

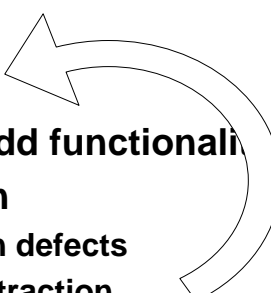
## Refactoring UML models

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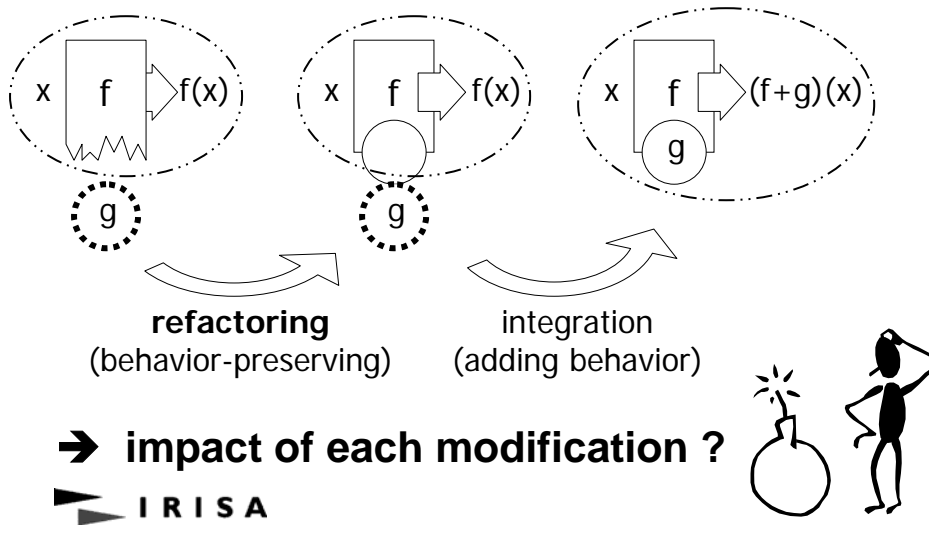


## Evolutionary software development

- Initial design
  - Evolution
    - Expansion: add functionality
    - Consolidation
      - .correct design defects
      - .introduce abstraction
- "iterative  
incremental  
use-case driven"
- 



## What is refactoring ?

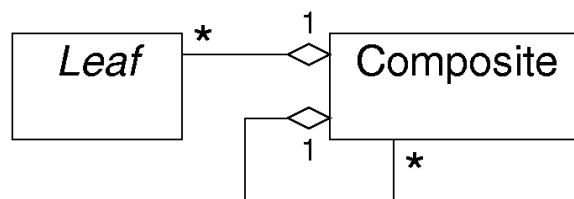


## Refactoring & UML ?

- **Source code refactoring :**
  - Opdyke, Brant, Roberts, Johnson...
  - Standard refactorings for Java available within Eclipse
- **Recent methods handle evolution**
  - XP, Joint Application Development...
  - Catalysis → UML

## Example of UML refactorings for Class diagrams

- renaming, signature changes
- structure modifications
- application of a design pattern:

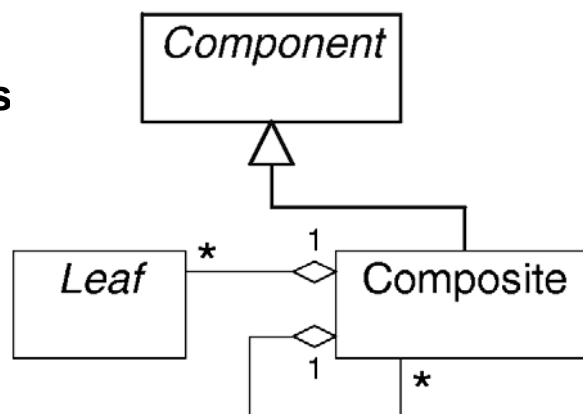


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## Class diagrams

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- add a new abstract superclass

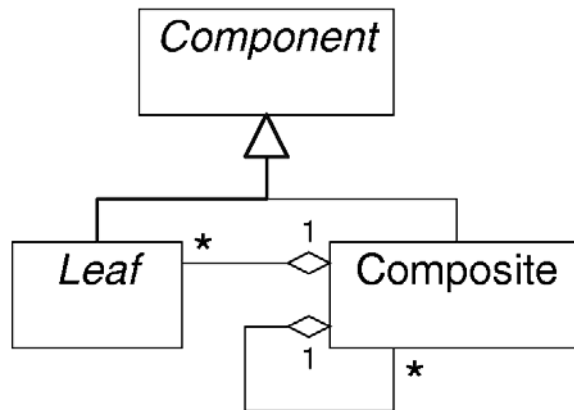


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## Class diagrams

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- make Leaf a subclass

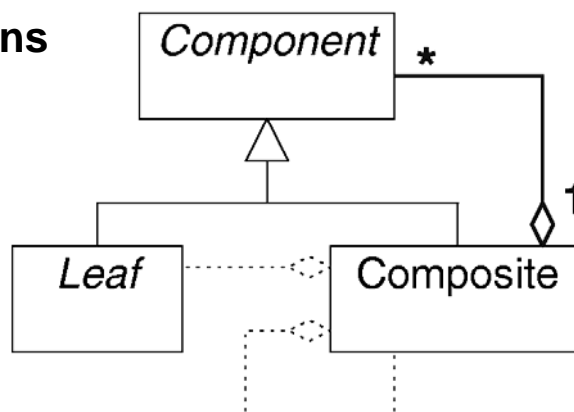


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## Class diagrams

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- merge the aggregations



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## Class diagram refactorings

Structural changes :

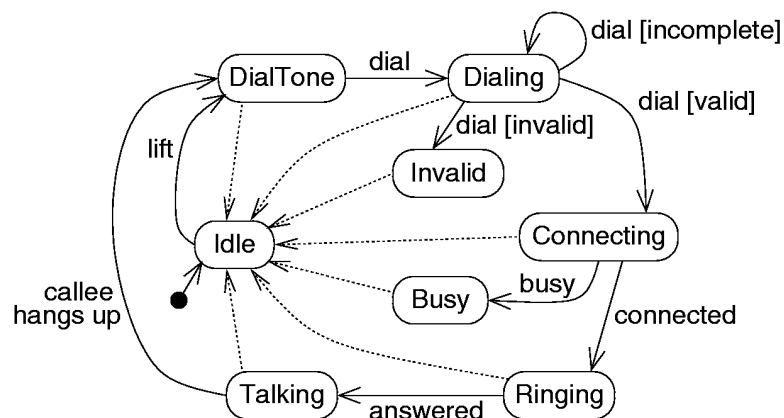
- add - remove - move - rename
- generalize - specialize
  - move through inheritance hierarchy
- merge Aggregations

→ design pattern introduction



## Statecharts

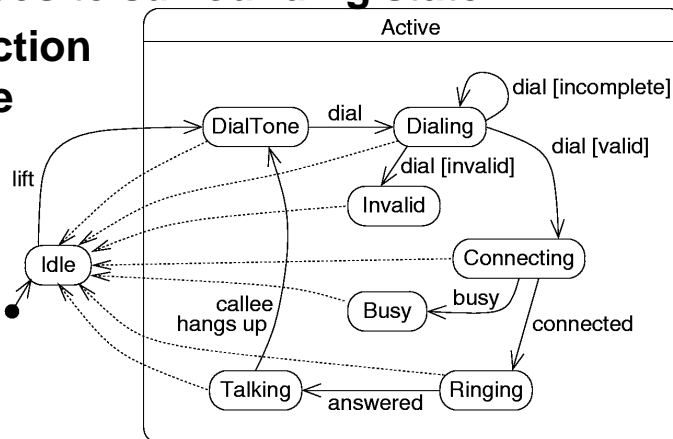
■ phone communication



# Statecharts

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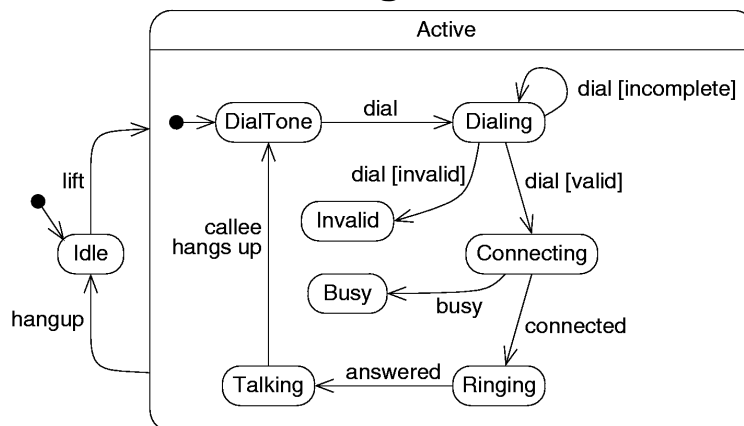
- Composite surrounding state
- extraction of Idle



# Statecharts

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- fold transitions to high-level



# Statechart refactorings

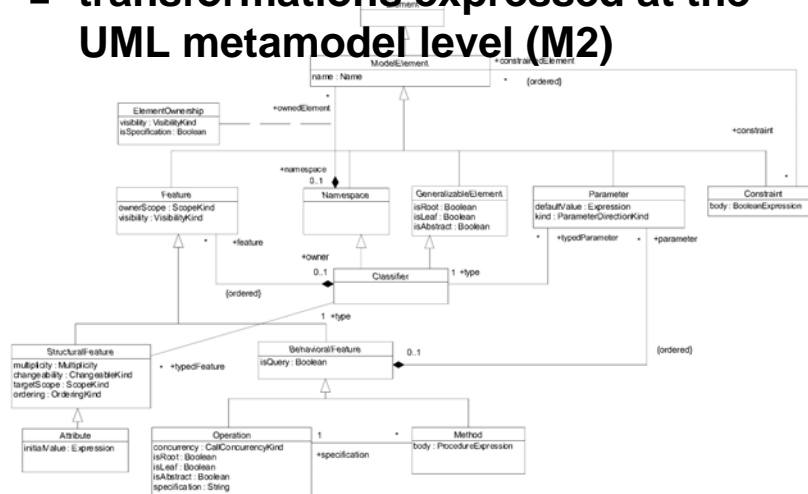
## Behavioral changes

- add, remove state
- (un)fold entry / exit actions
- (un)fold high-level transitions
- group into a composite
- move substate into / out of composite



# How UML refactoring works

- transformations expressed at the UML metamodel level (M2)



## Specification of refactorings

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- meta-level OCL
- preconditions
  - applicability (behavior preserved)
- postconditions
  - describe transformation effect
  - ensure respect of well-formedness rules



## Sample pre-post

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```
context Classifier :: addMethod(added : Method)
pre:
  added.parameter -> forAll(p1, p2 |
    p1.name=p2.name implies p1=p2) and
  sel f. allMethods().name -> excludes(added.name) and
  sel f. allOperations -> exists(op |
    op.hasSameSignature(sel f))
post:
  let m = sel f. allMethods() -> select(m |
    m.isEquivalentTo(added))
  in
  m -> notEmpty() and
  sel f. allOperations -> exists(m.specification)
```



# Conclusion

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- **UML model refactoring makes sense**
- **Initial set of UML refactorings...**
- **... to be expanded to other views**
  - collaborations, activity diagrams...
  - executable models (Action Semantics)
- **... to be widened**
  - less conservative, weaker preconditions
- **Tool support**
  - currently being implemented in Umlaut  
<http://modelware.irisa.fr>

