Architektur II
Principles

TU-Wien, Sommersemester 2003
Rudolf Lewandowski

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Principles of Object Oriented Class Design

- (OCP) Open Closed Principle
- (LSP) Liskov Substitution Principle
- (DIP) The Dependency Inversion Principle
- (ISP) The Interface Segregation Principle
- (LOD) Law of Demeter

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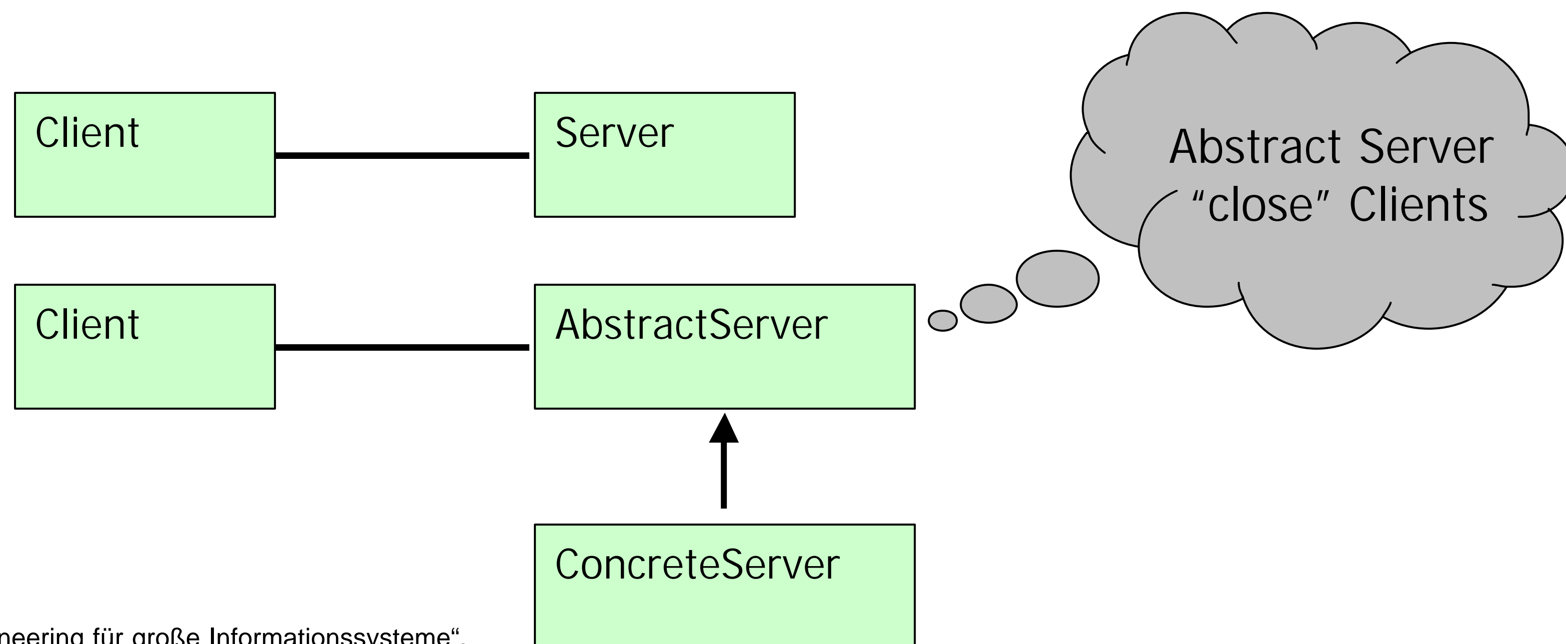
(OCP) Open Closed Principle

Bertrand Meyer

- A module is said to be open if it is still available for extensions.
- A module is said to be closed if it is available for use by other modules.



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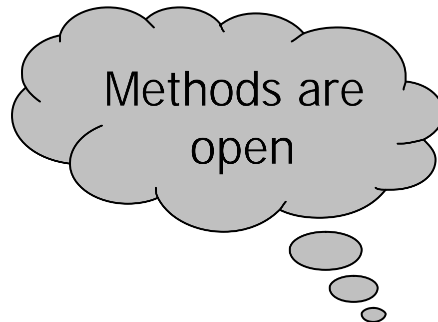
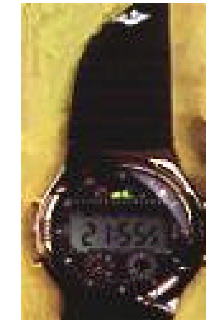
(OCP)
Open Closed Principle





```
Watch>>upperButtonClicked
        self state = #stopwatch ifTrue: [self startStopwatch].
        self state = #time ifTrue: [self showDate].
        self state = #set ifTrue: [self inrementTime]

Watch>>lowerButtonClicked
        self state = #stopwatch ifTrue: [self stopStopwatch].
        self state = #time ifTrue: [self showTime].
        self state = #set ifTrue: [self decrementTime]
```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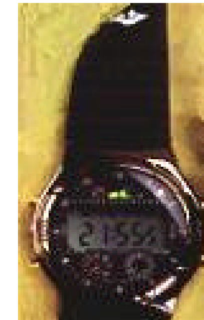
(OCP)
Open Closed Principle



- This Implementation cannot be closed.
  In an complex Application this "switch/case" Statement is repeated over and over.
- These statements are difficult to find, and it is easy to make mistakes when modifying them.
- Worse, every module that contains such a "switch/case" Statement retains a dependency upon every possible state the watch can be.
- The if statements are usually seldom so clean and nice as those shown.
- All methods have to be updated for each new state added.

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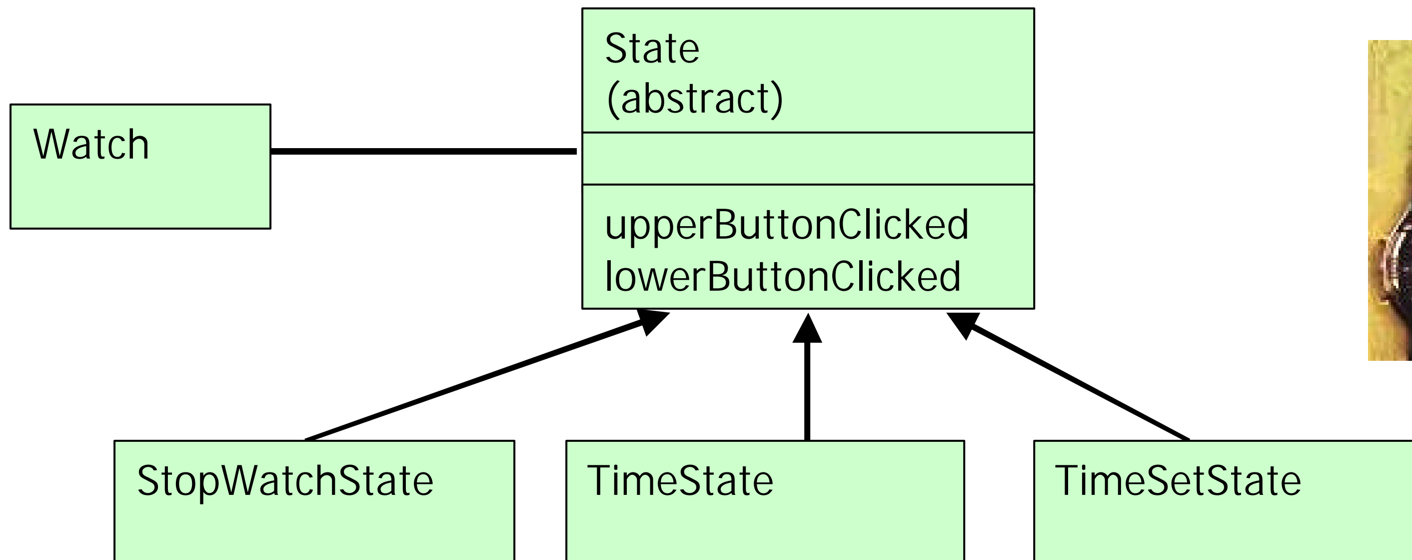
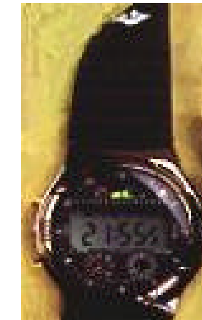
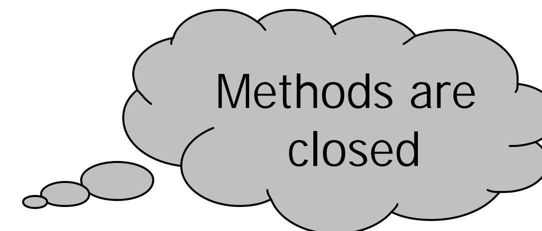
(OCP)
Open Closed Principle





```
Watch>>upperButtonClicked
        self state upperButtonClicked

Watch>>lowerButtonClicked
        self state lowerButtonClicked
```



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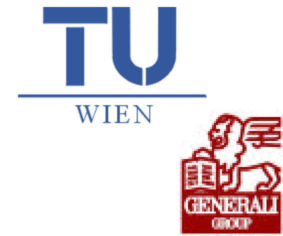
(LSP) Liskov Substitution Principle

Barbara Liskov



"What we want here is something like the following substitution property: If for each object o1 of type S there is an object o2 of type T such that all programs P defined in terms of T, the behavior of P is unchanged when o1 is substituted for o2 then S is a subtype of T."

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(LSP)
Liskov Substitution Principle

- Derived Classes must be usable through the base class interface without the need for the client to know the difference.
  - All derived classes must be suitable for their base classes
  - This principle guides us in the creation of abstractions

- If derived Classes are not suitable for their base classes then implementation within clients is often open.

```
...
aParameter class = BaseClass
    ifTrue: [...]
    ifFalse: [...]
```


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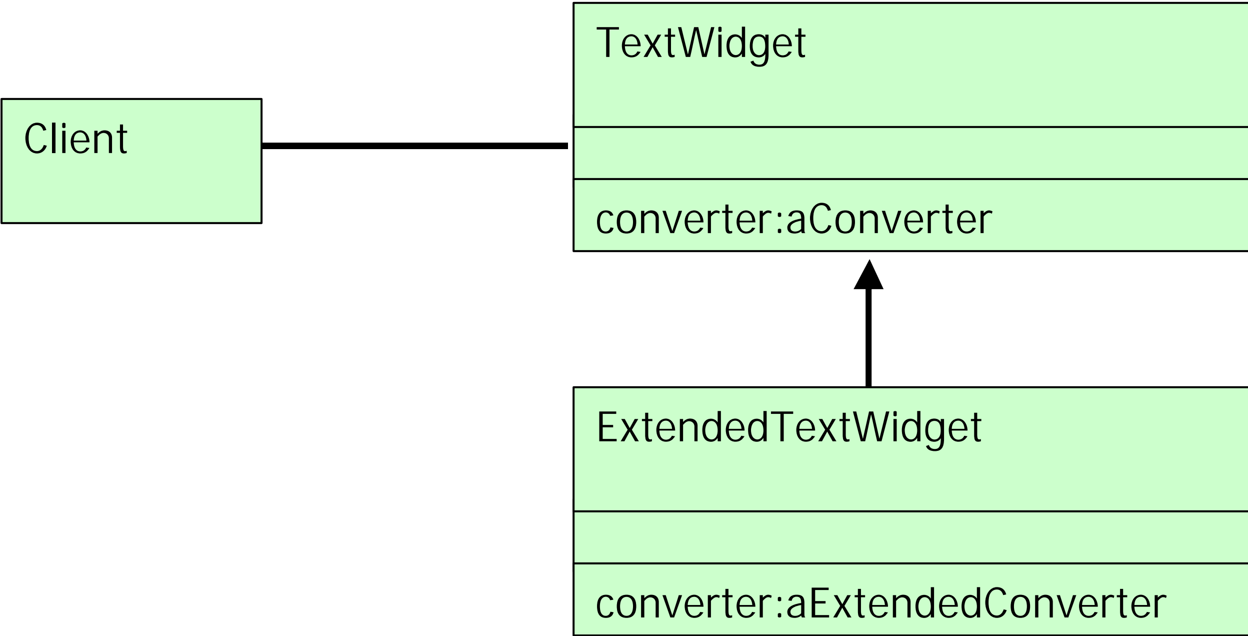
(LSP)
Liskov Substitution Principle



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(LSP)
Liskov Substitution Principle

- Design by Contracts (Assertions)
  - Precondition can be weakened in Subtypes
  - Postconditions can be strengthened in Subtypes
- Parametertypes of methods of Subtypes can only be of same type or one of its base types (Contravariant)

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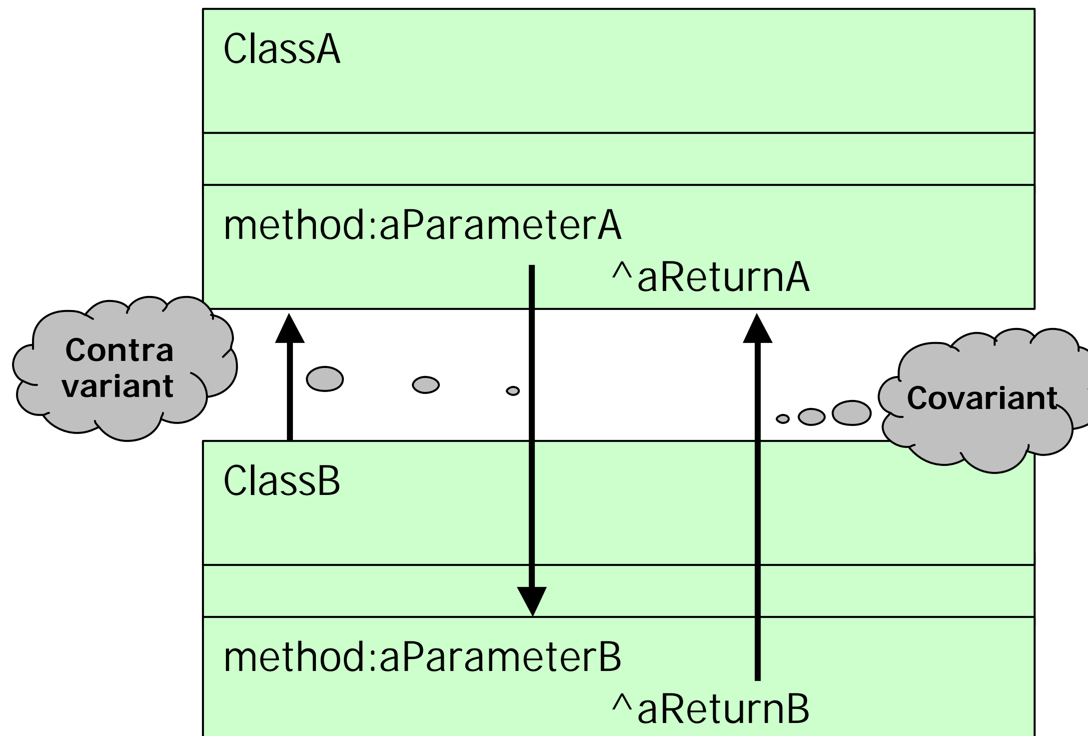
(LSP)
Liskov Substitution Principle



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(LSP) Liskov Substitution Principle

	When S is substitutable for T (polymorphism)			
	Must S subclass from T?	For S>>m to be consistent with T>>m		
		Return types	Argument Types	Behavioral Conditions
C++	Yes	Covariant	Must agree	n/a
Eiffel	Yes	Covariant	Covariant	May weaken preconditions or strengthen postconditions
Emerald	No	Covariant	Contravariant	n/a
Java	No	Covariant	Must agree	n/a
Modula-3	Yes	Must agree	Must agree	May raise fewer exceptions
POOL-I	No	Covariant	Contravariant	May have more "properties"
Smalltalk	No	No restriction	No restriction	n/a
Theoretical ideal	No	Covariant	Contravariant	May weaken preconditions or strengthen postconditions

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(DIP) The Dependency Inversion Principle

Robert Martin

- Details should depend upon abstractions. Abstractions should not depend upon details.

But: In Structured Analysis Structured Design High level Structures are decomposed into smaller ones. So these Structures depend on lower level ones.

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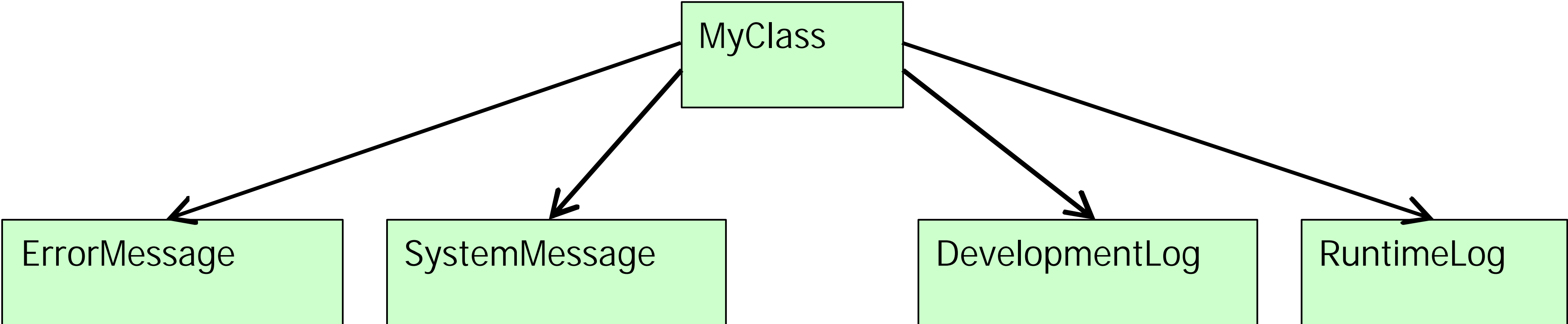
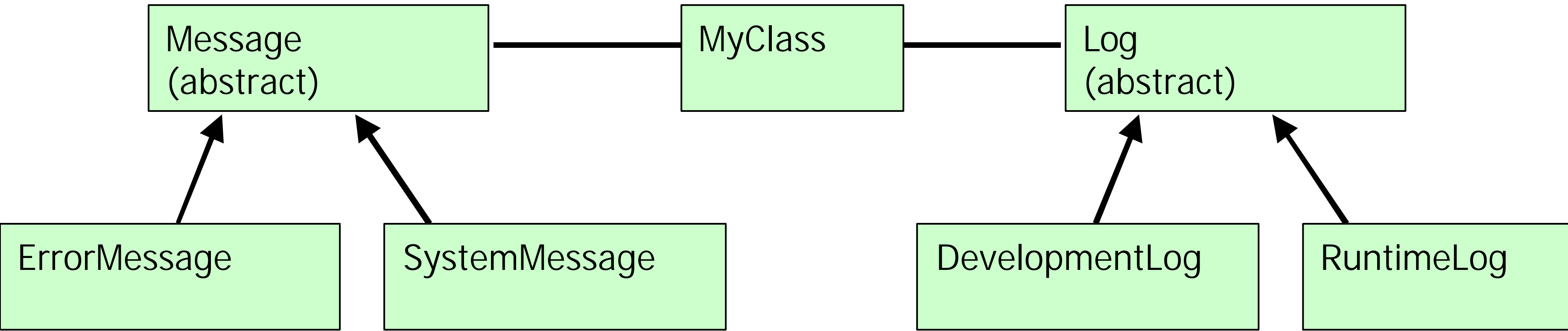
(DIP)
The Dependency Inversion Principle





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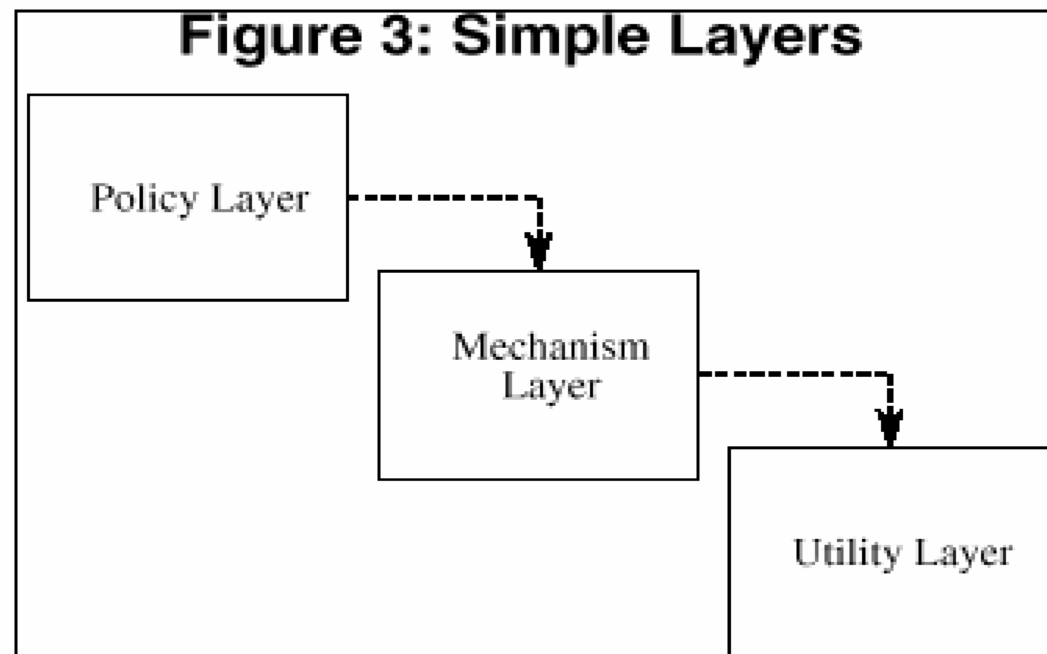
(DIP)
The Dependency Inversion Principle

- High level modules should not depend on low level modules

Grady Booch



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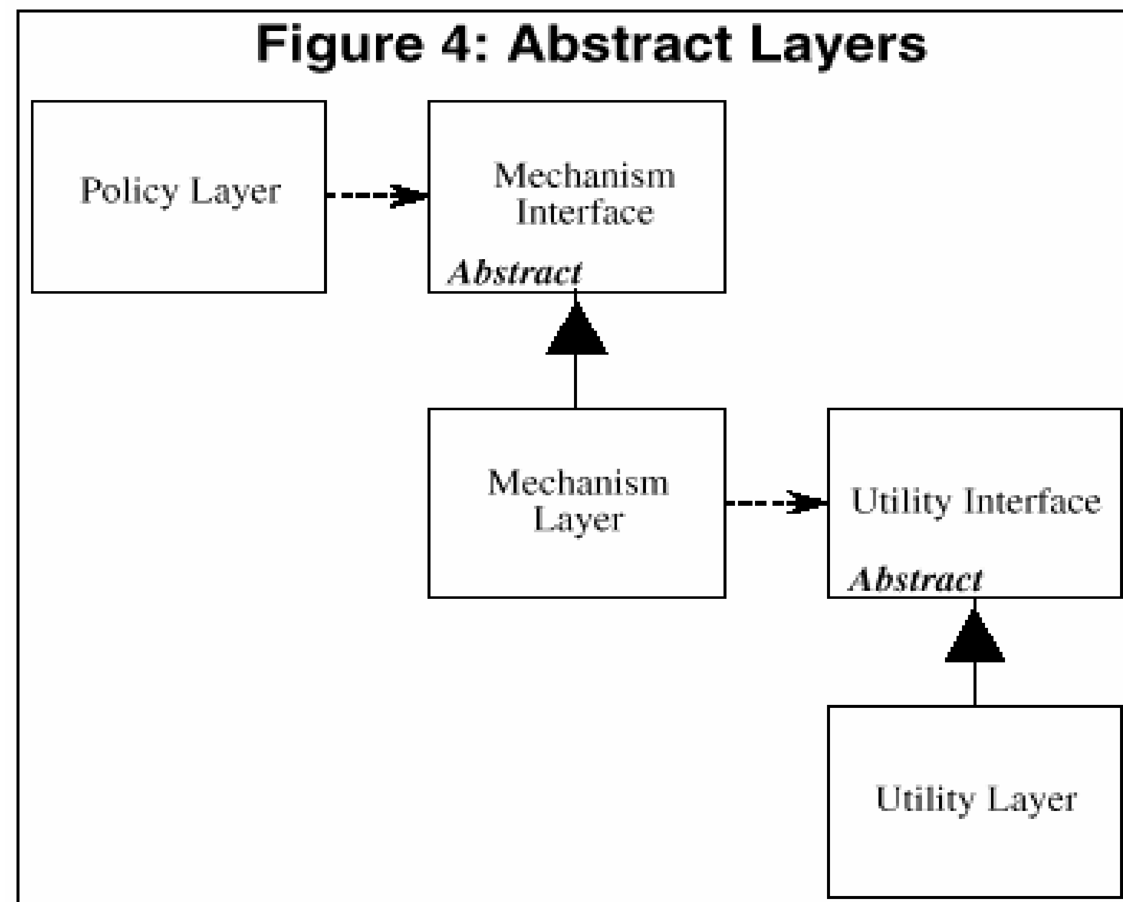
(DIP)
The Dependency Inversion Principle



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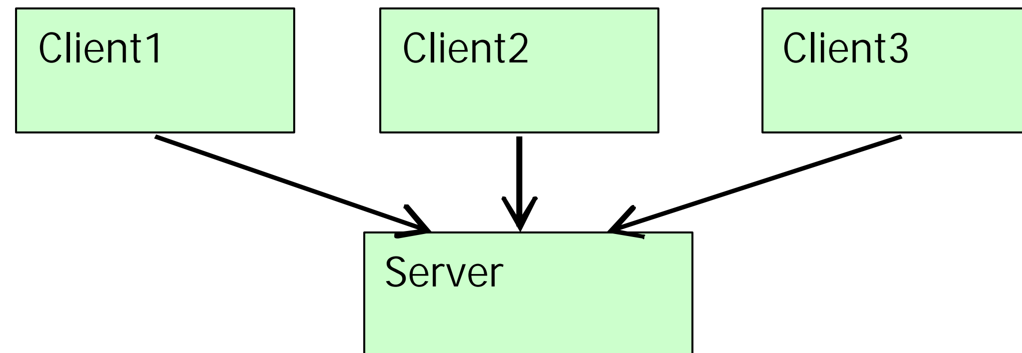
(ISP)
The interface Segregation Principle

- Clients should not depend on interfaces they do not use



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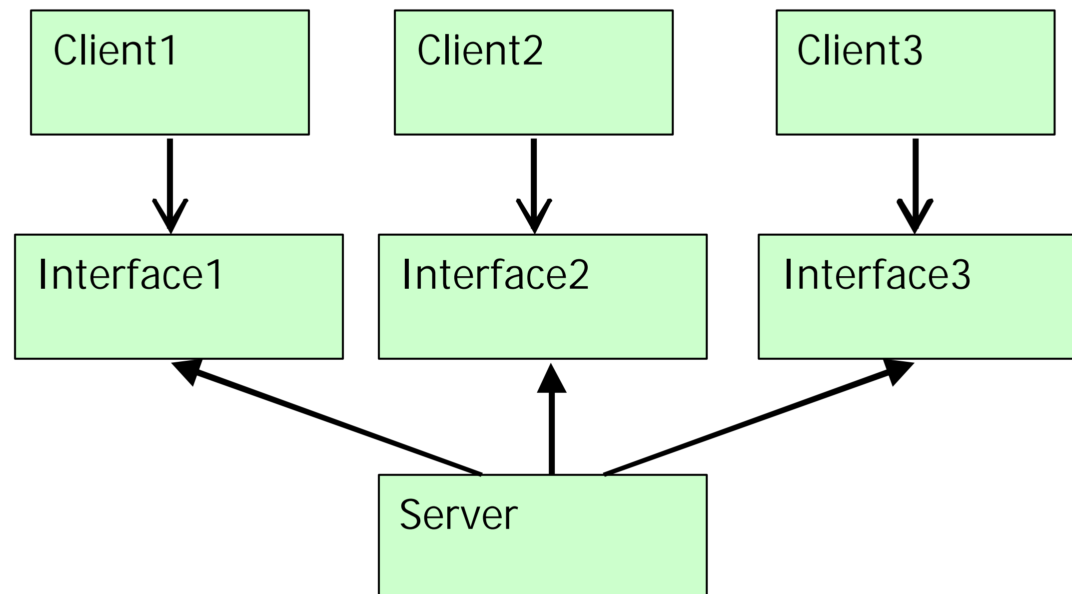
(ISP)
The interface Segregation Principle



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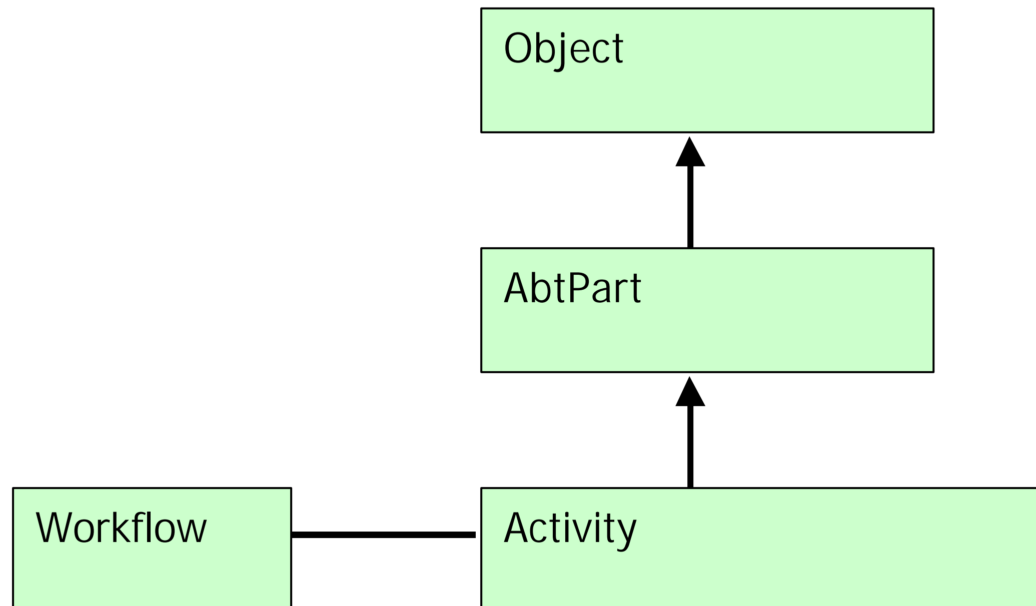
(ISP)
The interface Segregation Principle

- Smalltalk: Clients should not depend on interfaces they do not use



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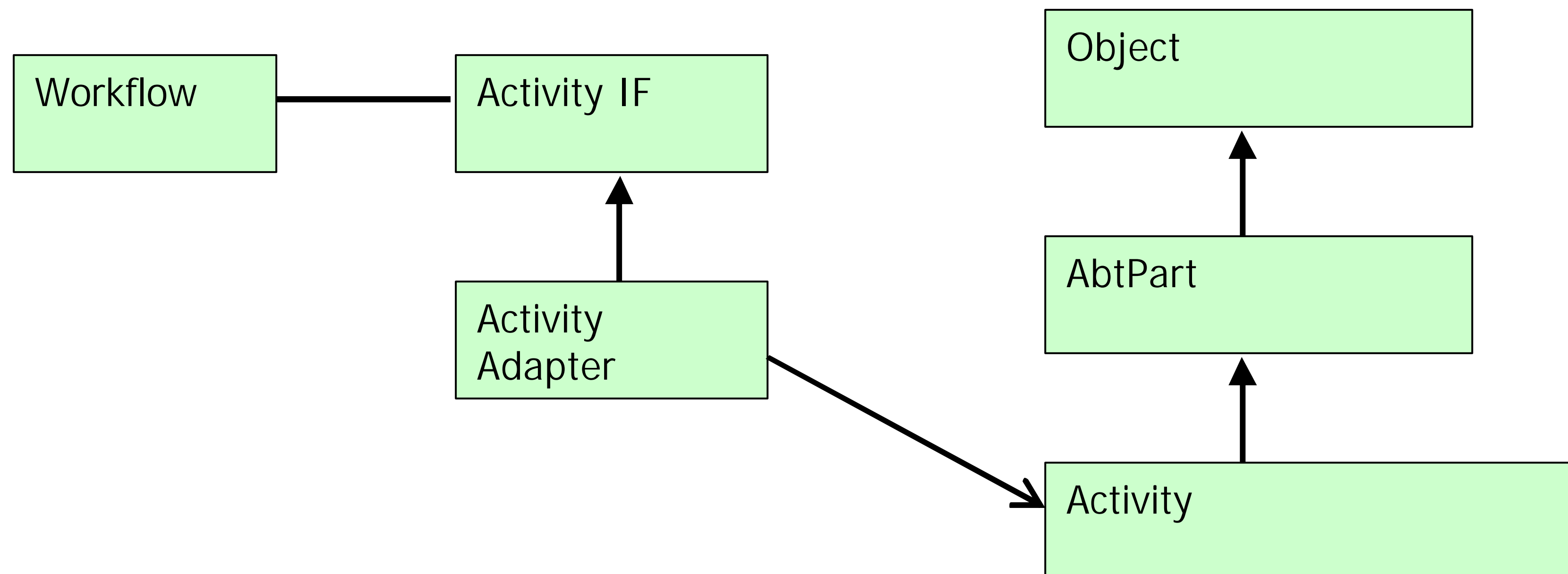
(ISP)
The interface Segregation Principle

- Use Adapters



Vorlesung „Software Engineering für große Informationssysteme“,
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(LOD) Law of Demeter

Karl J. Lieberherr

- Each unit should only use a limited set of other units: only units “closely” related to the current unit.
- “Each unit should only talk to its friends.” “Don’t talk to strangers.”
- Main Motivation: Control information overload. We can only keep a limited set of items in short-term memory.

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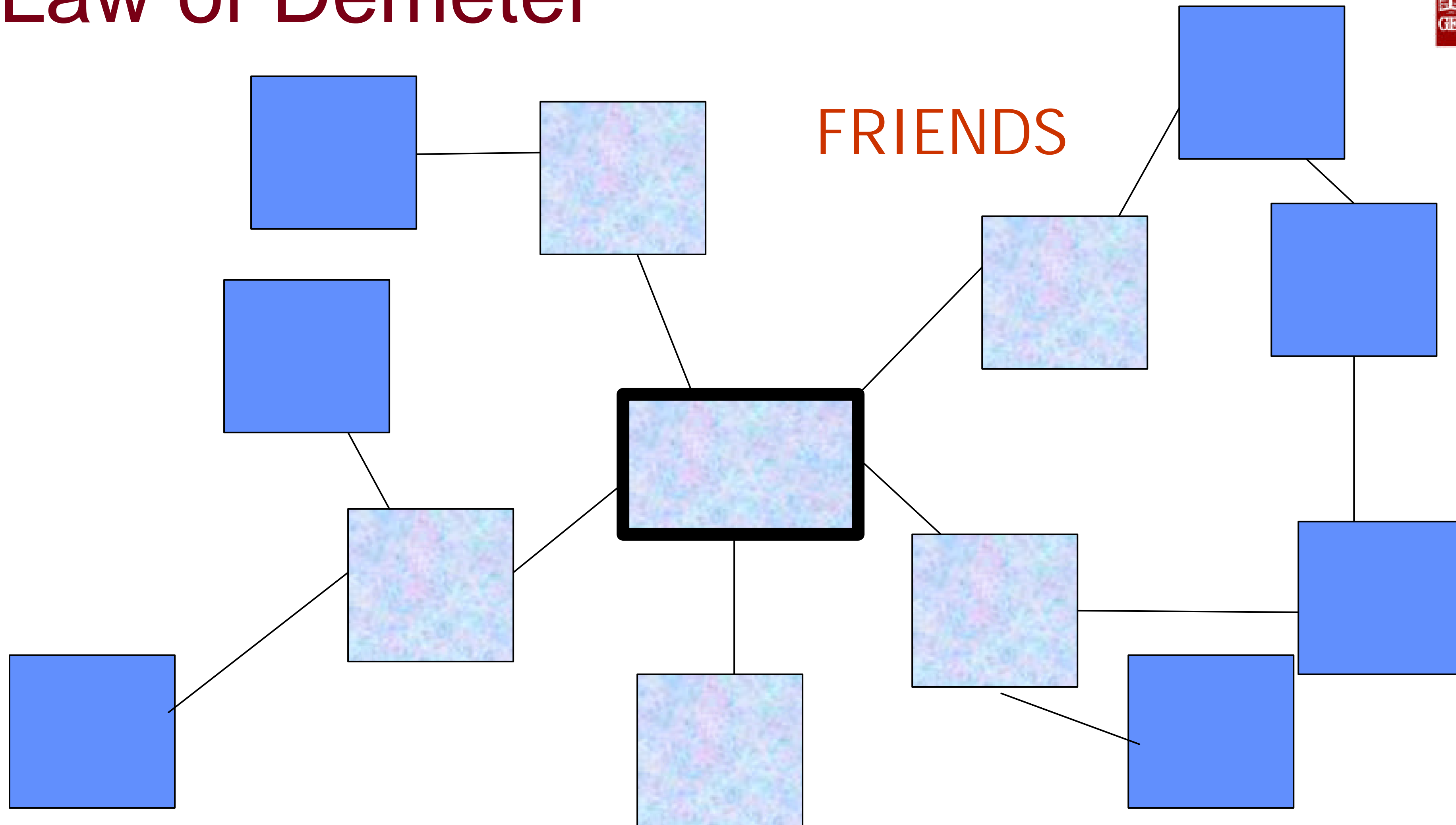
(LOD)
Law of Demeter



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(LOD)
Law of Demeter

- A Method of a Class may use
  - its Parameters
  - instance Variables
  - local Variables
  - Global Variables
- A method should have limited knowledge of an object model.

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Principles of Object Oriented Package Design

- (REP) The Reuse Release Principle
- (CCP) Common Closure Principle
- (CRP) Common Reuse Principle

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(REP)
The Reuse Release Principle

- Main Unit of reuse is the Module
- Expectations
  - Documentation
  - Accuracy
  - Maintenance
  - Predictability
- Reusers expect Release Control

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(REP)
The Reuse Release Principle

- Single Classes are seldom reusable
- Unreleased modules cannot be reused
- So the granularity of reuse is the granularity of release

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(CCP) Common Closure Principle

- The classes in a package should be closed together against the same kinds of changes. A change that affects a package affects all the classes in that package
- If two classes are so tightly bound together, either physically or conceptually, such that the almost always change together; then they should belong to the same package

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(CCP)
Common Closure Principle

- Recompilation issues (e.g. C++)
- A package is cohesive, if the classes within it are all closed to the same kind of modification.
- When this principle can be achieved, changes do not propagate through the system.
  - reduces frequency with which packages must be released

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(CRP)
Common Reuse Principle

- Classes within a package should be reused together
- Reuse creates a dependency upon the whole reused component
  - When a new release is created the package must be reintroduced
  - Users want each component as focused as possible

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Managing the development Environment

- (ADP) The Acyclic Dependencies Principle
- (SDP) The Stable Dependencies Principle
- (SAP) The Stable Abstractions Principle

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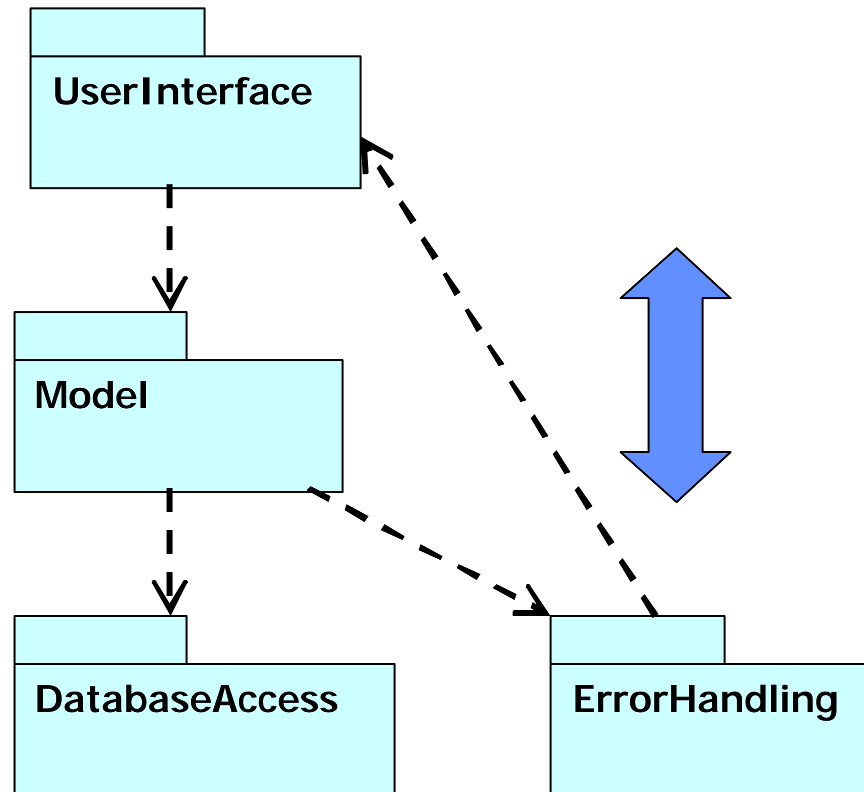
(ADP)
The Acyclic Dependencies Principle



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(ADP)
The Acyclic Dependencies Principle

- Smalltalk hides Cyclic Dependencies
  - unexpected Polymorphism
  - Smalltalk at:
  - perform:
  - Unallowed Class References
- All Applications of a cycle can only released together
- Inverse Dependencies
  - Callbacks
  - Events
  - Registry
  - Blocks

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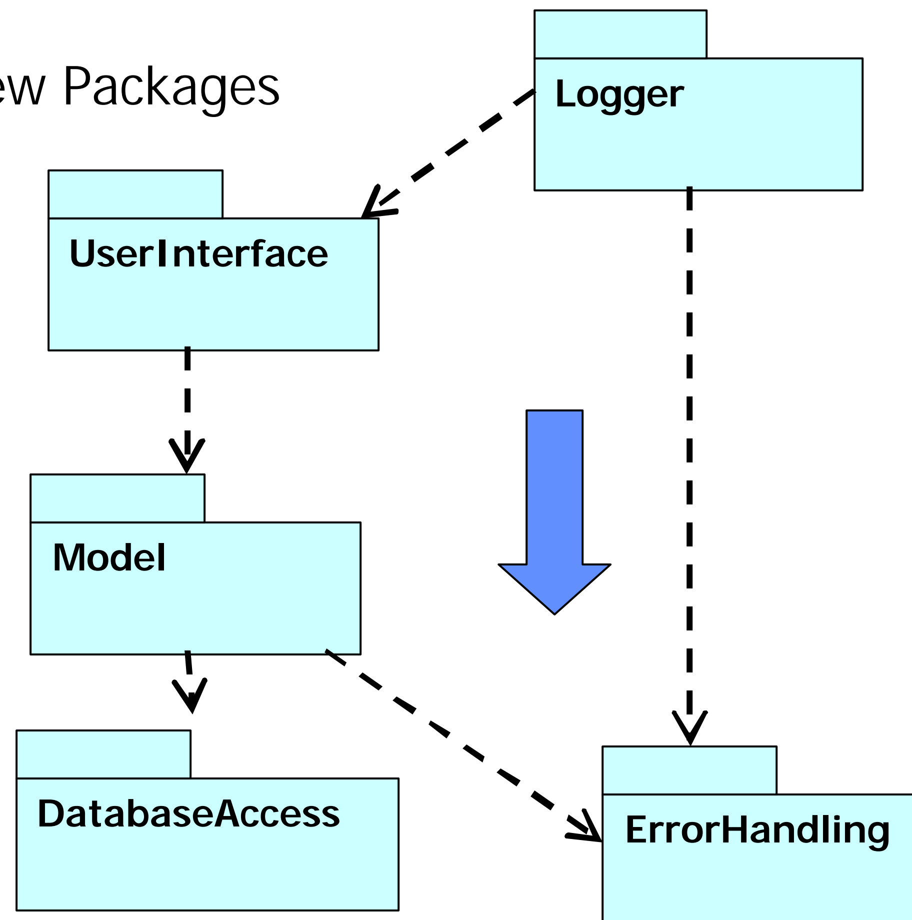
(ADP)
The Acyclic Dependencies Principle

Introduce new Packages



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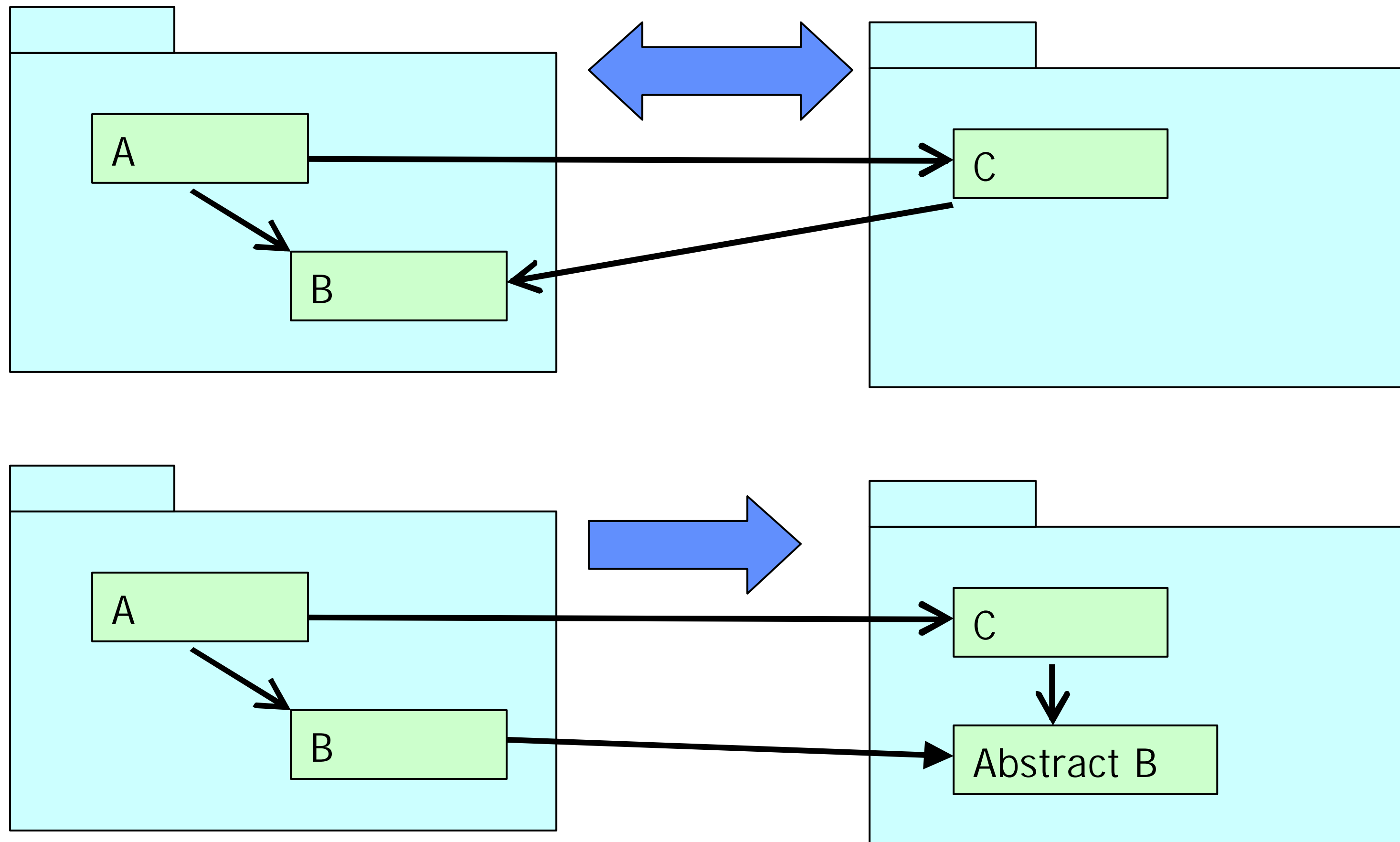
(ADP)
The Acyclic Dependencies Principle



Introduce new Abstract Classes

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(SDP)
The Stable Dependencies Principle

- Dependencies between released packages must run in the direction of stability. The dependee must be more stable than the depender
- The *Positional Instability* of a Package is
  - Ca (Affect Couplings) the number of classes outside the package depending on classes within the package.
  - Ce (Effect Coupling) the number of classes outside the package that classes within the package depend on.
  - I (Instability) = Ce / (Ce+Ca)

    0... ultimately stable

    1... Ultimately instable

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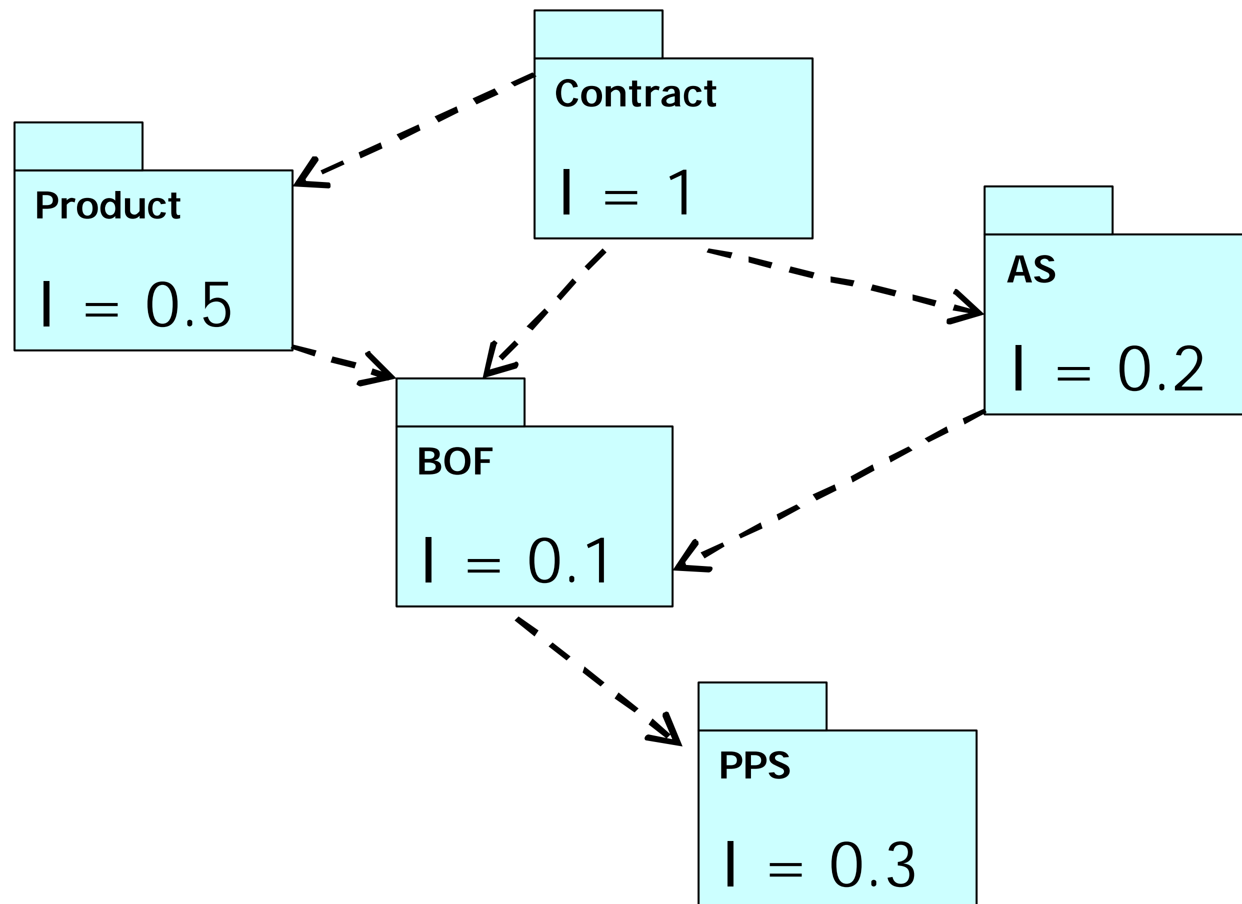
(SDP)
The Stable Dependencies Principle



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(SAP)
The Stable Abstractions Principle

- The more stable a package is , the more it must consist of abstract classes.
- A completely stable package should consist of nothing but abstract classes
- The A metric is The number of abstract classes divided by all classes of a package

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(SAP)
The Stable Abstractions Principle

- Stable high level designs
  - High level design decisions must be stable
  - We want high level design be flexible too
- Open Closed Principle provides a way
  - Abstractions can be stable (closed for modifications) and flexible (open for extensions)

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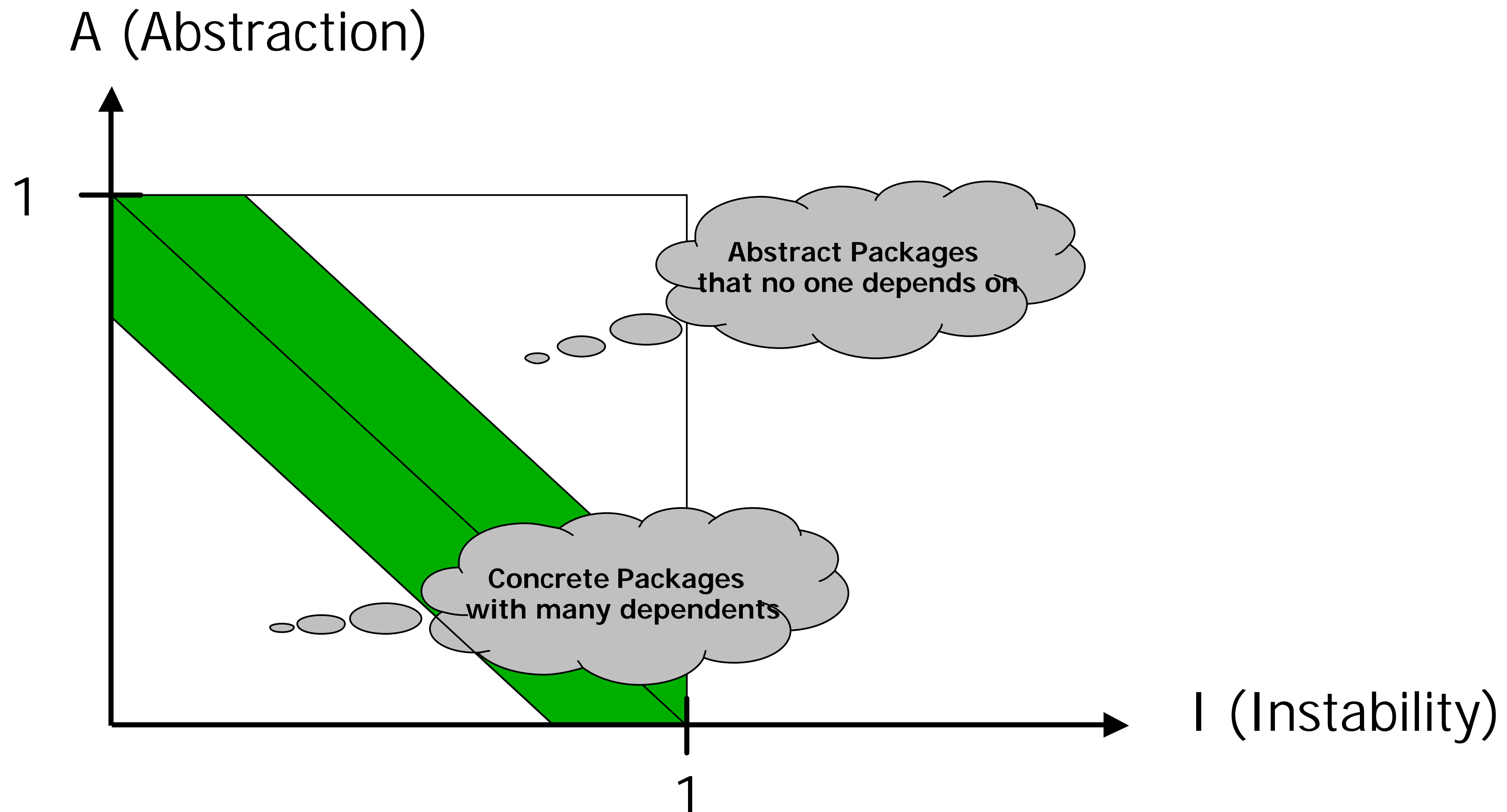
(SDP) vs.(SAP)
Stability vs. Abstraction



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