Symmetric Aspect-Orientation: Some Practical Consequences

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Introduction

- Symmetric aspect-oriented approaches promote aspect-oriented decomposition starting at the earliest phases of software development
- But academic symmetric aspect-oriented approaches seem to be too complicated for an average developer
- Can that be simplified to become widely accepted yet pertain essential features?
- What out of that do we already have in industry?

Overview

1. Symmetry of Aspect-Oriented Approaches
2. Peer Use Cases
3. Feature Modeling
4. Aspect-Oriented Implementation in Established Programming Languages
5. Summary: Modularity Challenges and Innovations

Asymmetric and Symmetric AOP

- Asymmetric AOP: *aspects* (on one side) as something that affects the *base code* (on the other side)
  - Aspects are said to be woven into the base code
  - AspectJ and like—PARC[1] AOP
  - Mainstream approach in AOP
- Symmetric AOP: aspects as partial *views* of classes
  - Functional classes are constructed by the compositions of selected *views*, i.e. aspects
  - Hyper/J—IBM Watson Research Center
  - No industry-strength languages

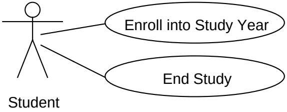
[1] Palo Alto Research Center

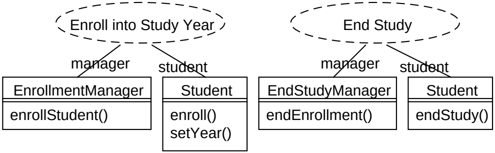
A More Comprehensive View of Symmetry

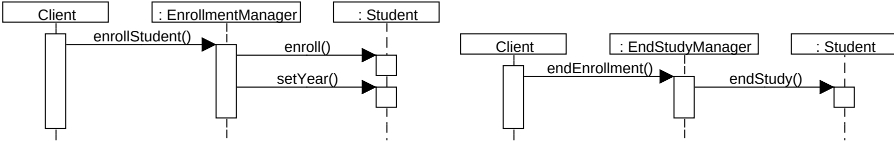
- Here, symmetry is perceived mostly as element symmetry
- A more comprehensive view of symmetry includes *join point symmetry* and *relationship symmetry*[2]

[2] W. Harrison, H. Ossher, P. Tarr. Asymmetrically vs. symmetrically organized paradigms for software composition. Research Report RC22685, IBM Watson Research Center, 2002.

Peer Use Cases—Inherently Symmetrical

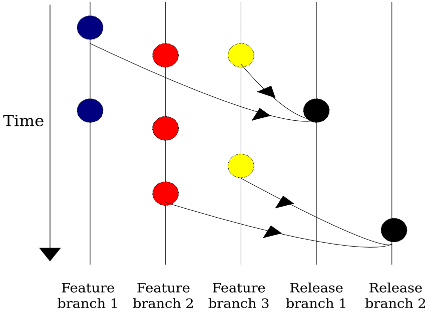






Feature Modeling

- Features are close to requirements
- Features are often given to developers as separate tasks
- If proper commit messages are used, the features can be tracked in version system
- Only temporary feature branches available



Rediscovering Symmetric AOP

- Developers apply symmetric aspect-oriented decomposition without actually being aware of it
- They are often forced to abandon this initial decomposition
- But some programming languages used in industry are close to symmetric aspect-orientation

Traits (1)

- A trait is a unit that groups (related) methods unable to stand as full-fledged class
- Multiple traits can be composed with a single class
- An example in Scala:

```
class Student() { }

trait BasicStudent extends Student{
    var _name = ""
    var _surname = ""
    def setName(str:String) = { _name = str }
    def setSurname(str:String) = { _surname = str }
    def getName = _name
    def getSurname = _surname
}
```

Traits (2)

```
trait PartTimeStudent extends Student {
    var tuitionFee = 0
    def payTuitionFee(amount:Int) =
      { tuitionFee = amount + tuitionFee }
    def tuitionFee = tuitionFee
}

object App {
    def main(args : Array[String]) {
        var student = new Student() with PartTimeStudent
            with BasicStudent
        ...
    }
}
```

Open Classes

- Ruby's open classes enable to define parts of the same class at multiple places
- The concerns can be stored in different files
- The composition is made by importing the source files
- An example in Ruby:

`Student.rb`:

```
class Student
  def initialize(name, surname)
    @name = name
    @surname = surname
  end
  def name; @name; end
  def surname; @surname; end
end
```

Open Classes (2)

`PartTimeStudent.rb`:

```
class Student
    def payTuitionFee(val)
        if @tuitionFee == nil
            @tuitionFee = val
        else
            @tuitionFee = @tuitionFee + val
        end
    end
    def tuitionFee @tuitionFee end
end
```

The composition—`App.rb`:

```
require "./Student.rb"
require "./PartTimeStudent.rb"
...
```

Prototype-Based Programming (1)

- Prototype-based programming is an object-oriented programming without classes
- Prototype objects can be cloned and dynamically extended with new methods
- The methods can be added in „batches“ with each one representing another concern
- An example in JavaScript:

```
var student = {
    "_name": "",
    "_surname":"",
    setName":function(name) { this._name = name },
    "getName":function() { return this._name },
    "setSurname":function(surname) { this._surname = surname },
    "getSurname":function() { return this._surname }
};
```

Prototype-Based Programming (2)

- The partTimeStudent object is a clone of student:

```
var Factory = function(){};
Factory.prototype = student;
var partTimeStudent = new Factory();
```

- Methods and attributes necessary for the role of a part-time student are added to it:

```
partTimeStudent['_tuitionFee'] = 0;
partTimeStudent['payTuitionFee'] =
    function(val) { this._tuitionFee = this._tuitionFee + val };
partTimeStudent['getTuitionFee'] =
    function() { return this._tuitionFee };
```

Emulation in Asymmetric Approaches (1)

- Symmetric aspect-oriented programming can be emulated to some extent in asymmetric approaches
- Keep the base as thin as possible and build everything with aspects
- Inter-type declarations establish the structure, including initial method bodies
- The behavior is then implemented by advices

Emulation in Asymmetric Approaches (2)

- An example in AspectJ

```
public class Student { }

public aspect BasicStudent {
    private String Student.name = null;
    private String Student.surname = null;
    public Student.new(String name, String surname) {...}
    public String Student.getName() {...}
    public String Student.getSurname() {...}
}

public aspect PartTimeStudent {
    private double Student.tuitionFee = 0;
    public void Student.payTuitionFee(double tuitionFee) {...}
    public double Student.getTuitionFee() {...}
}
```

The Key Modularity Challenges That Remain Unaddressed

- The design gap: no design notation used in industry enables aspect-oriented modeling
- Identify further features in industry-strength languages close to symmetric AOP

What Key Innovations May Help Address the Modularity Challenges?

- Constructs of existing industry-strength programming languages in which aspect-oriented programming is possible should be improved to provide better symmetric aspect orientation
- To spread the knowledge about symmetric aspect-oriented development to the industry
- Comprehensive studies and real applications of symmetric aspect-oriented development are needed