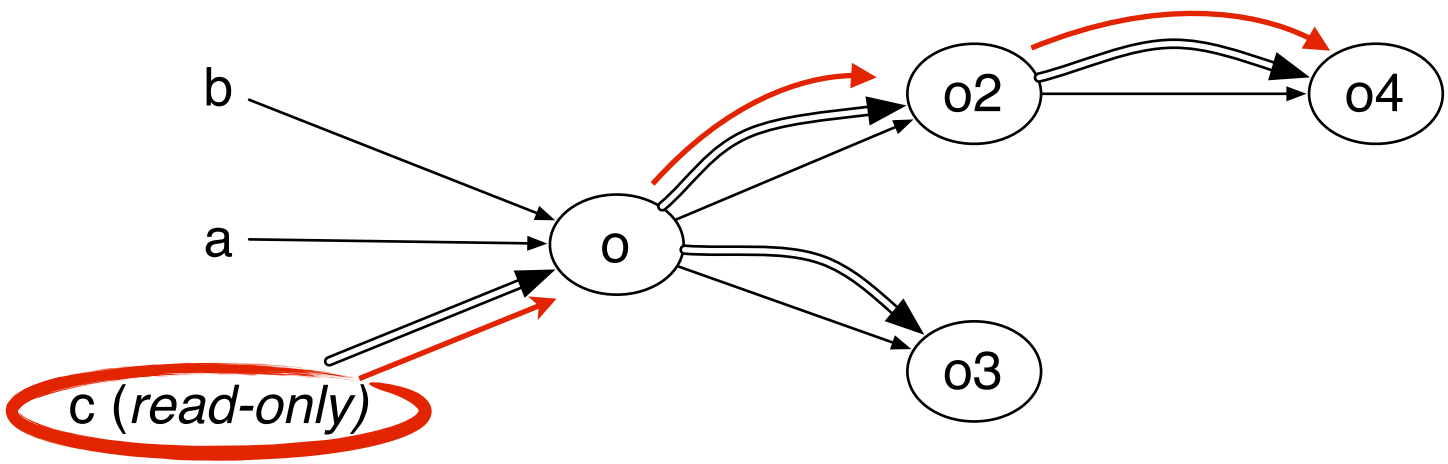
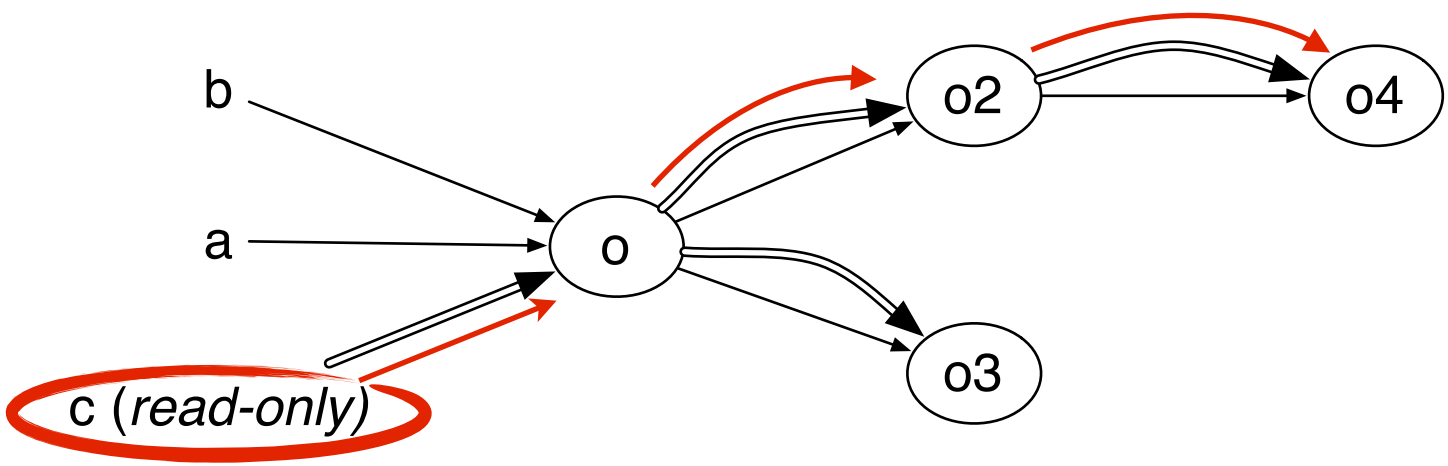


Principle of the Handle

The read-only mode propagates with execution

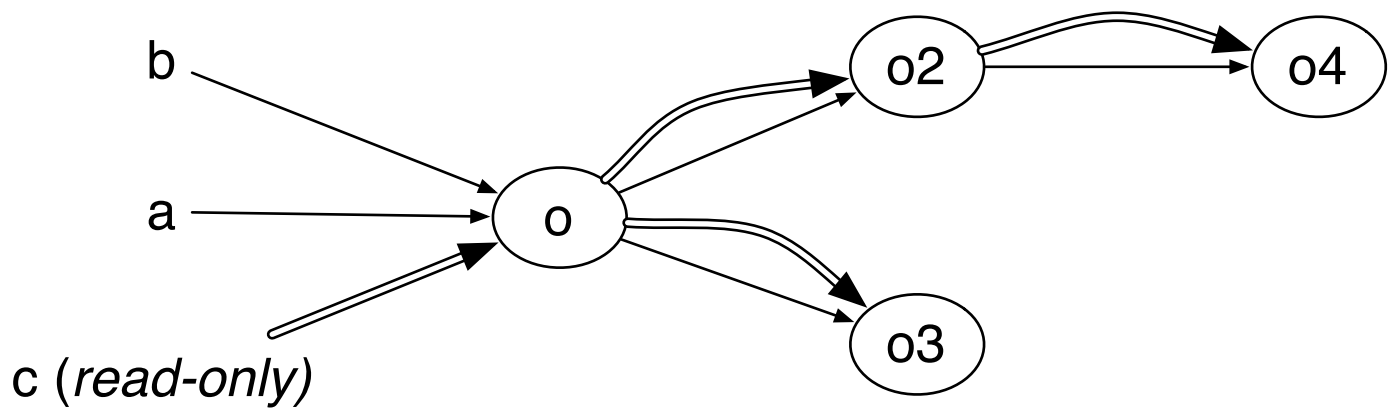
o4 attempts a side-effect!

=> Exception



Principle of the Handle

Via normal reference,
normal execution



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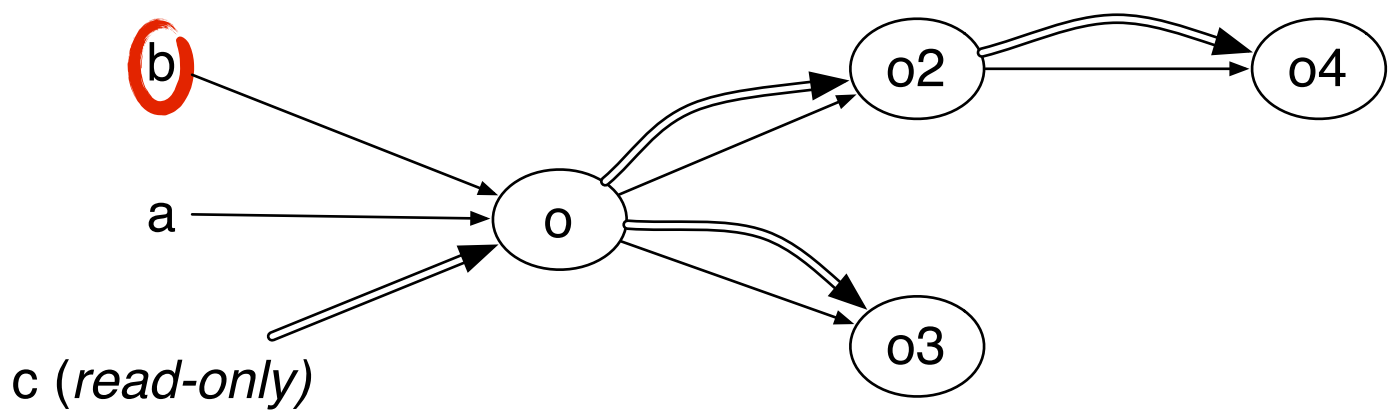

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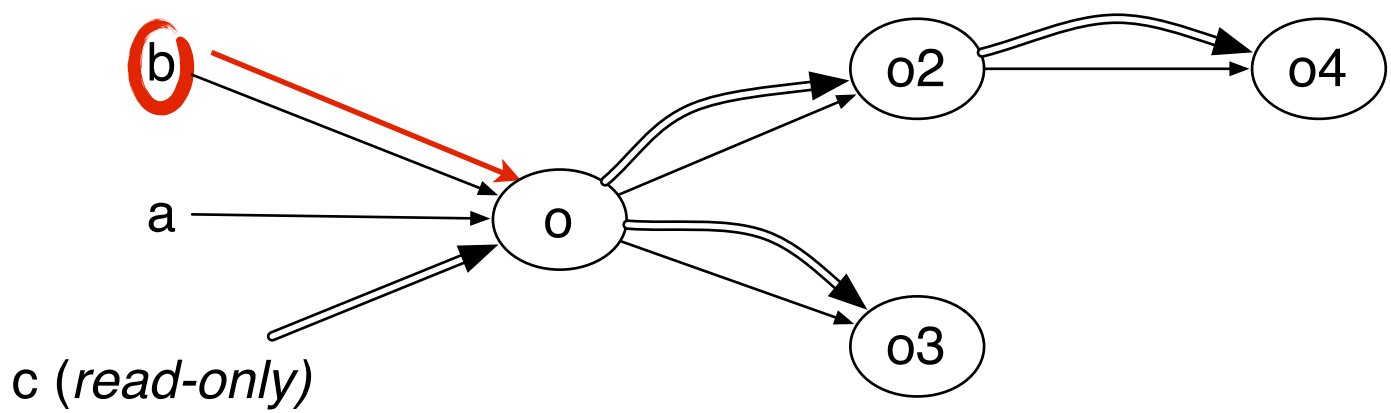

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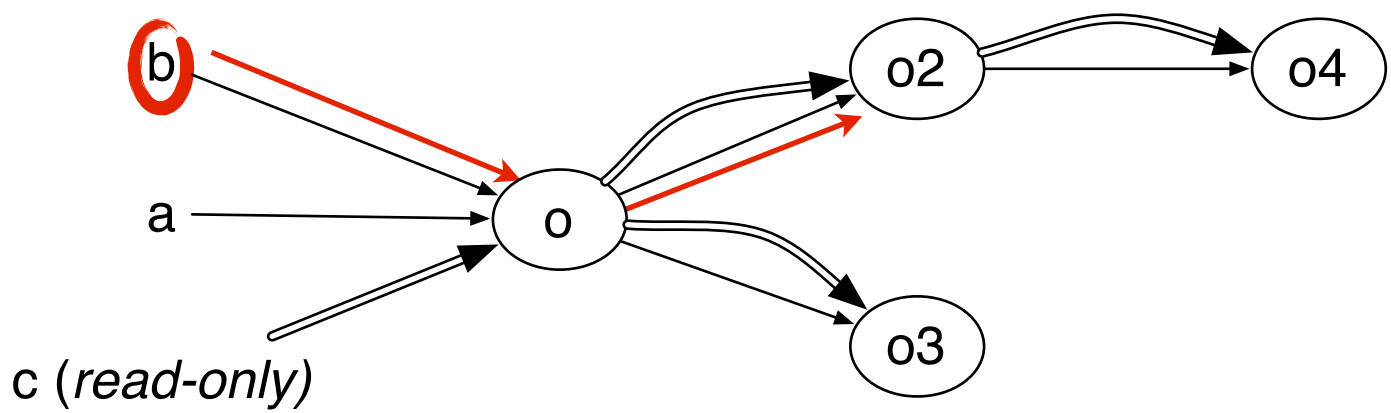

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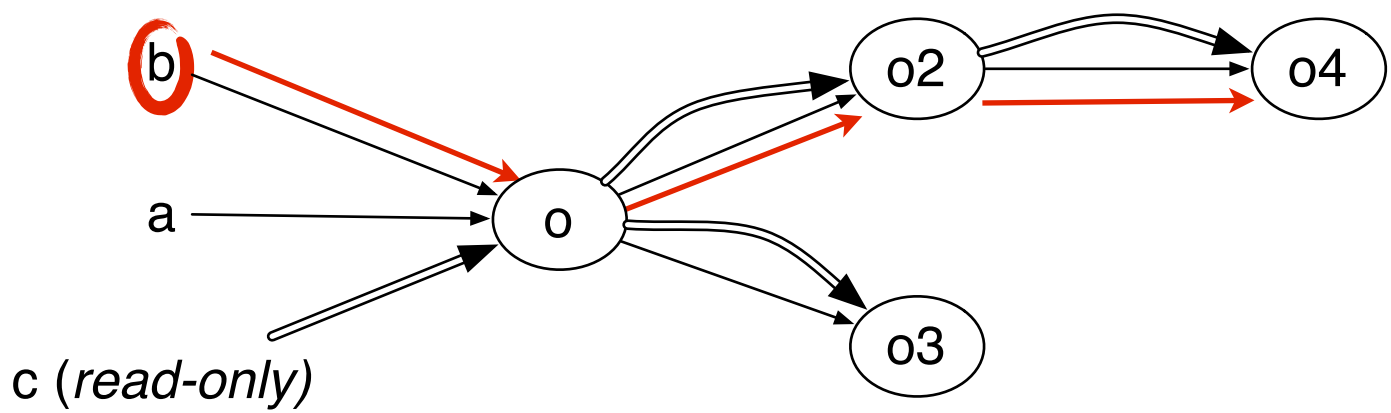

Principle of the Handle

Via normal reference,
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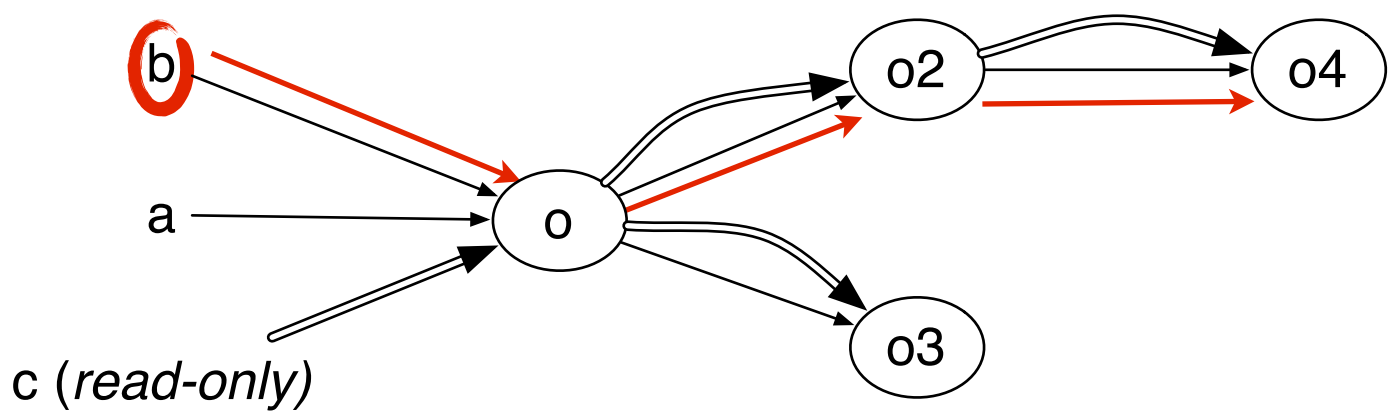
State changed



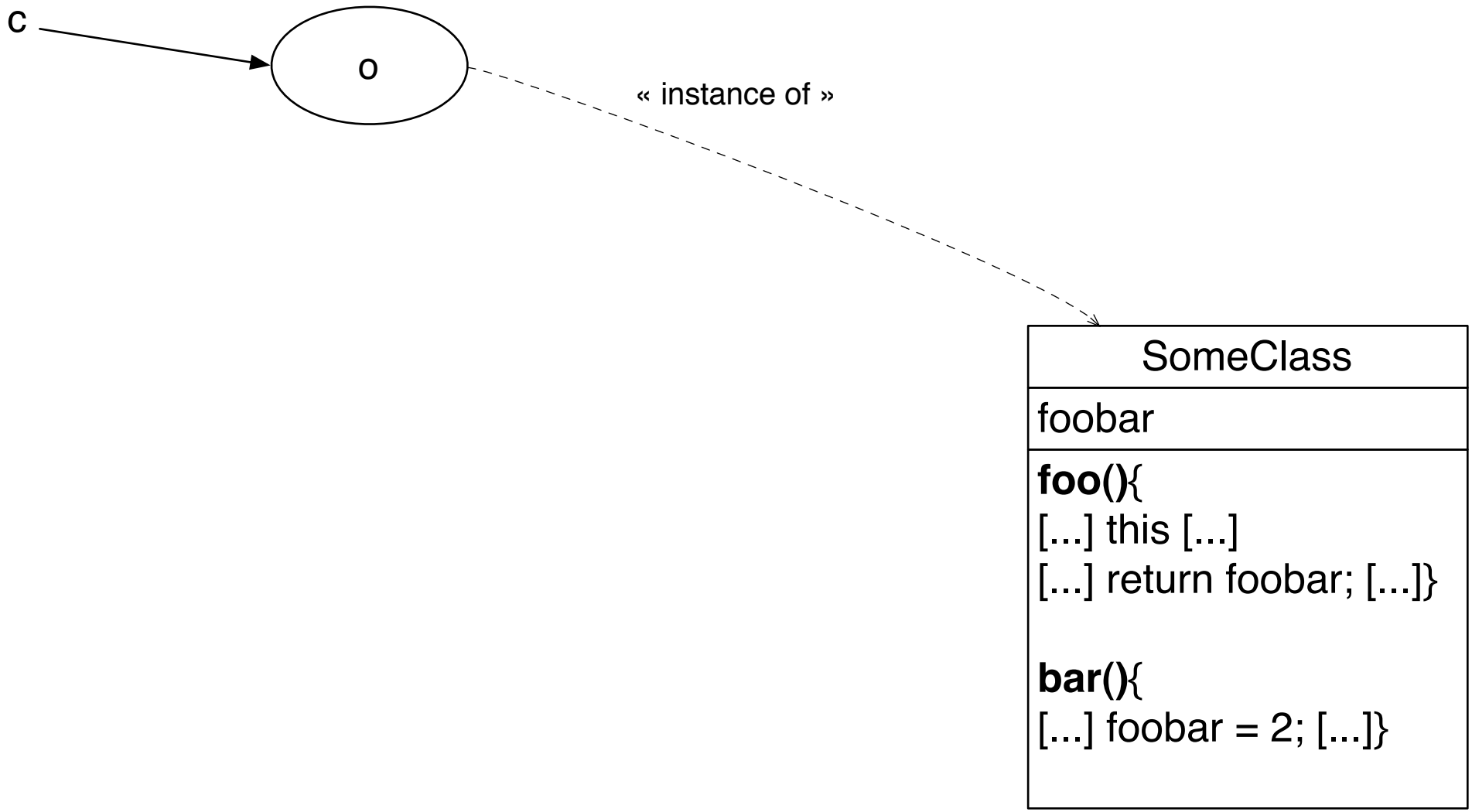
Implementation

- Bytecode rewriting to transform bytecodes of methods

- VM modification to create the "Handle"
  - Change the lookup.
  - The Handle representing the object aliased (same identity)

- Cache that associates a class name to the rewrote methods

Rewriting Process



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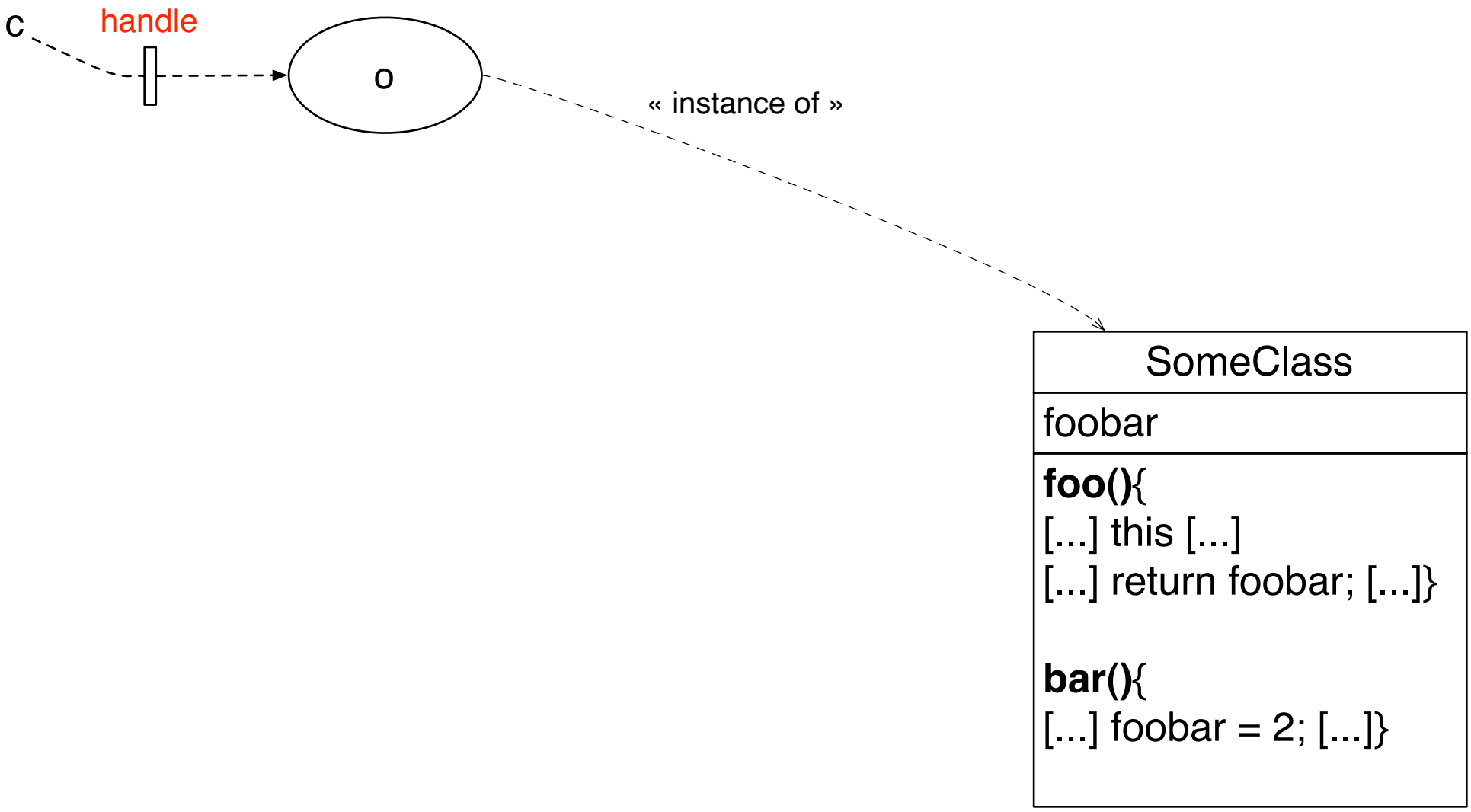

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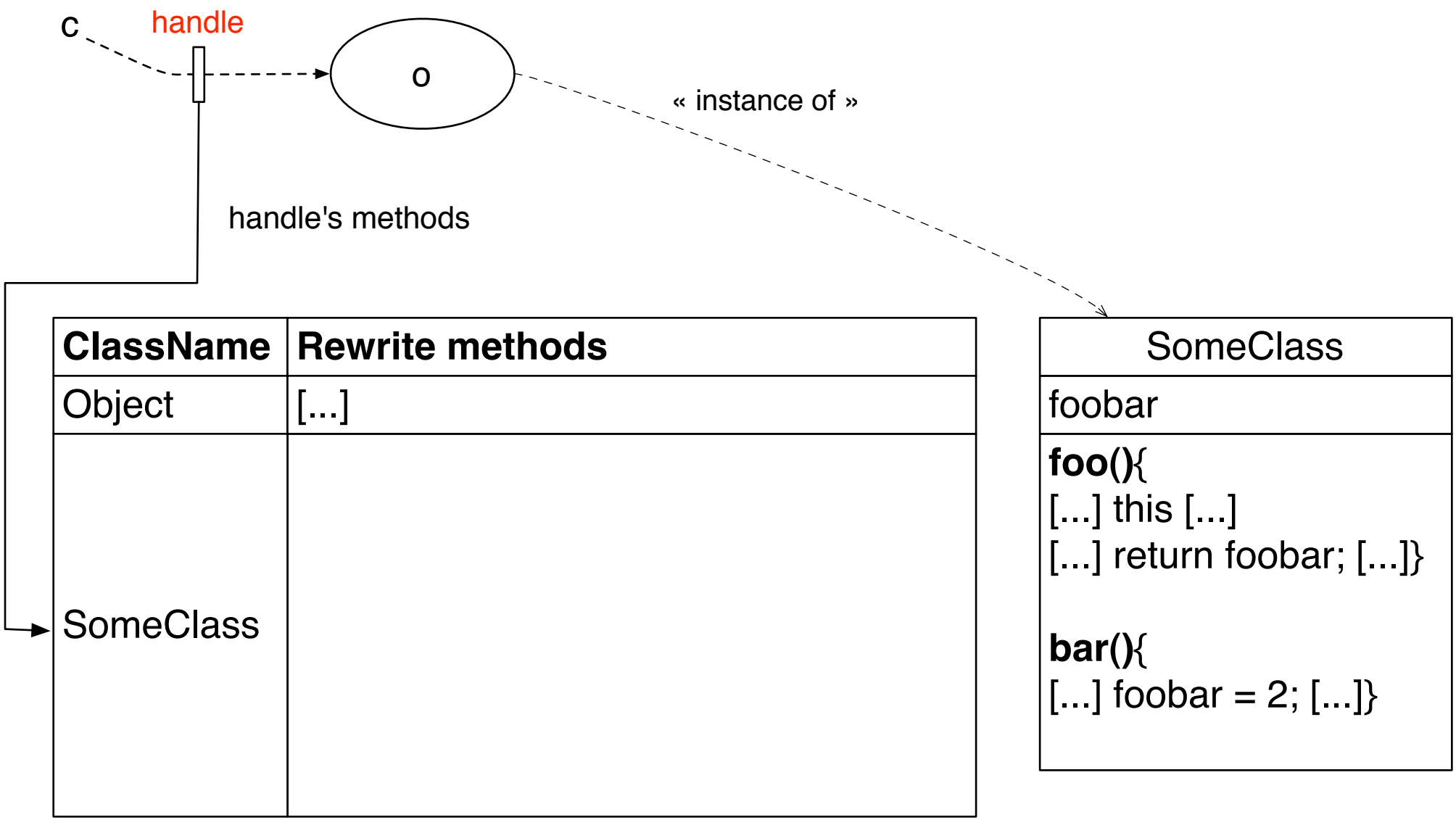
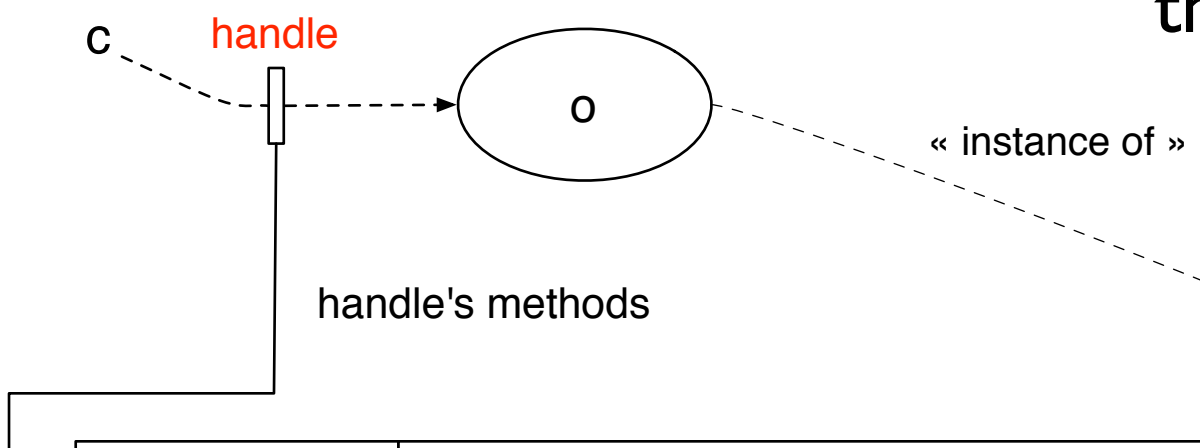


Rewriting Process

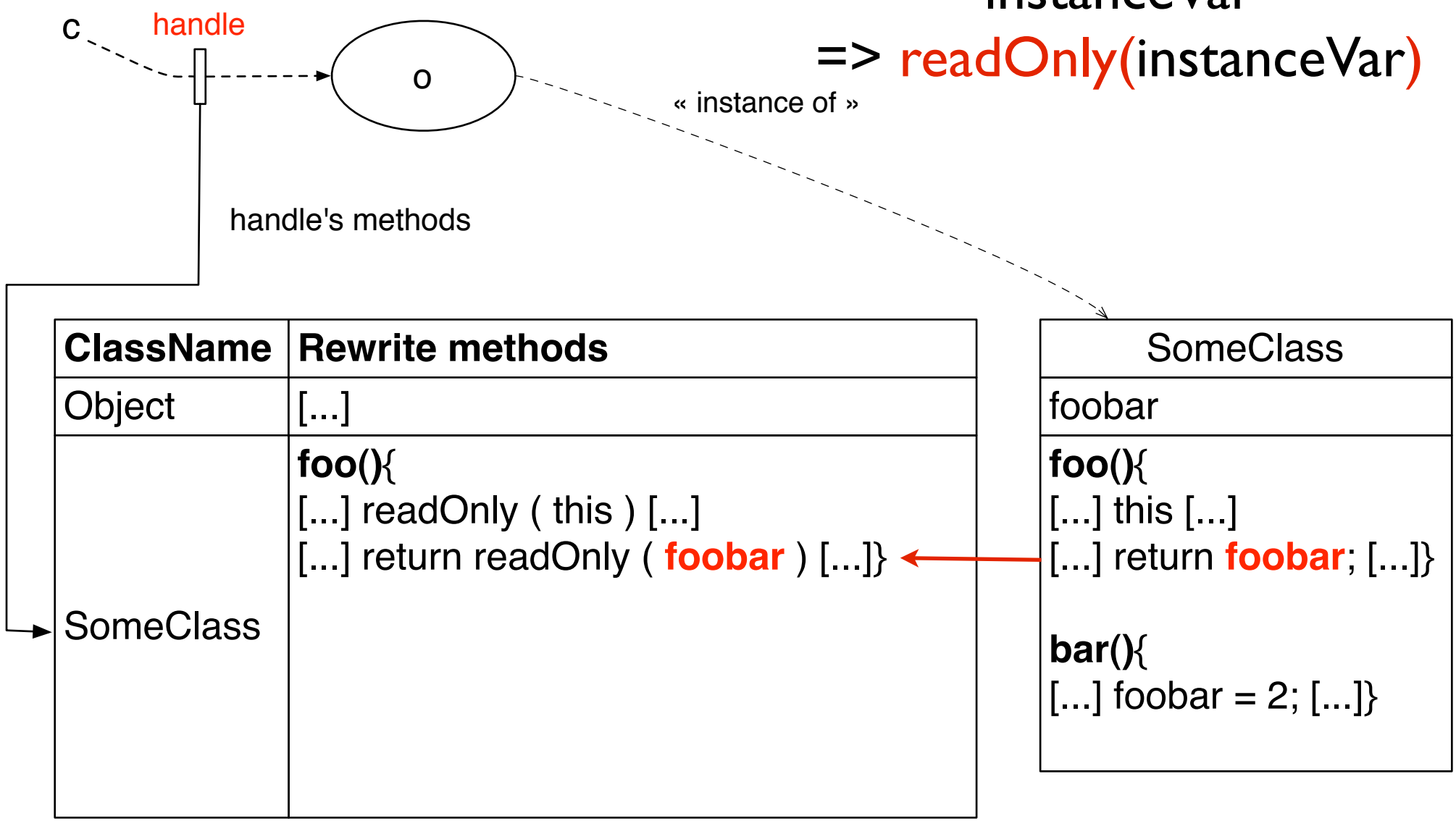
this => readOnly(this)



ClassName	Rewrite methods
Object	[...]
SomeClass	**foo(){** [...] readOnly (**this**) [...]

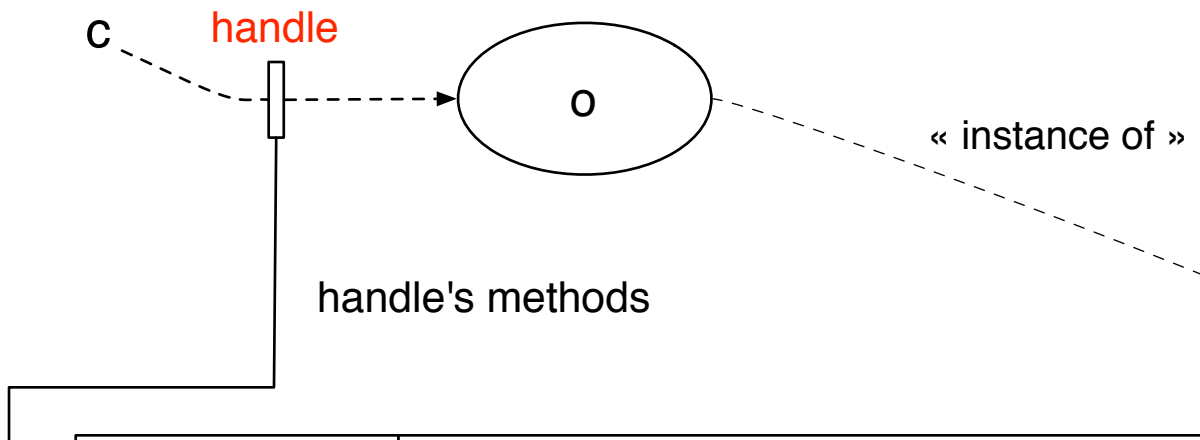
SomeClass
foobar
foo(){ [...] **this** [...] [...] return foobar; [...]} **bar(){** [...] foobar = 2; [...]}

Rewriting Process



Rewriting Process

a Method have Side effect => raise an Exception



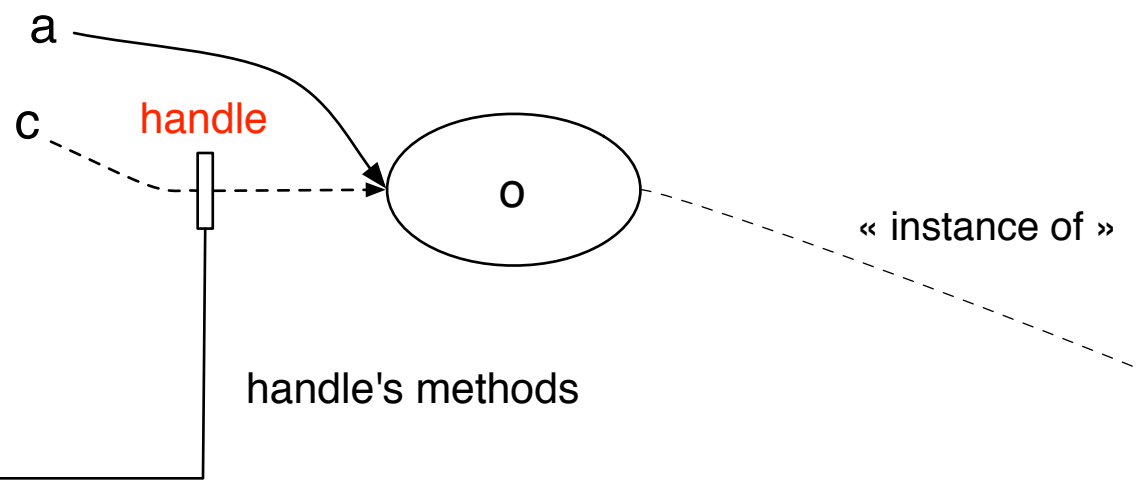
ClassName	Rewrite methods
Object	[...]

SomeClass	**foo()**{
	[...] readOnly (this) [...]
	[...] return readOnly (foobar) [...]}
	
	bar(){
	[...]throw new
	SideEffectDetectedException();[...]}

SomeClass
foobar

foo(){
[...] this [...]
[...] return foobar; [...]}
 	
bar(){
[...] **foobar =** 2; [...]}

Rewriting Process



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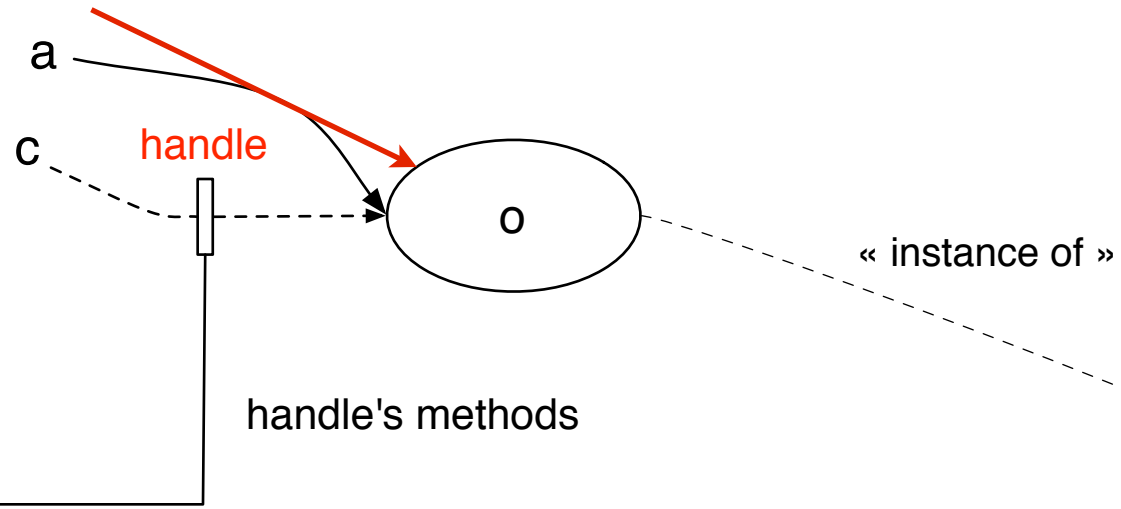

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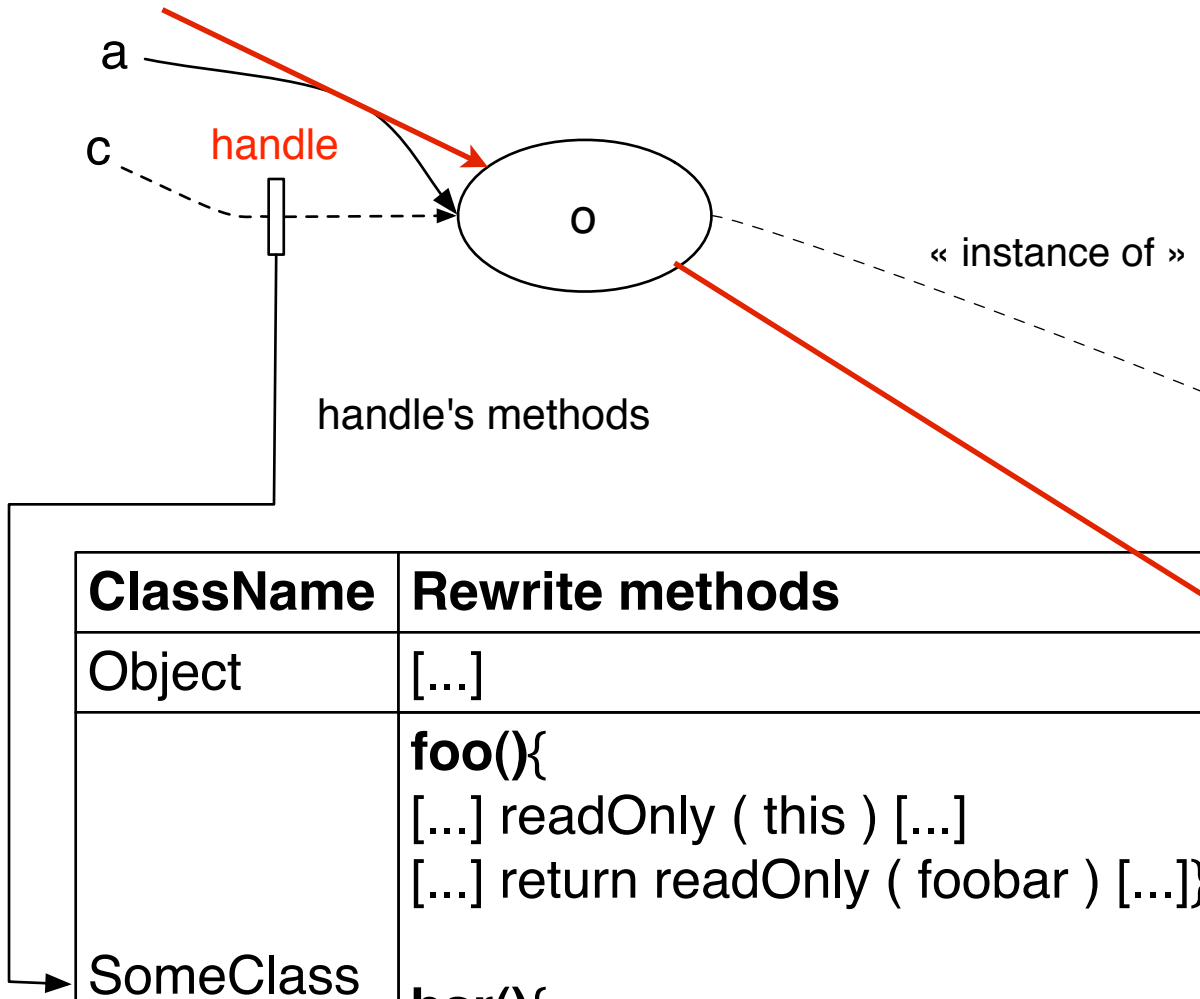

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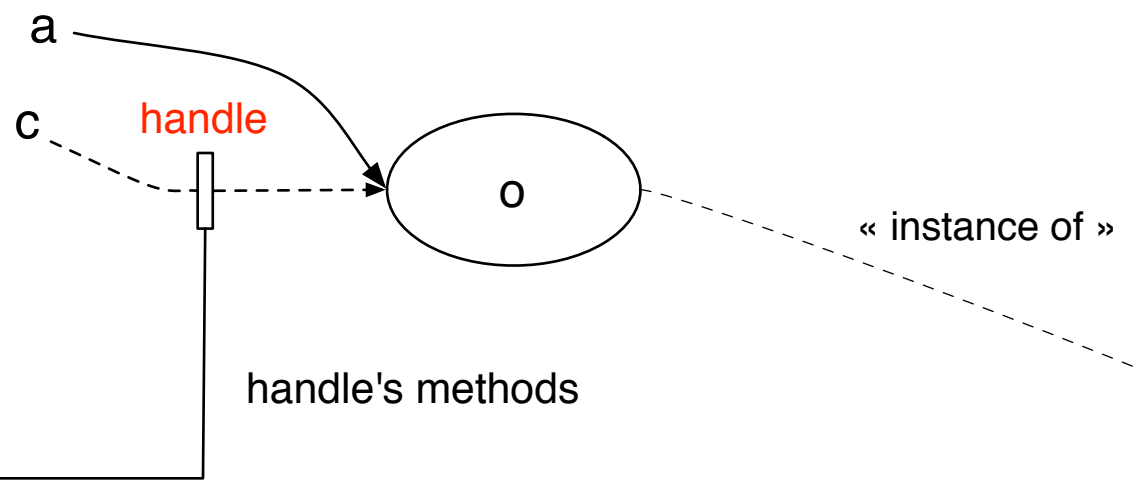

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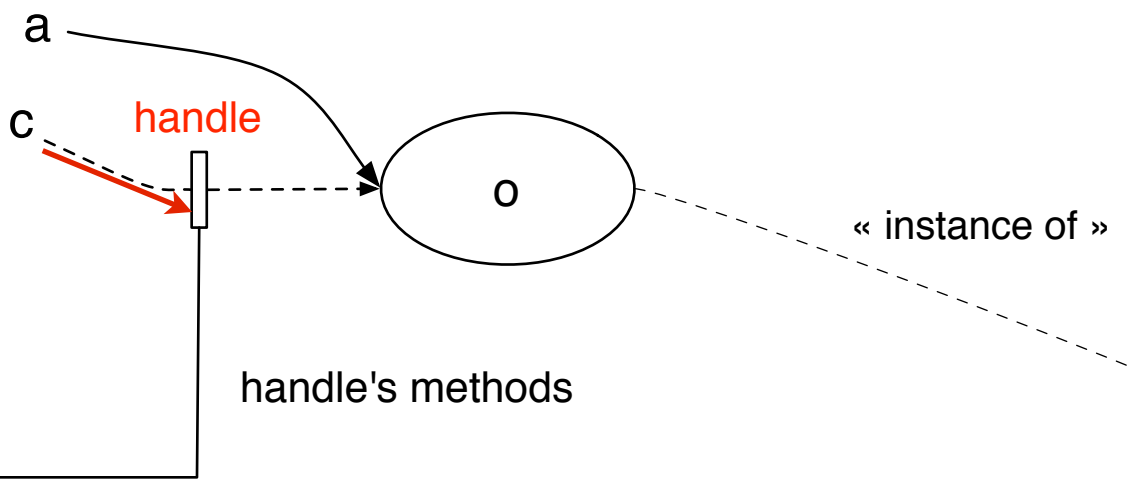

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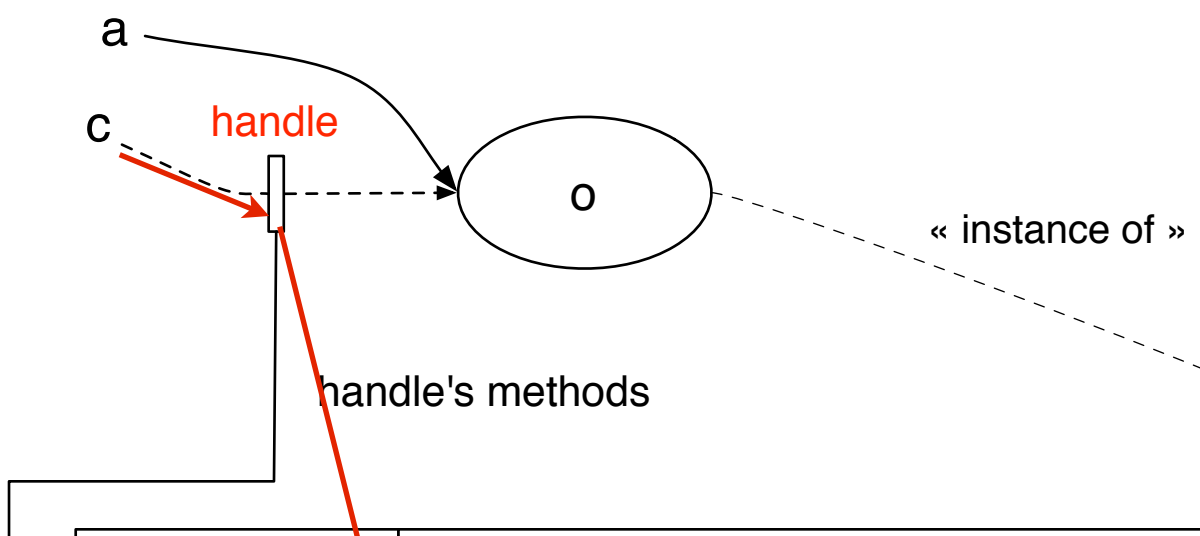

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Performance

- Proof-of-concept
- Bytecode rewriting : near 2.5 second for 450 methods
- Simple literal return, One millions send
  - Normal Virtual machine : 1109.3 ms
  - DRO Virtual Machine : 1200.5 ms
  - DRO Virtual Machine (to Handle) : 1290.1ms

Future Work

- Research
  - Generalize the idea
  - State
- Engineering
  - Primitives
  - Optimizing & Weak references

- ✔ Read-only Behavior
- ✔ Reference Based
- ✔ Propagation
- ✘ Change the object graph
- ✘ Static analysis
- ✘ Freeze the object