Information Systems Concepts

Specifying Operations

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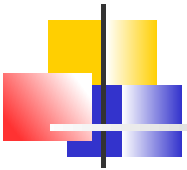
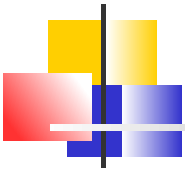
Based on Chapter 10 of Bennett, McRobb and Farmer:

Object Oriented Systems Analysis and Design Using UML, (4th Edition), McGraw Hill, 2010



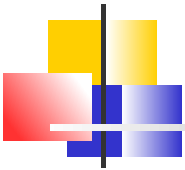
Outline

- Specifying Operations
  - Section 10.4 pp. 295–304



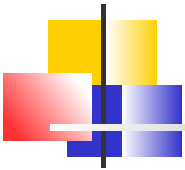
Why we specify operations

- 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



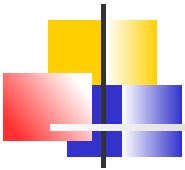
Types of operations and their effects

- Operations without side-effects are pure queries that
  - request data but do not change anything
  - carry out calculations
- Operations with **side-effects** may
  - create or destroy object instances
  - set attribute values
  - form or break links with other objects
  - send messages or events to other objects
  - any combination of these



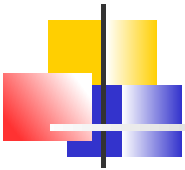
Services among objects

- When objects collaborate,
  one object typically provides a **service** to another
  for example,
  - A `Client` object might ask
    a `Campaign` object for its details
  - The same `Client` object might then ask
    a boundary object to display
    the related campaign details to the user



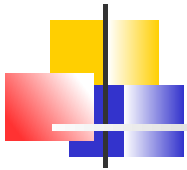
Contracts: an approach to defining services

- A service can be defined as a contract between the participating objects
- Contracts focus on inputs and outputs
- Intervening process is seen as a black box
- Irrelevant details are hidden
- This emphasizes service delivery, and ignores implementation



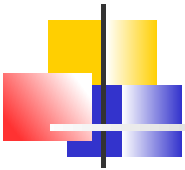
Contract-style operation specification

- intent or 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



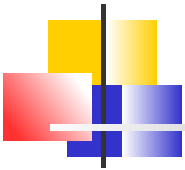
Types of logic specification

- Logic description is probably
  the most important element
- Two main categories:
  - *algorithmic* specifications are white box —
    they focus on *how* the operation might work
  - *non-algorithmic* specifications are black box —
    they focus on *what* the operation should achieve



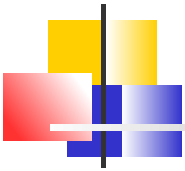
Non-algorithmic techniques

- appropriate where correct **result** matters more than method to arrive at it
- decision trees:
  complex decisions, multiple criteria and steps
  (not described further here)
- decision tables:
  similar applications to decision tree
- pre- and post-condition pairs:
  suitable where precise logic is unimportant or uncertain



Decision tables: example

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



Pre- and post-condition pairs

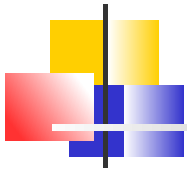
`CreativeStaff.changeGrade(gradeObj, gradeChangeDate)`

pre-conditions:

- `creativeStaff` object is valid
- `gradeObj` is valid
- `gradeChangeDate` is a valid date
- `gradeChangeDate` is greater than or equal to today's date

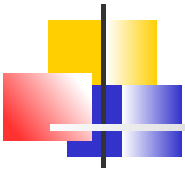
post-conditions:

- a new `staffGradeObj` exists
- new `staffGradeObj` is linked to the `creativeStaff` object
- new `staffGradeObj` is linked to the previous one
- value of previous `staffGradeObject.gradeFinishDate` set equal to `gradeChangeDate – 1 day`



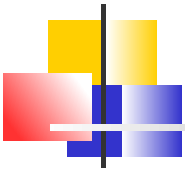
Algorithmic techniques

- suitable where users understand the **procedure** for arriving at a result
- can be constructed top-down, to handle arbitrarily complex functionality
- examples:
  - Structured English
  - Activity Diagrams



Algorithmic techniques: Structured English

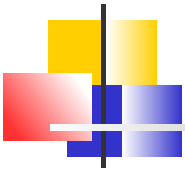
- commonly used, easy to learn
- three types of control structure, derived from structured programming:
  - sequences of instructions
  - selection of alternative instructions (or groups of instructions)
  - iteration (repetition) of instructions (or groups of instructions)



Sequence in Structured English

each instruction executed in turn, one after another

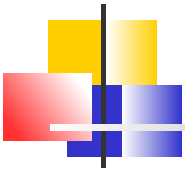
```
get client contact name
sale cost = item cost * ( 1 - discount rate )
calculate total bonus
description = new description
```



Selection in Structured English

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
```

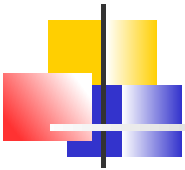


Iteration in Structured English

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

repeat
    allocate member of staff to campaign
    increment count of allocated staff
until count of allocated staff = 10
```



Algorithmic techniques: Activity Diagrams

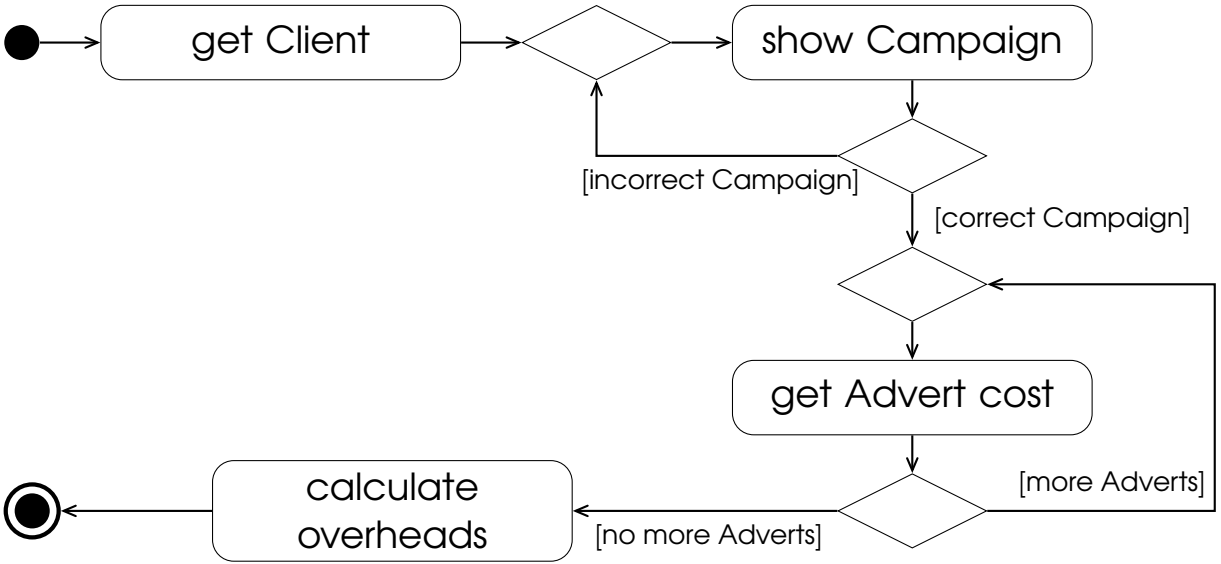
- are part of UML notation set
- can be used for operation logic specification,

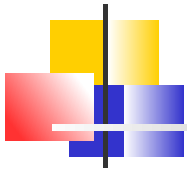
  among many other uses
- are easy to learn and understand
- have the immediacy of graphical notation
- bear some resemblance to

  old-fashioned flowchart technique

Activity Diagram: example

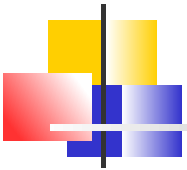
Use Case: `check campaign budget`





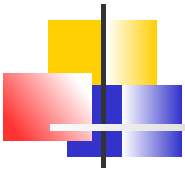
Object Constraint Language

- 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



OCL operations

- Operation is applied to the property
  - arithmetical operators `*`, `+`, – and `/`
  - set operators such as `size`, `isEmpty` and `select`
  - type operators such as `oclIsTypeOf`



OCL expressions: examples

- **context** `Person`
  `self.gender`

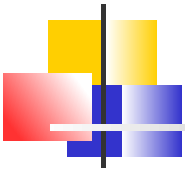
  In the context of a specific person, the value of the property 'gender' of that person.

- **context** `Person`
  inv: `self.savings >= 500`

  The property 'savings' of the person under consideration must be greater than or equal to 500.

- **context** `Person`
  inv: `self.husband->notEmpty()` **implies**
  `self.husband.gender = 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.



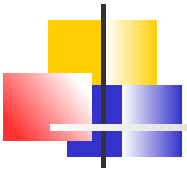
OCL expressions: examples (cont.)

- **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.

- **context** `Company`
  inv: `self.employee->select(age < 60)->notEmpty()`

  The set of employees of a company whose age is less than 60 is never empty.



Pre- and post-conditions in OCL

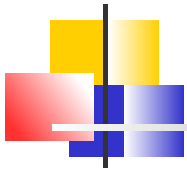
context `CreativeStaff::changeGrade`
`(grade:Grade, gradeChangeDate:Date)`

pre:

```
grade oclIsTypeOf(Grade)
gradeChangeDate >= today
```

post:

```
self.staffGrade->exists() and
self.staffGrade[previous]->notEmpty() and
self.staffGrade.gradeStartDate = gradeChangeDate and
self.staffGrade.previous.gradeFinishDate =
                                    gradeChangeDate - 1 day
```



Take Home Messages

- The role of operation specifications
- What is meant by 'Contracts'
- Algorithmic and non-algorithmic techniques, and how they differ
- How to use:
  - Decision Tables,
  - Pre- and Post-condition pairs,
  - Structured English,
  - Activity Diagrams and
  - Object Constraint Language