Open issues in extensible libraries

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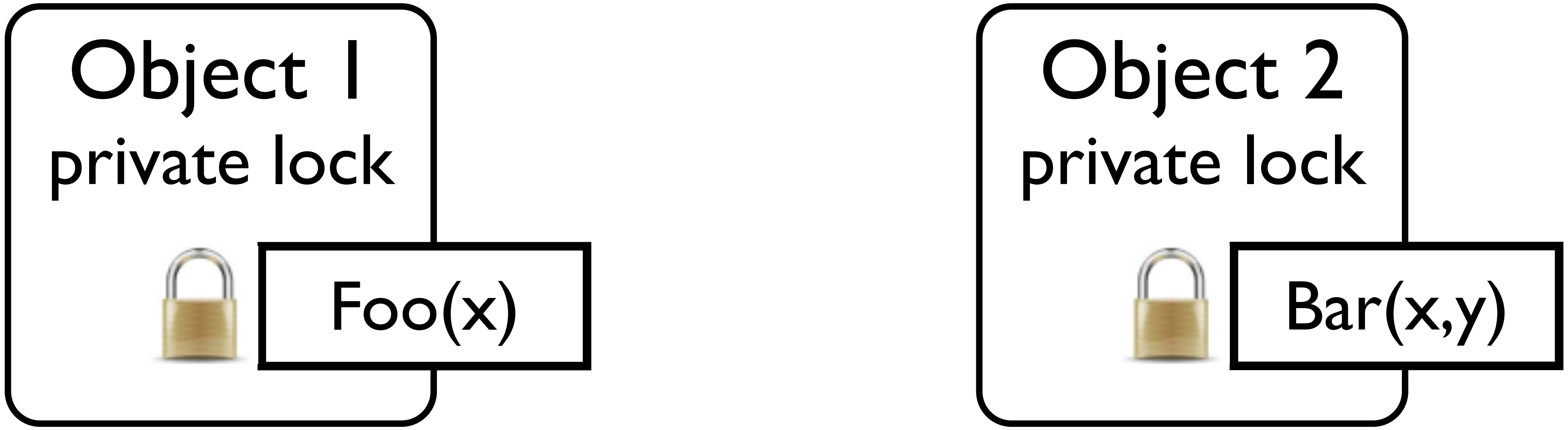


Object 1

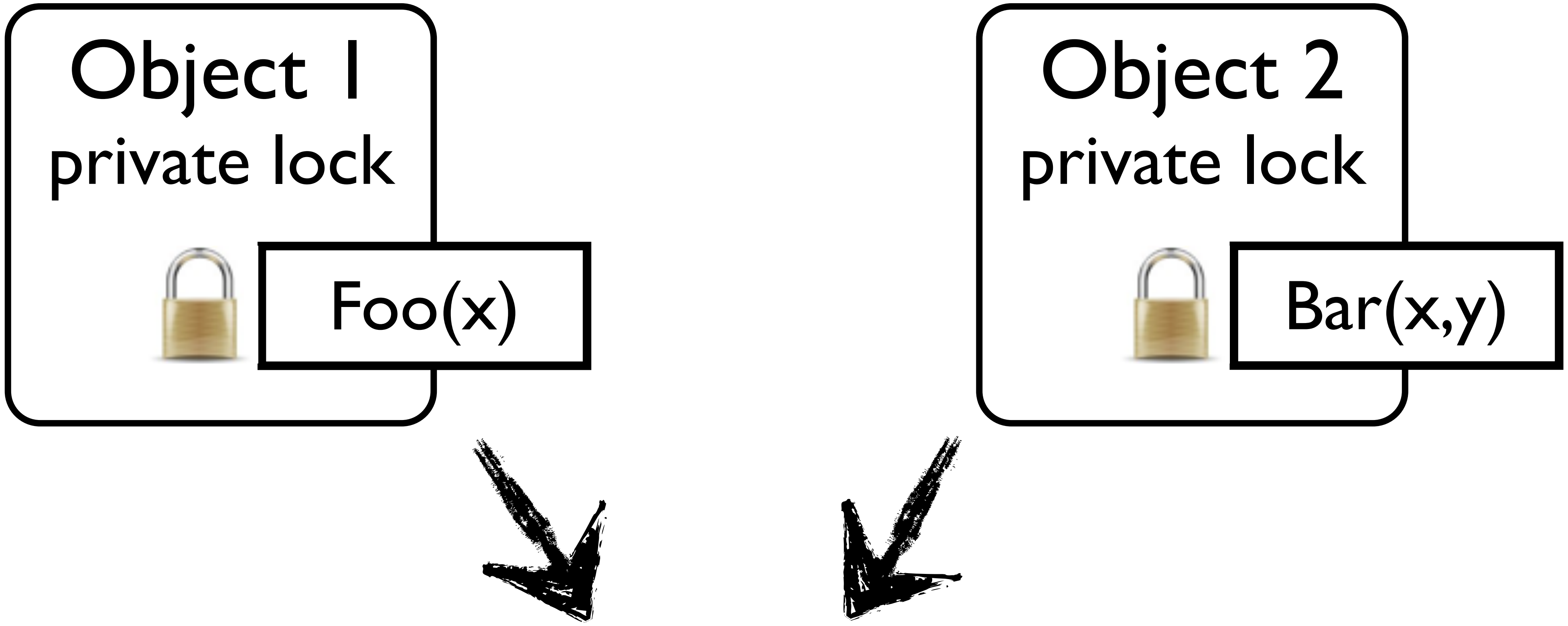
private lock

Foo(x)

Object 2

private lock

Bar(x,y)



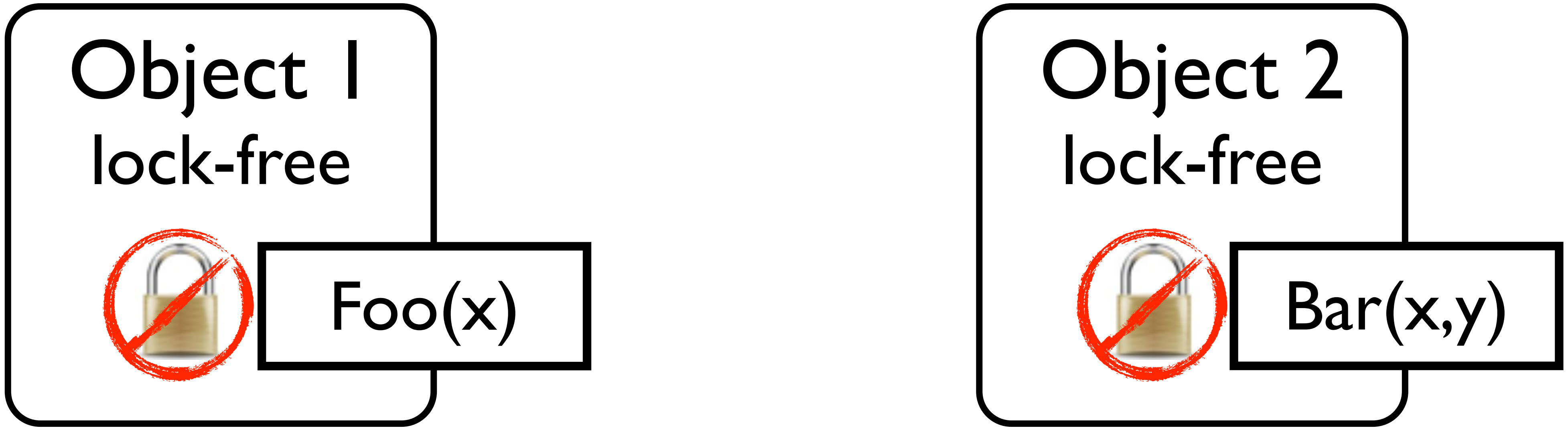
Object 1
private lock

Foo(x)

Object 2
private lock

Bar(x,y)

```
atomic {
   o1.Foo(x);
   o2.Bar(x, y);
}
```



Object 1

lock-free

Foo(x)

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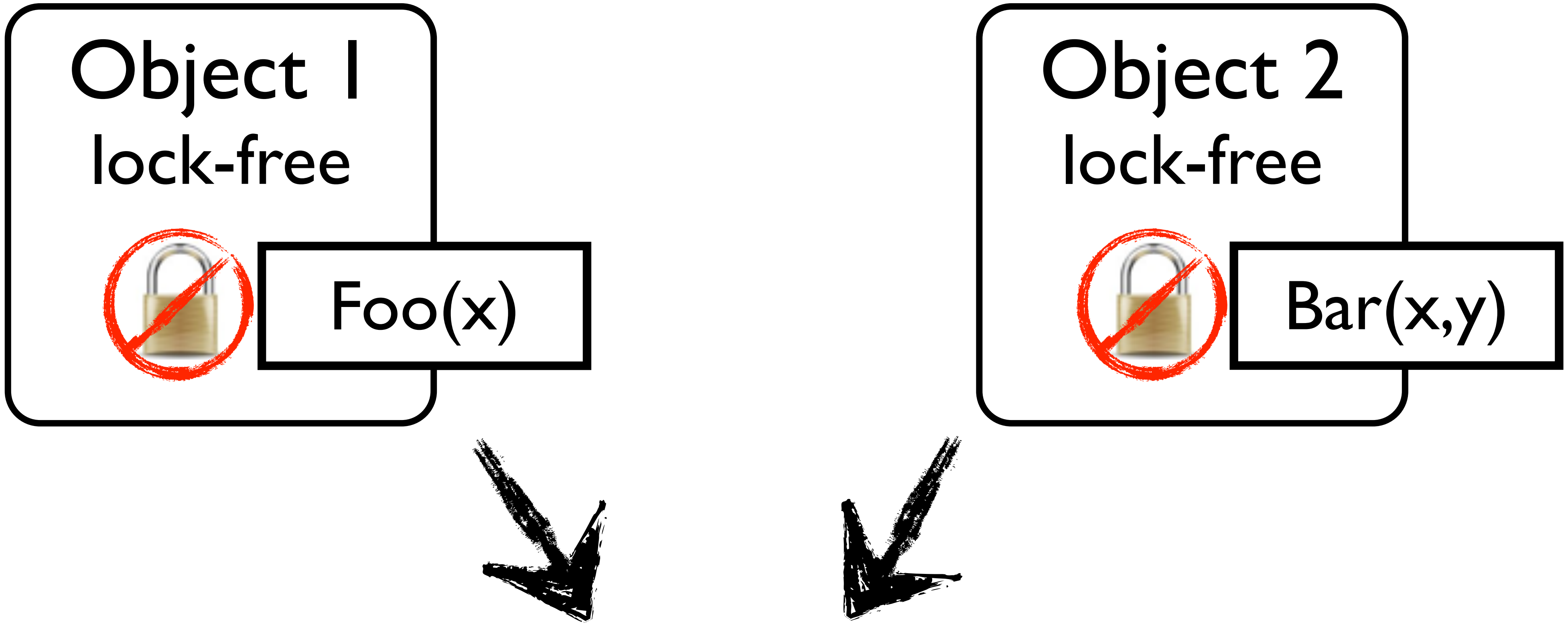
Bar(x,y)



Object 1
lock-free
Foo(x)

Object 2
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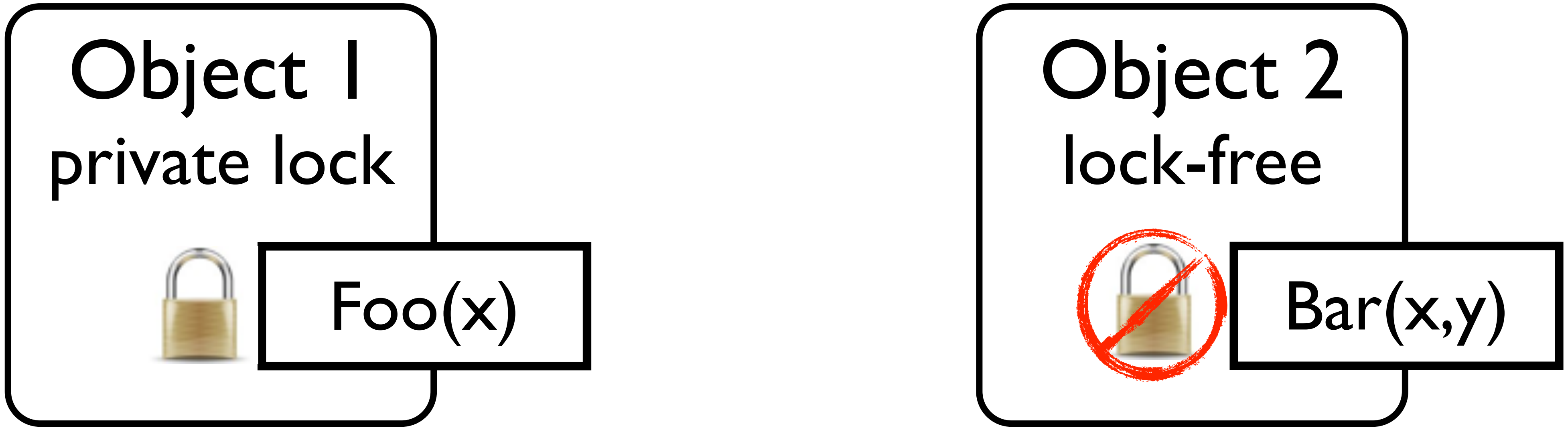
Bar(x,y)

```
atomic {
    o2.Bar(o1.Foo(x), y);
}
```



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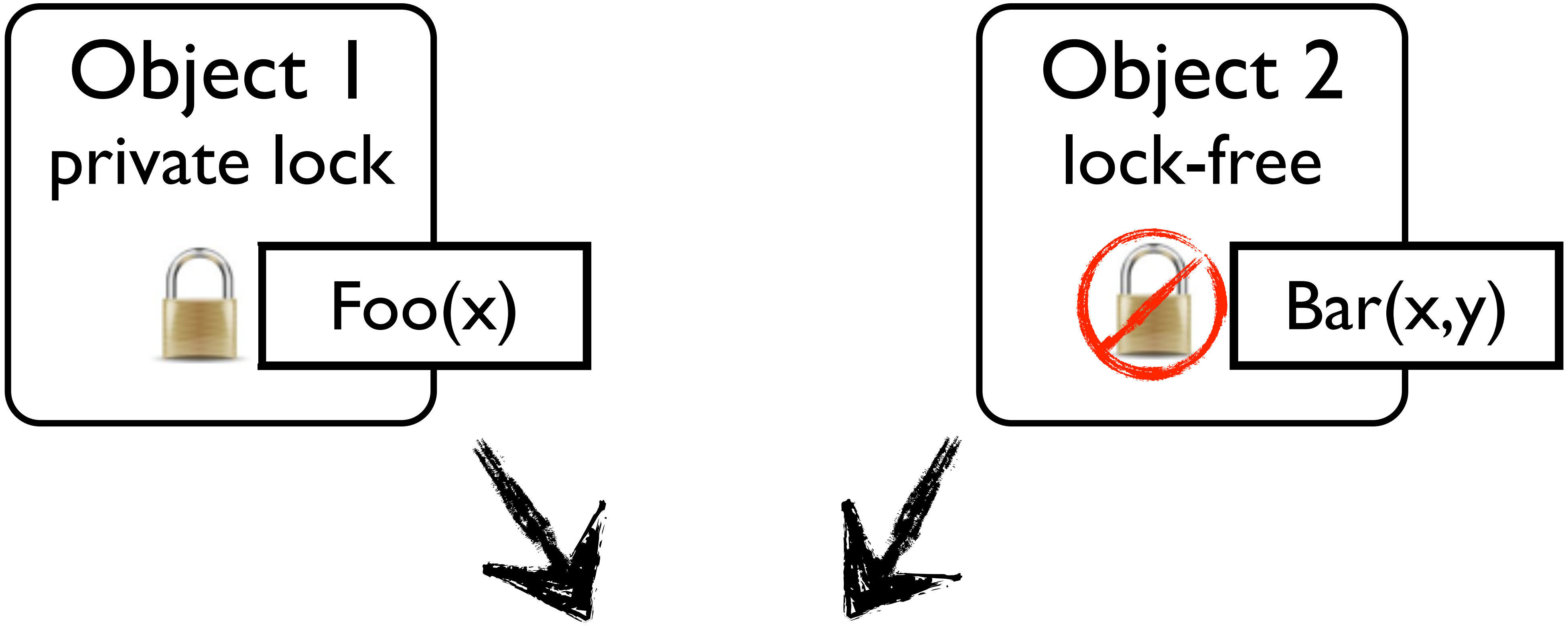

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```
atomic {
   o2.Bar(o1.Foo(x), y);
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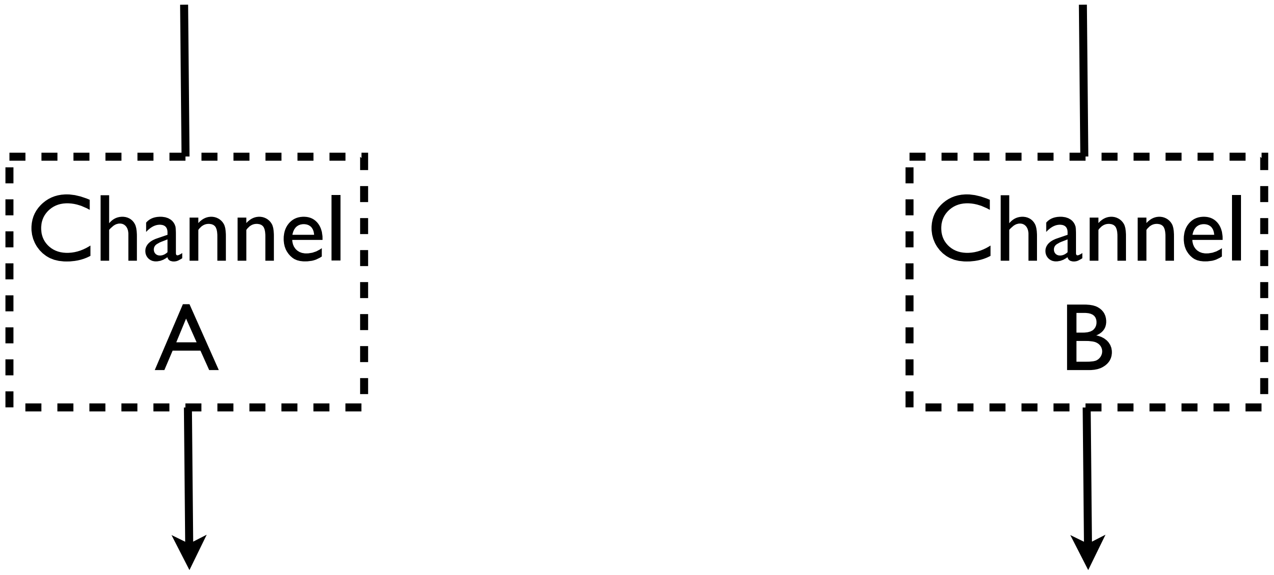
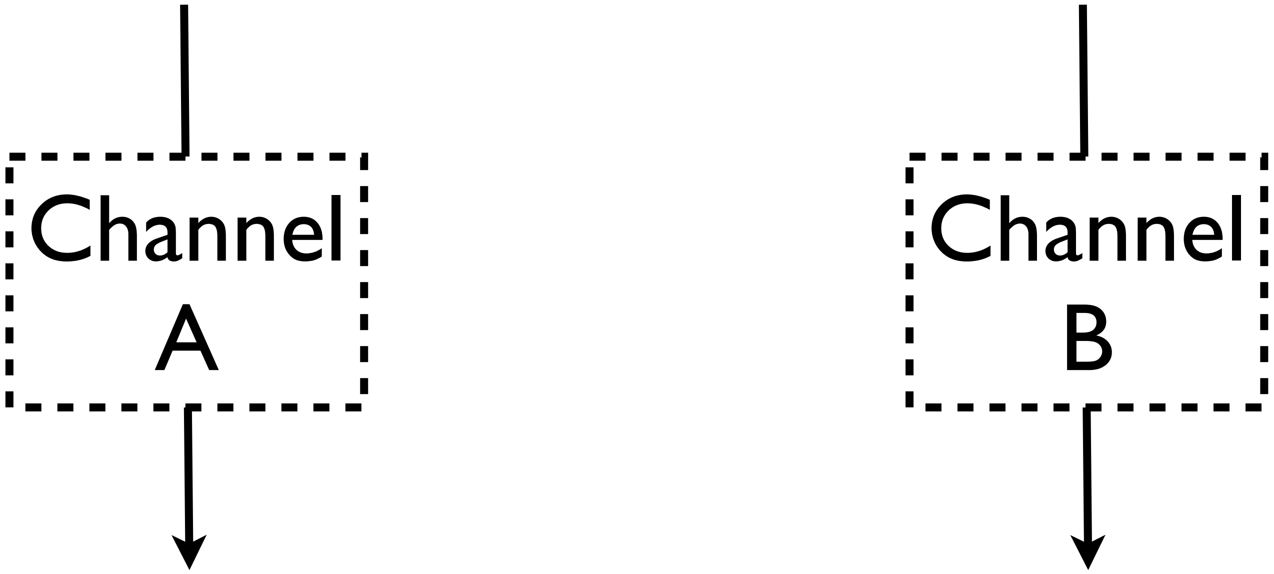
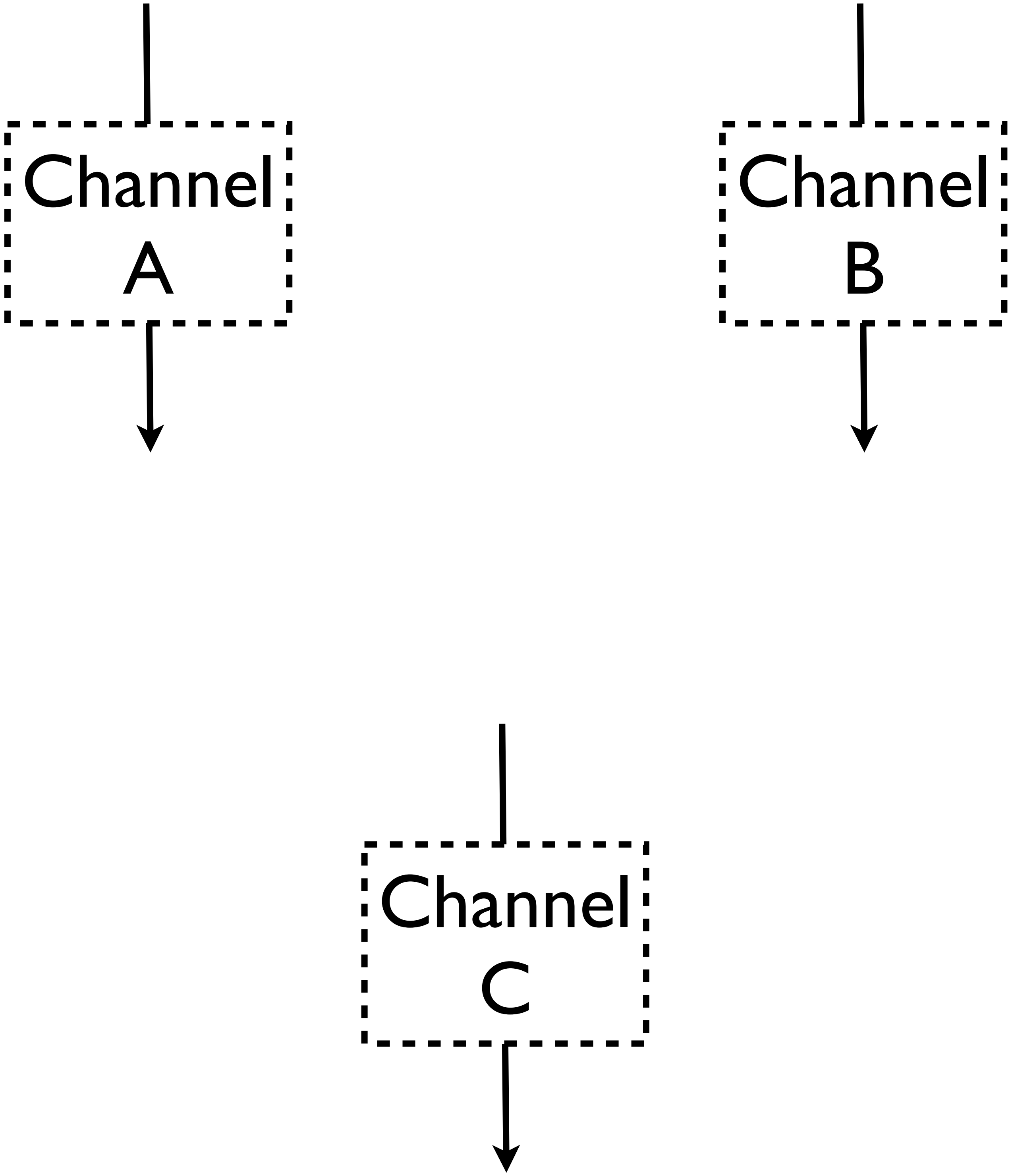
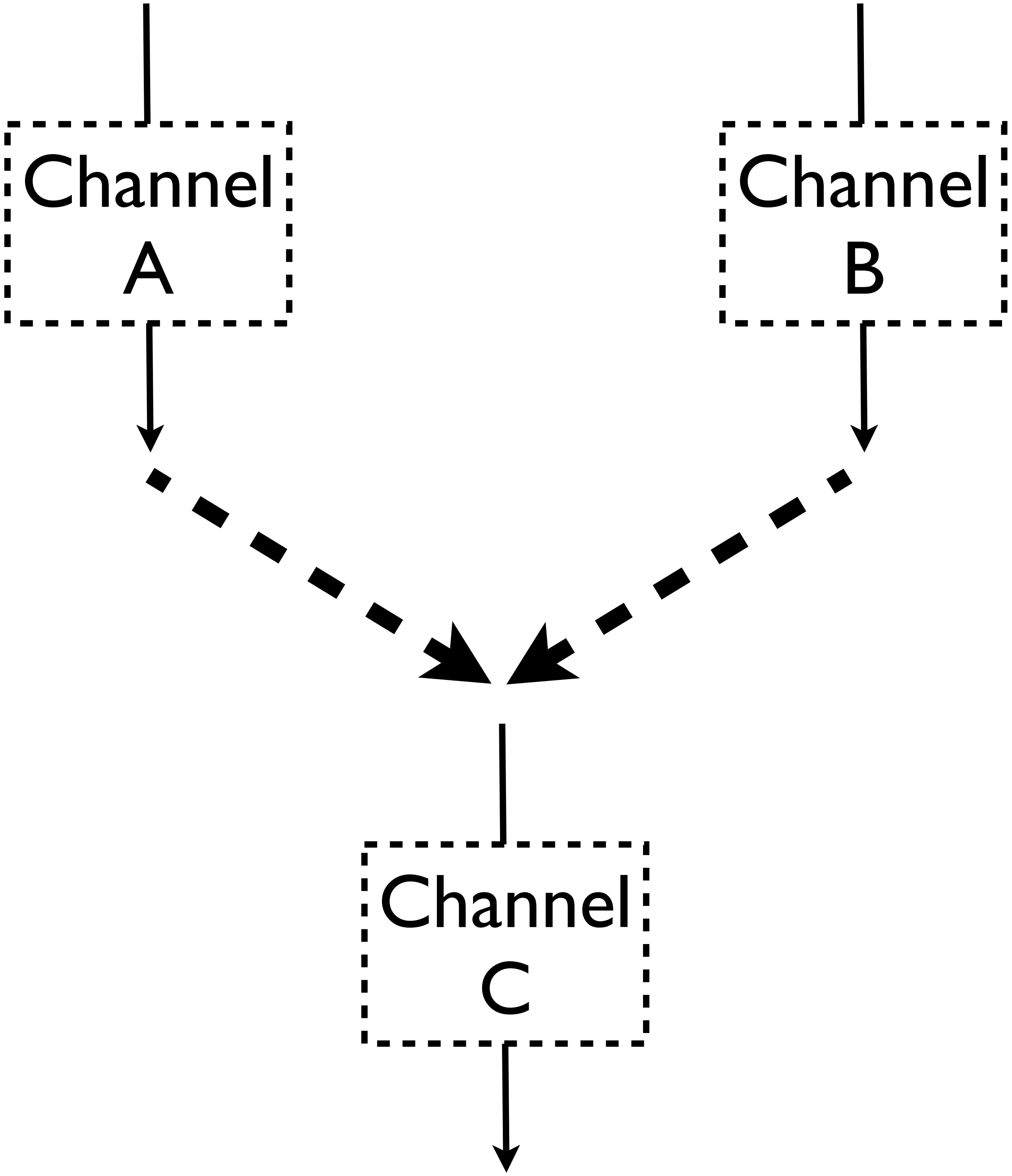

Channel A
Channel B



```
atomic {
   (receive(A), receive(B))
}
```



Channel A
Channel B
Channel C


Channel A
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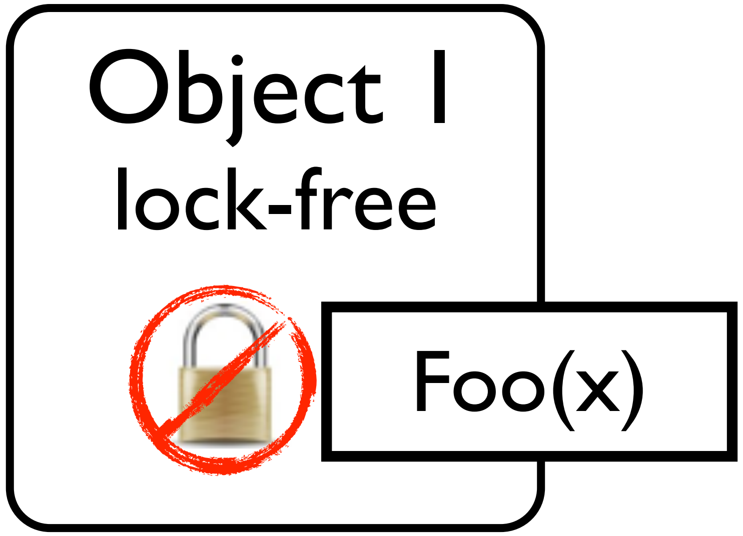
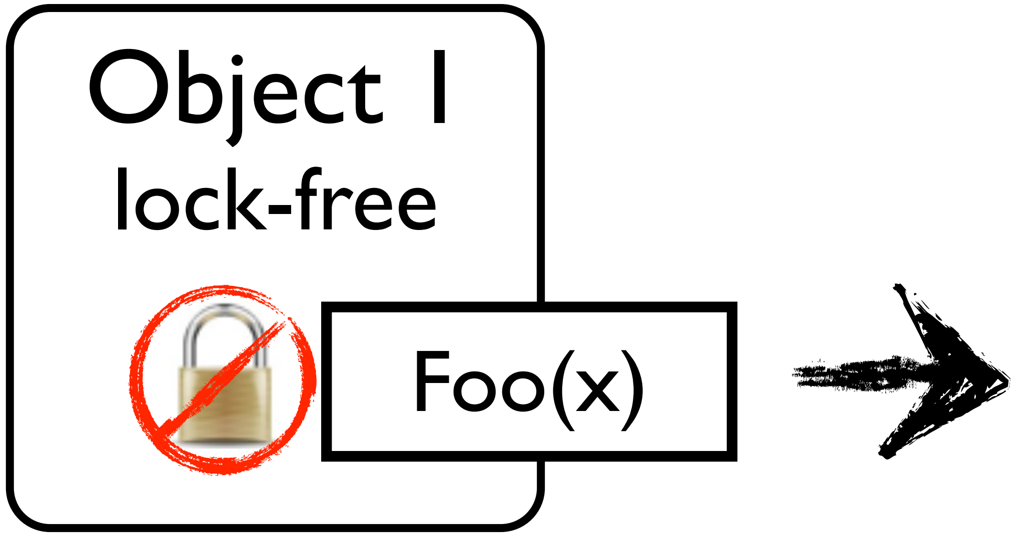


Object 1
lock-free

Foo(x)



Object 1

lock-free

Foo(x)

```
atomic {
   if (o1.Foo(x) == null)
     block;
}
```

Cards on the table

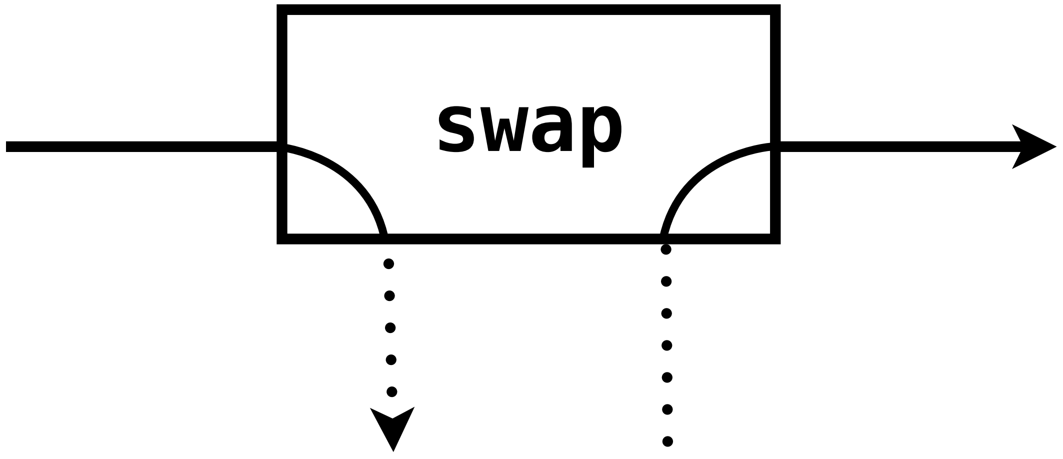
- **Assumption:** programmers will use a mixture of concurrency paradigms
- **Assumption:** programmers want to compose code they do not control
- **Conclusion:** the semicolon is not enough

A (big!) open issue:

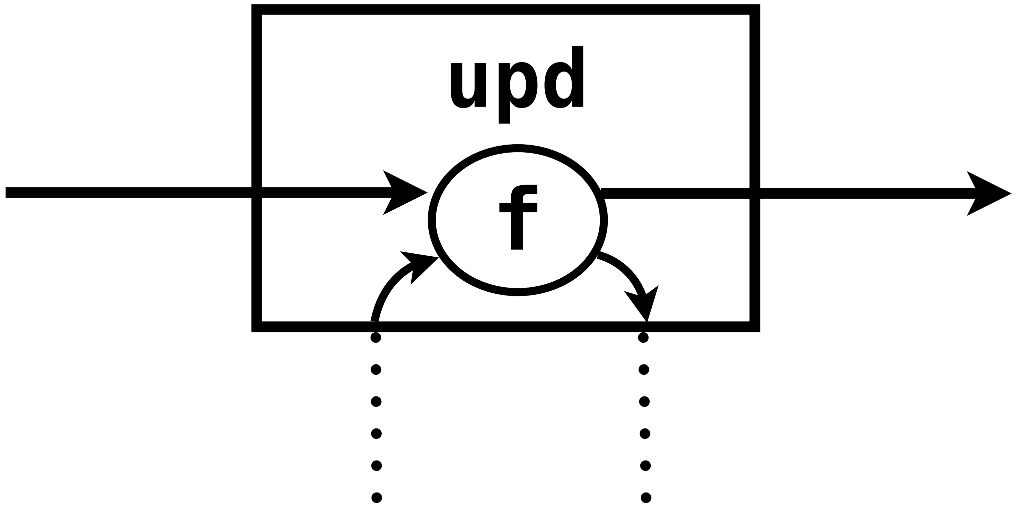
How do we support
abstraction and composition
across multiple paradigms,
without sacrificing performance?

My stake in the ground:
“Reagents”

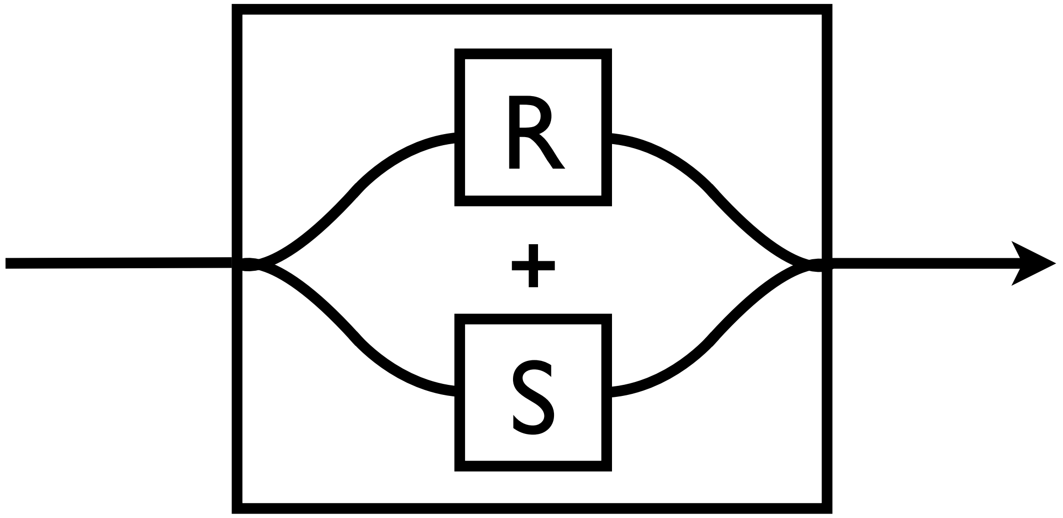
Message passing



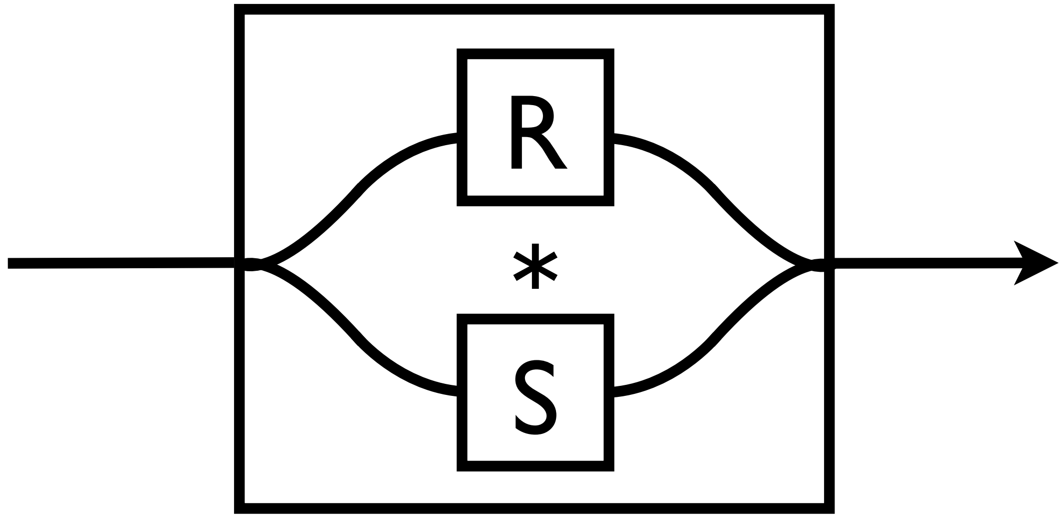
Shared state



Disjunction



Conjunction



```
class TreiberStack [A] {
  private val head = new Ref[List[A]](Nil)
  val push   = upd(head)(cons)
  val tryPop = upd(head)(trySplit)
  val pop    = upd(head)(split)
}
```

```
class TreiberStack [A] {
  private val head = new Ref[List[A]](Nil)
  val push   = upd(head)(cons)
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  val pop    = upd(head)(split)
}

class EliminationStack [A] {
  private val stack = new TreiberStack[A]
  private val (send, recv) = new Chan[A]
  val push = stack.push + swap(send)
  val pop  = stack.pop  + swap(recv)
}
```

Lessons from reagents

- Make composition is **pay-as-you-go**, *e.g.*, *k*CAS only when you use it
- Fully embrace underlying paradigms, even if it requires **escape hatches**
- Restrained ambitions: some compositions are **illegal** (*i.e.*, *ceci n'est pas une STM*)

But there’s more to learn

Isolation
Shared state

Interaction
Message passing

(A very small part of) The design space

Join calculus

CML

STM

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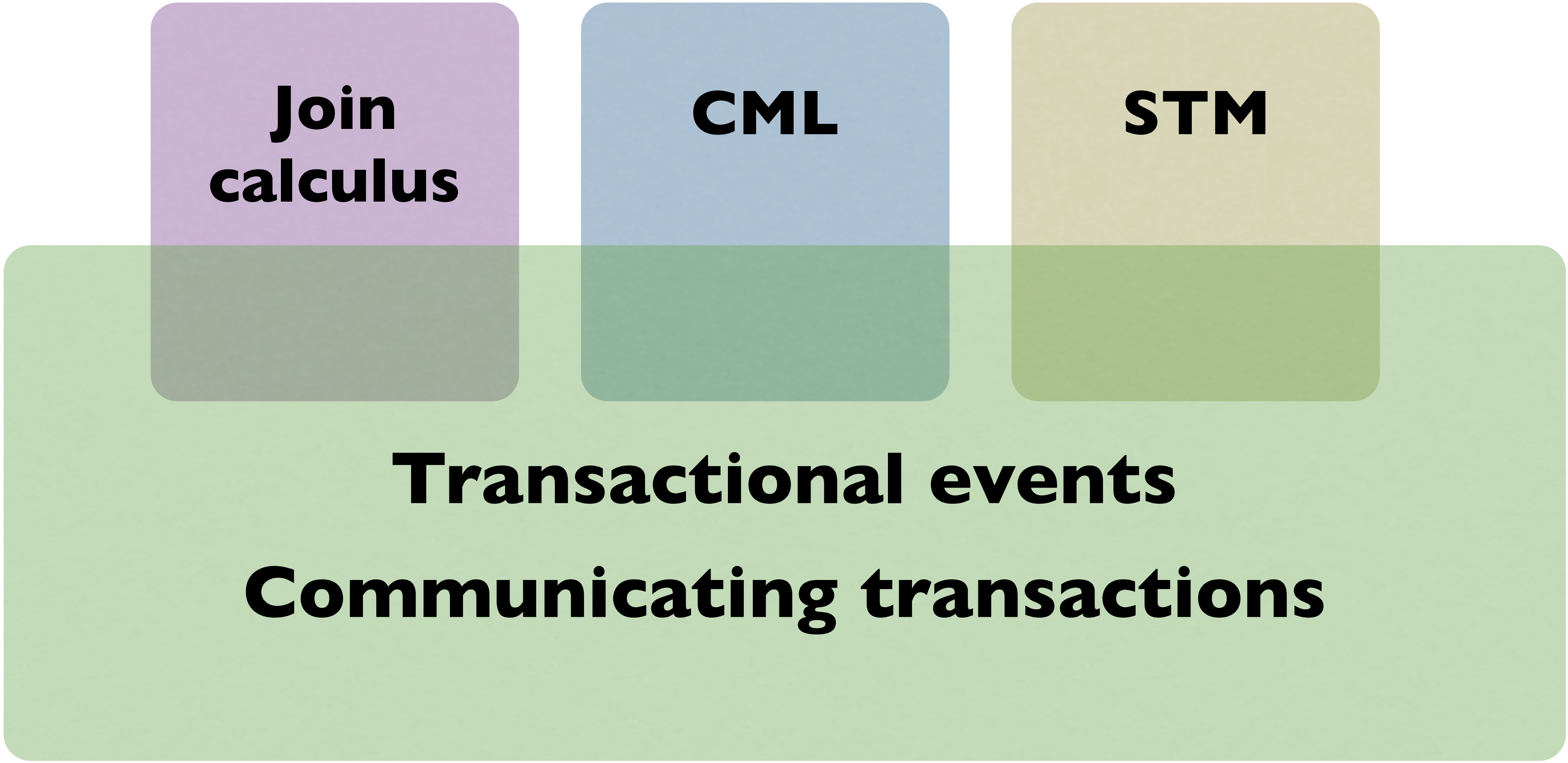
The design space



Join calculus

CML

STM

Transactional events

Communicating transactions