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What Is Object-Orientation?

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SPECIFYING OPERATIONS

In This Lecture You Will Learn:

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- Why operations need to be specified
- What is meant by “Contracts”
- Non-algorithmic ways of describing operations:
  - Decision Tables
  - Pre- and Post-Condition Pairs
- Algorithmic ways of describing operations:
  - Structured English and Pseudocode
  - Activity Diagrams
  - Object Constraint Language

Why We Specify Operations

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- From analysis perspective:
  - Ensure users' needs are understood
- From design perspective:
  - Guide programmer to an appropriate implementation (i.e. method)
- From test perspective:
  - Verify that the method does what was originally intended

Operations and Their Effects

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- Operations with side-effects may:
  - Create or destroy object instances
  - Set attribute values
  - Form or break links with other objects
  - Carry out calculations
  - Send messages or events to other objects
  - Any combination of these
- Some operations have no side-effects:
  - They return data but do not change anything

Services Among Objects

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- When objects collaborate, one object typically provides a service to another

- Examples:
  - A Client object might ask a Campaign object for its details
  - The same Client object might then ask a boundary object to display its related Campaign details to the user

Contracts: an Approach to Defining Services

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- A service can be defined as a contract between the participating objects
- Contracts focus on inputs and outputs
- The intervening process is seen as a black box, with irrelevant details hidden
- This emphasises service delivery, and ignores implementation

Contract-Style Operation Specification

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- Intent / purpose of the operation
- Operation signature, including return type
- Description of the logic
- Other operations called
- Events transmitted to other objects
- Any attributes set
- Response to exceptions (e.g. an invalid parameter)
- Non-functional requirements

(adapted from Larman, 1998 and Allen and Frost, 1998)

Types of Logic Specification

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- Logic description is probably the most important element
- Two main categories:
  - ***Non-algorithmic*** methods focus on ***what*** the operation should achieve — black box approach
  - ***Algorithmic*** types focus on ***how*** the operation should work — white box approach

Non-Algorithmic Techniques

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- Use when correct result matters more than the method used to reach it
- Or no decision made yet about best method
  - Decision tree: complex decisions, multiple criteria and steps (not described further here)
  - Decision table: similar applications to decision tree
  - Pre- and Post-Condition Pairs: suitable where precise logic is unimportant / uncertain

Decision Table

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- Many variants of this
- All work by identifying:
  - Combinations of initial conditions = ‘rules’
  - Outcomes that should result depending on what conditions are true = ‘actions’
- Rules and actions are displayed in tabular form

Example Decision Tree

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Conditions to be tested

Conditions and actions	Rule 1	Rule 2	Rule 3
Conditions			
Is budget likely to be overspent?	N	Y	Y
Is overspend likely to exceed 2%?	-	N	Y
Actions			
No action	X		
Send letter		X	X
Set up meeting			X

Possible actions

Pre- / Post- Condition Pair

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- Logically similar to decision table
- Identifies conditions that:
  - must be true for operation to execute = pre-conditions
  - must be true *after* operation has executed = post-conditions
- May be written in formal language (e.g. OCL)

Pre- / Post- Condition Pair: Change staff grade

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pre-conditions:

creativeStaffObject is valid

gradeObject is valid

gradeChangeDate is a valid date

post-conditions:

a new staffGradeObject exists

new staffGradeObject linked to creativeStaffObject

new staffGradeObject linked to previous

value of previous staffGradeObject.gradeFinishDate set equal to gradeChangeDate

Algorithmic Techniques

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- Suitable where a decision can be made about the best method to use
- Can be constructed top-down to handle arbitrarily complex functionality
- Examples:
  - Structured English
  - Activity Diagrams

Structured English

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- Commonly used, easy to learn
- Three types of control structure, derived from structured programming:
  - Sequences of instructions
  - Selection of alternative instructions (or groups of instruction)
  - Iteration (repetition) of instructions (or groups)

Sequence in Structured English

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- Each instruction is executed in turn, one after another:

get client contact name

sale cost = item cost * (1 - discount rate)

calculate total bonus

description = new description

Selection in Structured English

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- One or other alternative course is followed, depending on result of a test:

```
if client contact is 'Sushila'
    set discount rate to 5%
else
    set discount rate to 2%
end if
```

Iteration in Structured English

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- Instruction or block of instructions is repeated
  - Can be a set number of repeats
  - Or until some test is satisfied:

do while there are more staff in the list
calculate staff bonus
store bonus amount
end do

Activity Diagrams

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- Part of UML notation set
- Can be used for operation logic specification, among many other uses
- Easy to learn and understand
- Has the immediacy of graphic notation
- Some resemblance to old-fashioned flowchart technique

Example Activity Diagram: Check campaign budget

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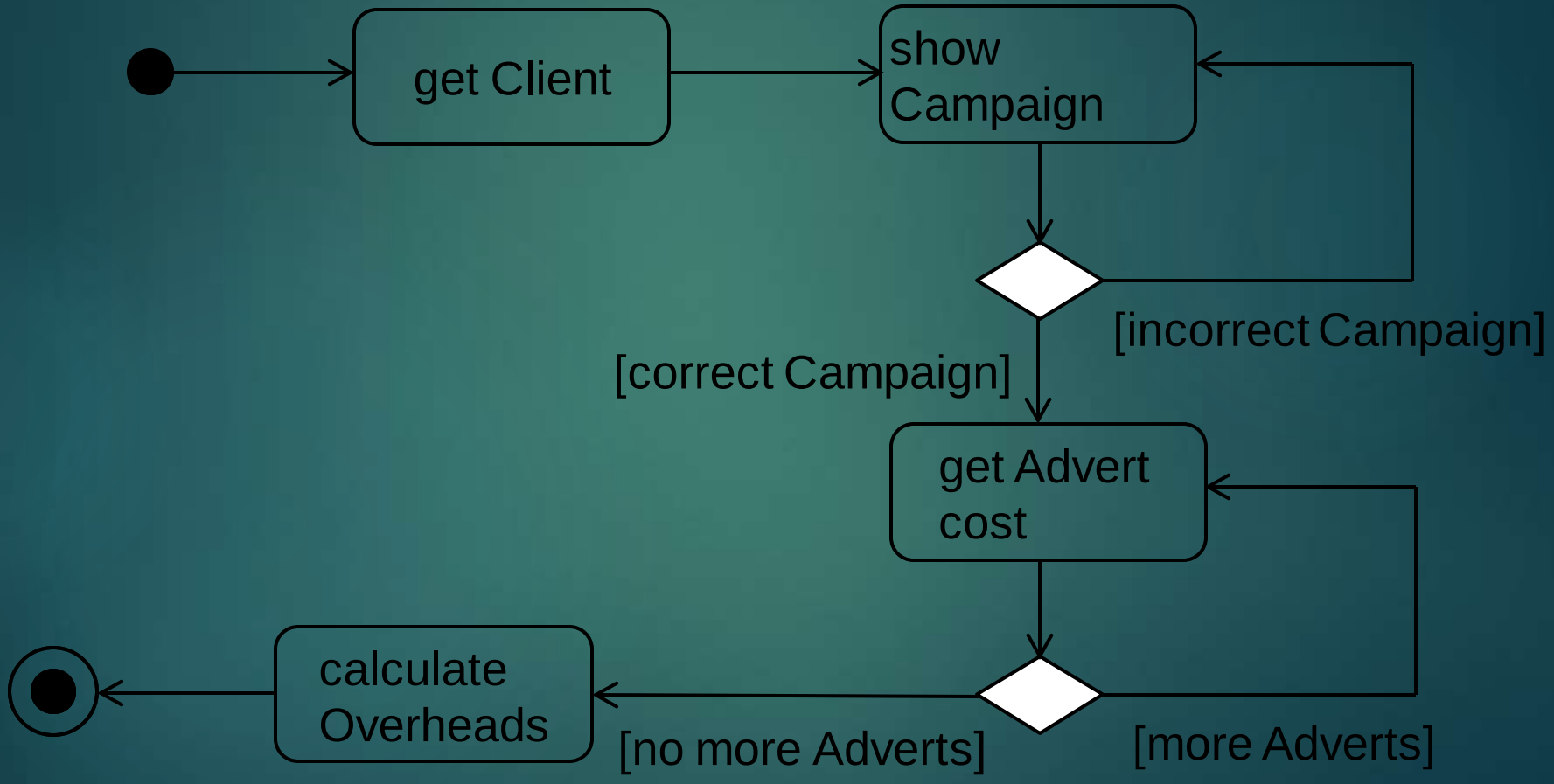

Object Constraint Language

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- A formal language used for:
  - Precise definition of constraints on model elements
  - E.g. pre- and post- conditions of operations
- OCL statements can:
  - Define queries
  - Reference values
  - State business rules

Object Constraint Language

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- Most OCL statements consist of:

Context, Property and Operation

- *Context*
  - Defines domain within which expression is valid
  - Instance of a type e.g. object in class diagram
  - Link (association instance) may be a context
- A *property* of that instance
  - Often an attribute, association-end or query operation

Object Constraint Language

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- OCL *operation* is applied to the property
- Operations include
  - Arithmetical operators *, +, - and /
  - Set operators such as size, isEmpty and select
  - Type operators such as oclIsTypeOf

OCL expression	Interpretation
context Person self.gender	In the context of a specific person, the value of the property 'gender' of that person—i.e. a person's gender.
context Person **inv:** self.savings >= 500	The property 'savings' of the person under consideration must be greater than or equal to 500.
context Person self.husband->notEmpty **implies** self.husband.gender = male	If the set 'husband' associated with a person is not empty, then the value of the property 'gender' of the husband must be male. Boldface denotes OCL keyword, but has no semantic import.
context Company **inv:** self.CEO->size <= 1	The size of the set of the property 'CEO' of a company must be less than or equal to 1. That is, a company cannot have more than 1 Chief Executive Officer.
context Company self.employee->select (age < 60)	The set of employees of a company whose age is less than 60.

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OCL Used for Pre- / Post-Conditions

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context: CreativeStaff::changeGrade(grade:Grade, gradeChangeDate:Date)

pre:

grade oclIsTypeOf(Grade)

gradeChangeDate >= today

post:

self.staffGrade[grade]->exists **and**

self.staffGrade[previous]->notEmpty **and**

self.staffGrade.gradeStartDate = gradeChangeDate **and**

self.staffGrade.previous.gradeFinishDate = gradeChangeDate

References

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- Bennett, McRobb and Farmer (2002)
- Yourdon (1989) covers Structured English and Pre- / Post-Conditions well
- Senn (1989) is good on Decision Tables
- Larman (1998) takes a contract-based approach to O-O analysis and design, with examples taken to Java code

(For full bibliographic details, see Bennett, McRobb and Farmer)

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