

**Inf2C-SEPP:
Lecture 10:
Software component
interactions.
Sequence diagrams**

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Previous lectures

- Design
 - Architectural design
 - Detailed design
 - Class diagrams
 - Notation
 - An approach for identifying objects and classes

This lecture

- Dynamic aspects of design
- Thinking about inter-object behaviour
- Sequence diagrams
- What is a good interaction pattern?

Dynamic aspects of design

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 2. Intra-object behaviour: what state changes does each object undergo as it receives messages, and how do they affect its behaviour?

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In this course, we only consider 1.

For 2, UML provides state diagrams, enhanced FSMs

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Interaction diagrams

- Describe the dynamic interactions between objects in the system, i.e. the pattern of message-passing (see next slide).
- Good for showing how the system realises (part of) a use case
- Particularly useful where the flow of control is complicated, since this can't be deduced from the class model, which is static.
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OO message-passing terminology

```
class A {  
    f() {  
        B b = ... ;  
        ...  
        b.g();  
        ...  
    }  
}
```

```
class B {  
    g(){  
    }  
}
```

Let *a* be some object of type *A*.

- Object *a* sends a (call) message *g* to object *b*
 - An invocation *a.f()* makes a call *b.g()*
- Object *b* sends a reply message to object *a*
- An invocation *b.g()* finishes and control flow returns to *a.f()*

Developing a sequence diagram

1. Decide exactly what behaviour to model.
2. Check that you know how the system provides the behaviour: are all the necessary classes and relationships in the class model?
3. Name the objects which are involved.
4. Identify the sequence of messages which the objects send to one another.
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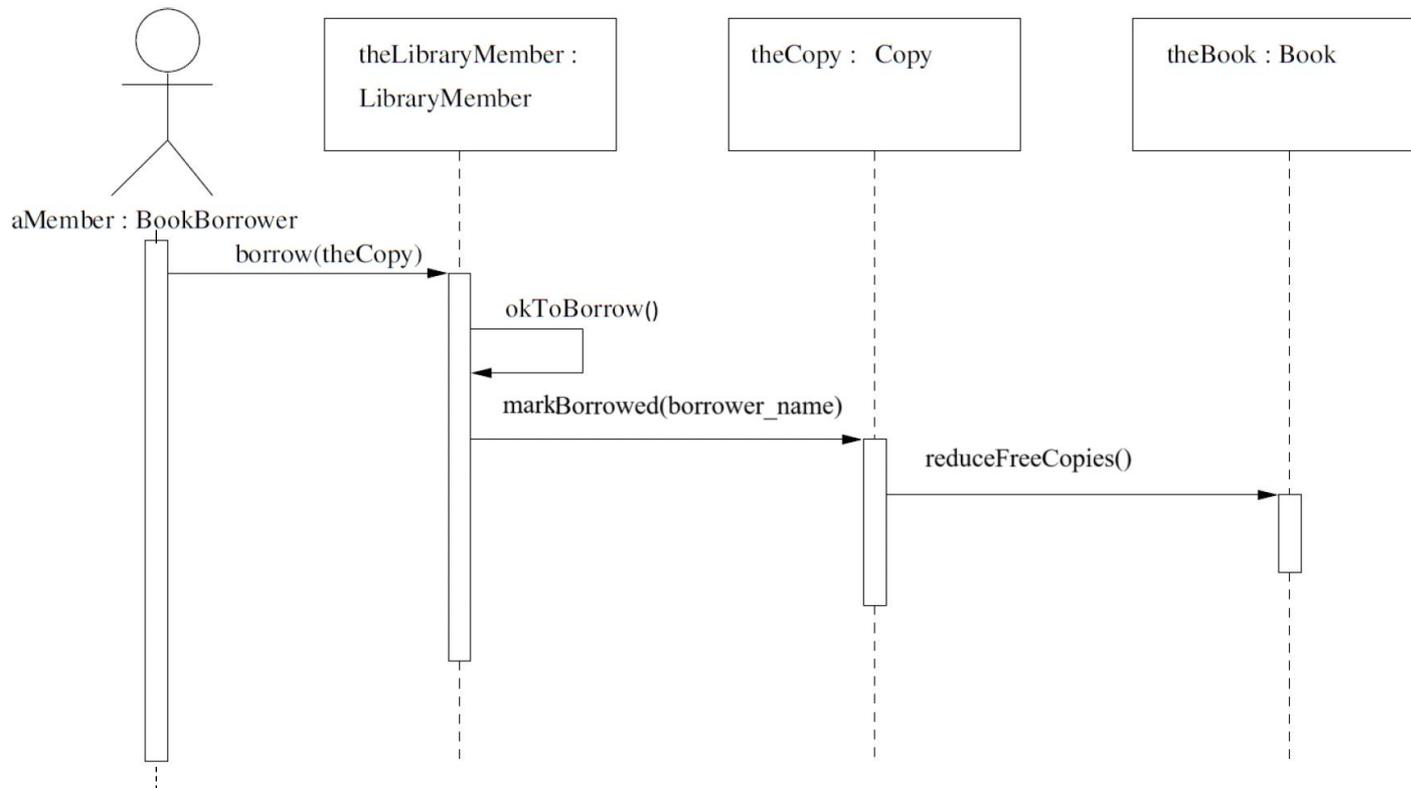
Example: A use case for a library system

Title: Borrow book

Primary Actor: BookBorrower

Description of main success scenario (MSS): A book borrower presents a copy of a book to the system. Assuming the borrower has not already checked out the maximum number of books, the system permits the loan, recording who the book is checked out to, and noting that the number of free copies of the book is reduced.

Sequence diagram for the use case MSS: high level view

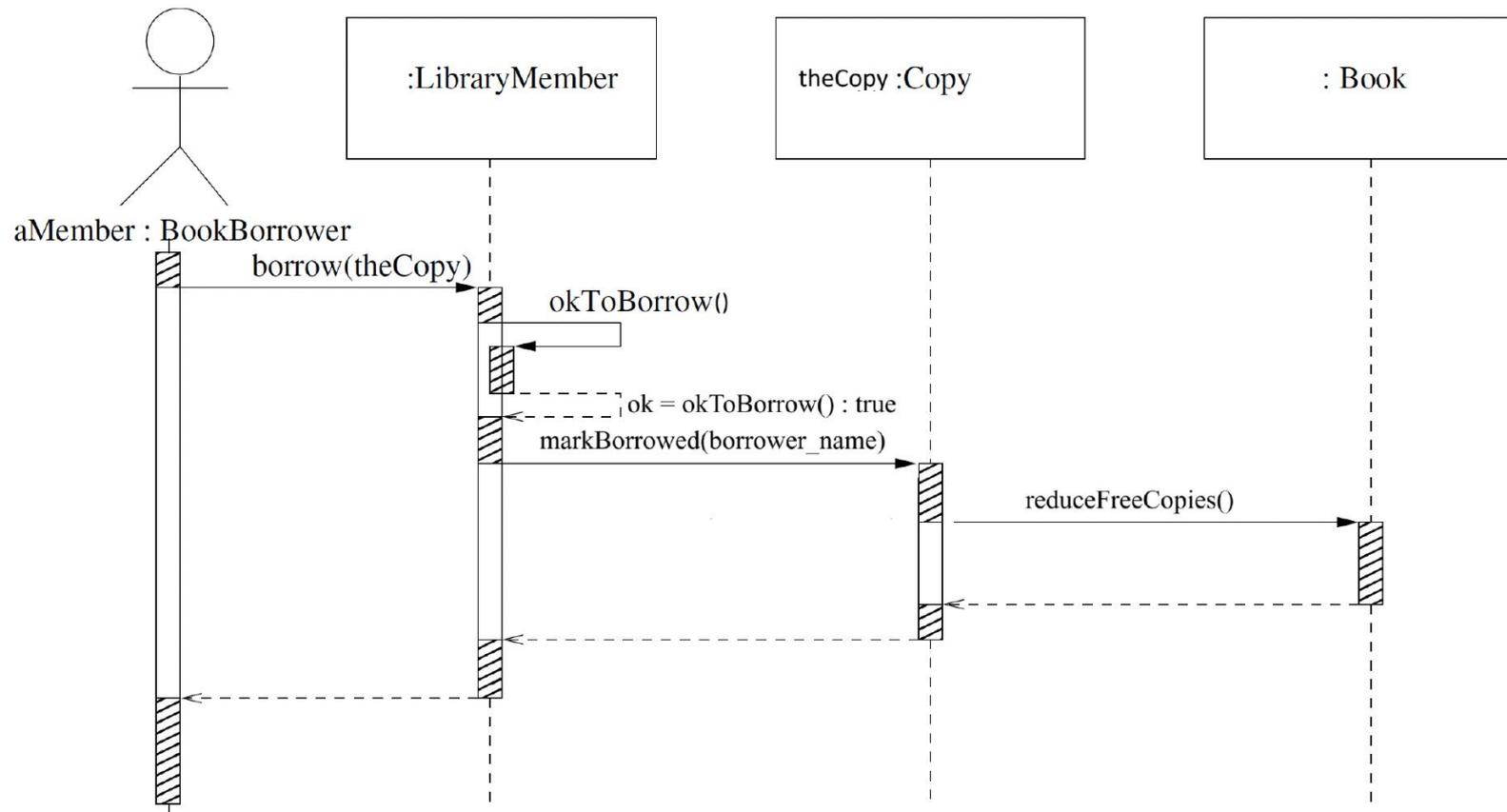


Sequence diagram for the use case MSS: high level view

Notation:

- Instance of actor (not actor!) as stick figure with name: rolename
- Objects (not classes!) as name: classname in rectangles
- Timelines as dashed lines from actor instance/object facing downwards, indicating actor instance/ object being alive
- Activation bars as rectangles on top of timelines showing when actor instances/ objects are active (while performing operation)
- Message calls as arrows with filled head and labelled as operationname(parameters) going from the caller (of the message/ operation) to the receiver (of the message/ handler of operation).

Sequence diagram for the use case MSS: Showing more detail



Adapted from: Stevens, P. and Pooley, R.J., 2006. Using UML: software engineering with objects and components. Pearson Education.

Sequence diagram for the use case MSS: Showing more detail

- **New notation:**
- Actor instances/ objects with any name if name left out (:rolename or :classname)
- Shading on activation bars to show when object is computing
- Return messages as dashed arrows with v-shaped arrowheads and including what is returned or nothing if return is void.

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 - conditional behaviour
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 - including one diagram in another
 - concurrent behaviour

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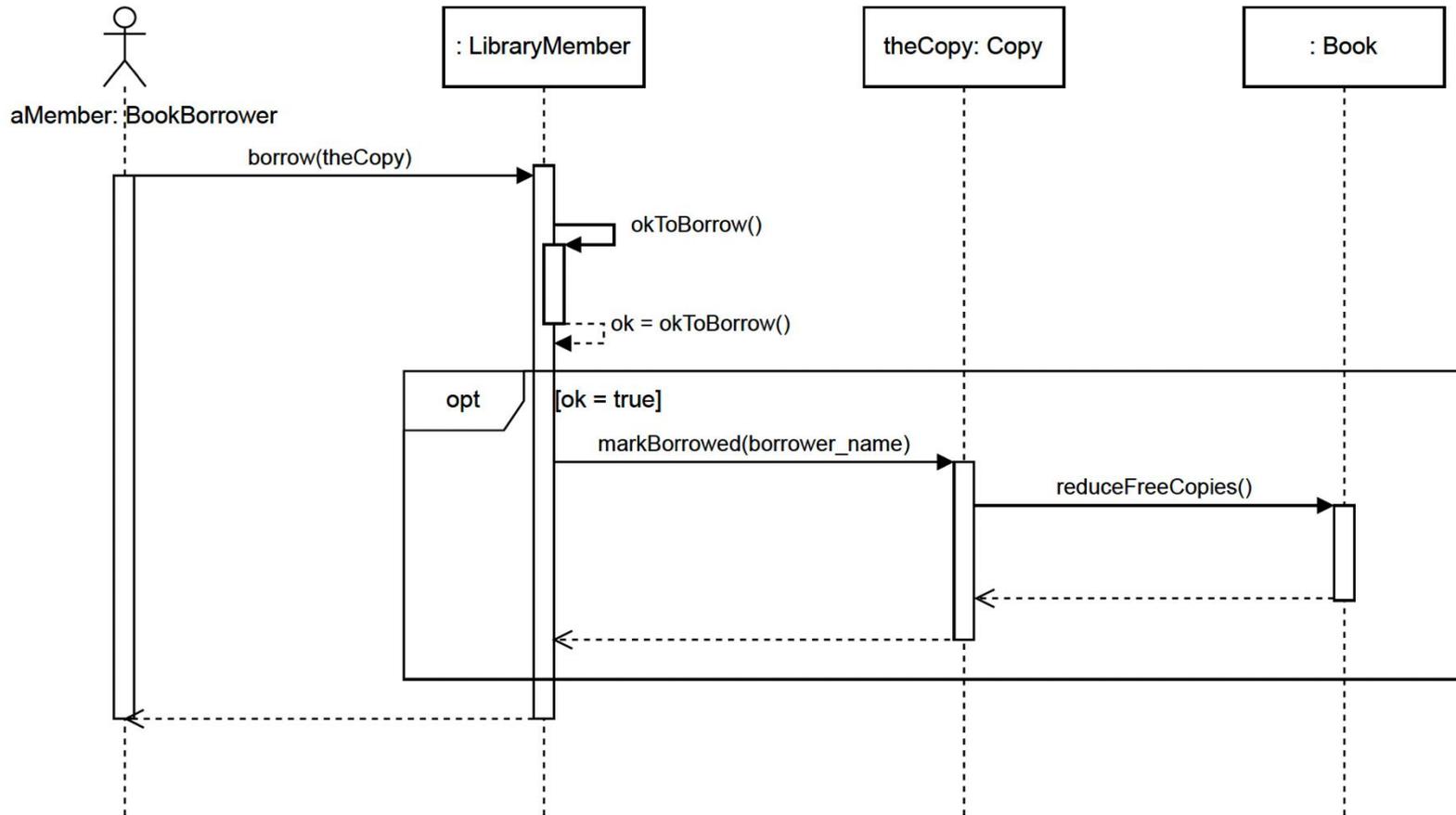
They are both based on the idea of sequence frames around involved object timelines.

Conditional behaviour in sequence diagrams

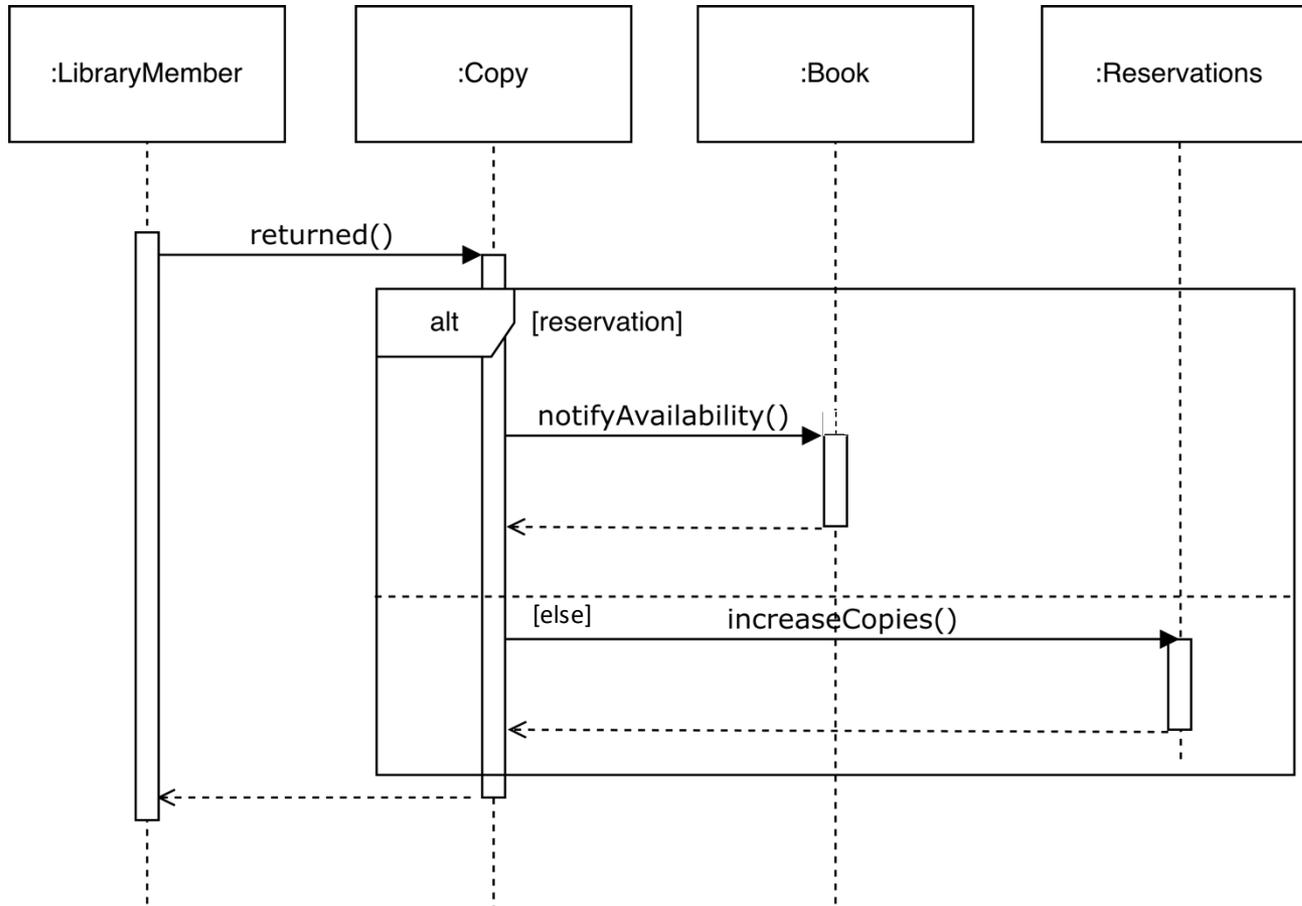
Split into two expressive notations:

- **Optional behaviour** (used to represent if statements), using an 'opt' frame and a guard condition
- **Alternative behaviour** (used to represent if/then/else statements), similar but using an 'alt' frame with different compartments for the different conditions

Optional behaviour in sequence diagrams



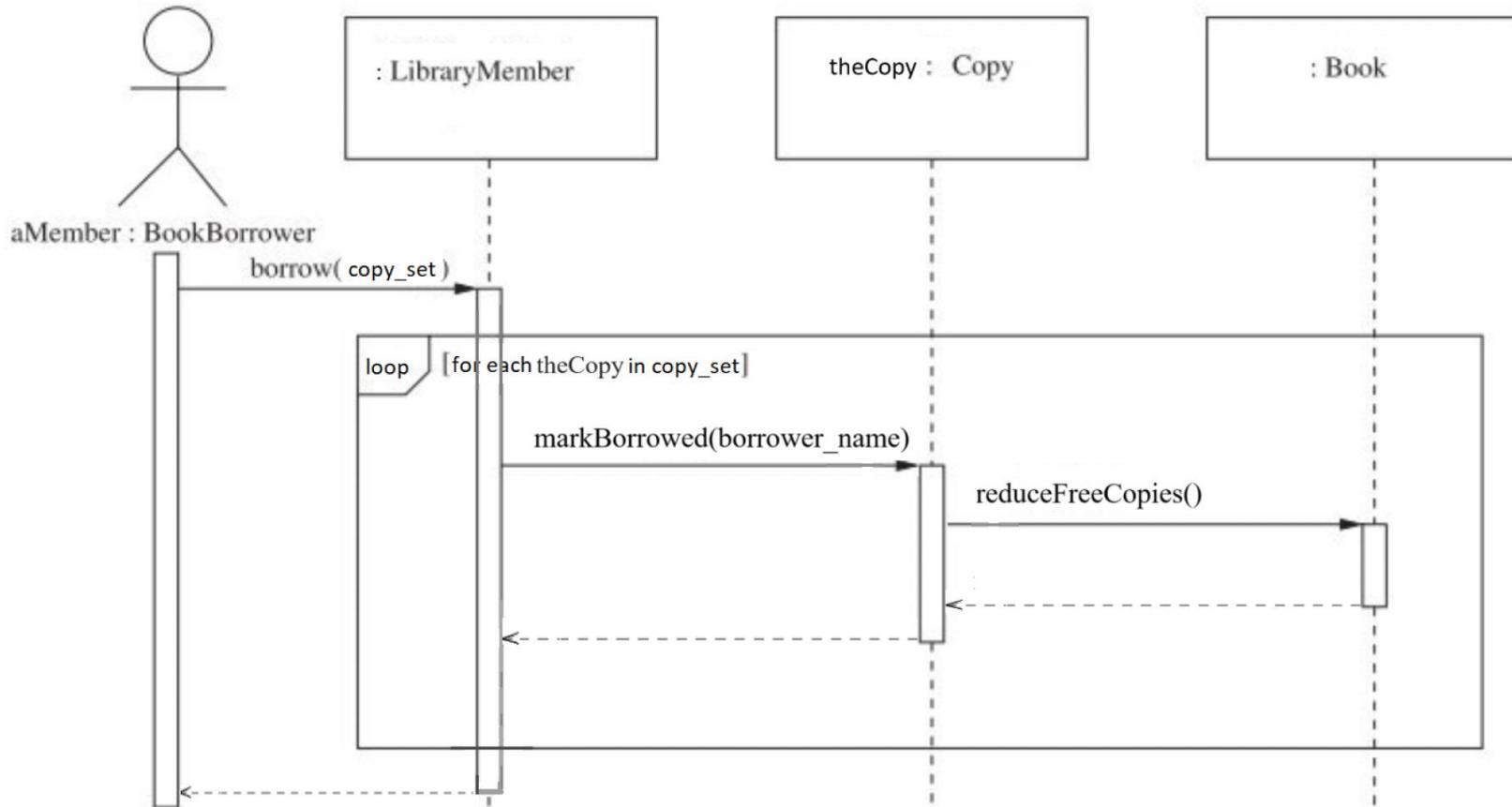
Alternative behaviour in sequence diagrams



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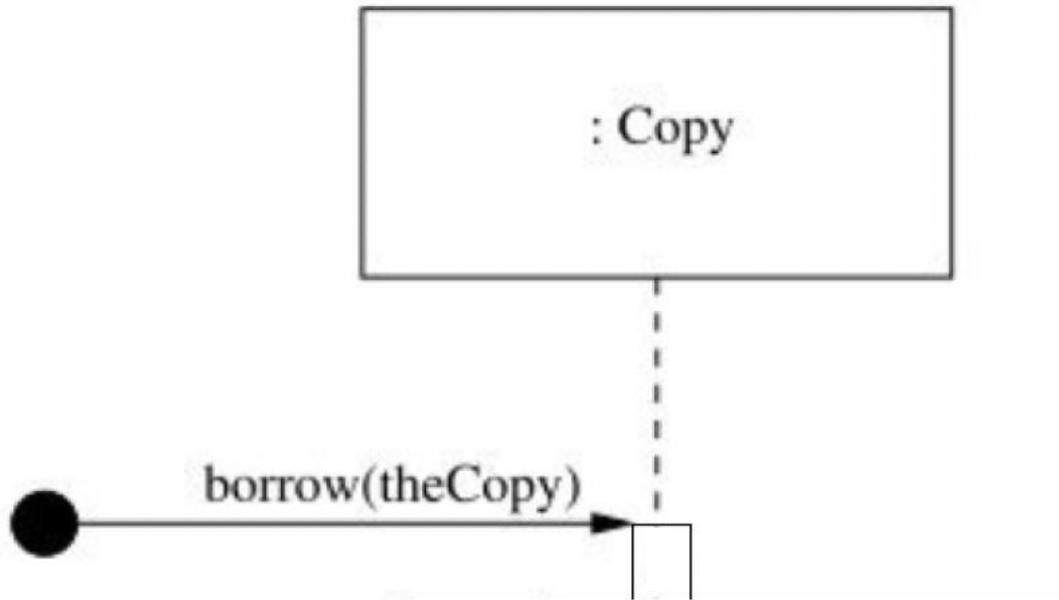
Iterative behaviour in sequence diagrams

Used to represent for/while/do-while statements, using a 'loop' frame and a loop condition

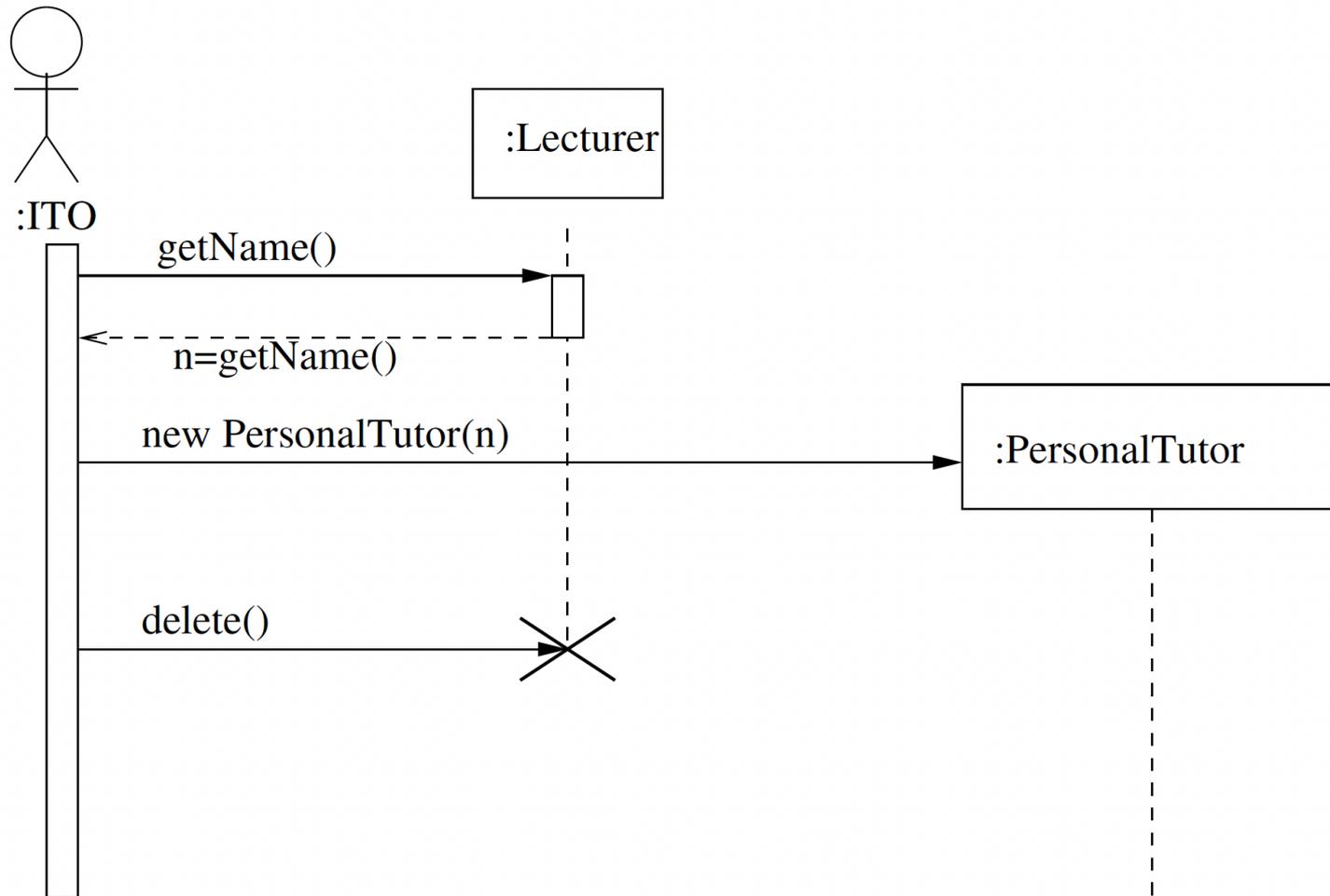


Found messages in sequence diagrams

Notation for a message when who initiates it is not made explicit (i.e. it is not specified as an actor instance or object).



Creation/deletion in sequence diagrams



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 - maintainability: which aspects might change, and how hard will it be to change the interaction accordingly?

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 - maintainability: which aspects might change, and how hard will it be to change the interaction accordingly?
 - performance: is all the work being done necessary?

Reading

- **Essential: Stevens**

- Ch 9: Essentials of sequence diagrams
- Ch 10: section 10.1, for conditional and iterative behaviour

- **Suggested: At least one of**

- The original paper on CRC cards, a technique for designing interactions: *A laboratory for teaching object oriented thinking*, by Kent Beck and Ward Cunningham.
- Stevens Chapter 5 section 5.6 on CRC cards