StrongAspectJ

Flexible and Safe Pointcut/Advice Bindings

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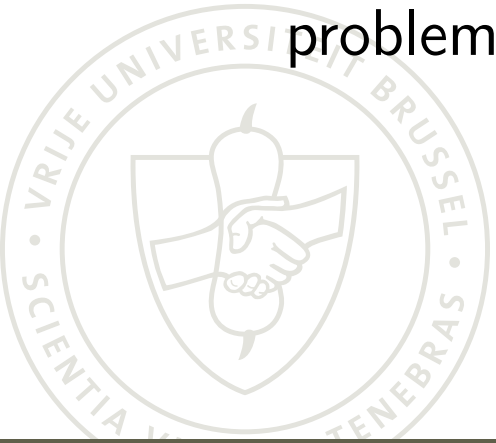

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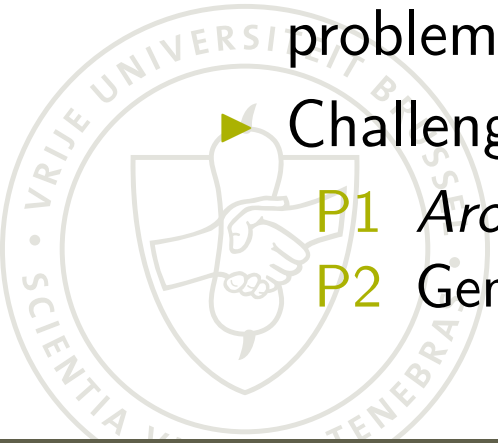
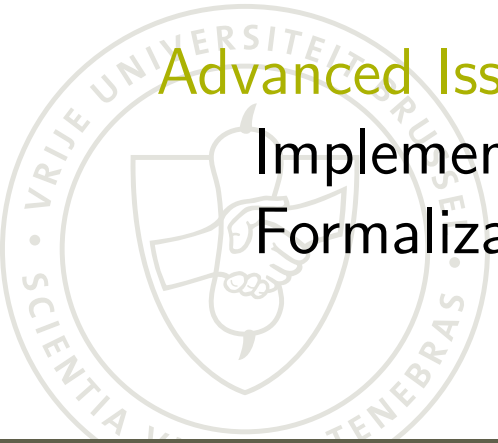
- Challenges of typing pointcuts and advice

  P1 *Around*-advice and *proceed* complicate subtype variance

  P2 Generic advice applies to heterogeneous join points



Outline



AspectJ Typing: Subtype Variance Example

```
pointcut pc(Employee e): args(e) && call(Number *(..));
Integer around(Person p): pc(p) { ... }
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- Advice types differ from pointcut types
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$$\texttt{Integer} <: \texttt{Number}$$
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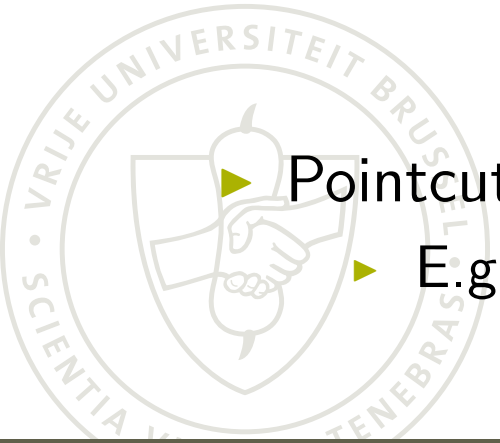
- Pointcut types may further differ from join point types
  - E.g. `args` matches subtype instances as well



AspectJ Typing: General Rules

- Substitution principle: method σ can be executed in place of method σ', if $\sigma \leq \sigma'$, where

$$R(S_1, S_2, \ldots) \leq R'(S'_1, S'_2, \ldots) \text{ iff } R <: R' \text{ and } S'_i <: S_i$$

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- Advice can safely replace or augment join point

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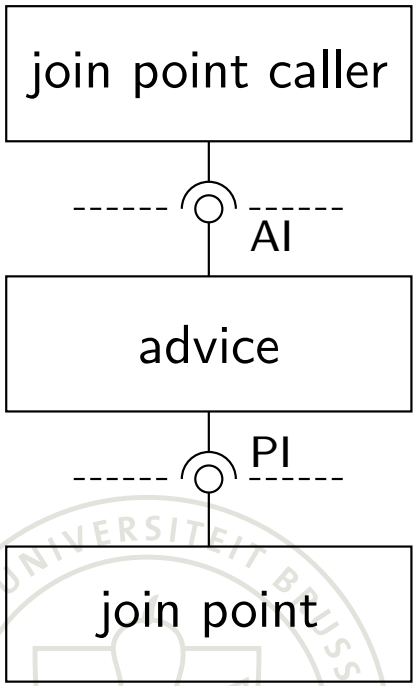

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  Advice interface *provided* to join point caller

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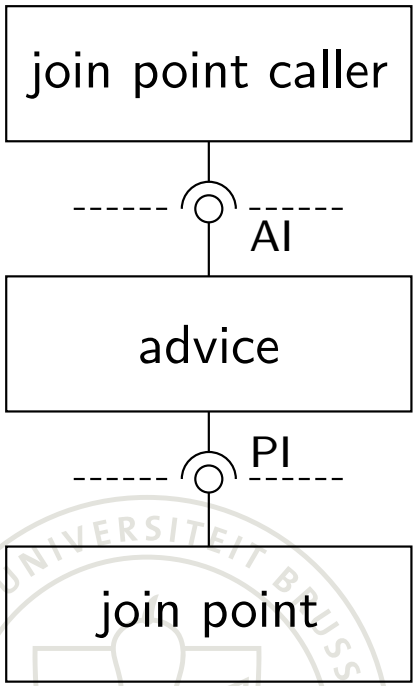

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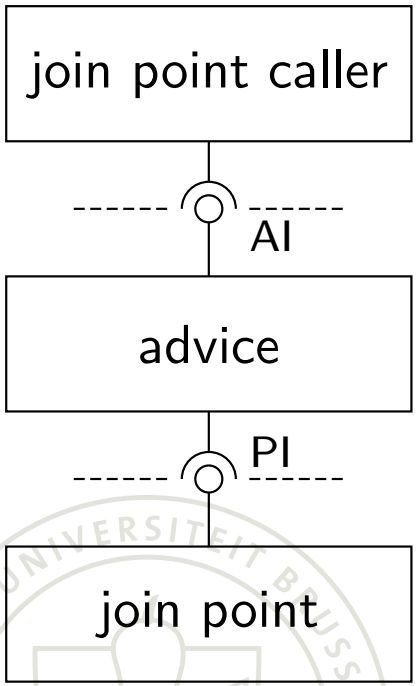

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- Incorrect assumption in case of type variance!
  - Advice provides more than the join point it replaces

Loophole: *Proceed*-Method

- Advice accepts any `Person`

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// Will be applied to join point  Employee.promote()
void around( Person p ): this(p) {
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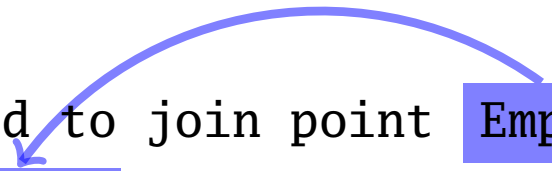

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- [Wand et al., TOPLAS04] identifies the loopholes
- [Clifton and Leavens, SCP06]: modified, safe proceed

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Number around(): call( Integer *(..)) {

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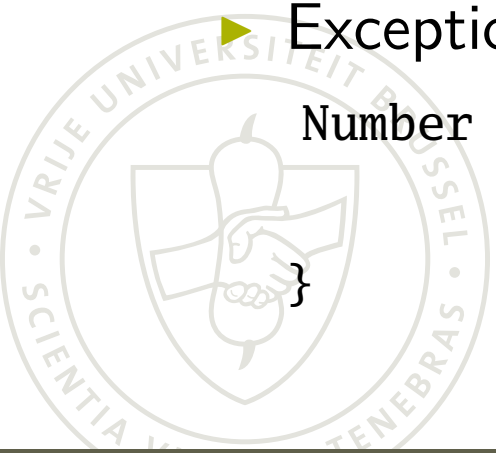

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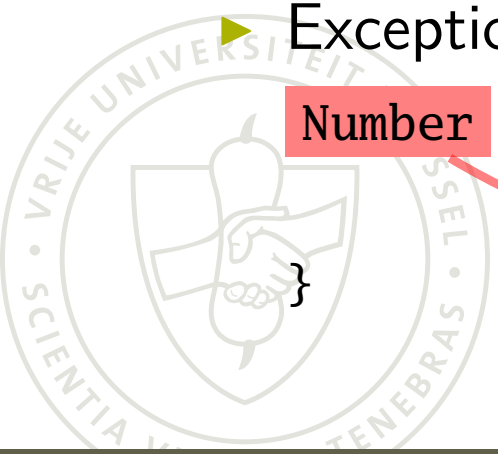

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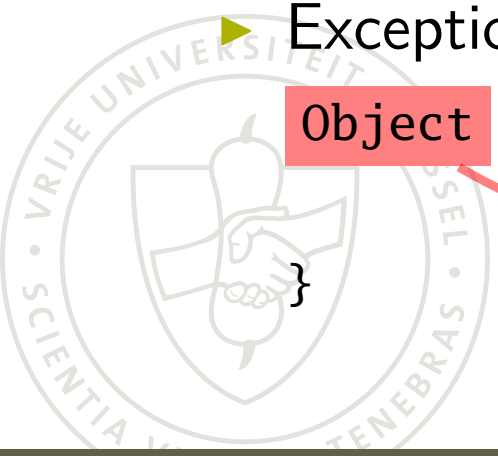

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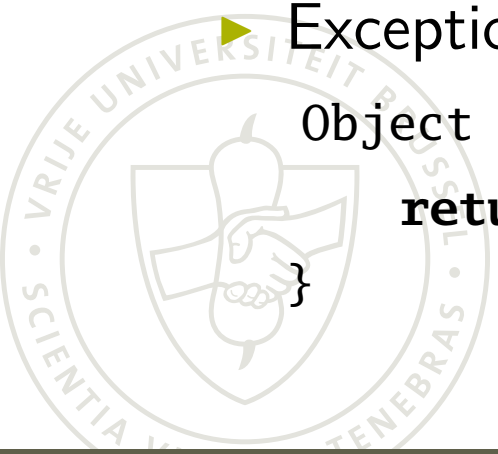

Generic Advice (`Object` return type) II

- Safe but restricted advice:

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Number around(): call(( Integer || Float ) *(..)) {
    Number n = proceed() ;
    while(n.intValue() > 100)
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    return n ;
}
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- [Jagadeesan et al., SCP06, Masuhara et al., ICFP05]
  - Identify loophole
  - Propose typing generic advice using type variables

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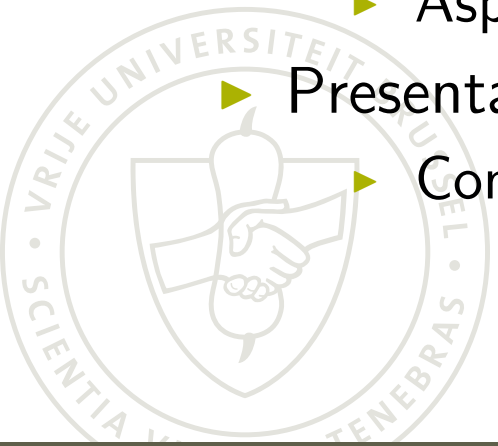
- Presentation: principles with StrongAspectJ examples
  - Complete language definition in paper



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σ_{advice} and $\sigma_{proceed}$ may be different

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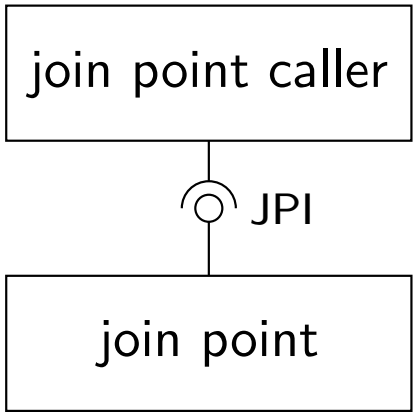

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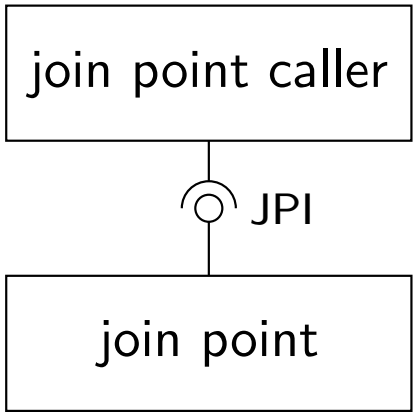

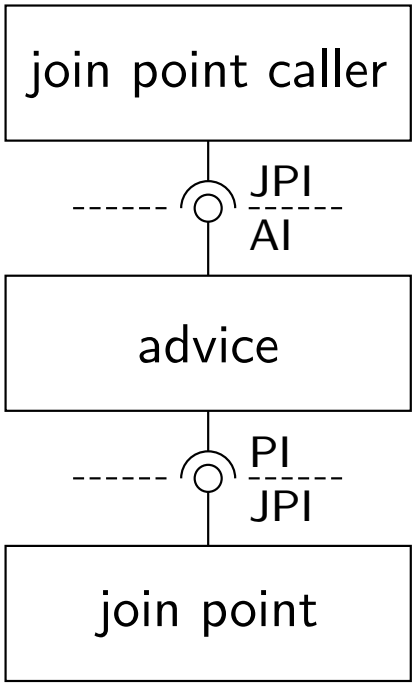

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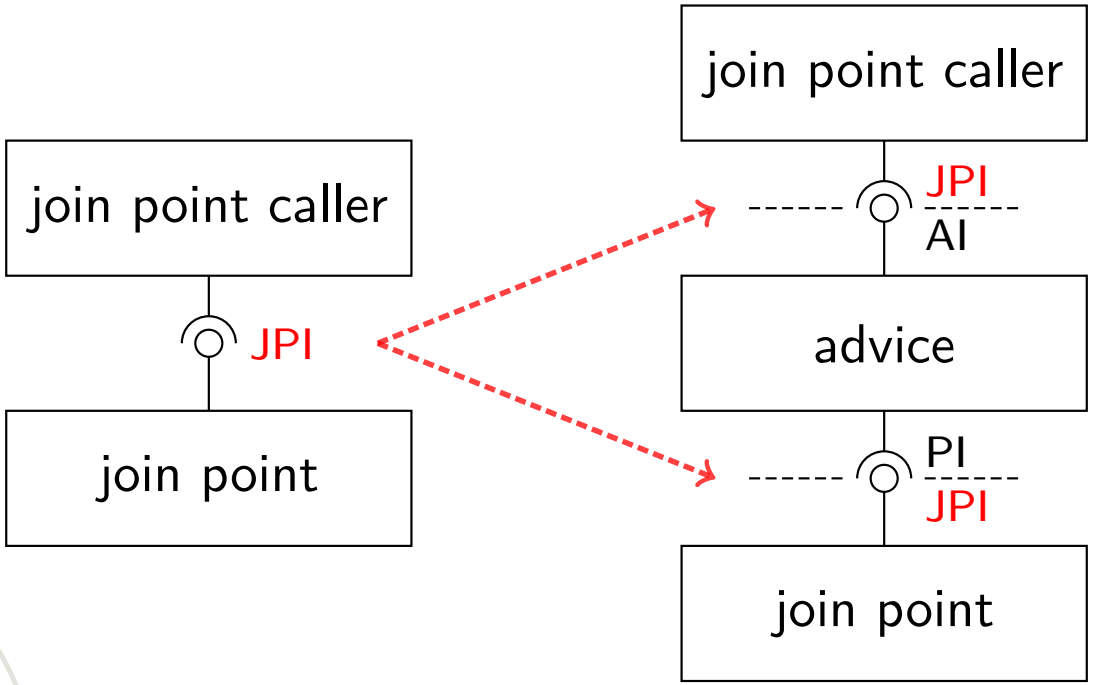

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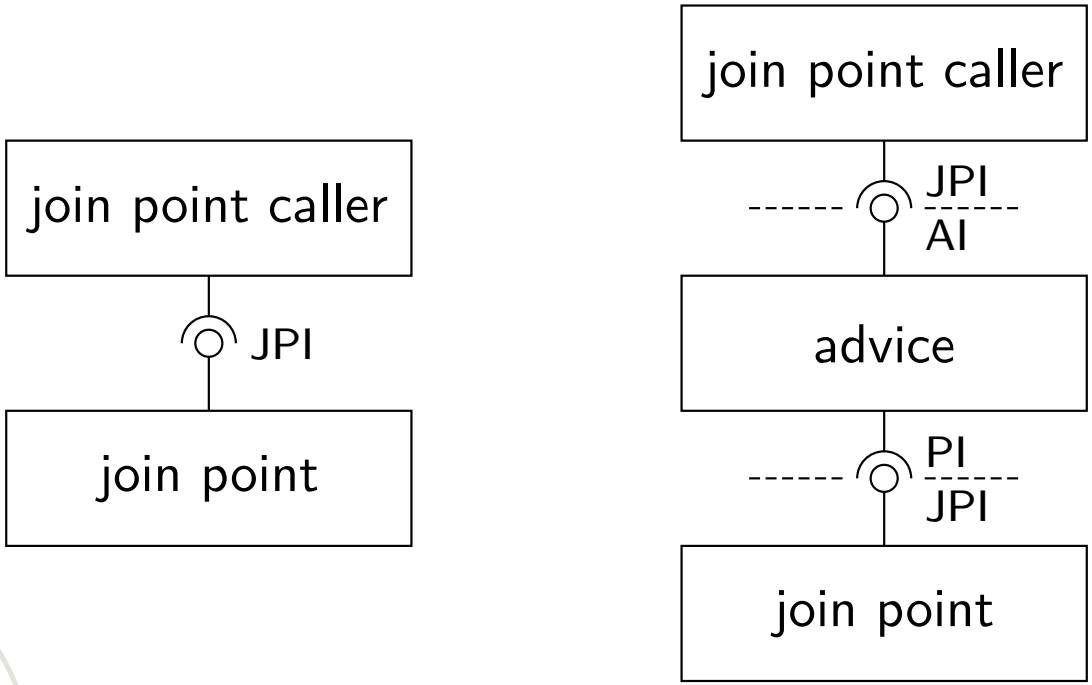

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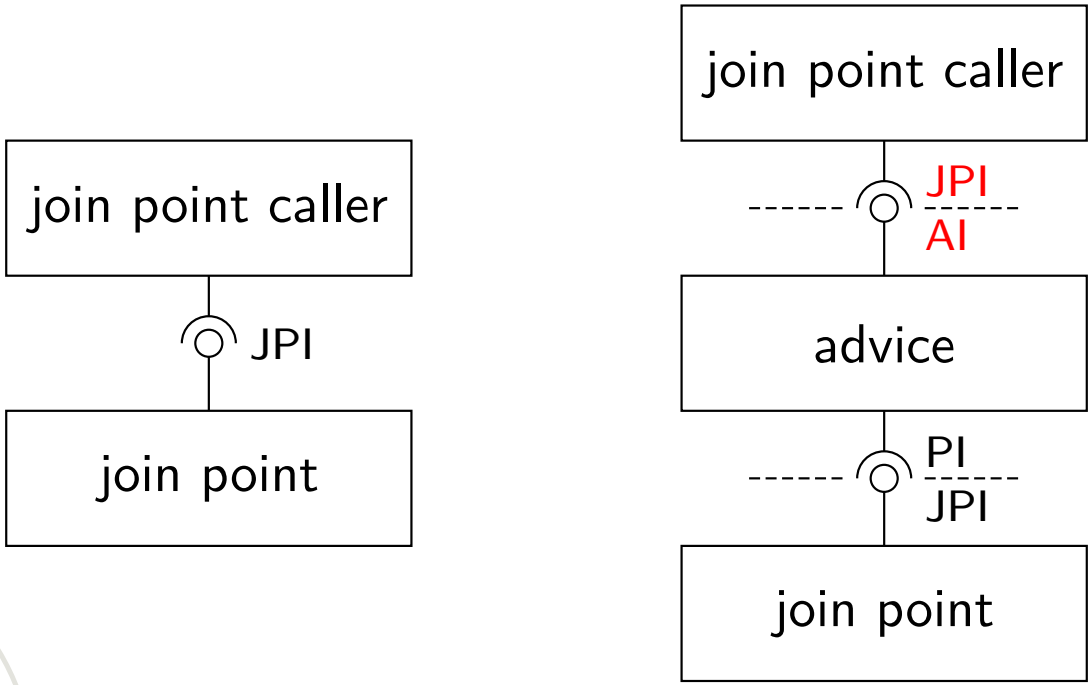

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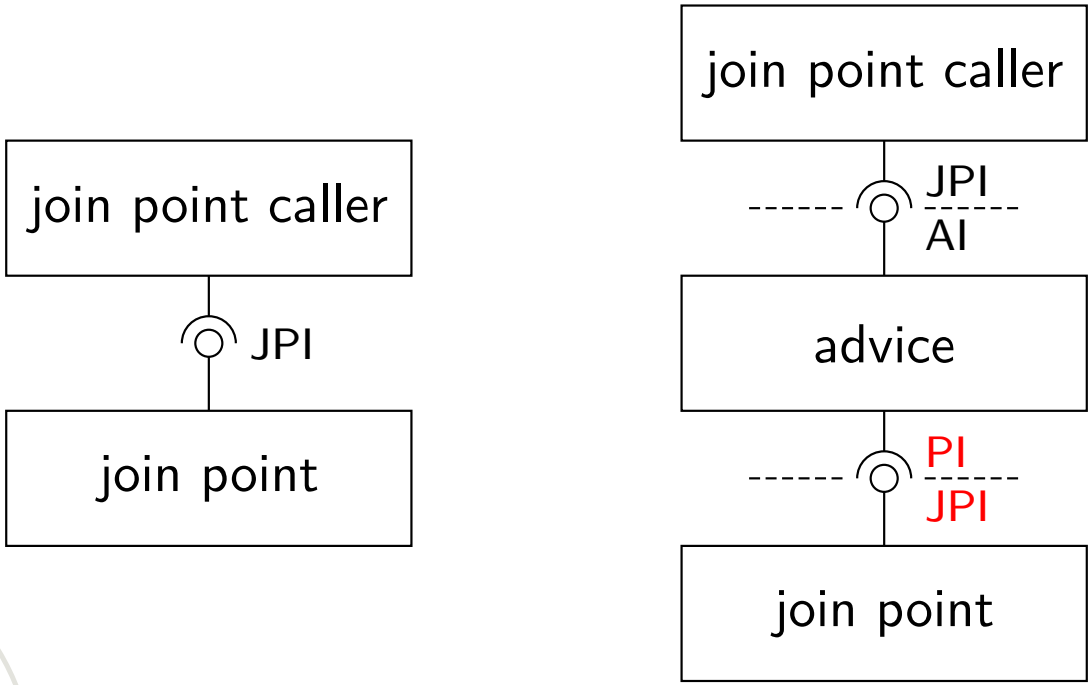

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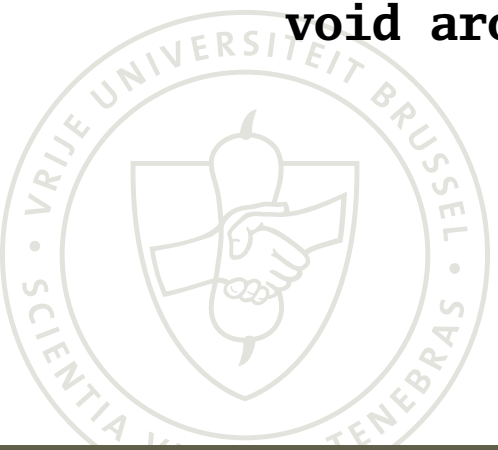

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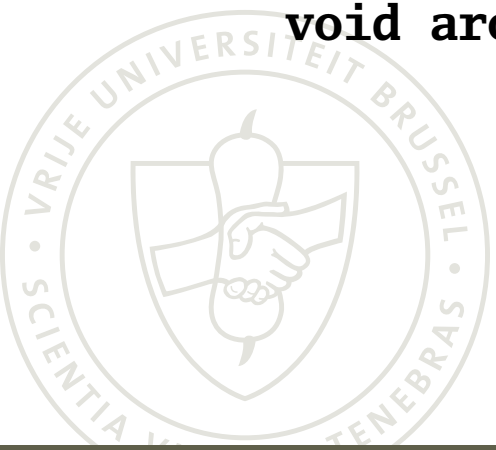

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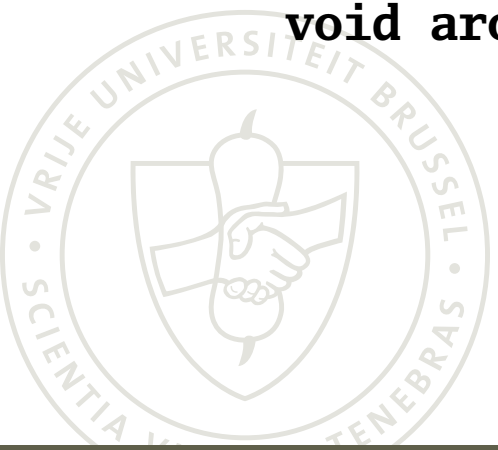

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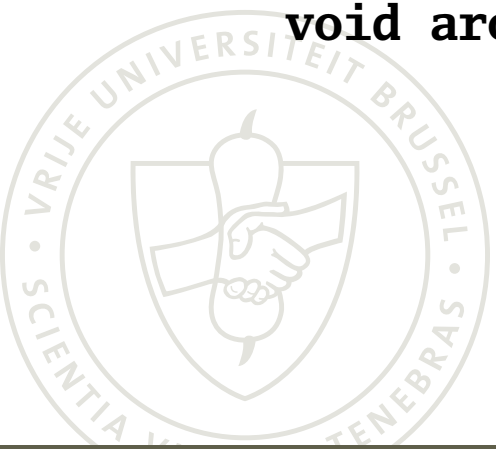

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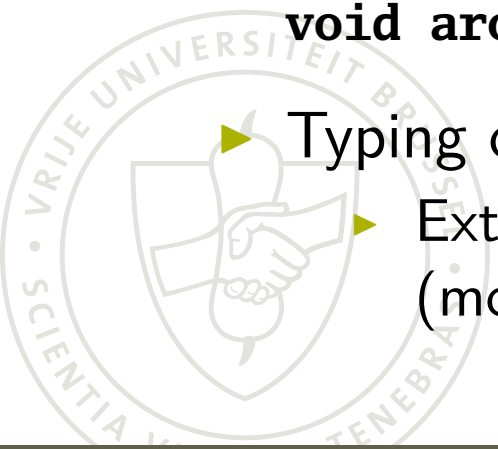
- Typing of generic advices using type variables
  - Extension of type relations to include type variables (more details in paper)



Practical Example: Factory Method Specialization

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class Factory {
  Component createTextArea(String t) { ... }
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aspect ScrollPaneFactory {
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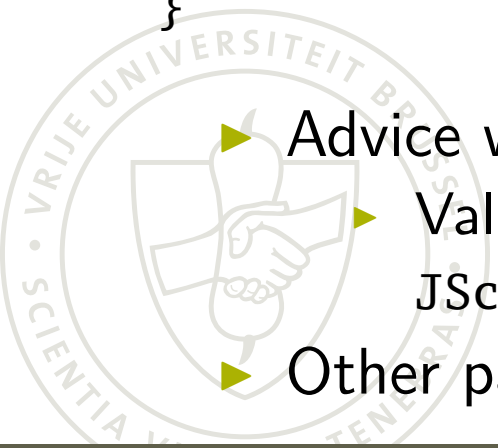
    `JScrollPane – Component`
- Other paper examples: Caching, Profiling



Two Implementations

1. StrongAJ: plugin for AspectBench Compiler (abc) 1.2.1
   - Implements complete StrongAspectJ proposal
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2. Type rules encoded in interfaces of AOP framework
   - Plain Java 5: type variables, wildcard type arguments
     - Type restrictions enforced using unmodified generics-aware compiler
   - Proof-of-concept in paper
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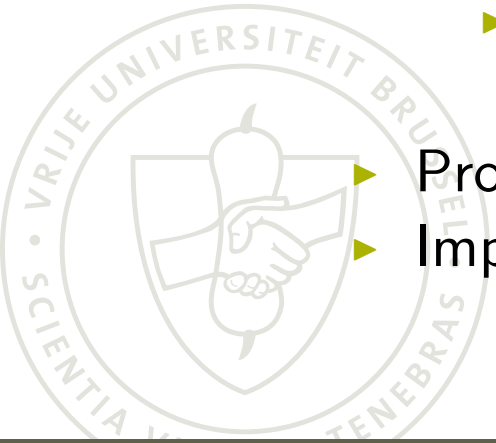

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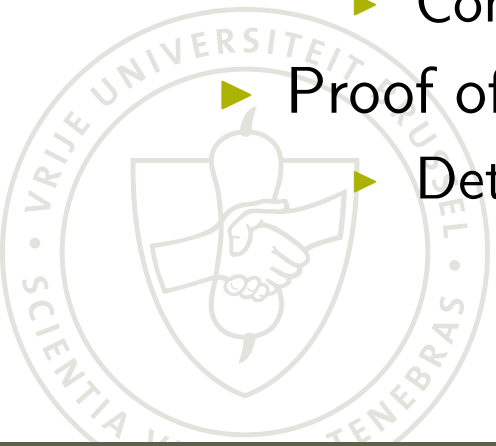
- Proof of type safety properties: preservation and progress
  - Details in paper and companion technical report



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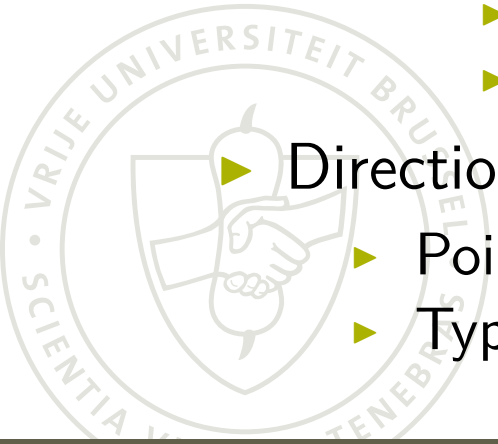
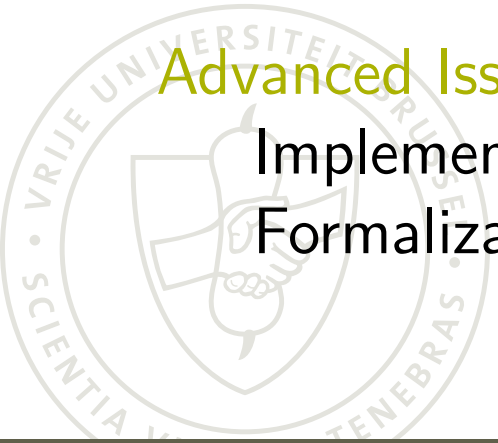


Discussion

- Motivation
  - AspectJ Typing Rules
  - Loopholes and Restrictions
- StrongAspectJ Proposal
  - Overview
  - Illustrated Typing Principles
- Advanced Issues
  - Implementations
  - Formalization



Selected Related Work I


C. Clifton and G. T. Leavens.
MiniMAO1: An imperative core language for studying aspect-oriented reasoning.
Science of Computer Programming, 63(3):321–374, 2006.


A. Colyer et al.
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Typed parametric polymorphism for aspects.
Science of Computer Programming, 63(3):267–296, 2006.

Selected Related Work II


H. Masuhara, H. Tatsuzawa, and A. Yonezawa.
Aspectual Caml: an aspect-oriented functional language.
In *Proc. of ICFP '05*, pages 320–330. ACM Press, 2005.


M. Wand, G. Kiczales, and C. Dutchyn.
A semantics for advice and dynamic join points in aspect-oriented programming.
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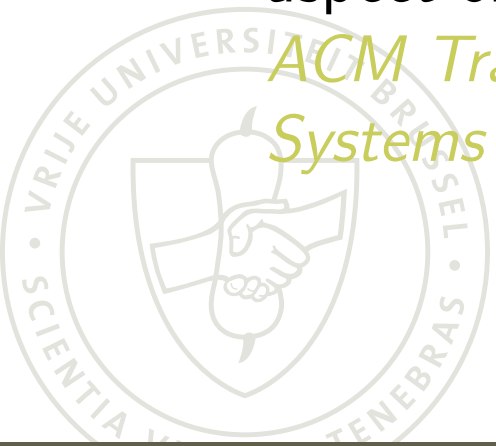

Formalization: Consistency Property

$$\textsc{Consistency-PC}\quad \frac{\begin{array}{c}\vdash \mathsf{match}(M,\phi) = \bar{y};\bar{K};M' \\ \vdash \phi : D\text{–}E(\bar{F}\text{–}\bar{G}\ \bar{z}) \qquad \vdash M : R\end{array}}{\begin{array}{c}\bar{y} = \bar{z} \qquad \vdash \bar{K} : \bar{G}' \qquad \vdash \bar{G}' <: \bar{G} \qquad \bullet;\bar{F}\ \bar{y} \vdash M' : R' \\ \vdash R' <: E \qquad \vdash D <: R\end{array}}$$

Formalization: Advice Typing

DEC-ADVICE

$$\frac{\begin{array}{c}\bar{X} \triangleleft \bar{C} \vdash \bar{C}, R, \bar{P}, S, \bar{Q} \\ \bar{X} \triangleleft \bar{C}; \bar{P}\ \bar{x}, S\ \texttt{proceed}(\bar{Q}) \vdash M : R' \\ \bar{X} \triangleleft \bar{C} \vdash R' <: R \\ \vdash \phi : D\text{–}E(\bar{F}\text{–}\bar{G}\ \bar{z}) \\ \bar{Z}, W \text{ fresh} \\ \exists \bar{V}. \left(\begin{array}{cc} \bar{X} \triangleleft \bar{C}, \bar{Z} \triangleleft \bar{G}, W \triangleleft E \vdash \bar{V}, \bar{V} <: \bar{C} & \\ \bar{Z} \triangleleft \bar{G} \vdash \bar{x}[\bar{Z}/\bar{z}] <: \bar{P}[\bar{V}/\bar{x}] & \bar{Z} \triangleright \bar{F} \vdash \bar{Q}[\bar{V}/\bar{x}] <: \bar{x}[\bar{Z}/\bar{z}] \\ W \triangleleft E \vdash W <: S[\bar{V}/\bar{x}] & W \triangleright D \vdash R[\bar{V}/\bar{x}] <: W \end{array} \right) \end{array}}{\vdash \texttt{advice}\ a\texttt{<}\bar{X} \triangleleft \bar{C}\texttt{>}R(\bar{P}\ \bar{x})\texttt{:}\phi\texttt{:}S(\bar{Q})\{M\}}$$