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Towards Unified Aspect-Oriented Programming

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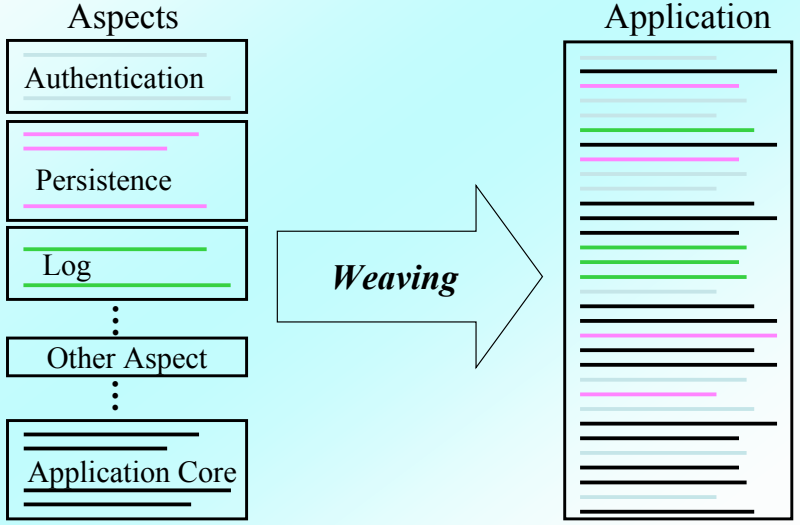
AOP (Aspect-Oriented Programming)



Aspects and Weaving

- Application core = Set of classes
  - Without any crosscutting code
- Aspects = crosscut application core classes
  - Alter application structure
    - Addition/Change of classes, methods, IVs, …
  - Alter application execution flow
    - Object creation/initialization, Access to IVs, Message dispatch…
- Weaving = Performing changes defined in Aspects

Need for Unification

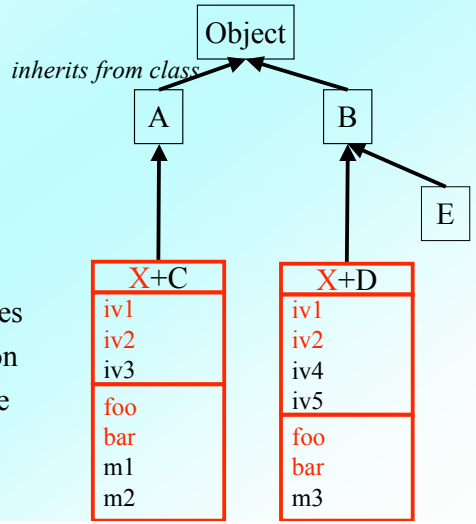
- Two kinds of crosscutting [Laddad 2003]:
  - Dynamic crosscutting = changes that affect applications execution flow
  - Static crosscutting = changes that affect applications structure
- Limitations of existing AOP platforms:
  - Different constructs for all kinds of crosscutting
  - Code complexity even for simple aspects
  - Aspect reuse not always possible
  - Aspect conflicts not always managed

Mixins

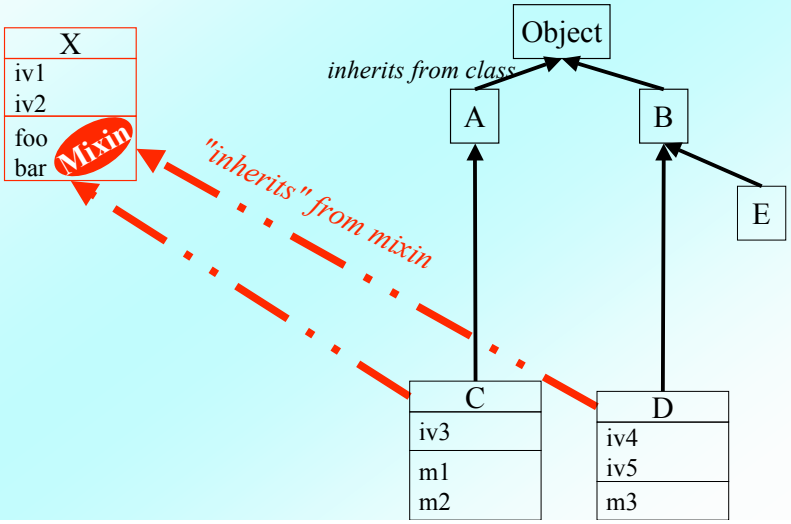
Unified Aspects = **Mixins** + Reflection

Need for Mixin-Based Inheritance

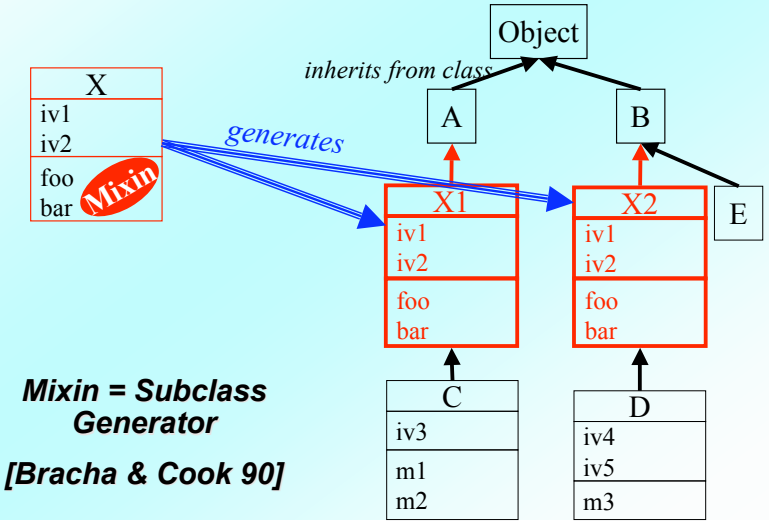
- Context
  - Single inheritance
  - Unrelated hierarchies
  - Same Properties
- Goal
  - Reuse shared properties
  - Avoid code duplication
  - Alternative to multiple inheritance



Mixin-Based Inheritance



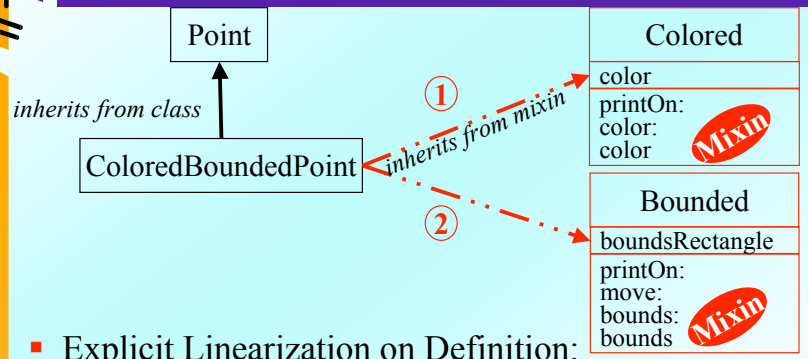
Single Inheritance Behind the Scene



Mixin = Subclass Generator

[Bracha & Cook 90]

Example of Mixin Inheritance



- Explicit Linearization on Definition:
  - *ColoredBoundedPoint mixins: {Colored. Bounded}*
- Lookup list
  - *ColoredBoundedPoint, Colored, Bounded, Point*

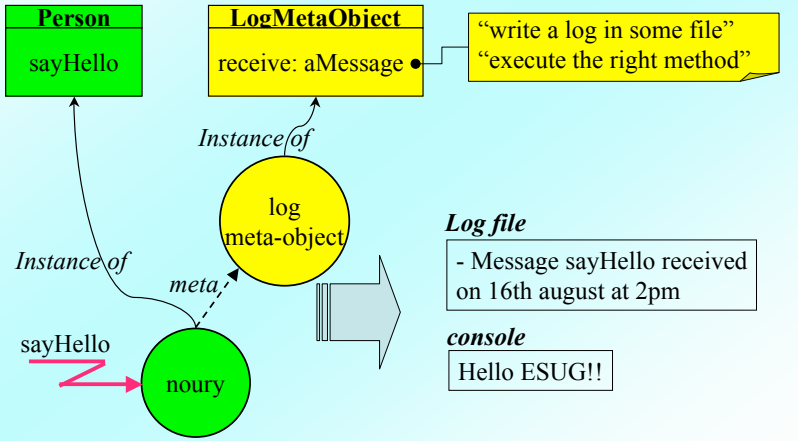
Reflection

Unified Aspects = Mixins + **Reflection**

OO Reflective Languages

- A Reflective language gives access to its own semantics
- Two programming levels
  - evaluator ➔ meta-level ➔ **meta-objects**
  - program ➔ base-level ➔ **base-objects**
- Meta-object = an object that **controls** one or more base-objects
  - i.e. Evaluates messages sends, field accesses, …

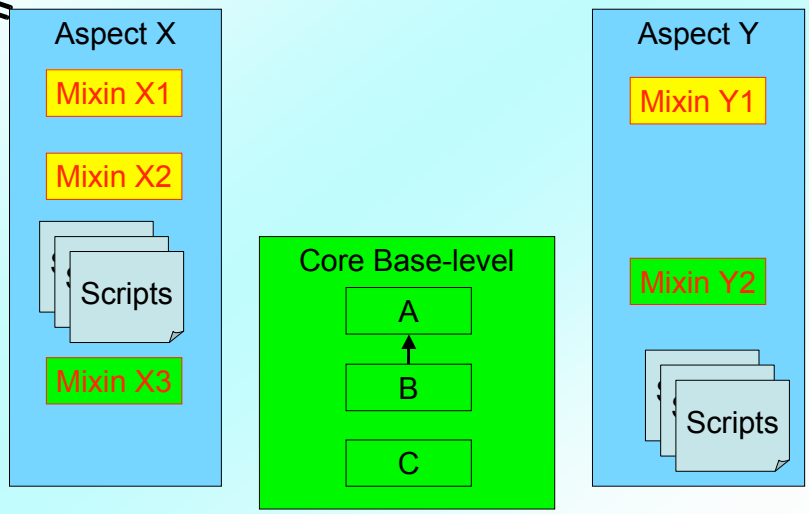
Example of Meta-Object Usage



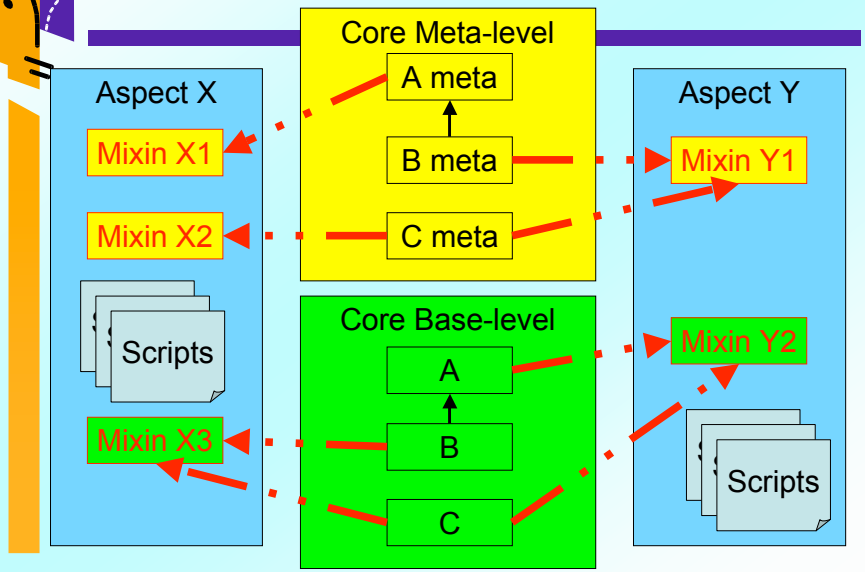
Unified Aspects

Unified Aspects = Mixins + Reflection

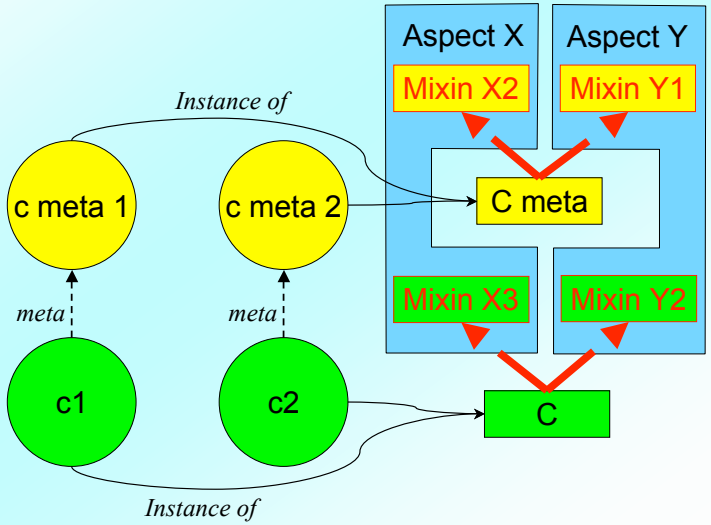
Developers Build Classes and Mixins



Static View After Weaving



Dynamic (partial) view after weaving



Weaving and Aspect Reuse

- Unified Aspects are reusable
  - Application independent mixins
- Weaving aspects into specific applications
  - Mapping mixins to application core classes
  - Pre/Post weaving scripts
- Weaving =
  1. Evaluate aspects pre-weaving scripts
  2. Link classes to mixins
  3. Evaluate aspects post-weaving scripts

Conclusion

Summary

- Crosscutting can be static or dynamic
  - Static : Alters applications structure
  - Dynamic : Alters applications behavior
- A **unified** representation of crosscutting
  - Mixins at base-level = static crosscutting
  - Mixins at meta-level = dynamic crosscutting
- **Reuse** is encouraged
- Simple conflict management = Mixins ordering

Future Work

- Weaving
  - Pre/Post weaving scripts reuse
  - High-level language for expressing pointcuts
- Advanced conflict management
  - Persistence: support application rebuilds
  - Order of pre/post weaving scripts evaluation
  - Finer grain: Method/Instance variable level