Refactoring UML models

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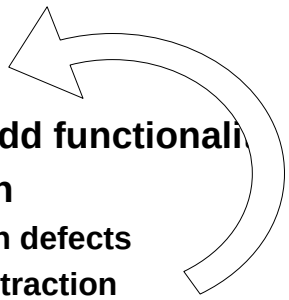
Evolutionary software development

- **Initial design**
- **Evolution**
  - **Expansion: add functionali**
  - **Consolidation**
    - **correct design defects**
    - **introduce abstraction**



"iterative incremental use-case driven"

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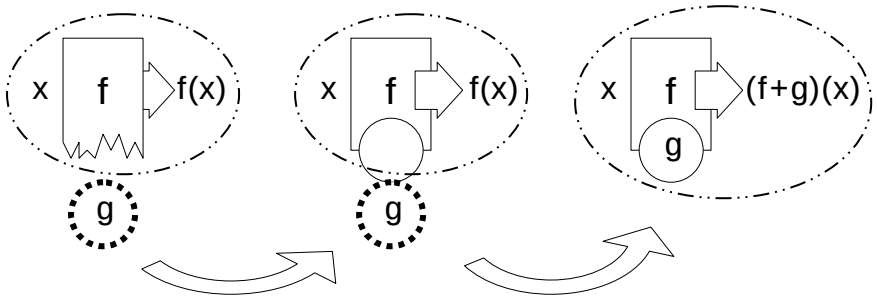
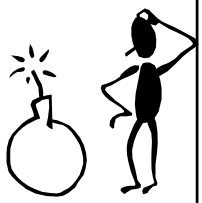
What is refactoring ?



refactoring
(behavior-preserving)

integration
(adding behavior)



➔ **impact of each modification ?**

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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**

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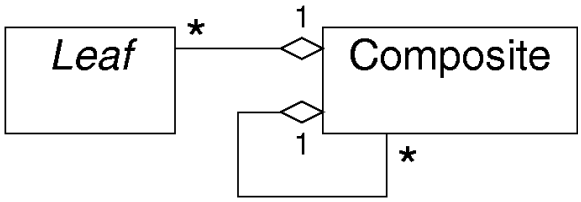
Example of UML refactorings for Class diagrams

- renaming, signature changes
- structure modifications

- application of a design pattern:



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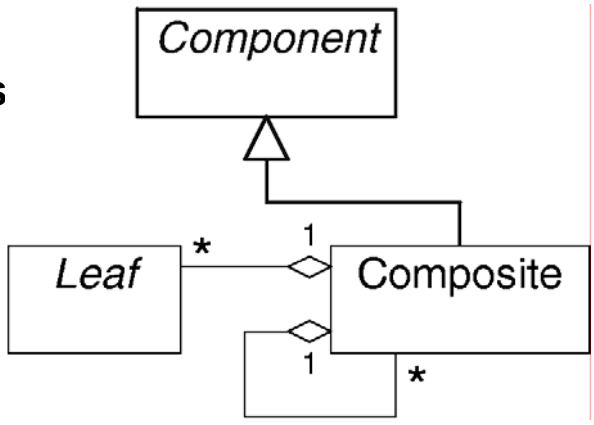
Class diagrams 2/4

- add a new abstract superclass



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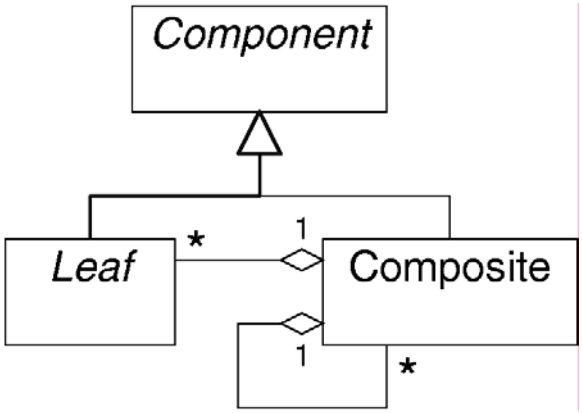
Class diagrams 3/4

- **make Leaf a subclass**



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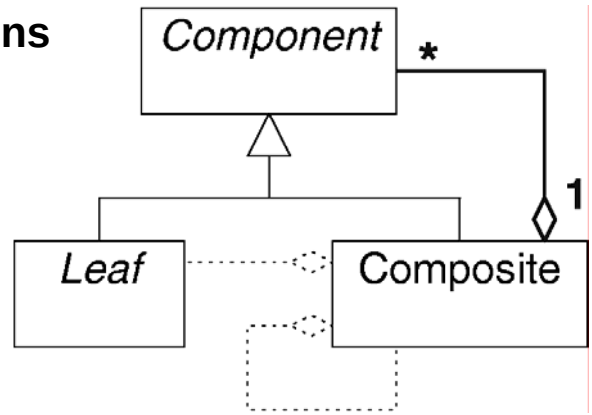
Class diagrams 4/4

- **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**

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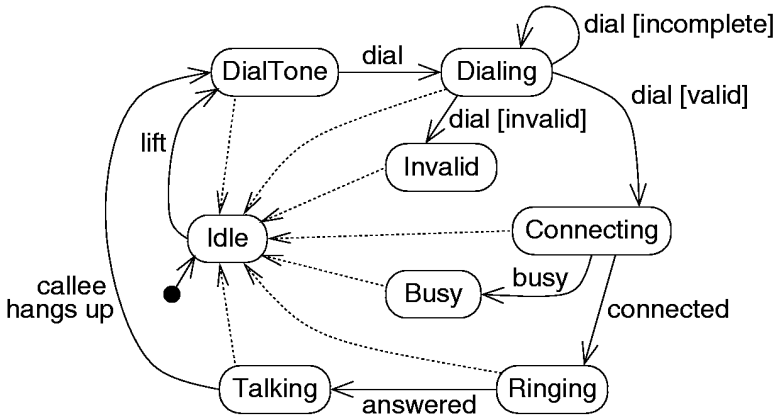
Statecharts

- **phone communication**



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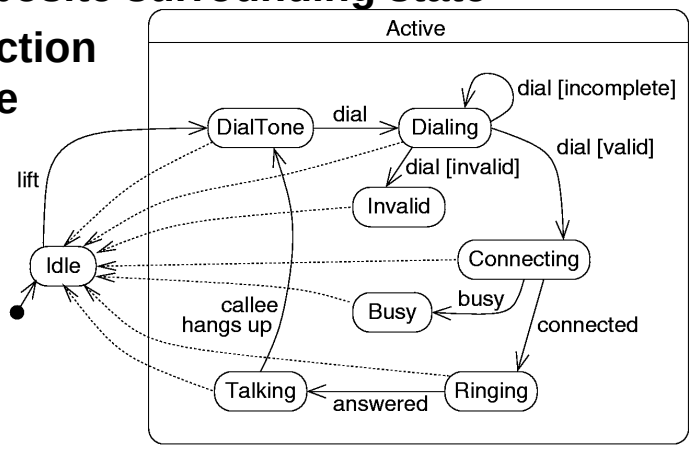
Statecharts 2/3

- **Composite surrounding state**
- **extraction of Idle**



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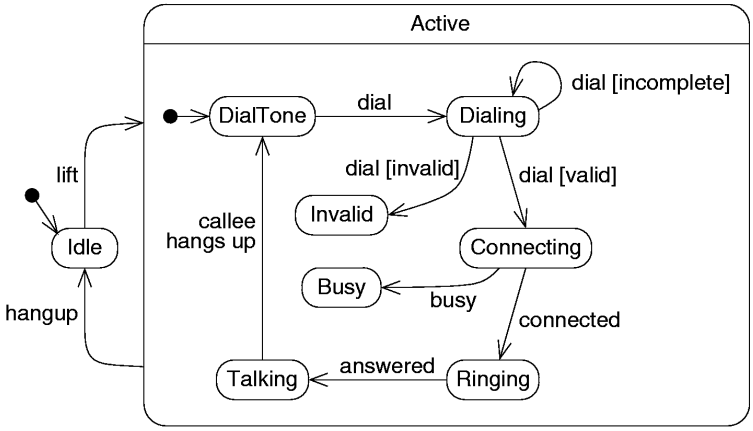
Statecharts 3/3

- **fold transitions to high-level**



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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**

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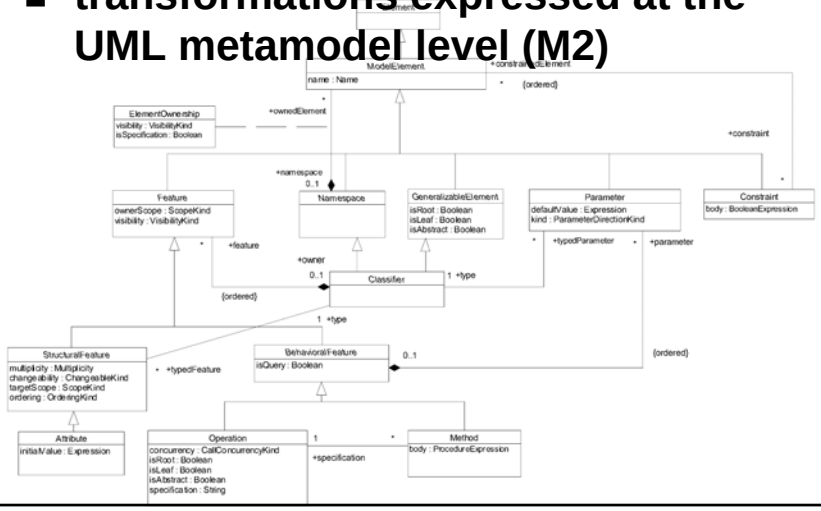
How UML refactoring works

- **transformations expressed at the UML metamodel level (M2)**



Specification of refactorings

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

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Sample pre-post

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

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Conclusion

- 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.inria.fr`

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