

Ingineria Programării

Cursul 5 – 19 Martie 2019

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Cuprins

- ▶ Din Cursurile trecute...
- ▶ SOLID and Other Principles
- ▶ GRASP
 - Low coupling
 - High cohesion
- ▶ Unit Testing

RE

- ▶ De ce avem nevoie de modelare?
- ▶ Cum putem modela un proiect?
- ▶ SCRUM – roles, values, artifacts, events, rules

SOLID and Other Principles

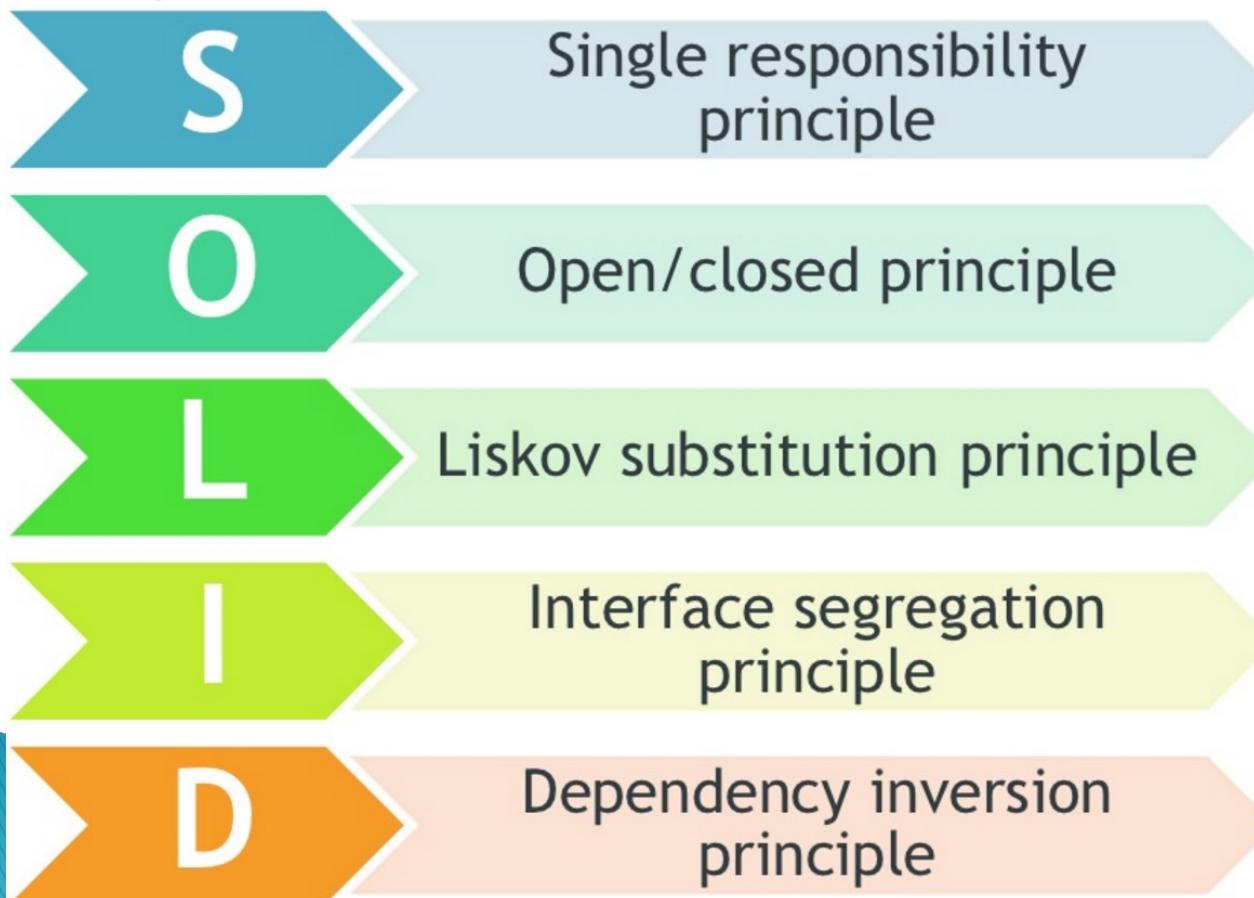
- ▶ SOLID Principles
 - SRP – Single Responsibility Principle
 - OCP – Open/Closed Principle
 - LSP – Liskov Substitution Principle
 - ISP – Interface Segregation Principle
 - DIP – Dependency Inversion Principle
- ▶ DRY – Don't Repeat Yourself
- ▶ YAGNI – You Aren't Gonna Need It
- ▶ KISS – Keep It Simple, Stupid



S.O.L.I.D.
Principles

SOLID

- ▶ SOLID was introduced by Robert C. Martin in the an article called the “Principles of Object Oriented Design” in the early 2000s



SOLID – Single Responsibility Principle

- ▶ Every object should have a single responsibility, and all its services should be narrowly aligned with that responsibility



SINGLE RESPONSIBILITY PRINCIPLE

Every object should have a single responsibility, and all its services should be narrowly aligned with that responsibility.



SOLID – SRP – Definitions

- ▶ “The Single Responsibility Principle states that every object should have a single responsibility, and that responsibility should be entirely encapsulated by the class.” – Wikipedia
- ▶ “There should never be more than one reason for a class to change.” – Robert Martin
- ▶ Low coupling & strong cohesion



SOLID – SRP – Problems & Solutions

- ▶ **Classic violations**
 - Objects that can print/draw themselves
 - Objects that can save/restore themselves
- ▶ **Classic solution**
 - Separate printer & Separate saver
- ▶ **Solution**
 - Multiple small interfaces (ISP)
 - Many small classes
 - Distinct responsibilities
- ▶ **Result**
 - Flexible design
 - Lower coupling & Higher cohesion

SOLID – SRP – Example

▶ Two responsibilities

```
interface Modem {  
    public void dial(String pno);  
    public void hangup();  
  
    public void send(char c);  
    public char recv();  
}
```

▶ Separated interfaces

```
interface DataChannel {  
    public void send(char c);  
    public char recv();  
}
```

```
interface Connection {  
    public void dial(String phn);  
    public char hangup();  
}
```

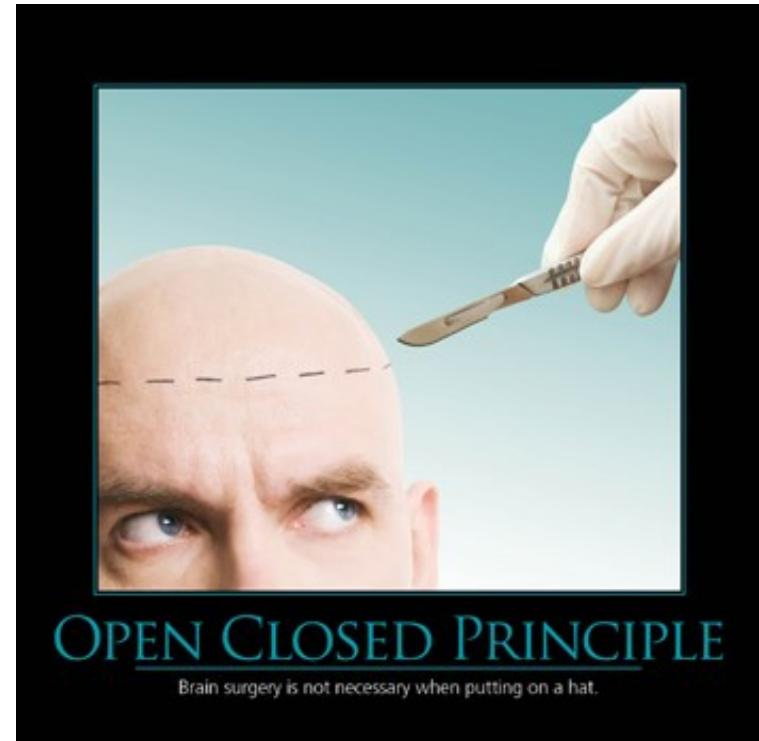
SOLID – Open/Closed Principle

- ▶ *Open chest surgery is not needed when putting on a coat*
- ▶ Bertrand Meyer originated the OCP term in his 1988 book, *Object Oriented Software Construction*



OPEN CLOSED PRINCIPLE

Open Chest Surgery Is Not Needed When Putting On A Coat



OPEN CLOSED PRINCIPLE

Brain surgery is not necessary when putting on a hat.

SOLID – OCP – Definitions

- ▶ “The Open / Closed Principle states that software entities (classes, modules, functions, etc.) should be open for extension, but closed for modification.” – Wikipedia
- ▶ “All systems change during their life cycles. This must be borne in mind when developing systems expected to last longer than the first version.” – Ivar Jacobson
- ▶ **Open to Extension** – New behavior can be added in the future
- ▶ **Closed to Modification** – Changes to source or binary code are not required

SOLID – OCP – How?

- ▶ Change behavior without changing code?!
 - Rely on abstractions, not implementations
 - Do not limit the variety of implementations
- ▶ In .NET – Interfaces, Abstract Classes
- ▶ In procedural code – Use parameters
- ▶ Approaches to achieve OCP
 - Parameters – Pass delegates / callbacks
 - Inheritance / Template Method pattern – Child types override behavior of a base class
 - Composition / Strategy pattern – Client code depends on abstraction, "Plug in" model

SOLID – OCP – Problems & Solutions

- ▶ Classic violations
 - Each change requires re-testing (possible bugs)
 - Cascading changes through modules
 - Logic depends on conditional statements
- ▶ Classic solution
 - New classes (nothing depends on them yet)
 - New classes (no legacy coupling)
- ▶ When to apply OCP?
 - Experience tell you
- ▶ OCP add complexity to design (TANSTAAFL)
- ▶ No design can be closed against all changes

SOLID - OCP - Example

```
// Open-Close Principle - Bad example
class GraphicEditor {
    public void drawShape(Shape s) {
        if (s.m_type==1)
            drawRectangle(s);
        else if (s.m_type==2)
            drawCircle(s);
    }
    public void drawCircle(Circle r)
{....}
    public void drawRectangle(Rectangle r)
{....}
}

class Shape {
    int m_type;
}

class Rectangle extends Shape {
    Rectangle() {super.m_type=1;}
}

class Circle extends Shape {
    Circle() {super.m_type=2;}
}
```

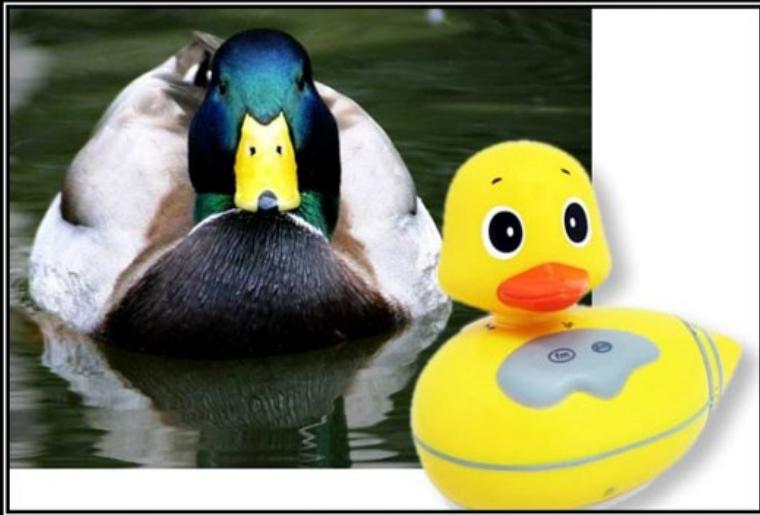
```
// Open-Close Principle - Good
example
class GraphicEditor {
    public void drawShape(Shape s) {
        s.draw();
    }
}

class Shape {
    abstract void draw();
}

class Rectangle extends Shape {
    public void draw() {
        // draw the rectangle
    }
}
```

SOLID – Liskov Substitution

- ▶ If it looks like a duck, quacks like a duck, but needs batteries – you probably have the wrong abstraction
- ▶ Barbara Liskov described the principle in 1988



LISKOV SUBSTITUTION PRINCIPLE

If It Looks Like A Duck, Quacks Like A Duck, But Needs Batteries - You Probably Have The Wrong Abstraction



**Liskov Substitution
Principle**

SOLID – LSP – Definitions

- ▶ "The Liskov Substitution Principle states that Subtypes must be substitutable for their base types." – Agile Principles, Patterns, and Practices in C#
- ▶ Substitutability – child classes must not
 - Remove base class behavior
 - Violate base class invariants
- ▶ Normal OOP inheritance
 - IS-A relationship
- ▶ Liskov Substitution inheritance
 - IS-SUBSTITUTABLE-FOR



SOLID – LSP – Problems & Solutions

- ▶ The problem
 - Polymorphism break Client code expectations
 - "Fixing" by adding if-then - nightmare (OCP)
- ▶ Classic violations
 - Type checking for different methods
 - Not implemented overridden methods
 - Virtual methods in constructor
- ▶ Solutions
 - “Tell, Don’t Ask” – Don’t ask for types and Tell the object what to do
 - Refactoring to base class– Common functionality and Introduce third class

SOLID - LSP - Example (1)

```
// Violation of Liskov's Substitution Principle
class Rectangle{
    int m_width;
    int m_height;

    public void setWidth(int width) {
        m_width = width;
    }

    public void setHeight(int h) {
        m_height = ht;
    }

    public int getWidth() {
        return m_width;
    }

    public int getHeight() {
        return m_height;
    }

    public int getArea() {
        return m_width * m_height;
    }
}
```

```
class Square extends Rectangle {
    public void setWidth(int width) {
        m_width = width;
        m_height = width;
    }

    public void setHeight(int height) {
        m_width = height;
        m_height = height;
    }
}
```

SOLID - LSP - Example (2)

```
class LspTest
{
private static Rectangle getNewRectangle()
{
    // it can be an object returned by some factory ...
    return new Square();
}

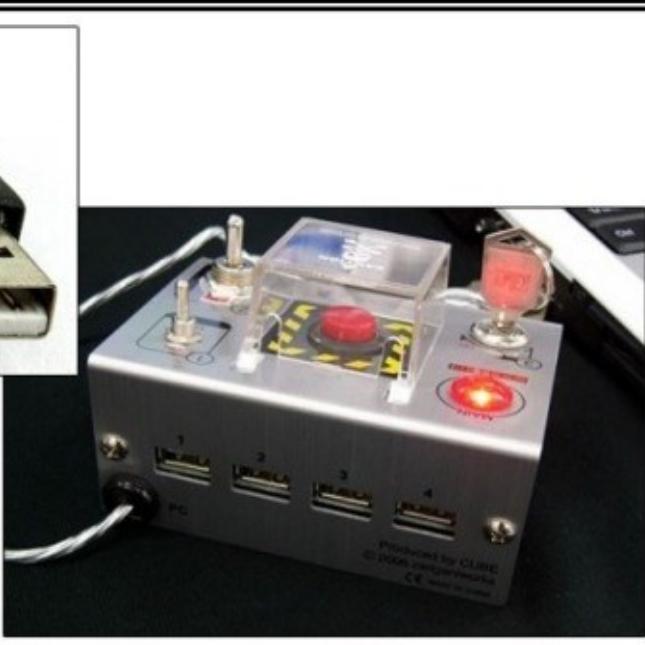
public static void main (String args[])
{
    Rectangle r = LspTest.getNewRectangle();
    r.setWidth(5);
    r.setHeight(10);

    // user knows that r it's a rectangle. It assumes that he's able to set the width
    // and height as for the base class

    System.out.println(r.getArea());
    // now he's surprised to see that the area is 100 instead of 50.
}
}
```

SOLID – Interface Segregation

- ▶ You want me to plug this in. Where?



INTERFACE SEGREGATION PRINCIPLE
You Want Me To Plug This In, Where?



Interface Segregation Principle

If IRequireFood, I want to Eat(Food food) not,
LightCandelabra() or LayoutCutlery(CutleryLayout preferredLayout)



SOLID – ISP – Definitions

- ▶ “The Interface Segregation Principle states that Clients should not be forced to depend on methods they do not use.” – Agile Principles, Patterns, and Practices in C#
- ▶ Prefer small, cohesive interfaces – Interface is the interface type + All public members of a class
- ▶ Divide “fat” interfaces into smaller ones
 - “fat” interfaces means classes with useless methods, increased coupling, reduced flexibility and maintainability



SOLID – ISP – Problems & Solutions

- ▶ Classic violations
 - Unimplemented methods (also in LSP)
 - Use of only small portion of a class
- ▶ When to fix?
 - Once there is pain! Do not fix, if is not broken!
 - If the "fat" interface is yours, separate it to smaller ones
 - If the "fat" interface is not yours, use "Adapter" pattern
- ▶ Solutions
 - Small interfaces
 - Cohesive interfaces
 - Focused interfaces
 - Let the client define interfaces
 - Package interfaces with their implementation

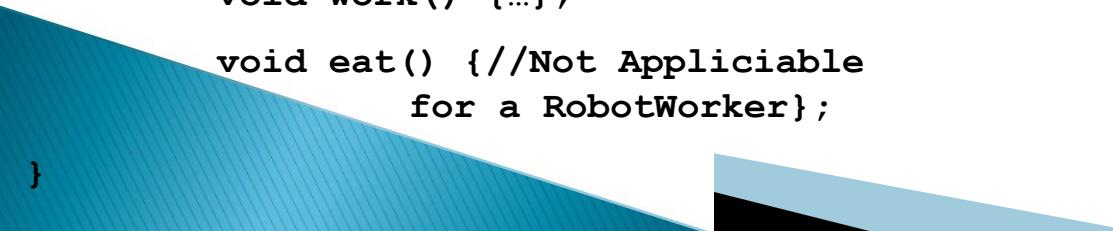
SOLID - ISP - Example

```
//Bad example (polluted interface)          //Solution: split into two interfaces

interface Worker {
    void work();
    void eat();
}

ManWorker implements Worker {
    void work() {...};
    void eat() {30 min break;};
}

RobotWorker implements Worker {
    void work() {...};
    void eat() {//Not Applicable
        for a RobotWorker};
}
```



SOLID – Dependency Inversion

- ▶ Would you solder a lamp directly to the electrical wiring in a wall?



Dependency Inversion Principle

Would you solder a lamp directly
to the electrical wiring in a wall?

Port doesn't define device

SOLID – DIP – Definitions

- ▶ “High-level modules should not depend on low-level modules. Both should depend on abstractions.”
- ▶ “Abstractions should not depend on details. Details should depend on abstractions.” – Agile Principles, Patterns, and Practices in C#

SOLID – DIP – Dependency

- ▶ Framework
- ▶ Third Party Libraries
- ▶ Database
- ▶ File System
- ▶ Email
- ▶ Web Services
- ▶ System Resources
(Clock)
- ▶ Configuration
- ▶ The new Keyword
- ▶ Static methods
- ▶ Thread.Sleep
- ▶ Random

SOLID – DIP – Problems & Solutions

- ▶ How it should be
 - Classes should declare what they need
 - Constructors should require dependencies
 - Dependencies should be abstractions and be shown
- ▶ How to do it
 - Dependency Injection
 - The Hollywood principle "Don't call us, we'll call you!"
- ▶ Classic violations
 - Using of the new keyword, static methods/properties
- ▶ How to fix?
 - Default constructor, main method/startng point
 - Inversion of Control container

SOLID – DIP – Example

//DIP - bad example

```
public class EmployeeService {  
    private EmployeeFinder emFinder //concrete class, not abstract. Can access a SQL DB for instance  
    public Employee findEmployee(...) {  
        emFinder.findEmployee(...)  
    }  
}
```

//DIP - fixed

```
public class EmployeeService {  
    private IEmployeeFinder emFinder //depends on an abstraction, no an implementation  
    public Employee findEmployee(...) {  
        emFinder.findEmployee(...)  
    }  
}
```

//Now its possible to change the finder to be a XmlEmployeeFinder, DBEmployeeFinder, FlatFileEmployeeFinder, MockEmployeeFinder....

Other Principles

- ▶ Don't Repeat Yourself (DRY)
- ▶ You Ain't Gonna Need It (YAGNI)
- ▶ Keep It Simple, Stupid (KISS)

OP – Don't Repeat Yourself

- ▶ Repetition is the root of all software evil

I will not repeat myself
I will not repeat myself

DON'T REPEAT YOURSELF

Repetition is the root of all software evil

OP – DRY – Definitions

- ▶ "Every piece of knowledge must have a single, unambiguous representation in the system." – The Pragmatic Programmer
- ▶ "Repetition in logic calls for abstraction. Repetition in process calls for automation." – 97 Things Every Programmer Should Know
- ▶ Variations include:
 - Once and Only Once
 - Duplication Is Evil (DIE)

OP – DRY – Problems

- ▶ Magic Strings/Values
- ▶ Duplicate logic in multiple locations
- ▶ Repeated if–then logic
- ▶ Conditionals instead of polymorphism
- ▶ Repeated Execution Patterns
- ▶ Lots of duplicate, probably copy–pasted, code
- ▶ Only manual tests
- ▶ Static methods everywhere

OP – You Ain't Gonna Need It

- ▶ Don't waste resources on what you might need



YOU AIN'T GONNA NEED IT

Don't waste resources on what you might need.

OP – YAGNI – Definitions

- ▶ "A programmer should not add functionality until deemed necessary." – Wikipedia
- ▶ "Always implement things when you actually need them, never when you just foresee that you need them." – Ron Jeffries, XP co-founder

OP – YAGNI – Problems

- ▶ Time for adding, testing, improving
- ▶ Debugging, documented, supported
- ▶ Difficult for requirements
- ▶ Larger and complicate software
- ▶ May lead to adding even more features
- ▶ May be not known to clients

OP – Keep It Simple, Stupid

- ▶ You don't need to know the entire universe when living on the Earth



KEEP IT SIMPLE, STUPID

You don't need to know the entire universe when living on the Earth

OP – KISS – Definitions

- ▶ "Most systems work best if they are kept simple." – U.S. Navy
- ▶ "Simplicity should be a key goal in design and unnecessary complexity should be avoided."
– Wikipedia

GRASP

- ▶ GRASP = General Responsibility Assignment Software Patterns (Principles)
- ▶ Descrise de Craig Larman în cartea *Applying UML and Patterns. An Introduction to Object Oriented Analysis and Design*
- ▶ Ne ajută să alocăm responsabilități claselor și obiectelor în cel mai elegant mod posibil
- ▶ Exemple de principii folosite în GRASP:
Information Expert (sau *Expert*), *Creator*, *High Cohesion*, *Low Coupling*, *Controller*
Polymorphism, *Pure Fabrication*, *Indirection*,
Protected Variations

Ce responsabilități?

- ▶ Să facă:
 - Să facă ceva el însuși, precum crearea unui obiect sau să facă un calcul
 - Inițializarea unei acțiuni în alte obiecte
 - Controlarea și coordonarea activităților altor obiecte

- ▶ Să cunoască:
 - Atributele private
 - Obiectele proprii
 - Lucrurile pe care le poate face sau le poate apela

Pattern

- ▶ Traducere: şablon, model
- ▶ Este o soluţie generală la o problemă comună
- ▶ Fiecare pattern are un nume sugestiv și ușor de reținut (ex. composite, observer, iterator, singleton, etc.)

Information Expert 1

- ▶ **Problemă:** dat un anumit comportament (operație), cărei clase trebuie să-i fie atribuit?
- ▶ O alocare bună a operațiilor conduce la sisteme care sunt:
 - Ușor de înțeles
 - Mai ușor de extins
 - Refolosibile
 - Mai robuste

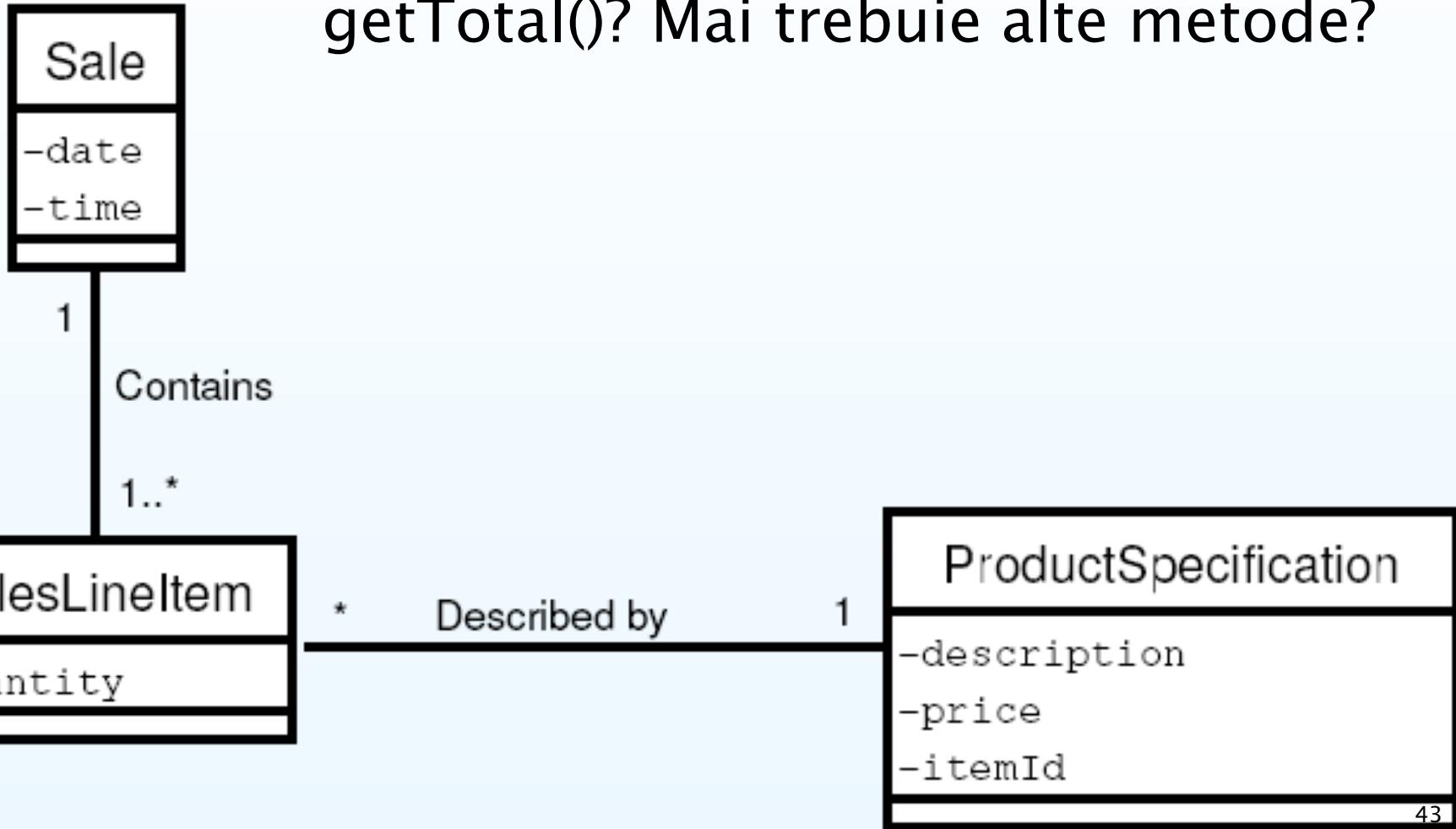
Information Expert 2

- ▶ **Soluție:**
- ▶ asignez o responsabilitate clasei care are *informațiile necesare* pentru îndeplinirea acelei responsabilități

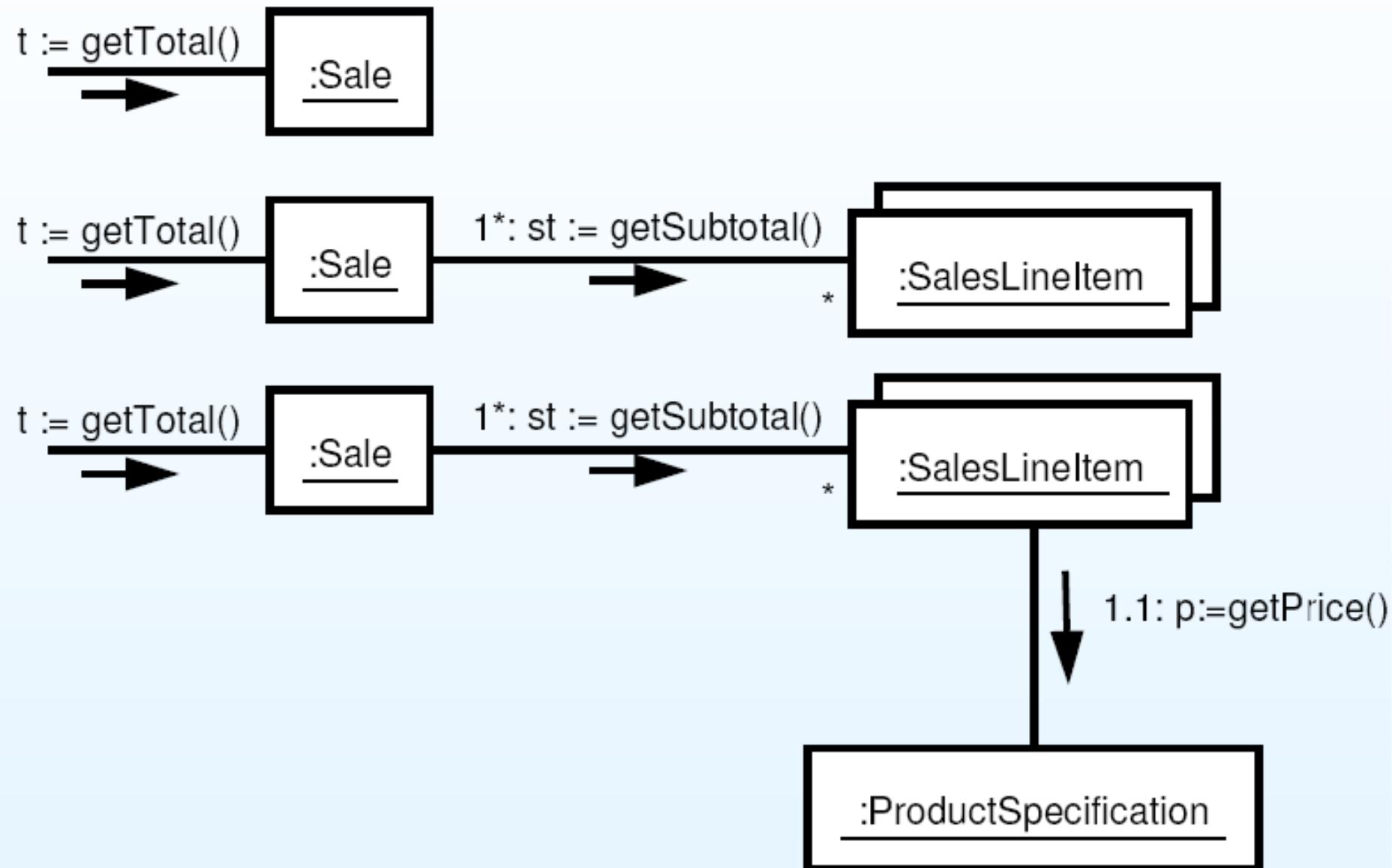
- ▶ **Recomandare:**
- ▶ începeți asignarea responsabilităților evidențiiind clar care sunt responsabilitățile

Exemplul 1

- ▶ Carei clase trebuie sa-i fie asignată metoda `getTotal()`? Mai trebuie alte metode?

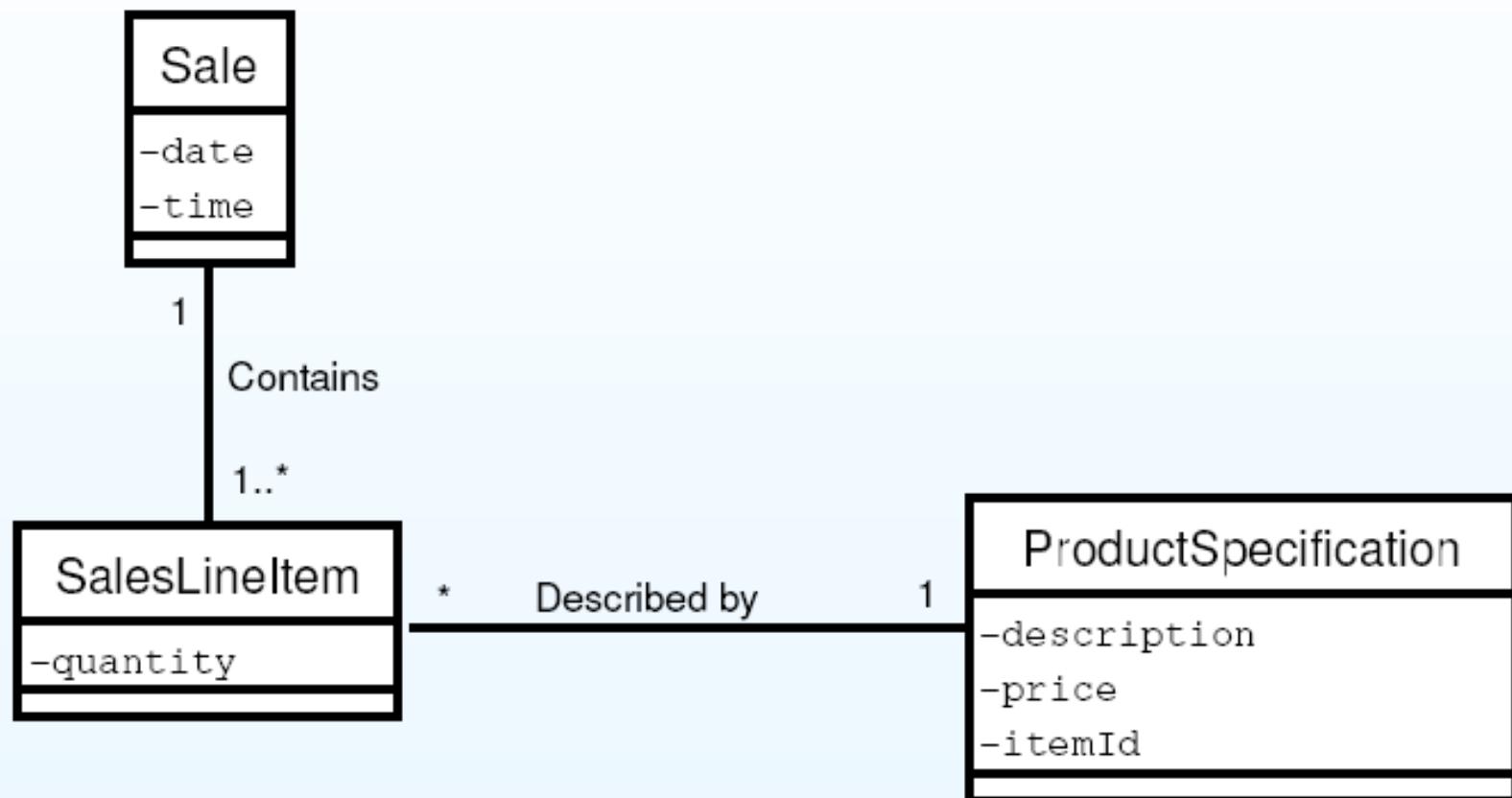


Exemplul 2

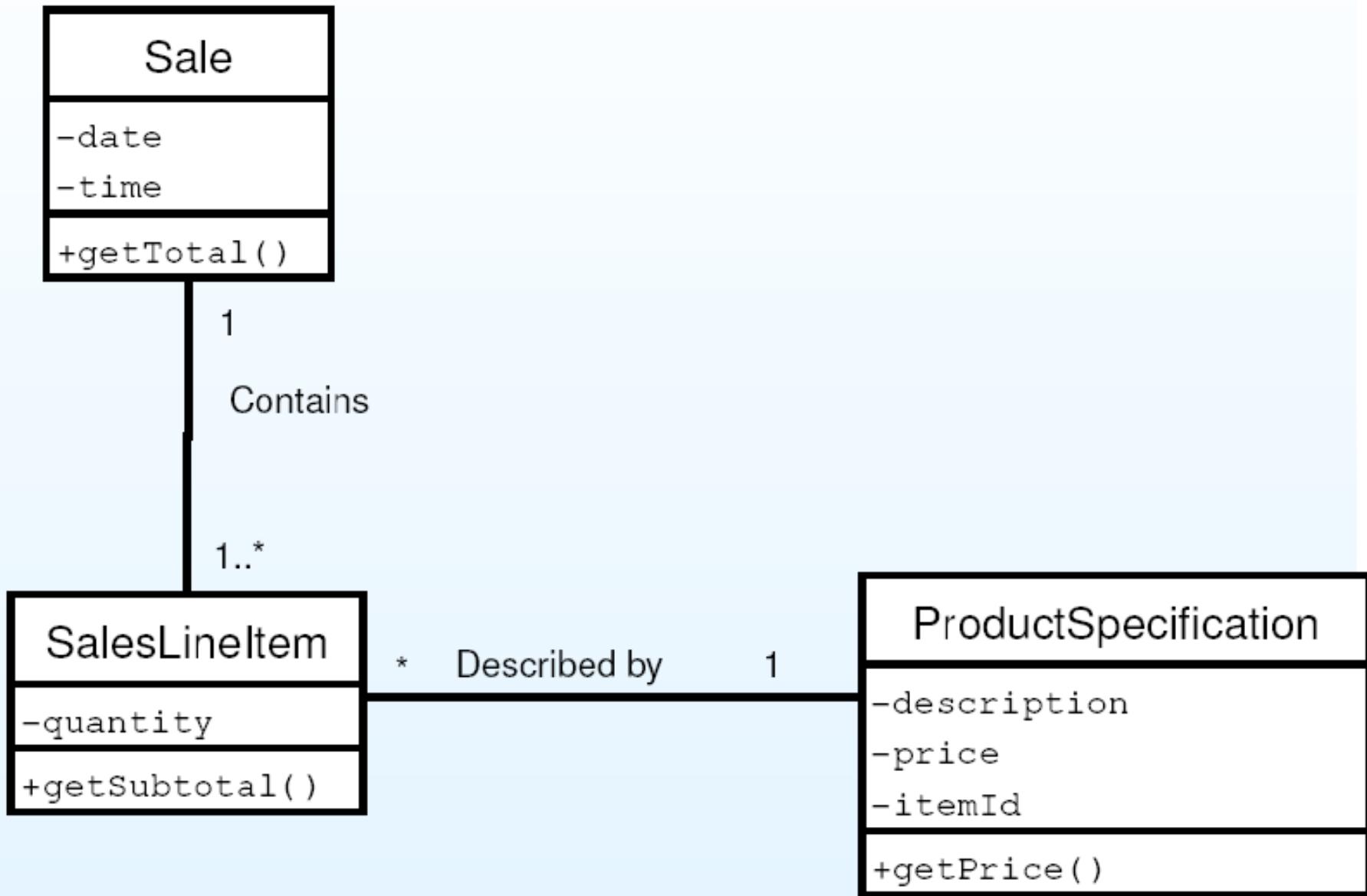


Soluție posibilă 1

Clasă	Responsabilități
Sale	să cunoască valoarea totală a cumpărăturilor
SalesLineItem	să cunoască subtotalul pentru un produs
ProductSpecification	să cunoască prețul produsului



Soluție posibilă 2

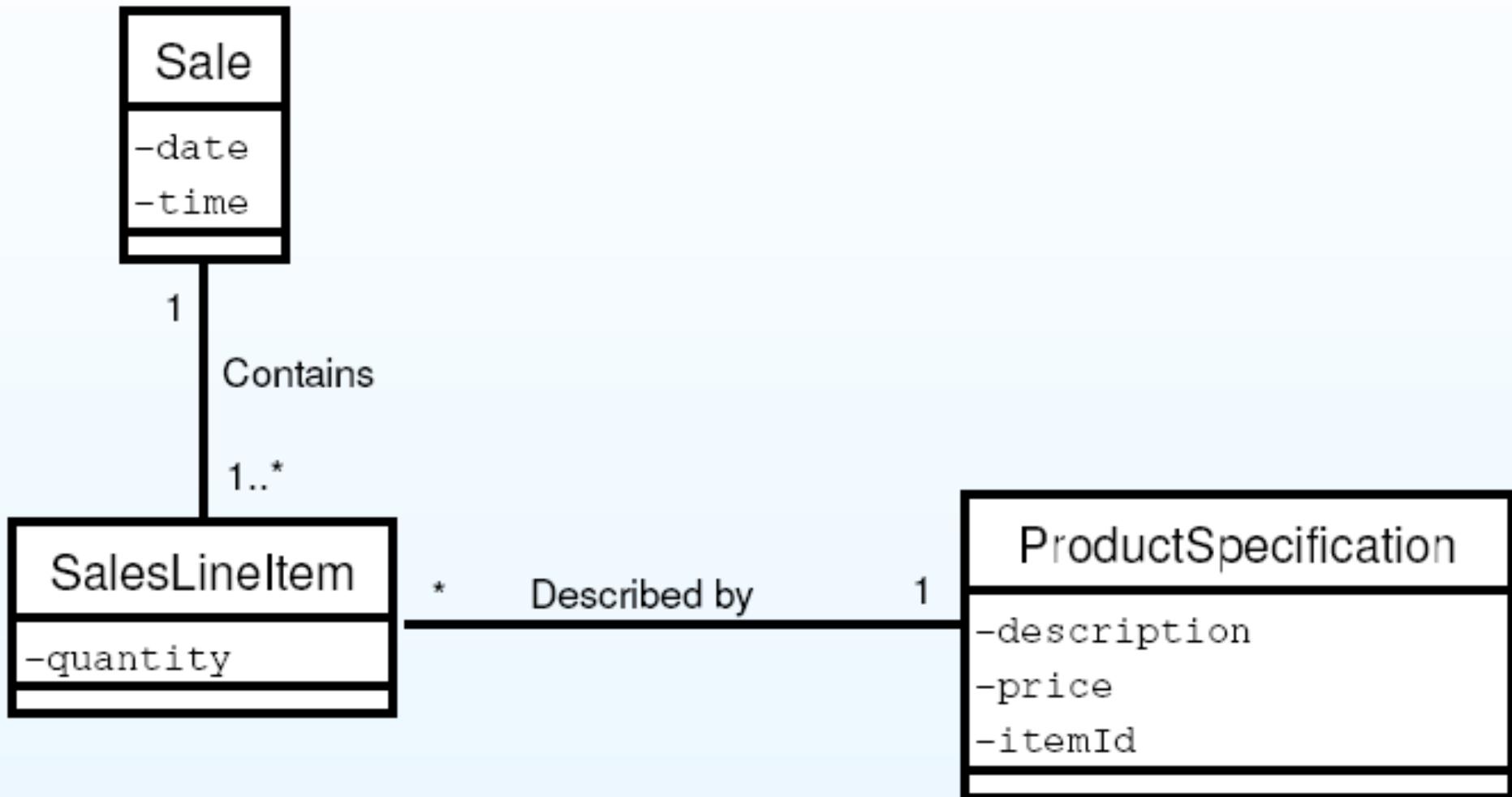


Creator 1

- ▶ **Problemă:** cine trebuie să fie responsabil cu crearea unei instanțe a unei clase?
- ▶ **Soluție:** Asignați clasei B responsabilitatea de a crea instanțe ale clasei A doar dacă cel puțin una dintre următoarele afirmații este adevărată:
 - B *agregă obiecte de tip A*
 - B *conține obiecte de tip A*
 - B *folosește obiecte de tip A*
 - B *are datele de initializare care trebuie transmise la instantierea unui obiect de tip A* (B este deci un Expert în ceea ce privește crearea obiectelor de tip A)
- ▶ *Factory pattern* este o variantă mai complexă

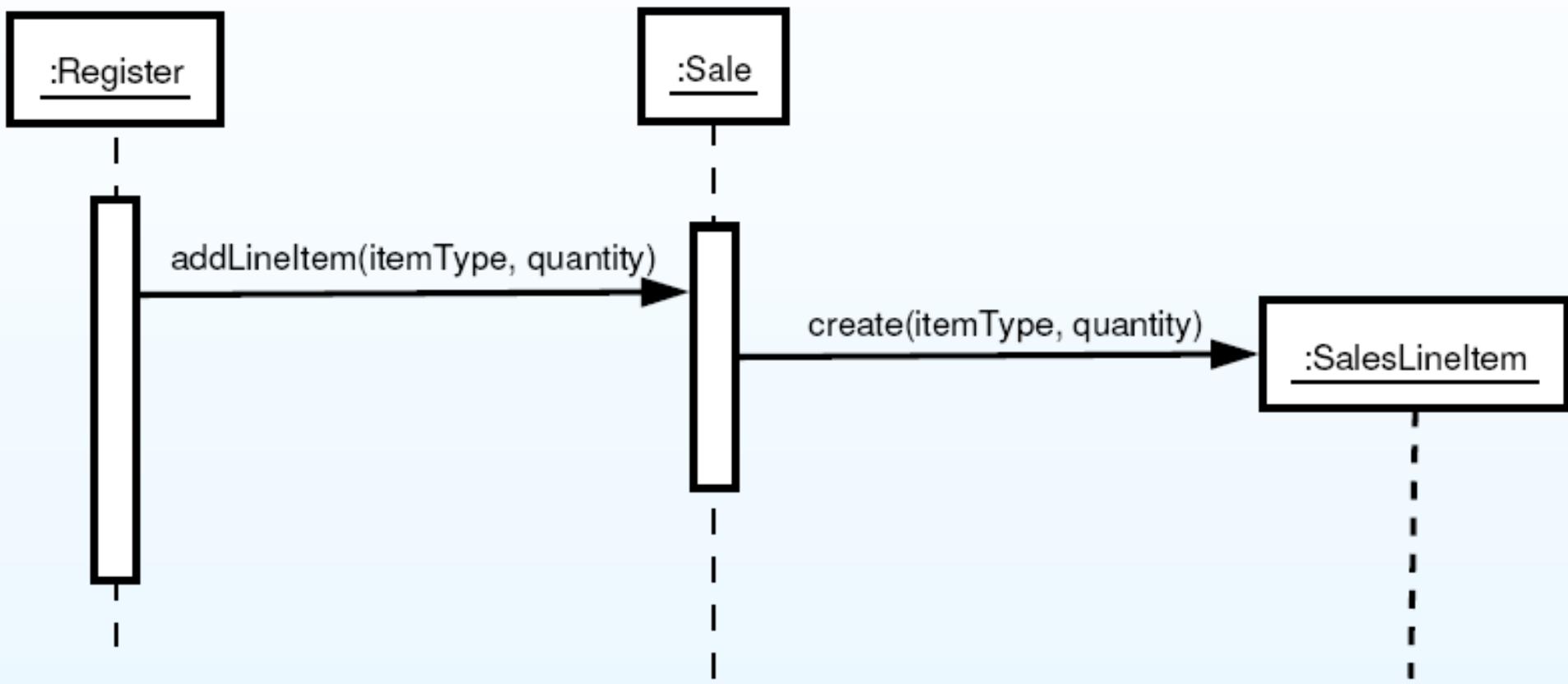
Creator 2

- ▶ Cine este responsabil cu crearea unei instanțe a clasei SalesLineItem?



Creator 3

- ▶ Deoarece Sale conține (agregă) instanțe de tip SalesLineItem, Sale este un bun candidat pentru a i se atribui responsabilitatea creării acestor instanțe



Low coupling (cuplaj redus)

- ▶ Cuplajul este o măsură a gradului de dependență a unei clase de alte clase
- ▶ Tipuri de Dependență:
 - este conectată cu
 - are cunoștințe despre
 - se bazează pe
- ▶ O clasă care are cuplaj mic (redus) nu depinde de “multe” alte clase; unde “multe” este **dependent de contex**
- ▶ O clasă care are cuplaj mare depinde de multe alte clase

Cuplaj 2

- ▶ Probleme cauzate de cuplaj:
 - schimbări în clasele relaționate forțează schimbări locale
 - clase **greu de Înțeles** în izolare (scoase din context)
 - clase **greu de refolosit** deoarece folosirea lor presupune și prezența claselor de care depind

Cuplaj 3

- ▶ Forme comune de cuplaj de la clasa A la clasa B sunt:
 - A are un atribut de tip B
 - O instanță a clasei A apelează un serviciu oferit de un obiect de tip B
 - A are o metodă care referențiază B (parametru, obiect local, obiect returnat)
 - A este subclasă (direct sau indirect) a lui B
 - B este o interfață, iar A implementează această interfață

Legea lui Demeter

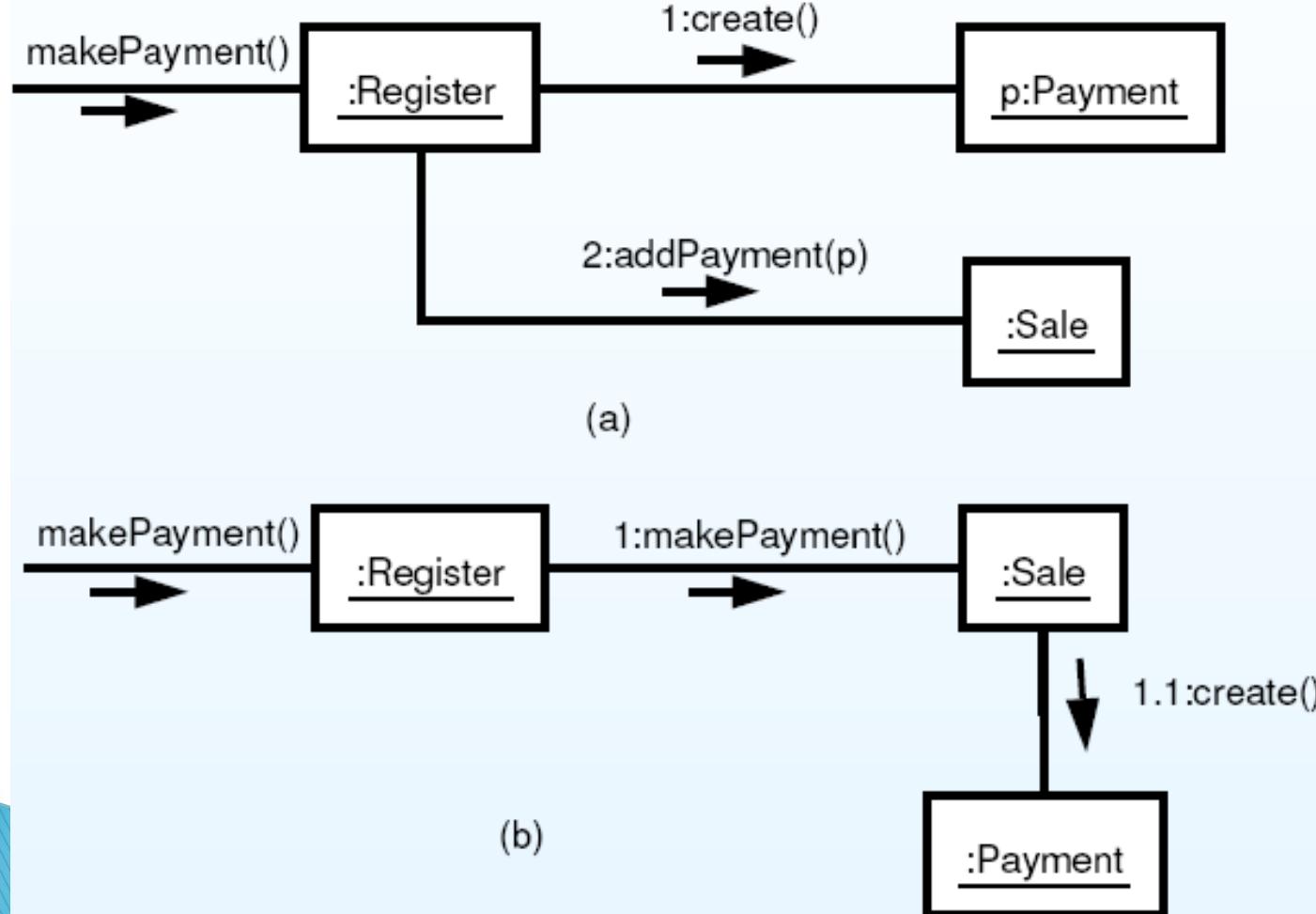
- ▶ *Don't talk to strangers*
- ▶ Orice metodă a unui obiect trebuie să apeleze doar metode aparținând
 - lui însuși
 - oricărui parametru al metodei
 - oricărui obiect pe care l-a creat
 - oricăror obiecte pe care le conține

Vizualizarea Cuplajelor

- ▶ Diagrama de clase
- ▶ Diagrama de colaborare

Exemplul 1

- ▶ Există legături între toate clasele
- ▶ Elimină cuplajul dintre Register și Payment



High Cohesion

- ▶ Coeziunea este o măsură a cât de puternic sunt focalizate responsabilitățile unei clase
- ▶ O clasă ale cărei responsabilități sunt foarte strâns legate și care nu face foarte multe lucruri are o **coeziune mare**
- ▶ O clasă care face multe lucruri care nu sunt relateionate sau face prea multe lucruri are o **coeziune mică (slabă)**

Coeziune

- ▶ Probleme cauzate de o slabă coeziune:
 - greu de înțeles
 - greu de refolosit
 - greu de menținut
 - delicate; astfel de clase sunt mereu supuse la schimbări

Coeziune și Cuplaj

- ▶ Sunt principii vechi în design-ul software
- ▶ Promovează un design modular
- ▶ Modularitatea este proprietatea unui sistem care a fost descompus într-o mulțime de module coeziive și slab cuplate

Controller 1

- ▶ **Problemă:** Cine este responsabil cu tratarea unui eveniment generat de un actor?
- ▶ Aceste evenimente sunt asociate cu operații ale sistemului
- ▶ Un **Controller** este un obiect care nu ține de interfața grafică și care este responsabil cu recepționarea sau gestionarea unui eveniment
- ▶ Un Controller definește o metodă corespunzătoare operației sistemului

Controller 2

- ▶ **Soluție:** asignează responsabilitatea pentru recepționarea sau gestionarea unui eveniment unei clase care reprezintă una dintre următoarele alegeri:
 - Reprezintă întregul sistem sau subsistem (fațadă controller)
 - Reprezintă un scenariu de utilizare în care apare evenimentul;

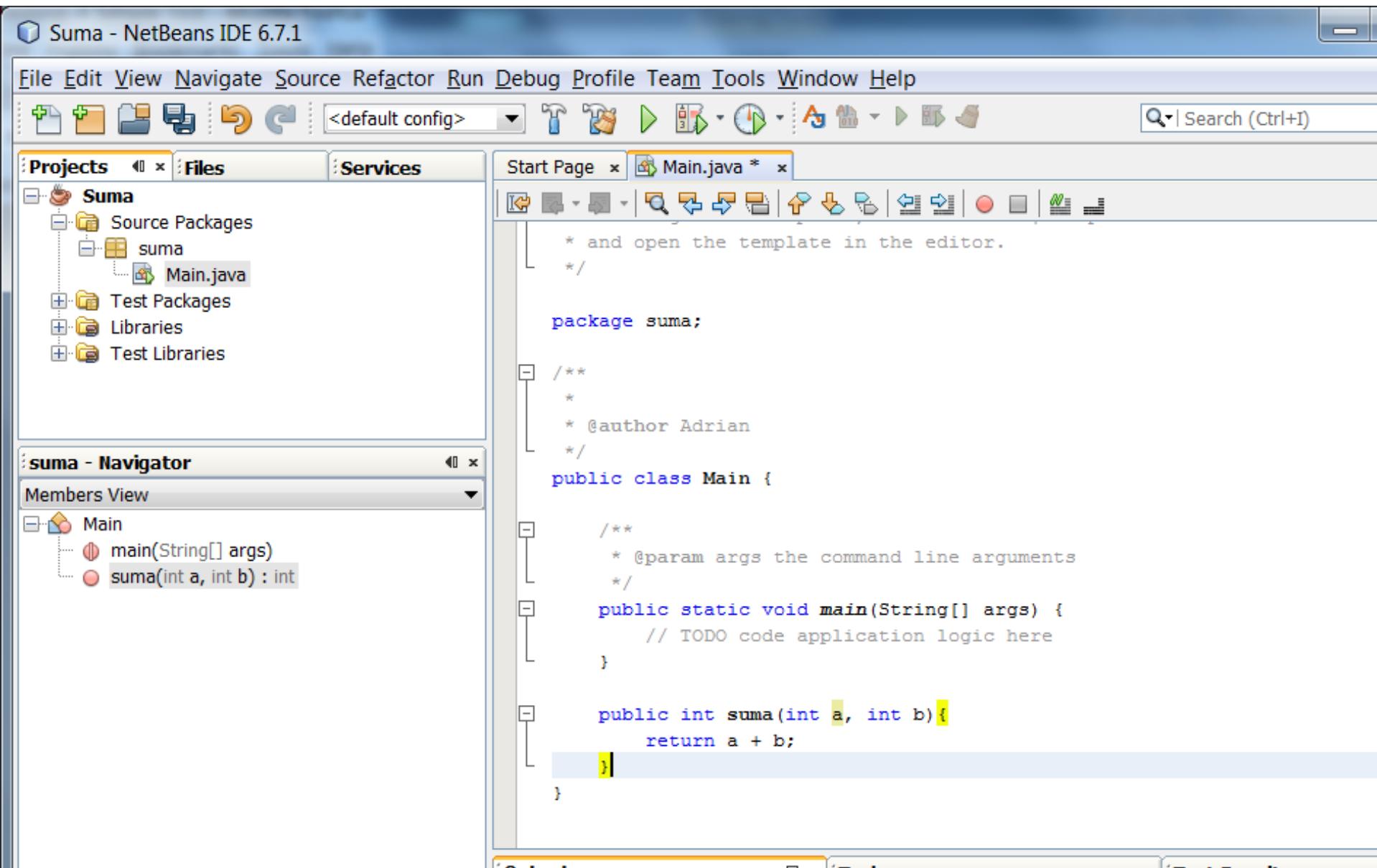
Controller 3

- ▶ În mod normal, un controller ar trebui să delege altor obiecte munca care trebuie făcută;
- ▶ **Controller-ul coordonează sau controlează activitatea, însă nu face prea multe lucruri el însuși**
- ▶ O greșală comună în design-ul unui controller este să i se atribuie prea multe responsabilități (fațade controller)

Unit Testing

- ▶ Testarea unei funcții, a unui program, a unui ecran, a unei funcționalități
- ▶ Se face de către programatori
- ▶ Predefinită
- ▶ Rezultatele trebuie documentate
- ▶ Se folosesc simulațoare pentru Input și Output

Unit Testing - Exemplu 1 (1)



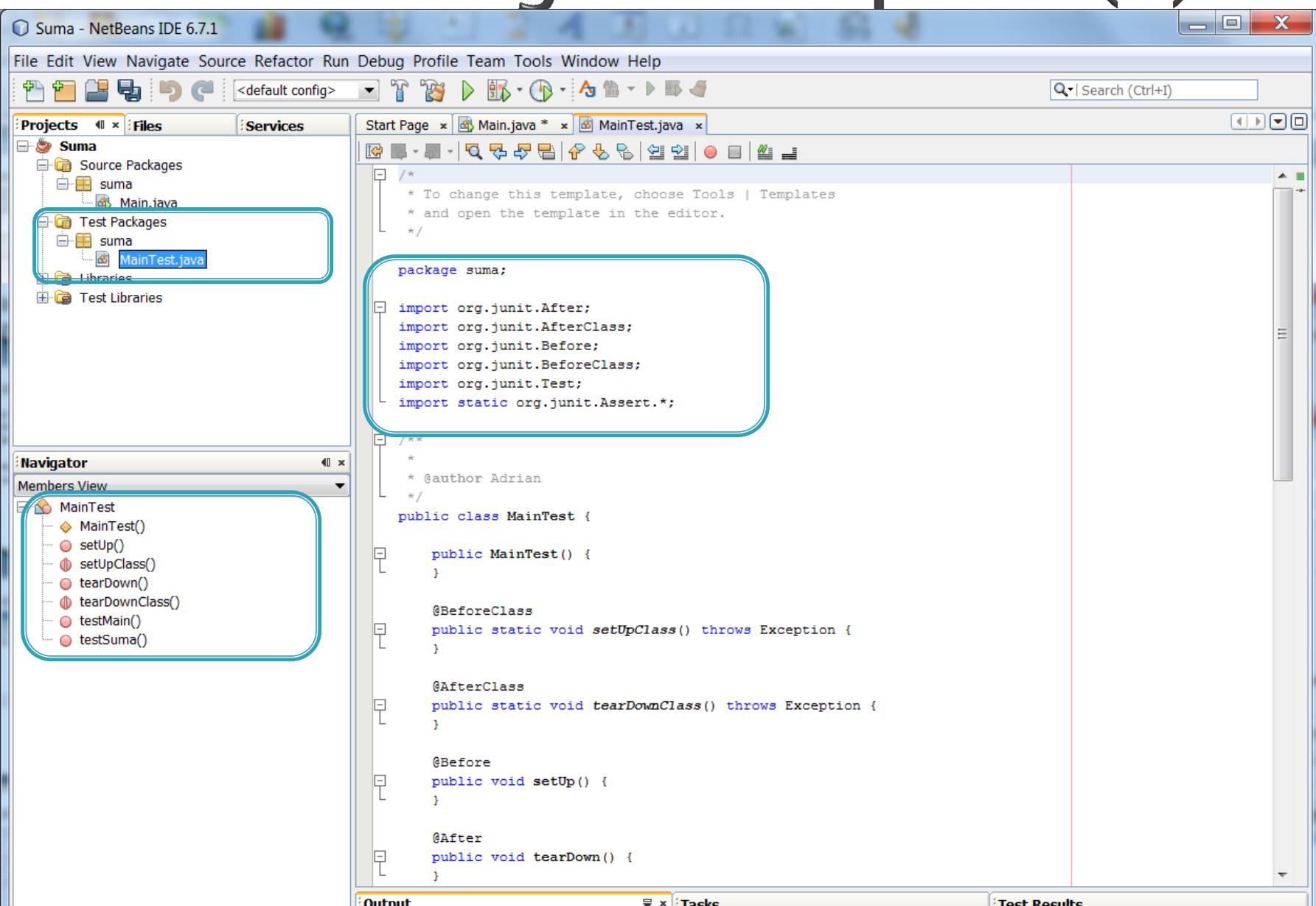
Unit Testing - Exemplu 1 (2)

The screenshot shows an IDE interface with several windows open:

- Projects** window: Shows a project named "Suma" with a "Source Packages" folder containing "suma" and a "Main.java" file selected.
- Files** window: Shows the "Main.java" file content:

```
/*  
 * To change this template, choose Tools | Templates  
 * and open the template in the editor.  
  
 * Author: nor Adrian  
  
 */  
  
class Main {  
    public static void main(String[] args) {  
        // TODO code application logic here  
  
        int sum = suma(1, 2);  
        System.out.println("Suma: " + sum);  
    }  
  
    public int suma(int a, int b) {  
        return a + b;  
    }  
}
```
- Services** window: A context menu is open over the "Main.java" file, with the "Create JUnit Tests" option highlighted.
- Select JUnit Version** dialog: Shows two options: "JUnit 3.x" (selected) and "JUnit 4.x".
- Create Tests** dialog: Shows the configuration for generating tests:
 - Class to Test:** suma.Main
 - Class Name:** suma.MainTest
 - Location:** Test Packages
 - Code Generation** section:
 - Method Access Levels:** Public, Protected, Package Private (all checked)
 - Generated Code:** Test Initializer, Test Finalizer, Default Method Bodies (all checked)
 - Generated Comments:** Javadoc Comments, Source Code Hints (both checked)

Unit Testing - Exemplu 1 (3)



Unit Testing – Exemplu 1 (4)

The screenshot shows the Eclipse IDE interface with the following details:

- Toolbar:** Contains icons for New, Open, Save, Cut, Copy, Paste, Find, Run, Stop, and others.
- Menu Bar:** Includes File, Source, Refactor, Run, Debug, Profile, Team, Tools, Window, and Help.
- ActionBar:** Shows the current configuration as <default config>, and various tool icons.
- Left Sidebar:** Labeled "Services" and "t.java".
- Central Area:** Displays two tabs: "Start Page" and "Main.java *". Below them is the "MainTest.java" editor tab, which is active and highlighted with a blue border.
- Main Test Java Code:** The code is annotated with a large blue rounded rectangle highlighting the test method definition.

```
    }
}

/**
 * Test of suma method, of class Main.
 */
@Test
public void testSuma() {
    System.out.println("suma");
    int a = 0;
    int b = 0;
    Main instance = new Main();
    int expResult = 0;
    int result = instance.suma(a, b);
    assertEquals(expResult, result);
    // TODO review the generated test code and remove the default call
    fail("The test case is a prototype.");
}
```

Unit Testing - Exemplu 1 (5)

The screenshot shows an IDE interface with the following components:

- Projects** view: Shows a project named "Suma" with Source Packages (containing "suma" and "Main.java") and Test Packages (containing "suma" and "MainTest.java").
- Code Editor**: Displays the content of "MainTest.java". The code includes annotations for setup and teardown methods, and two test methods: "testMain" and "testSuma". The "testMain" method contains a TODO comment and a fail statement.
- Context Menu**: A context menu is open over the "MainTest.java" file, with the "Run File" option highlighted.
- Navigator** view: Shows the class structure of "MainTest" with methods like "setUp", "tearDown", "testMain", and "testSuma".
- Output - Suma (test)**: Shows the test results with a summary of 0.0% completion, indicating 2 failed tests. The failed tests are "testMain FAILED" and "testSuma FAILED".
- Test Results**: A table showing the results of the tests, with "main" and "suma" listed.

Unit Testing – Exemplu 1 (6)

```
    @Test
    public void testSuma() {
        System.out.println("suma");
        int a = 0;
        int b = 0;
        Main instance = new Main();
        int expResult = 0;
        int result = instance.suma(a, b);
        assertEquals(expResult, result);
        // TODO review the generated test code and remove the default call to fail.
        //fail("The test case is a prototype.");
    }
}
```

The screenshot shows an IDE interface with three tabs at the top: "Output - Suma (test)", "Tasks", and "Test Results".

- Output - Suma (test):** Shows a progress bar at 50.0% completion. Below it, a message indicates 1 test passed and 1 test failed in 0.019 seconds.
- Tasks:** A red bar indicating task status.
- Test Results:** A table with two rows:

main	
suma	

In the "Output" tab, the failed test is detailed:

- 1 test passed, 1 test failed.(0.019 s)
- suma.MainTest FAILED
 - testMain FAILED (at suma.MainTest.testMain(MainTest.java:49))
 - testSuma passed (0.0 s)

Unit Testing - Example 2 (1)

BasicOperations.java x BasicOperationsTest.java

```
package math;

public class BasicOperations {

    public int add(int x, int y){
        return x + y;
    }

    public int min(int x, int y){
        return x + y;
    }

    public int mul(int x, int y){
        return x * y;
    }

    public int div(int x, int y){
        return x / y;
    }

    /**
     * @param args
     */
    public static void main(String[] args) {
        // TODO Auto-generated method stub
        BasicOperations bc = new BasicOperations();
        System.out.println(bc.add(3,5));
    }
}
```

Unit Testing - Example 2 (2)

The screenshot shows an IDE interface with two main panes. The left pane displays the JUnit runner results, and the right pane shows the corresponding Java code.

JUnit Runner Results:

- Runs: 4/4
- Errors: 0
- Failures: 1

Test Details:

- test.BasicOperationsTest [Runner: JUnit 4] (0.004 s)
 - testAdd (0.000 s)
 - testMin (0.003 s) Failure Trace
 - testMul (0.000 s)
 - testDiv (0.001 s)

Failure Trace:

```
java.lang.AssertionError: Result expected:<2> but was:<8>
at test.BasicOperationsTest.testMin(BasicOperationsTest.java:20)
```

Java Code (BasicOperationsTest.java):

```
package test;

import static org.junit.Assert.*;

public class BasicOperationsTest {

    @Test
    public void testAdd() {
        BasicOperations bo = new BasicOperations();
        assertEquals("Result", 8, bo.add(3, 5));
    }

    @Test
    public void testMin() {
        BasicOperations bo = new BasicOperations();
        assertEquals("Result", 2, bo.min(5, 3));
    }

    @Test
    public void testMul() {
        BasicOperations bo = new BasicOperations();
        assertEquals("Result", 15, bo.mul(3, 5));
    }

    @Test
    public void testDiv() {
        BasicOperations bo = new BasicOperations();
        assertEquals("Result", 2, bo.div(4, 2));
    }
}
```

Unit Testing - Example 2 (3)

The screenshot shows an IDE interface with two main panes. The left pane displays the JUnit view, which includes a summary bar at the top indicating "Runs: 4/4", "Errors: 1", and "Failures: 0". Below this, a tree view shows the test results for "test.BasicOperationsTest [Runner: JUnit 4] (0.004 s)". The "testDiv" method is highlighted with a red error icon and a red box, while the other three methods ("testAdd", "testMin", "testMul") are marked with green checkmarks. The right pane shows the source code for "BasicOperationsTest.java". The "testDiv" method is also highlighted with a red box. The failure trace for the "testDiv" error is shown in the bottom-left corner of the IDE.

Package Explorer Hierarchy JUnit

Finished after 0.019 seconds

Runs: 4/4 Errors: 1 Failures: 0

test.BasicOperationsTest [Runner: JUnit 4] (0.004 s)

- testAdd (0.000 s)
- testMin (0.000 s)
- testMul (0.000 s)
- testDiv (0.004 s)**

Failure Trace

java.lang.ArithmetricException: / by zero

at math.BasicOperations.div(BasicOperations.java:18)

at test.BasicOperationsTest.testDiv(BasicOperationsTest.java:32)

```
package test;

import static org.junit.Assert.*;

public class BasicOperationsTest {

    @Test
    public void testAdd() {
        BasicOperations bo = new BasicOperations();
        assertEquals("Result", 8, bo.add(3, 5));
    }

    @Test
    public void testMin() {
        BasicOperations bo = new BasicOperations();
        assertEquals("Result", 2, bo.min(5, 3));
    }

    @Test
    public void testMul() {
        BasicOperations bo = new BasicOperations();
        assertEquals("Result", 15, bo.mul(3, 5));
    }

    @Test
    public void testDiv() {
        BasicOperations bo = new BasicOperations();
        assertEquals("Result", 0, bo.div(4, 0));
    }
}
```

Unit Testing - Example 2 (4)

The screenshot shows the Eclipse IDE interface with the following details:

- Top Bar:** Package Explorer, Hierarchy, JUnit.
- Left Panel (Test Results):** Shows "Finished after 0.016 seconds".
 - Runs: 4/4 Errors: 0 Failures: 0
 - test.BasicOperationsTest [Runner: JUnit 4] (0.000 s)
 - testAdd (0.000 s)
 - testMin (0.000 s)
 - testMul (0.000 s)
 - testDiv (0.000 s)
- Right Panel (Source Code):** BasicOperations.java and BasicOperationsTest.java.
 - BasicOperations.java:** Contains a single method: `public int div(int a, int b)` which returns `a/b` if `b` is not zero, otherwise it throws an `ArithmaticException`.
 - BasicOperationsTest.java:** Contains four test methods:
 - testAdd:** Checks if `bo.add(3, 5)` equals 8.
 - testMin:** Checks if `bo.min(5, 3)` is not equal to 3.
 - testMul:** Checks if `bo.mul(3, 5)` equals 15.
 - testDiv:** Checks if `bo.div(4, 2)` equals 3. If not, it fails with the message "Incorrect result!".

The test results and the testDiv method in the source code are highlighted with blue rounded rectangles.

```
package test;

import static org.junit.Assert.*;

public class BasicOperationsTest {

    @Test
    public void testAdd() {
        BasicOperations bo = new BasicOperations();
        assertTrue("Result", 8 == bo.add(3, 5));
    }

    @Test
    public void testMin() {
        BasicOperations bo = new BasicOperations();
        assertFalse("Result", ! (3 != bo.min(5, 3)));
    }

    @Test
    public void testMul() {
        BasicOperations bo = new BasicOperations();
        assertEquals("Result", 15, bo.mul(3, 5));
    }

    @Test
    public void testDiv() {
        BasicOperations bo = new BasicOperations();
        if(bo.div(4, 2) == 3)
            fail("Incorrect result!");
    }
}
```

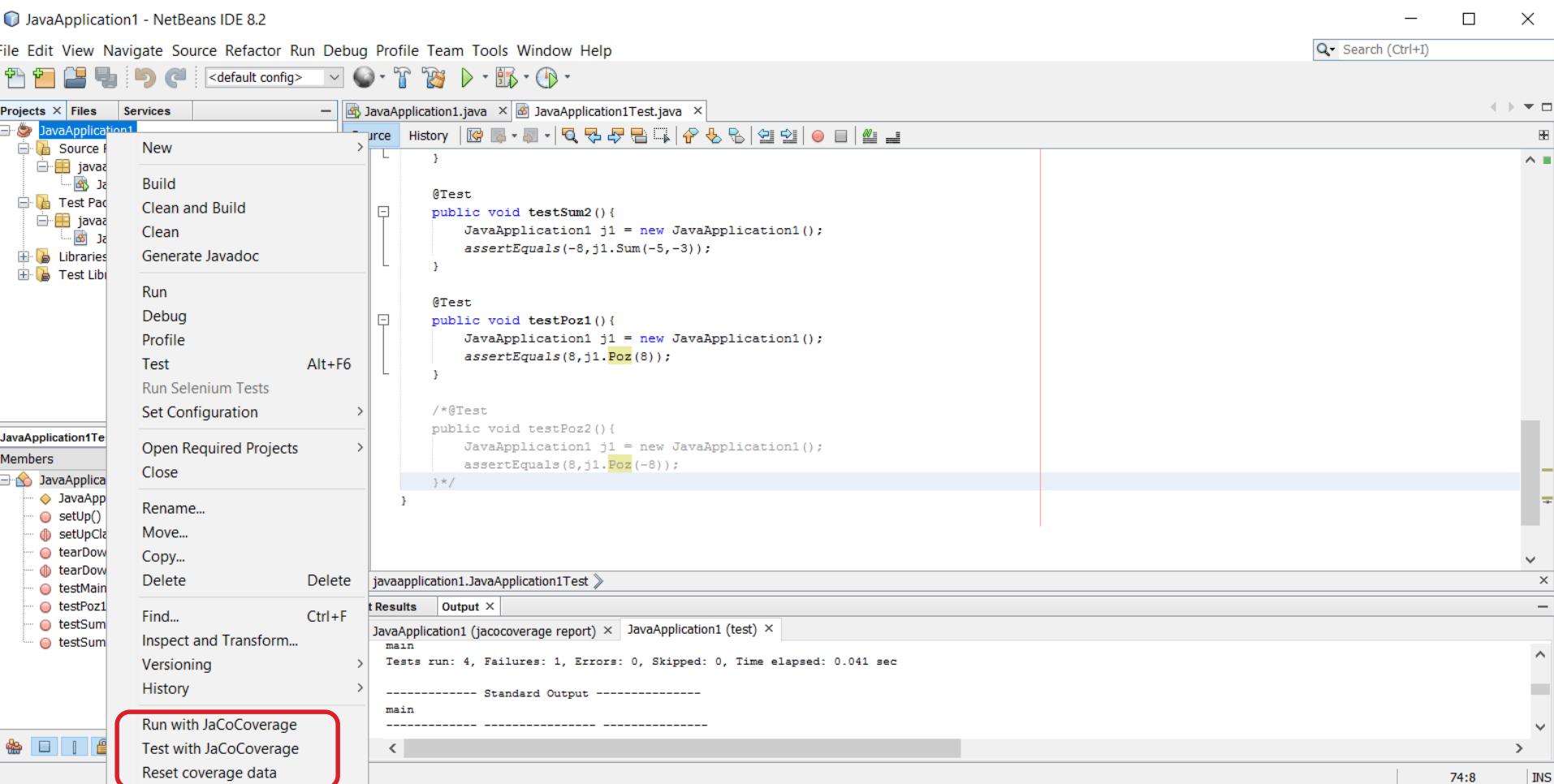
Code Coverage

- ▶ NetBeans – TikiOne JaCoCoverage:
- ▶ <http://plugins.netbeans.org/plugin/48570/tikione-jacocoverage>

- ▶ Java Code Coverage for Eclipse:
- ▶ <http://www.eclemma.org/>

- ▶ IntelliJ – Running with coverage:
- ▶ <https://www.jetbrains.com/help/idea/2016.3/running-with-coverage.html>

NetBeans – 1



NetBeans – 2

JavaApplication1 - NetBeans IDE 8.2

File Edit View Navigate Source Refactor Run Debug Profile Team Tools Window Help

Search (Ctrl+I)

Projects Files Services JavaApplication1.java JavaApplication1Test.java

New Build Clean and Build

Source History

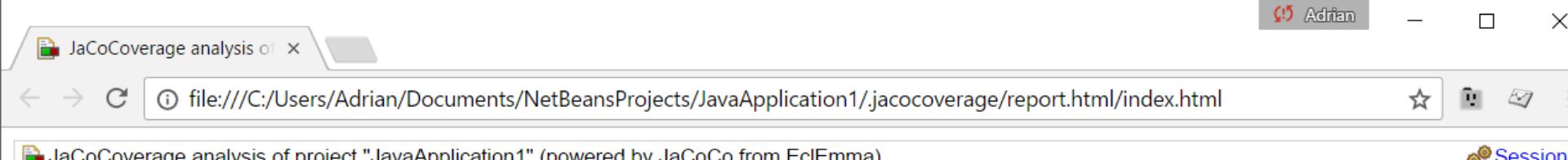
JaCoCoverage analysis of project "JavaApplication1" (powered by JaCoCo from EclEmma)

file:///C:/Users/Adrian/Documents/NetBeansProjects/JavaApplication1/jacocoverage/report.html/index.html

Created with JaCoCo 0.7.6.2016021808

Element	Missed Instructions	Cov.	Missed Branches	Cov.	Missed	Cxty	Missed	Lines	Missed	Methods	Missed	Classes
javaapplication1	80%	50%	1	5	1	7	0	4	0	1		
Total	4 of 20	80%	1 of 2	50%	1	5	1	7	0	4	0	1

NetBeans – 3



JaCoCoverage analysis of project "JavaApplication1" (powered by JaCoCo from



JavaApplication1

Element	Missed Instructions	Cov.	Missed Branches	Cov.	Missed	Cxts	Missed	Lines	Missed	Methods
Poz(int)		50%		50%	1	2	1	3	0	1
main(String[])		100%		n/a	0	1	0	2	0	1
Sum(int, int)		100%		n/a	0	1	0	1	0	1
JavaApplication1()		100%		n/a	0	1	0	1	0	1
Total	4 of 20	80%	1 of 2	50%	1	5	1	7	0	4

Concluzii

- ▶ SOLID
- ▶ Design Patterns
 - Definitions, Elements, Example, Classification
- ▶ JUnit Testing

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- ▶ Adrian Iftene, Curs 9 TAIP:
<http://thor.info.uaic.ro/~adiftene/Scoala/2011/TAIP/Courses/TAIP09.pdf>

Bibliografie

- ▶ Craig Larman. *Applying UML and Patterns. An Introduction to Object Oriented Analysis and Design*
- ▶ Ovidiu Gheorghieş, Curs 6 IP

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- ▶ WebProjectManager: <http://profs.info.uaic.ro/~adrianaa/uml/>
- ▶ Diagrame de Stare și de Activitate:
http://software.ucv.ro/~soimu_anca/itpm/Diagrame%20de%20Stare%20si%20Activitate.doc
- ▶ Deployment Diagram:
http://en.wikipedia.org/wiki/Deployment_diagram
<http://www.agilemodeling.com/artifacts/deploymentDiagram.htm>
- ▶ GRASP:
[http://en.wikipedia.org/wiki/GRASP_\(Object_Oriented_Design\)](http://en.wikipedia.org/wiki/GRASP_(Object_Oriented_Design))
- ▶ <http://web.cs.wpi.edu/~gpollice/cs4233-a05/CourseNotes/maps/class4/GRASPPatterns.html>
- ▶ Introduction to GRASP Patterns:
[http://faculty.inverhills.edu/dlevitt/CS%202000%20\(FP\)/GRASP%20Patterns.pdf](http://faculty.inverhills.edu/dlevitt/CS%202000%20(FP)/GRASP%20Patterns.pdf)

Links (2)

- ▶ Gang-Of-Four: <http://c2.com/cgi/wiki?GangOfFour>,
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- ▶ Design Patterns Book: <http://c2.com/cgi/wiki?DesignPatternsBook>
- ▶ About Design Patterns: <http://www.javacamp.org/designPattern/>
- ▶ Design Patterns – Java companion:
<http://www.patterndepot.com/put/8/JavaPatterns.htm>
- ▶ Java Design patterns:
http://www.allapplabs.com/java_design_patterns/java_design_patterns.htm
- ▶ Overview of Design Patterns:
http://www.mindspring.com/~mgrand/pattern_synopses.htm
- ▶ Gang of Four: http://en.wikipedia.org/wiki/Gang_of_four
- ▶ JUnit in Eclipse: <http://www.vogella.de/articles/JUnit/article.html>
- ▶ JUnit in NetBeans: <http://netbeans.org/kb/docs/java/junit-intro.html>

Links (3)

- ▶ <https://scotch.io/bar-talk/s-o-l-i-d-the-first-five-principles-of-object-oriented-design>
- ▶ <https://www.slideshare.net/enbohm/solid-design-principles-9016117>
- ▶ <https://siderite.blogspot.com/2017/02/solid-principles-plus-dry-yagni-kiss-final.html>
- ▶ <https://thefullstack.xyz/dry-yagni-kiss-tdd-soc-bdfu>