Programmierung 2

Object-Oriented Programming with Java

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P2 — Object-Oriented Programming

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Roadmap

> Goals, Schedule
> What is programming all about?
> What is Object-Oriented programming?
> Foundations of OOP
> Why Java?
> Programming tools, version control

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Your Learning Targets

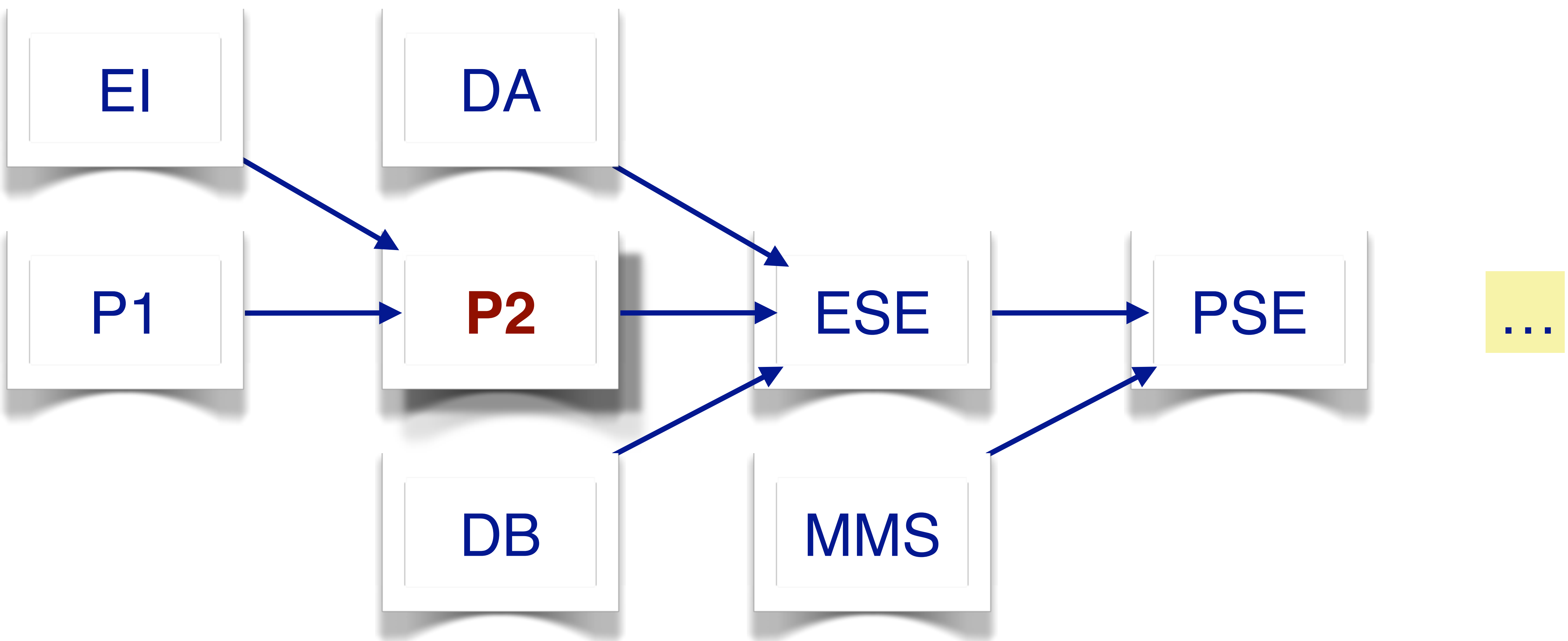
Knowledge

+

Skills

- You understand **requirements engineering, designing** and **implementing** object-oriented software
- You can understand and create basic **UML Diagrams**
- You understand and can apply various **Design Patterns**
- You apply a **Test-Driven Development process**
- You use your **IDE, Debugger** efficiently and effectively
- You can **communicate** and work in **Teams**

The Big Picture



Recommended Texts

> ***Java in Nutshell: 5th edition***,
> David Flanagan, O'Reilly, 2005.

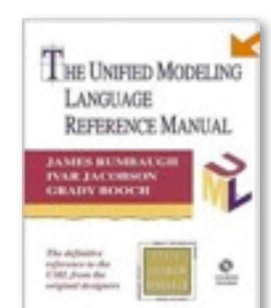
> ***An Introduction to Object-Oriented Programming***,
> Timothy Budd, Addison-Wesley, 2004.

> ***Object-Oriented Software Construction***,
> Bertrand Meyer,Prentice Hall, 1997.

> ***Object Design - Roles, Responsibilities and Collaborations***,
> Rebecca Wirfs-Brock, Alan McKean, Addison-Wesley, 2003.

> ***Design Patterns: Elements of Reusable Object-Oriented Software*,**
> Erich Gamma, Richard Helm, Ralph Johnson and John Vlissides, Addison Wesley, Reading, Mass., 1995.

> ***The Unified Modeling Language Reference Manual*,**
> James Rumbaugh, Ivar Jacobson, Grady Booch, Addison-Wesley, 1999



Schedule

1. Introduction
2. Object-Oriented Design Principles
3. Design by Contract
4. A Testing Framework
5. Iterative Development
6. Debugging and Tools
7. Inheritance and Refactoring
8. Advanced OO Design (lab)
9. GUI Construction
10. Guidelines, Idioms and Patterns
11. A bit of C++
12. A bit of Smalltalk
13. Guest Lecture — *Einblicke in die Praxis*
14. *Final Exam*

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What is the hardest part of programming?

What constitutes programming?

> Understanding requirements
> Design
> Testing
> Debugging
> Developing data structures and algorithms
> User interface design
> Profiling and optimization
> Reading code
> Enforcing coding standards
> ...

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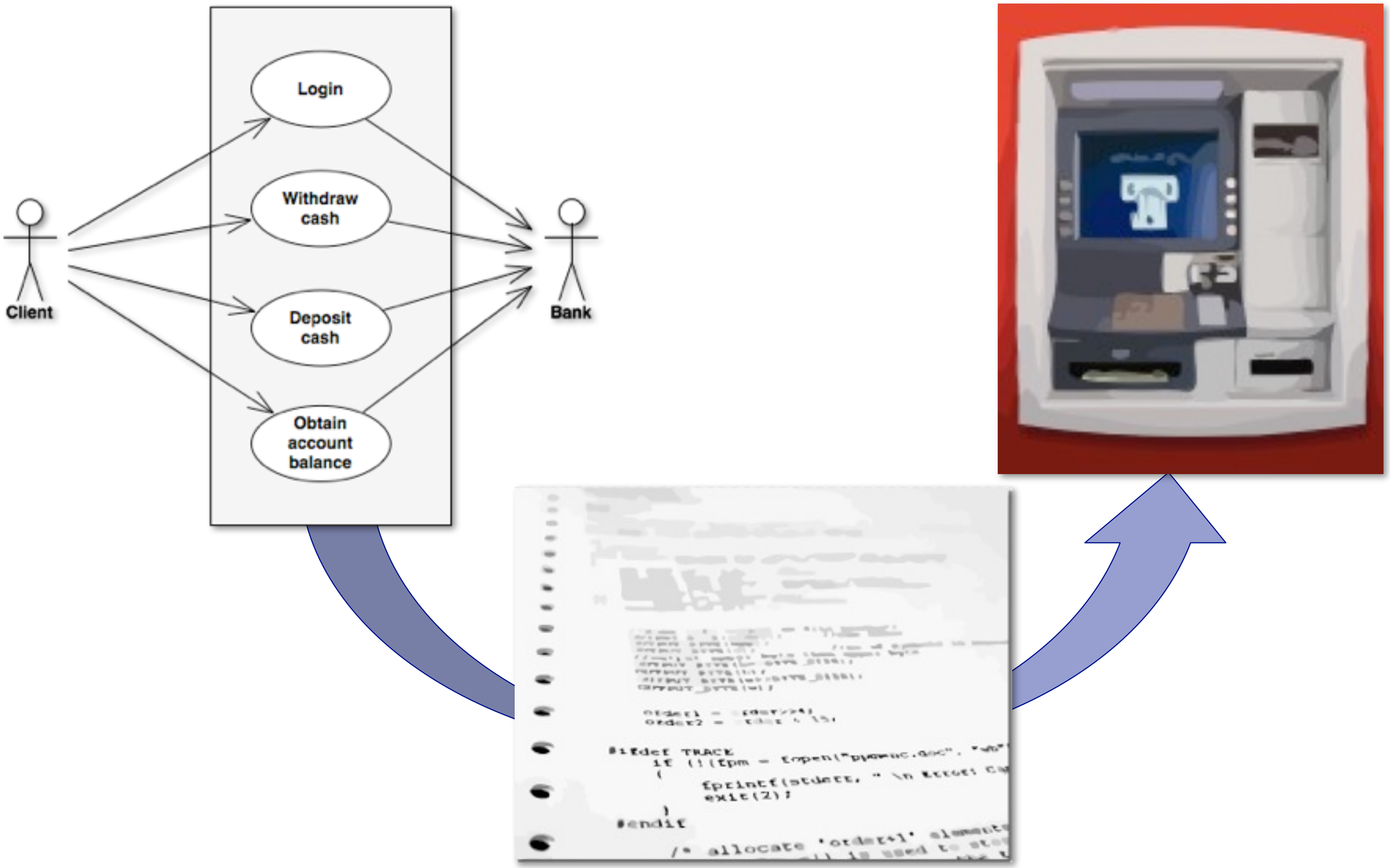
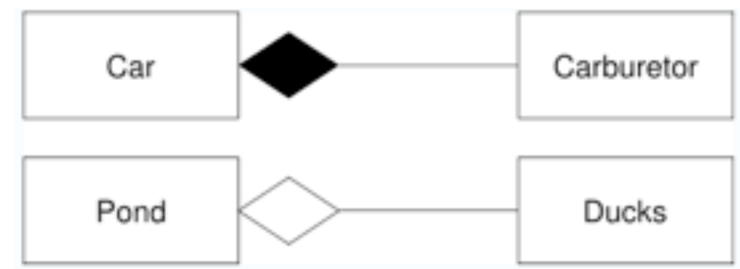
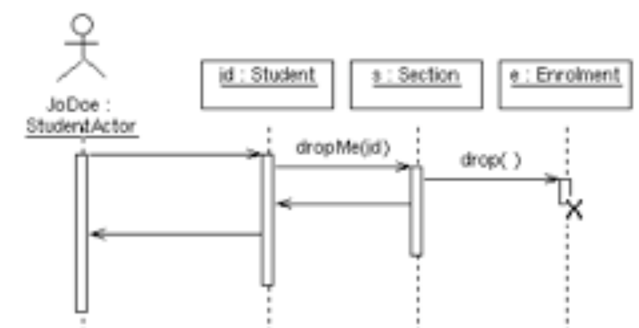
Programming is modeling

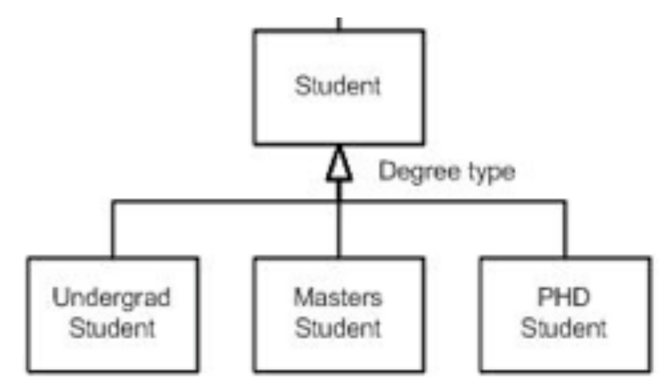


What is Object-Oriented Programming?

Encapsulation	**Abstraction & Information Hiding**
Composition	**Nested Objects**
Distribution of Responsibility	***Separation of concerns (e.g., HTML, CSS)***
Message Passing	***Delegating responsibility***
Inheritance	***Conceptual hierarchy, polymorphism and reuse***





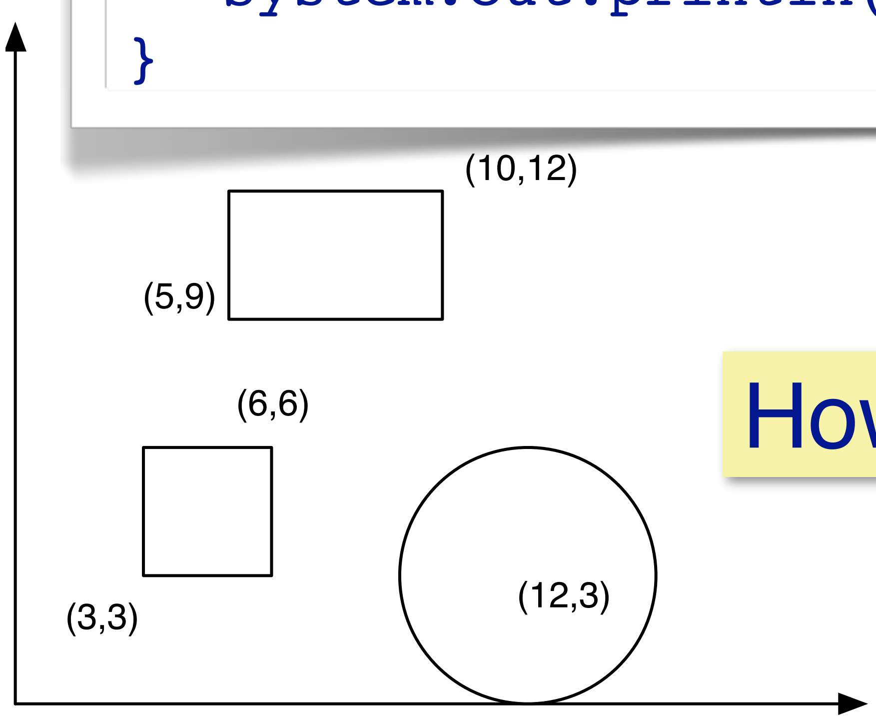


Procedural versus OO designs

Problem: compute the total area of a set of geometric shapes

```
public static void main(String[] args) {
   Picture myPicture = new Picture();
   myPicture.add(new Square(3,3,3));         // (x,y,width)
   myPicture.add(new Rectangle(5,9,5,3));  // (x,y,width,height)
   myPicture.add(new Circle(12,3,3));        // (x,y,radius)

   System.out.println("My picture has size " + myPicture.size());
}
```



How to compute the size?

Procedural approach: *centralize* computation

```
double size() {
    double total = 0;
    for (Shape shape : shapes) {
        switch (shape.kind()) {
        case SQUARE:
            Square square = (Square) shape;
            total += square.width * square.width;
            break;
        case RECTANGLE:
            Rectangle rectangle = (Rectangle) shape;
            total += rectangle.width * rectangle.height;
            break;
        case CIRCLE:
            Circle circle = (Circle) shape;
            total += java.lang.Math.PI * circle.radius * circle.radius / 2;
            break;
        }
    }
    return total;
}
```

Object-oriented approach: *distribute* computation

```
double size() {
    double total = 0;
    for (Shape shape : shapes) {
        total += shape.size();
    }
    return total;
}
```

```
public class Square extends Shape {
...
    public double size() {
        return width*width;
    }
}
```

What are the advantages and disadvantages of the two solutions?

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Object-Oriented Design in a Nutshell

- Identify *minimal* requirements
- Make the requirements *testable*
- Identify objects and their *responsibilities*
- Implement and *test* objects
- Refactor to *simplify* design
- Iterate!

Responsibility-Driven Design

> Objects are responsible to *maintain information and provide services*

> A good design exhibits:
> — *high cohesion* of operations and data within classes
> — *low coupling* between classes and subsystems

> Every method should perform *one, well-defined task:*
> — High level of abstraction — write to an interface, not an implementation

Design by Contract

- Formalize client/server contract as *obligations*
- Class invariant — formalize valid state
- Pre- and post-conditions on all public services
  - —*clarifies responsibilities*
  - —*simplifies design*
  - —*simplifies debugging*

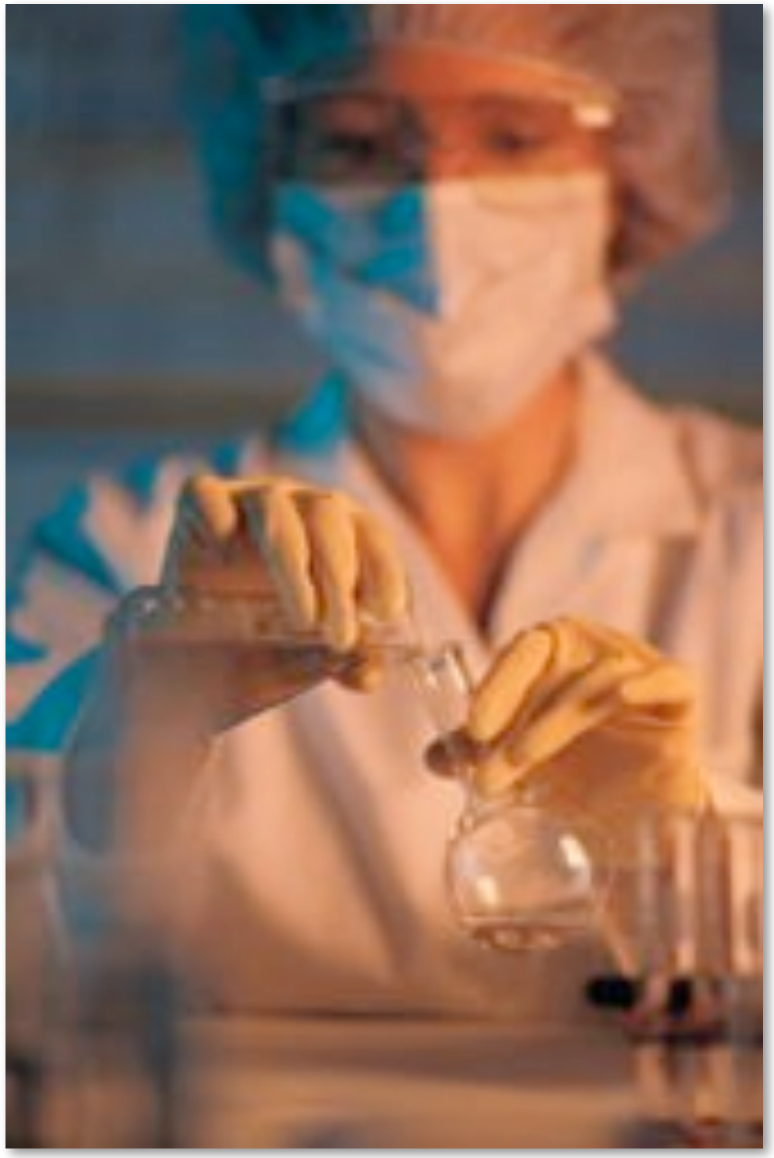
Extreme Programming

Some key practices:

> Simple design
>
> —*Never anticipate functionality that you “might need later”*
>
> Test-driven development
>
> —*Only implement what you test!*
>
> Refactoring
>
> —*Aggressively simplify your design as it evolves*
>
> Pair programming
>
> —*Improve productivity by programming in pairs*

Testing

> Formalize requirements
> Know when you are done
> Simplify debugging
> Enable changes
> Document usage



Code Smells

> Duplicated code
> Long methods
> Large classes
> Public instance variables
> No comments
> Useless comments
> Unreadable code
> …

Refactoring

> *"Refactoring is the process of **rewriting** a computer program or other material to improve its structure or readability, while explicitly **keeping its meaning** or behavior."*
>
> — *wikipedia.org*

Common refactoring operations:

> Rename methods, variables and classes
> Redistribute responsibilities
> Factor out helper methods
> Push methods up or down the hierarchy
> Extract class
> …

Design Patterns

"a general repeatable solution to a commonly-occurring problem in software design."

Example

- Adapter — "adapts one interface for a class into one that a client expects."

Patterns:

- Document "best practice"
- Introduce standard vocabulary
- Ease transition to OO development

But …

- May increase flexibility at the cost of simplicity

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Why Java?

Special characteristics

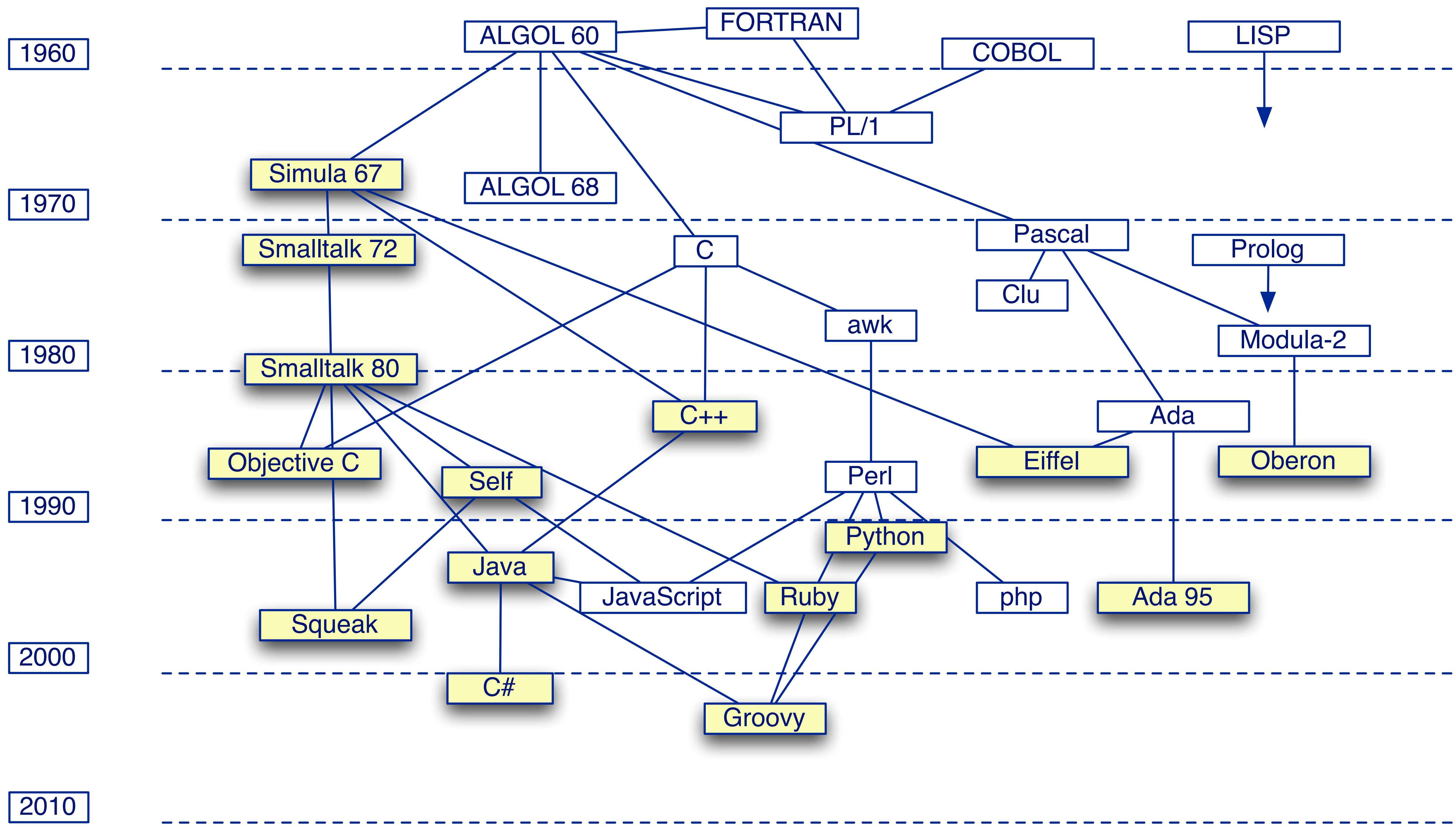
> Resembles C++ minus the complexity
> Clean integration of many features
> Dynamically loaded classes
> Large, standard class library

Simple Object Model

> “Almost everything is an object”
> No pointers
> Garbage collection
> Single inheritance; multiple subtyping
> Static and dynamic type-checking

Few innovations, but reasonably clean, simple and usable.

History



1960
1970
1980
1990
2000
2010
ALGOL 60
FORTRAN
COBOL
LISP
PL/1
Simula 67
ALGOL 68
Smalltalk 72
C
Pascal
Prolog
Clu
awk
Modula-2
Smalltalk 80
C++
Ada
Objective C
Self
Perl
Eiffel
Oberon
Python
Java
JavaScript
Ruby
php
Ada 95
Squeak
C#
Groovy

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Programming Tools

Know your tools!

- —IDEs (Integrated Development Environment)— e.g., Eclipse,
- —Version control system — e.g., svn,cvs, rcs
- —Build tools — e.g., maven, ant, make
- —Testing framework — e.g., Junit
- —Debuggers — e.g., jdb
- —Profilers — e.g., java -prof, jip
- —Document generation — e.g., javadoc

Version Control Systems

A version control system keeps track of multiple file revisions:

> *check-in* and *check-out* of files
> *logging changes* (who, where, when)
> *merge* and *comparison* of versions
> *retrieval* of arbitrary versions
> *"freezing"* of versions as releases
> *reduces storage space* (manages sources files + multiple *"deltas"*)

Version Control

Version control enables you to make radical changes to a software system, with the assurance that ***you can always go back*** to the last working version.

✎ When should you use a version control system?

✔ *Use it whenever you have one available, for even the **smallest project!***

*Version control is as **important** as **testing** in iterative development!*

What you should know!

- ✎ *What is meant by “separation of concerns”?*
- ✎ *Why do real programs change?*
- ✎ *How does object-oriented programming support incremental development?*
- ✎ *What is a class invariant?*
- ✎ *What are coupling and cohesion?*
- ✎ *How do tests enable change?*
- ✎ *Why are long methods a bad code smell?*

Can you answer these questions?

- ✎ *Why does up-front design increase risk?*
- ✎ *Why do objects “send messages” instead of “calling methods”?*
- ✎ *What are good and bad uses of inheritance?*
- ✎ *What does it mean to “violate encapsulation”?*
- ✎ *Why is strong coupling bad for system evolution?*
- ✎ *How can you transform requirements into tests?*
- ✎ *How would you eliminate duplicated code?*
- ✎ *When is the right time to refactor your code?*