Implementing a Universe Type System for Scala

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Introduction

Scala

- Functional
  - Every function is a value
- Object oriented
  - Every value is an object
  - Every operation is a message send
- Interoperable with Java
  - Compiled to Java bytecode
  - Access to Java classes

Universe Type System

- Ownership topology
- Owner-as-modifier for encapsulation

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Outline

Scala

Most relevant features

- Type inference for variables, method return types and type parameters
- Type annotations
- Plugins for the compiler

Exemplary use of annotations

```
0 package ch.ethz.inf.sct.uts.examples
  import ch.ethz.inf.sct.uts.annotation._
2 class A {
    val b = new (B @rep)
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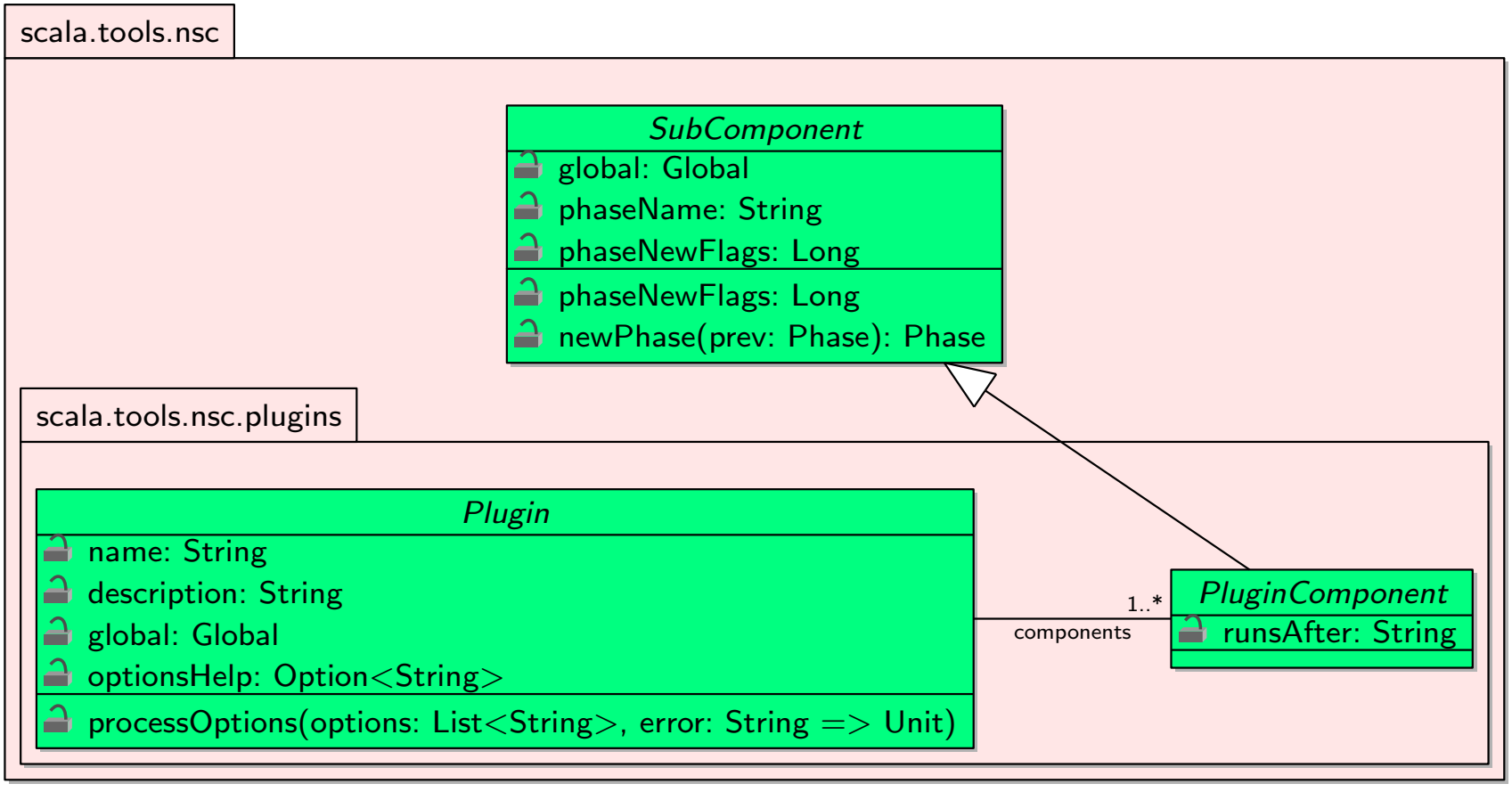
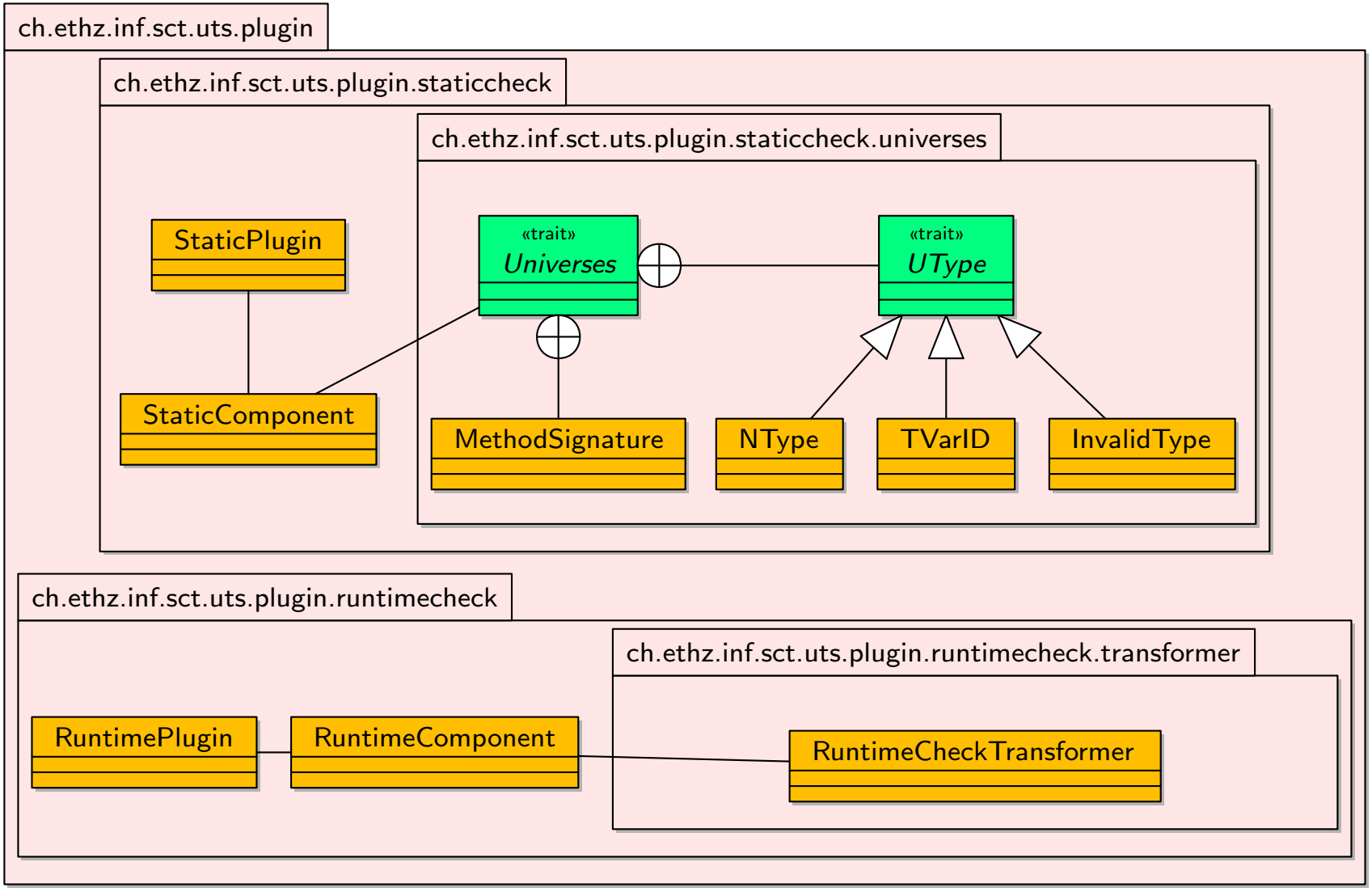
Scala Compiler Plugins




```
0 scalac -Xplug-types \
   -Xplugin:<path-to-plugin.jar> \
2  -P:<plugin-name>:<plugin-option> <source files>
```

Universe Type System Plugins for Scala



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2 class B {
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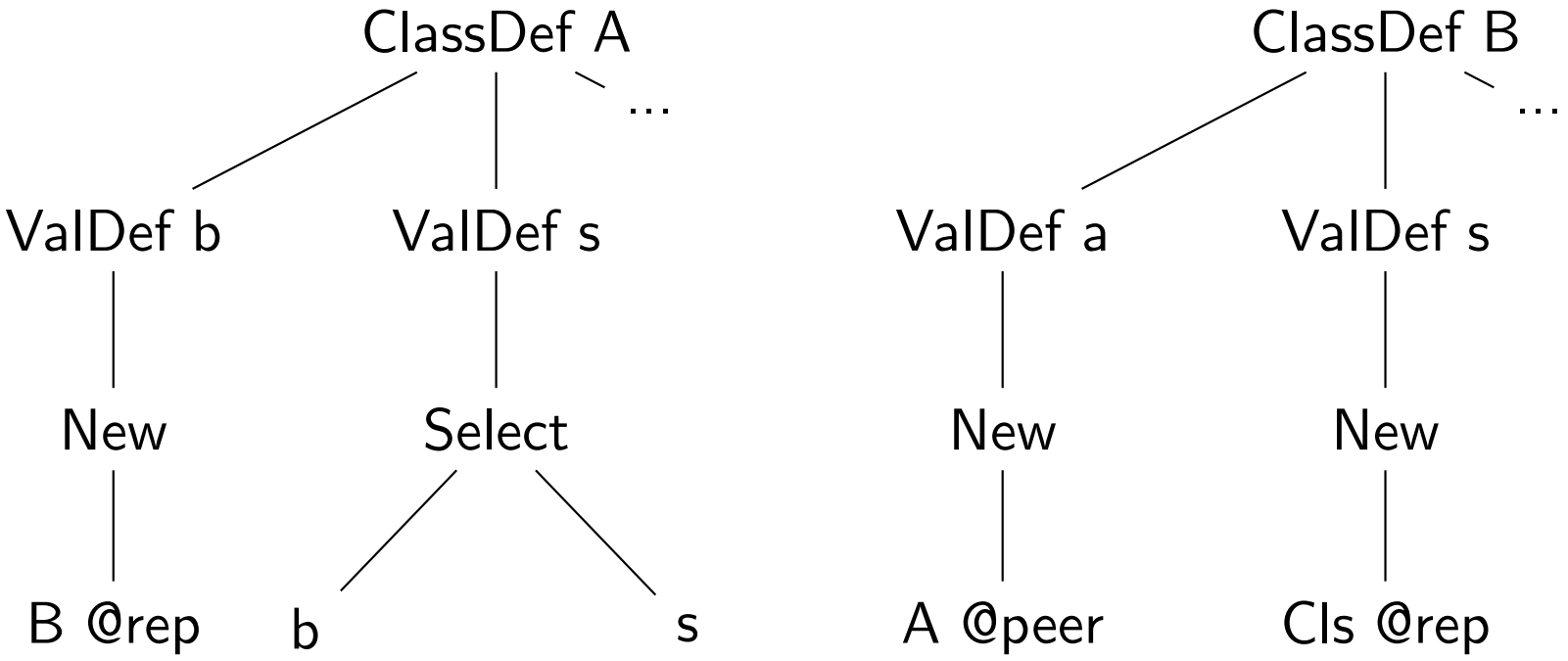
Inference on the AST



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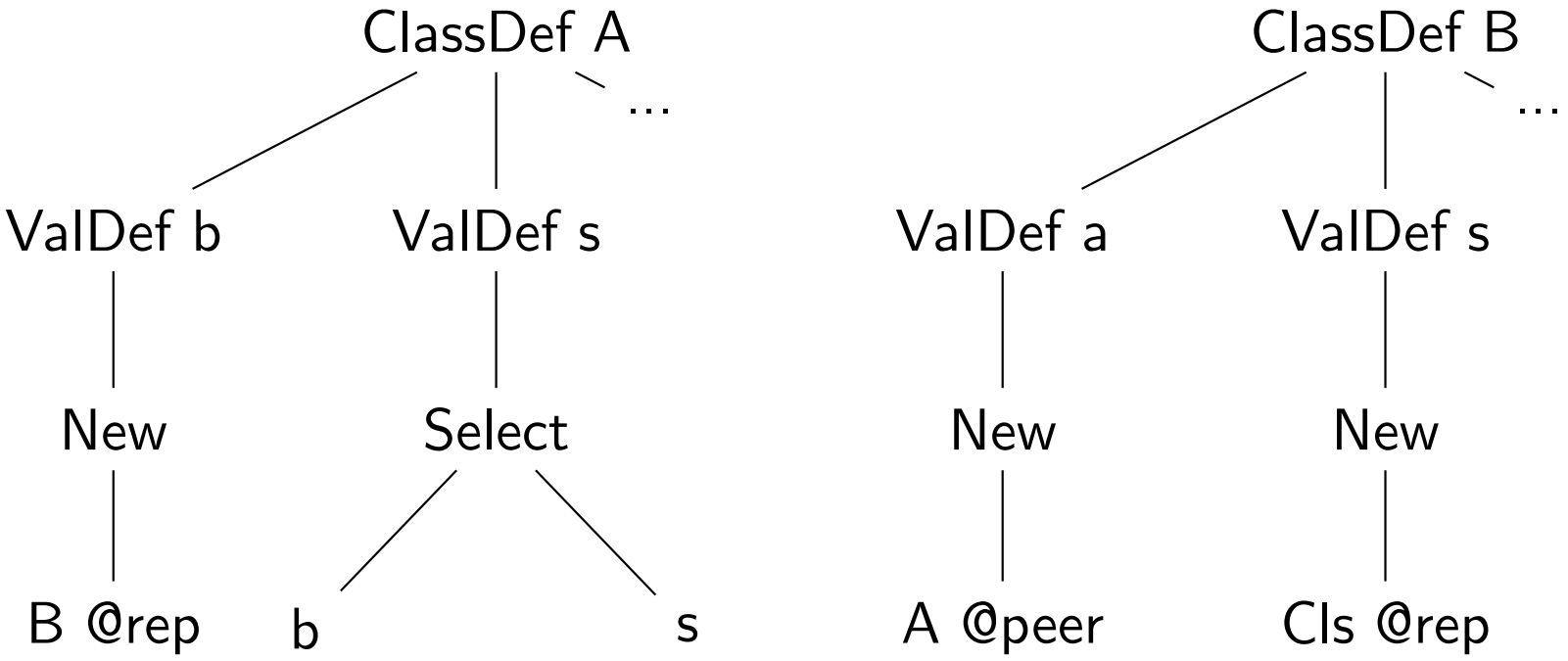

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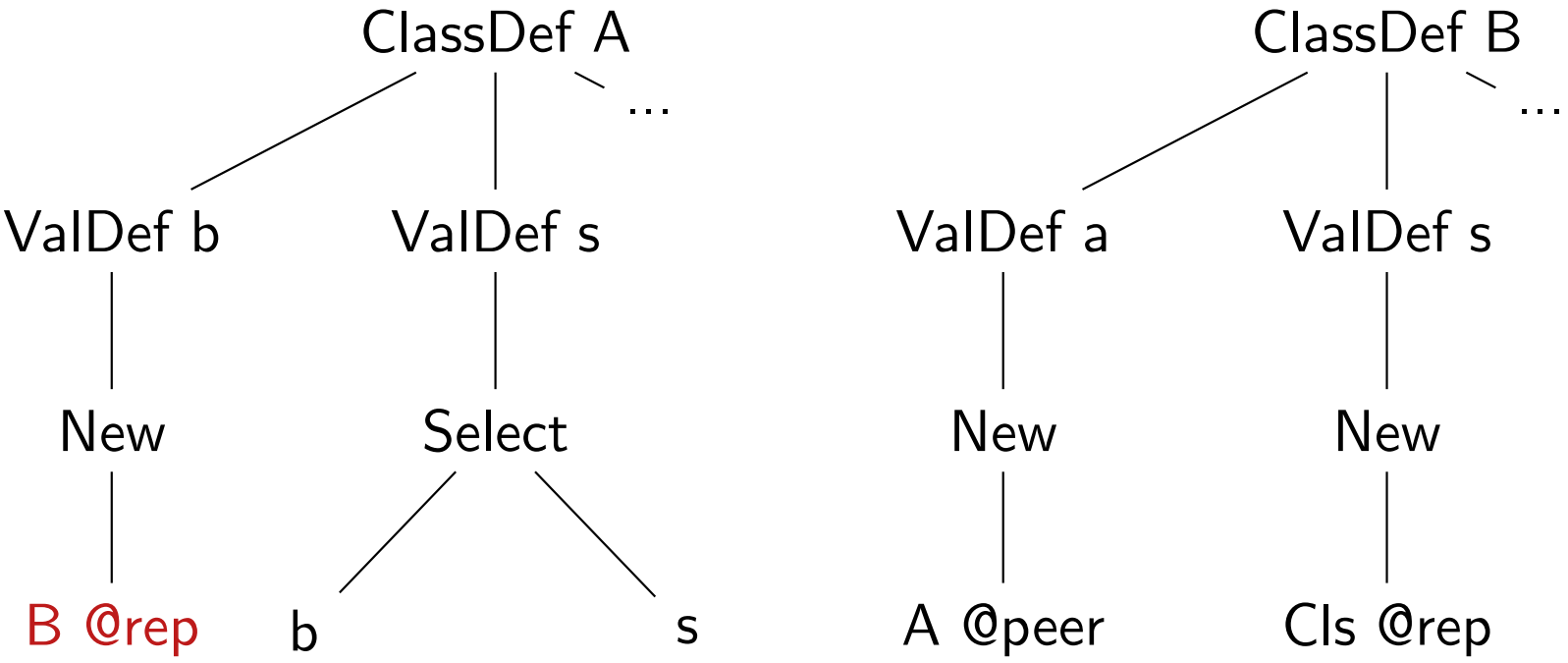

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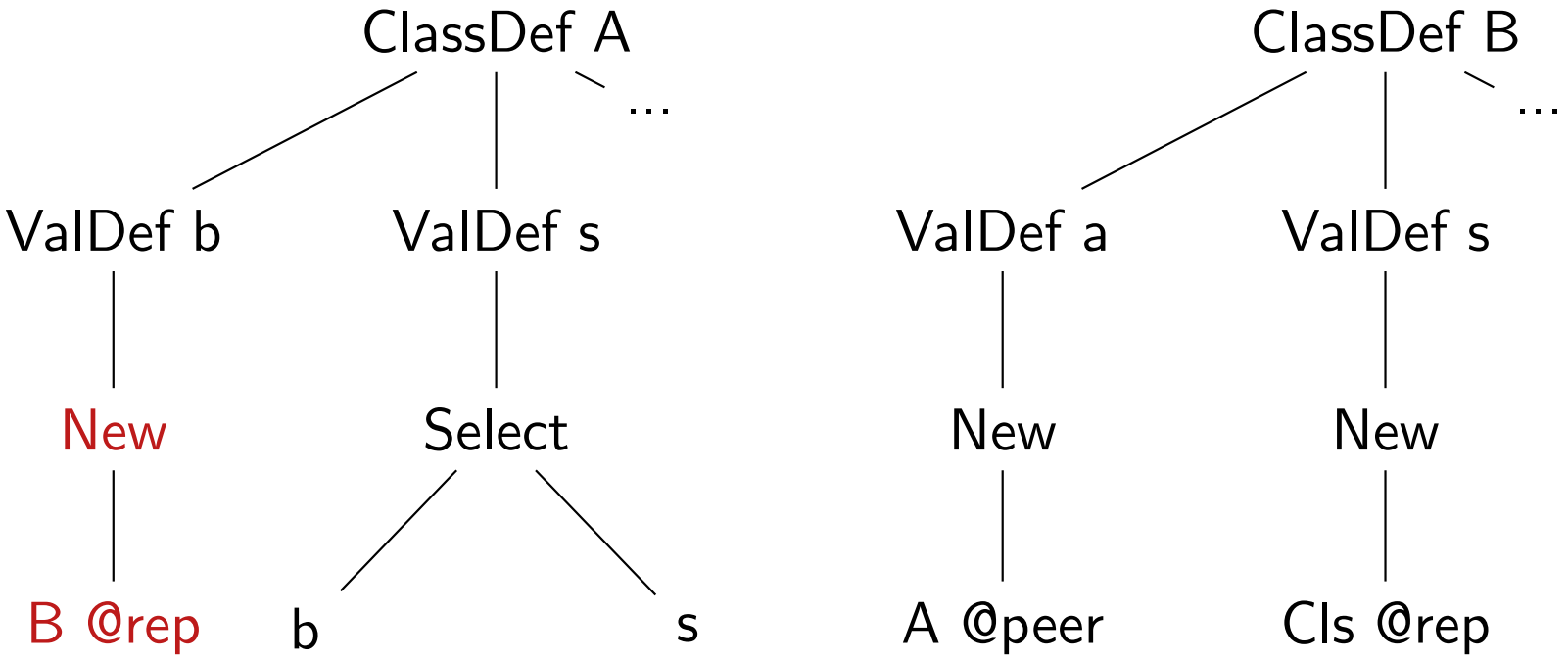

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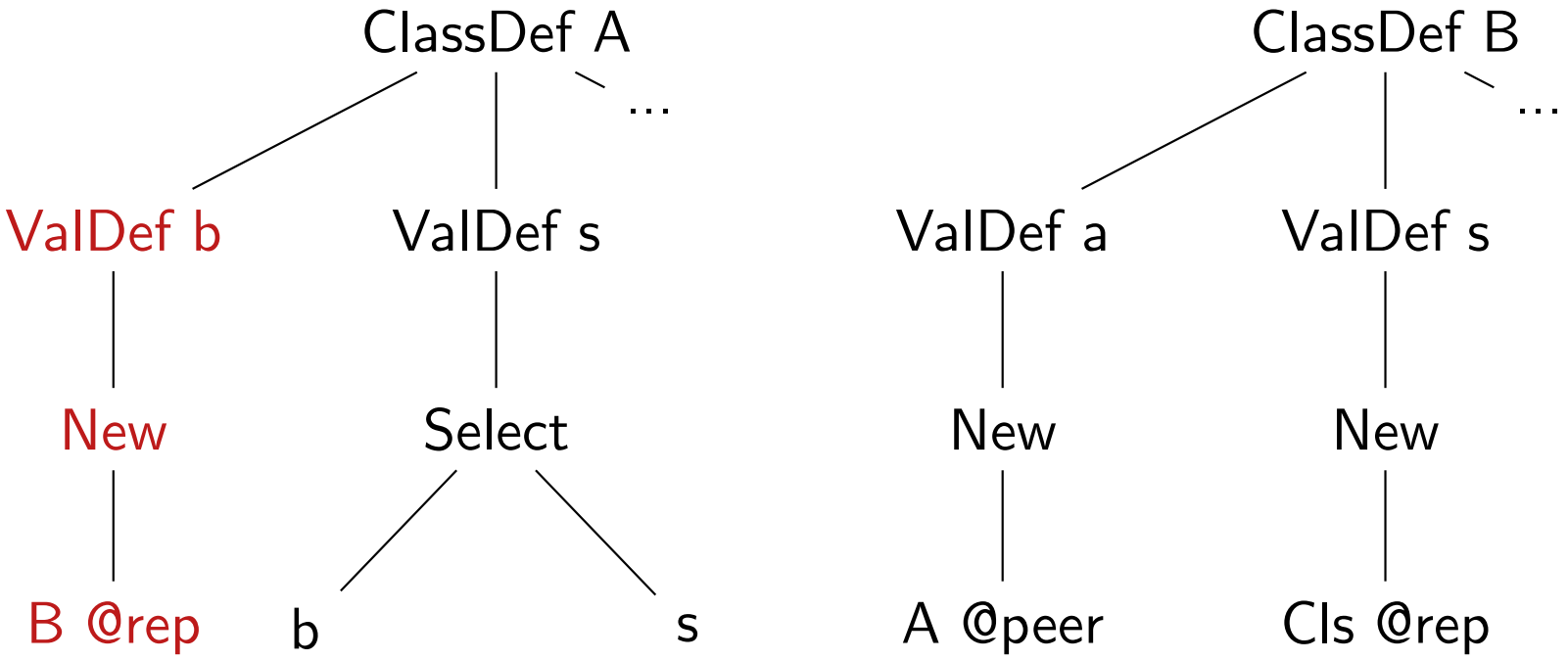

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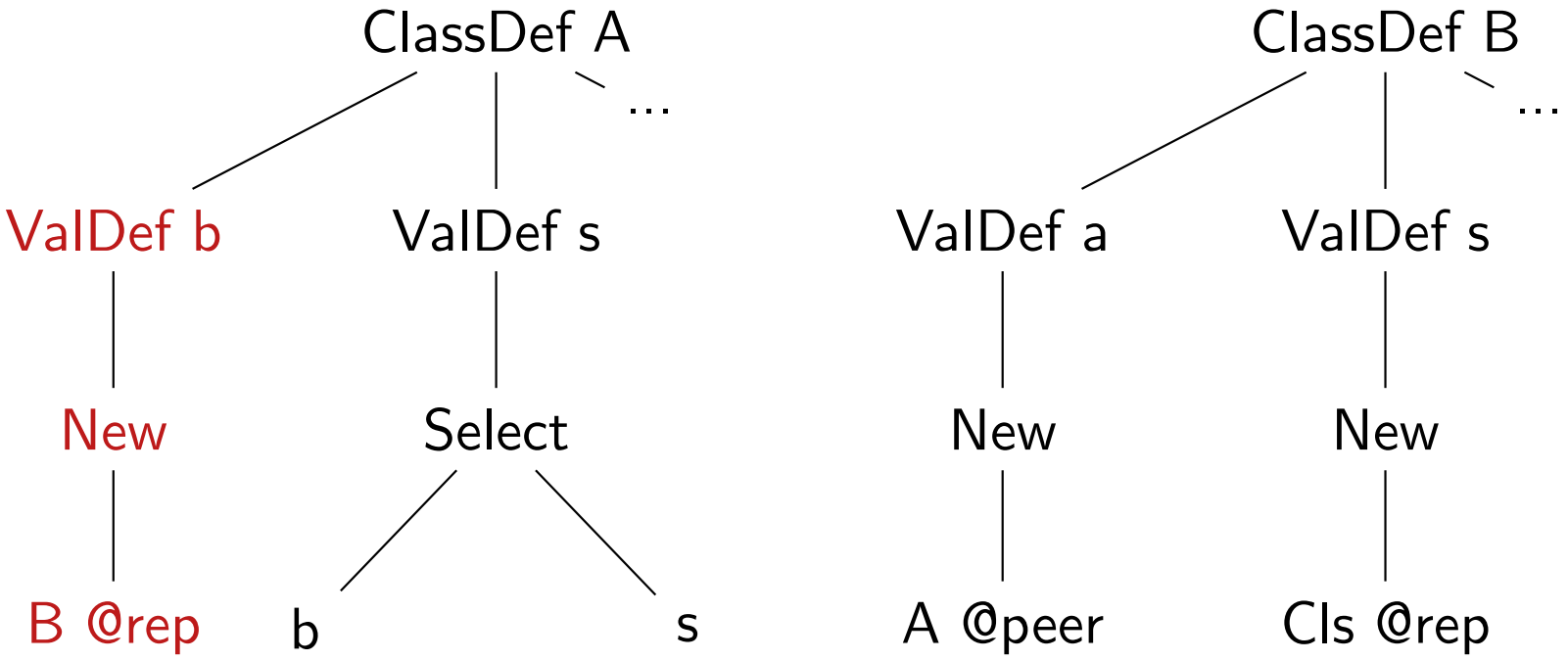

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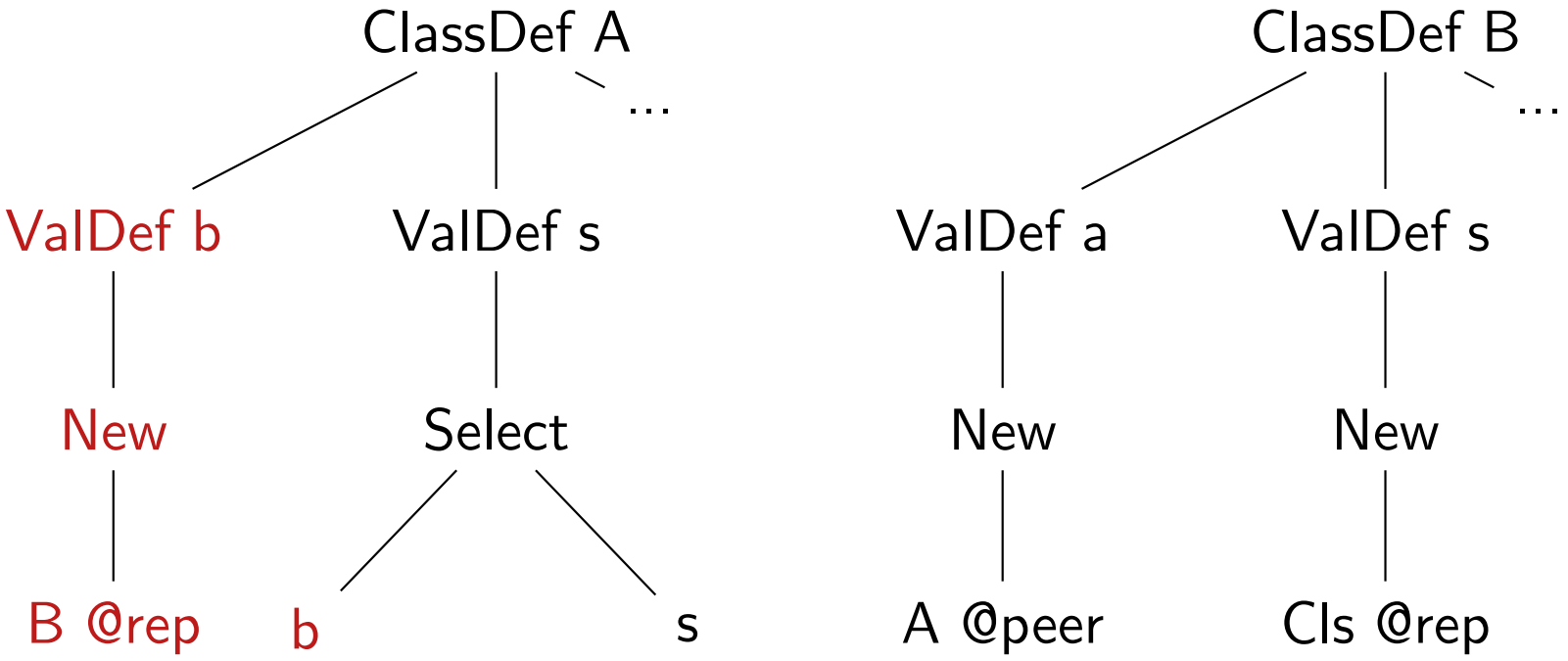

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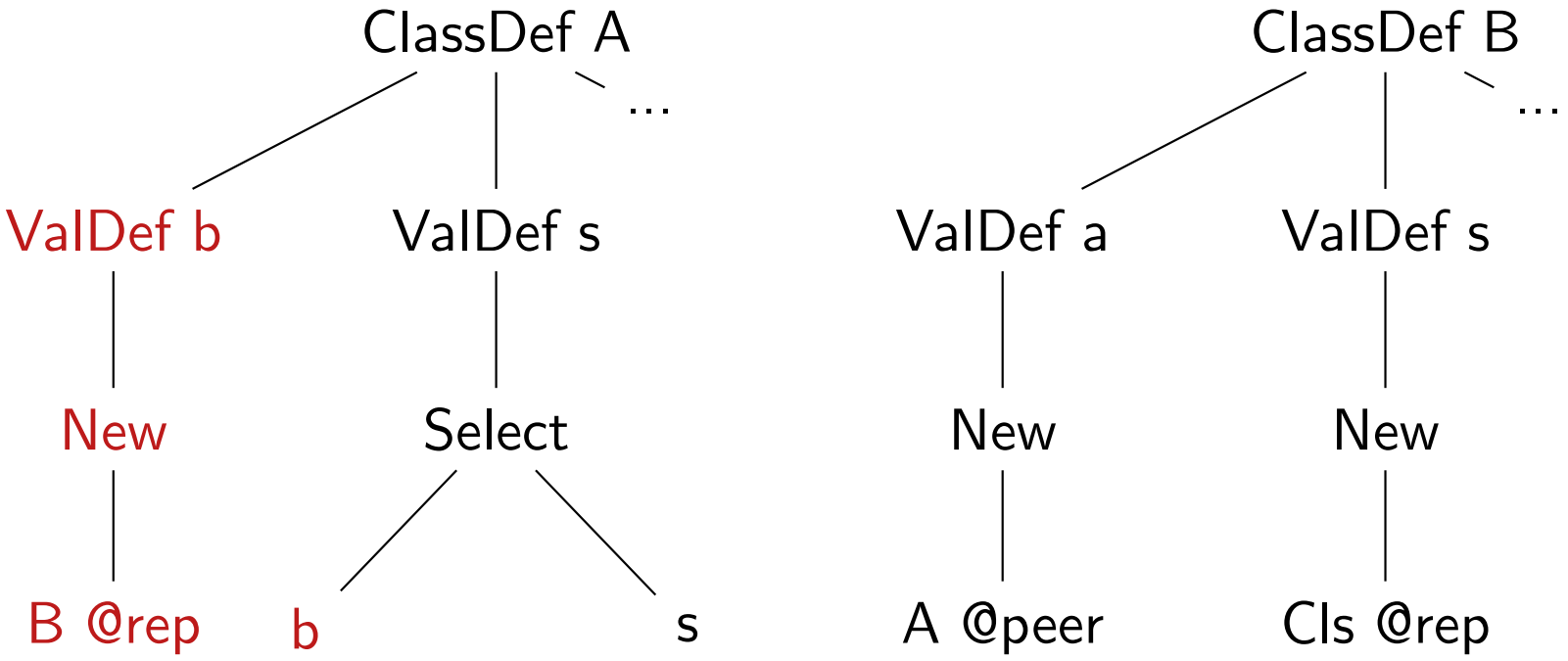

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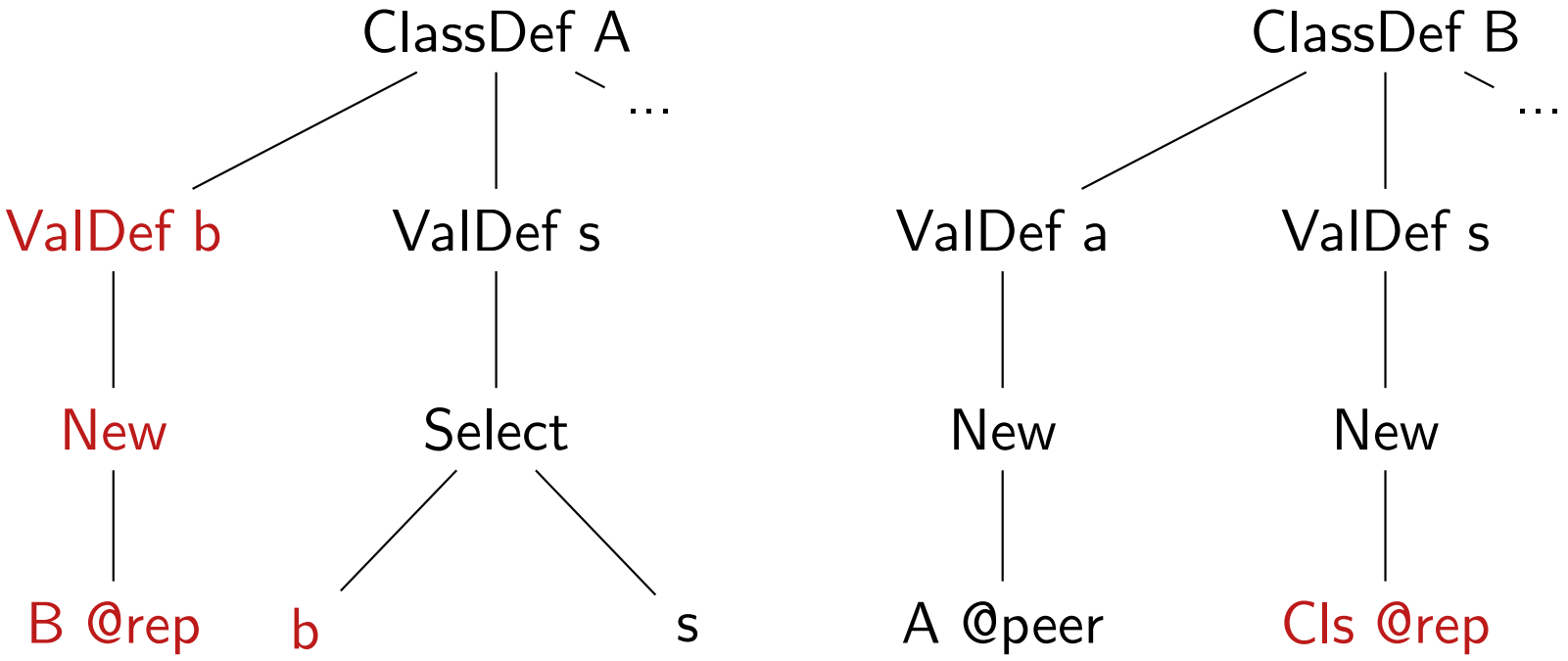

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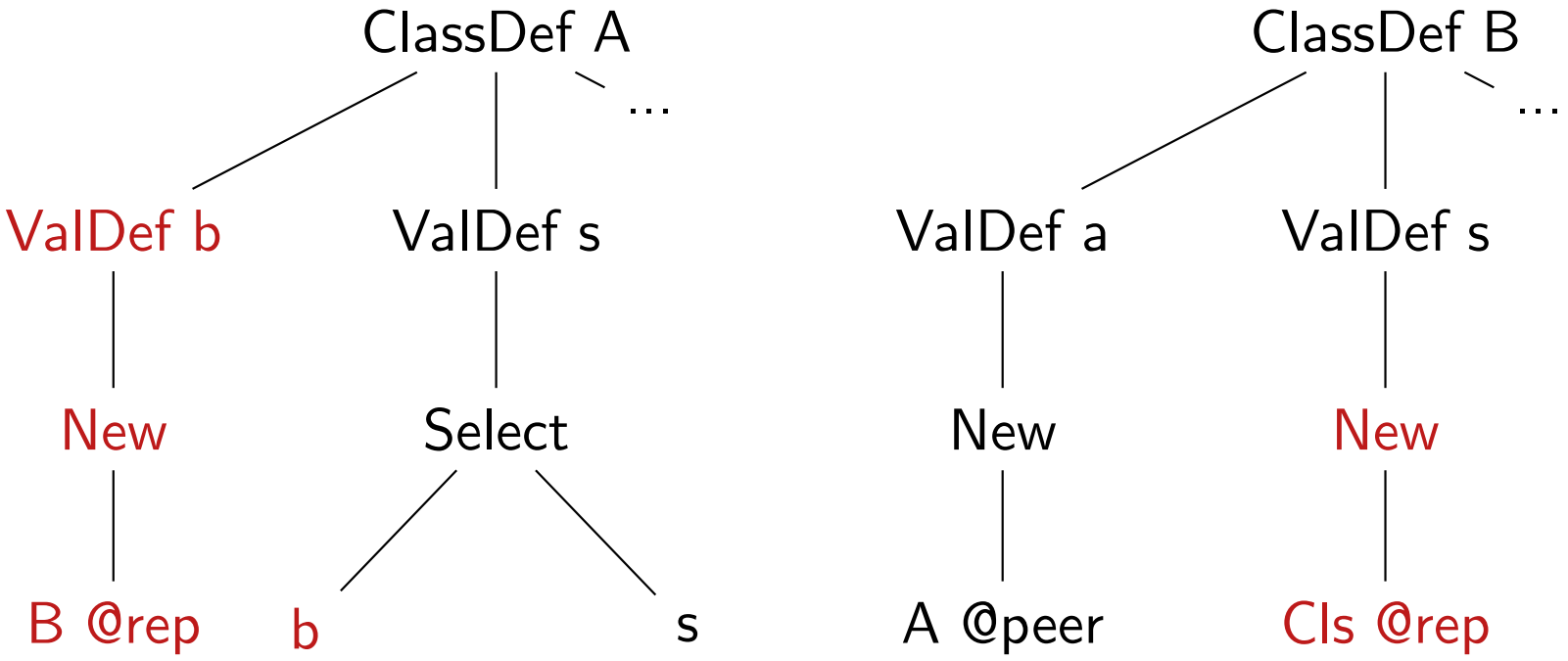

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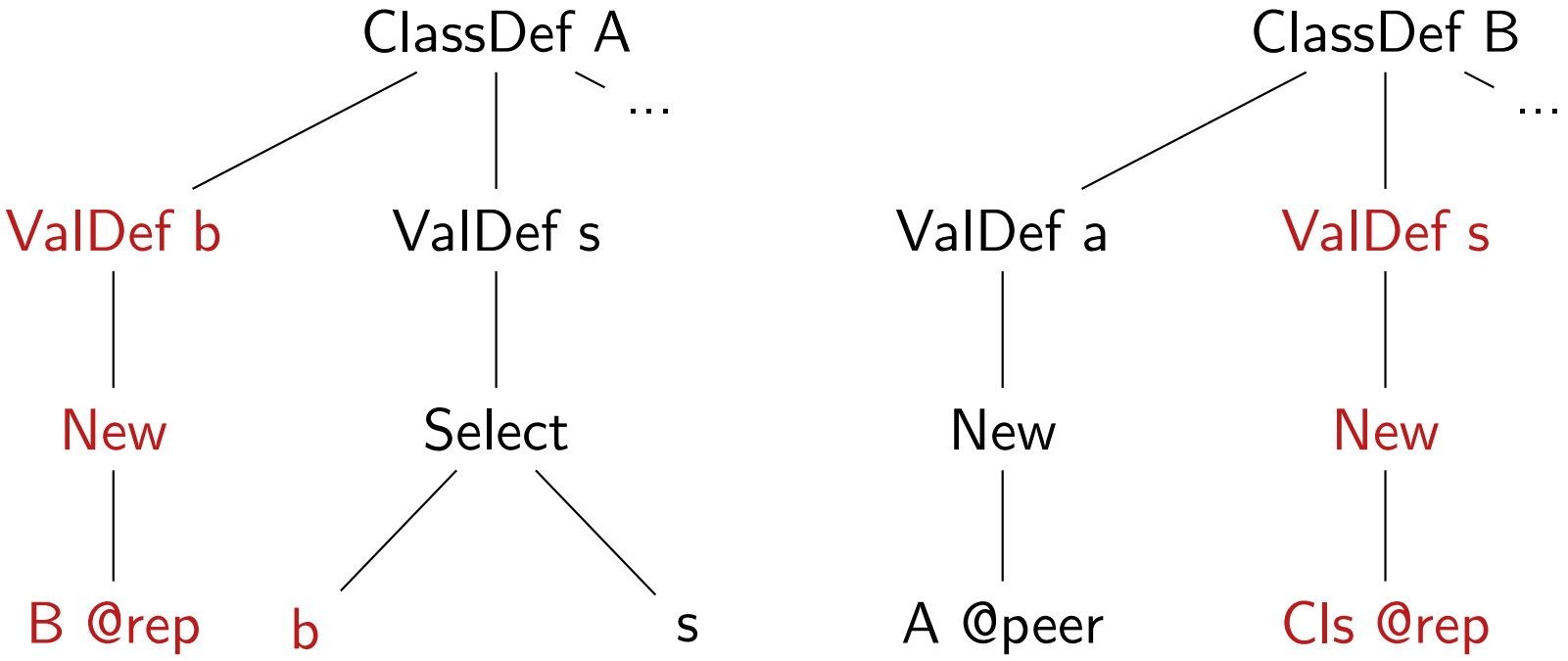

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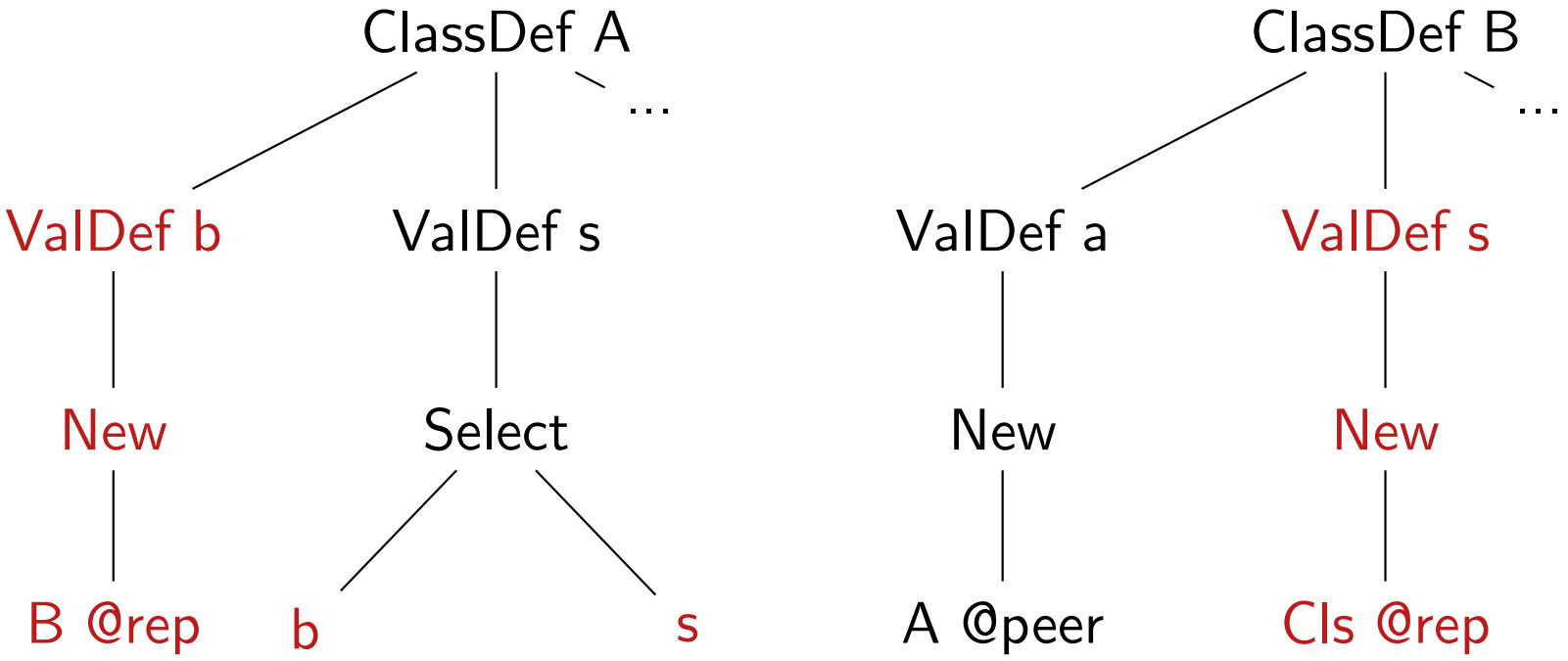

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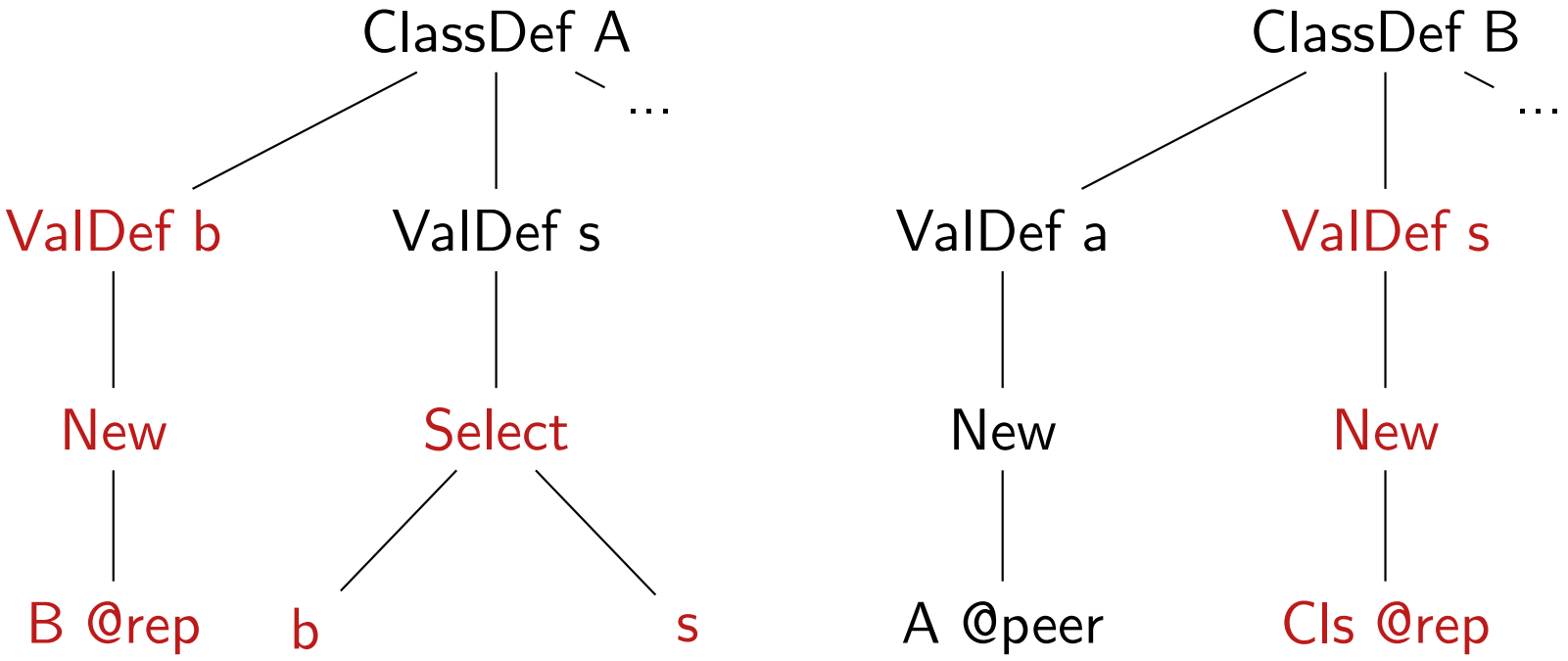

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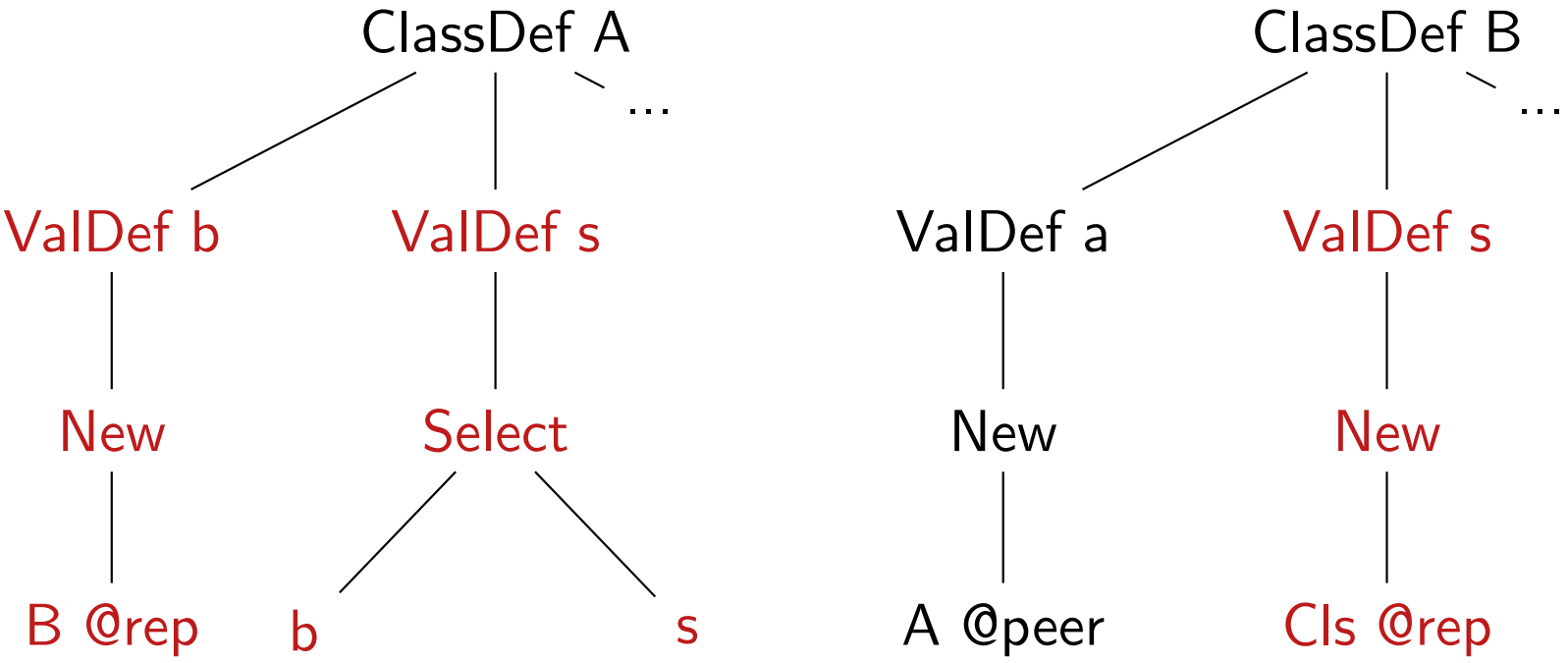

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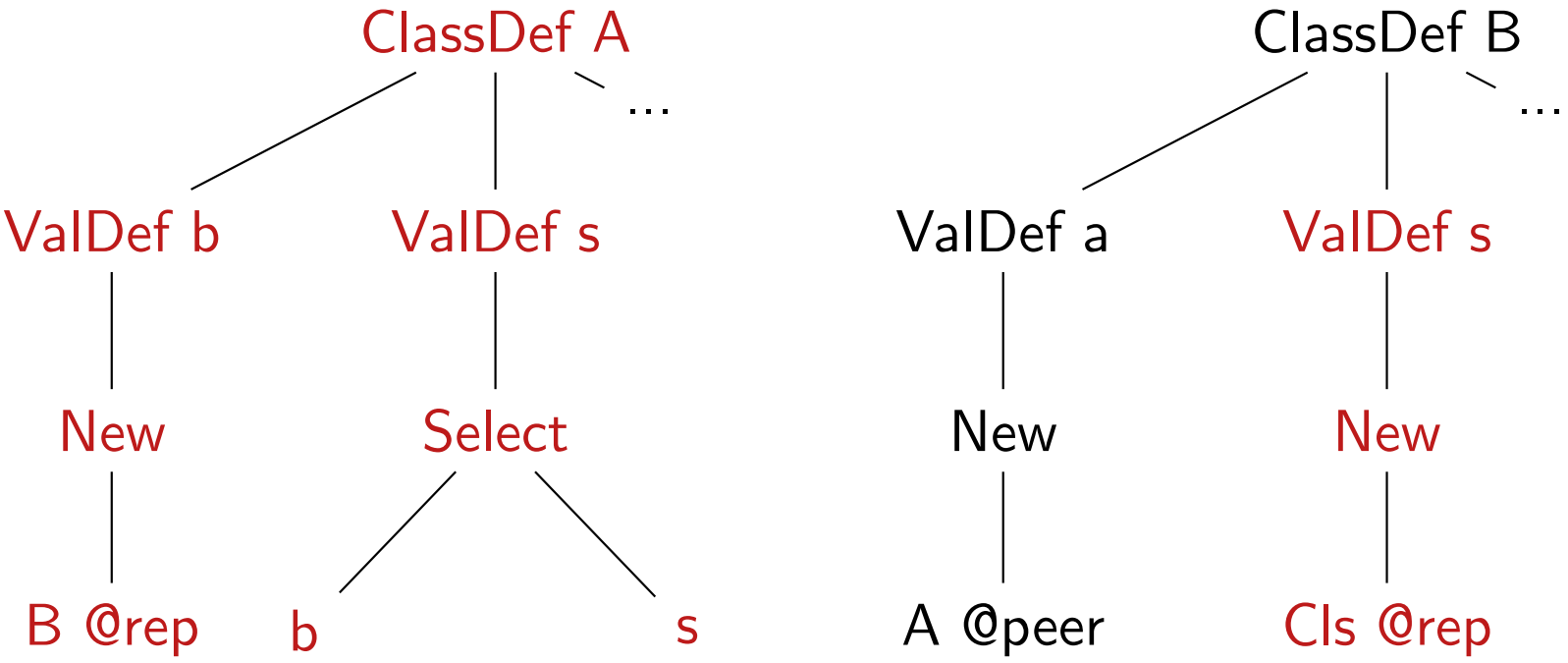

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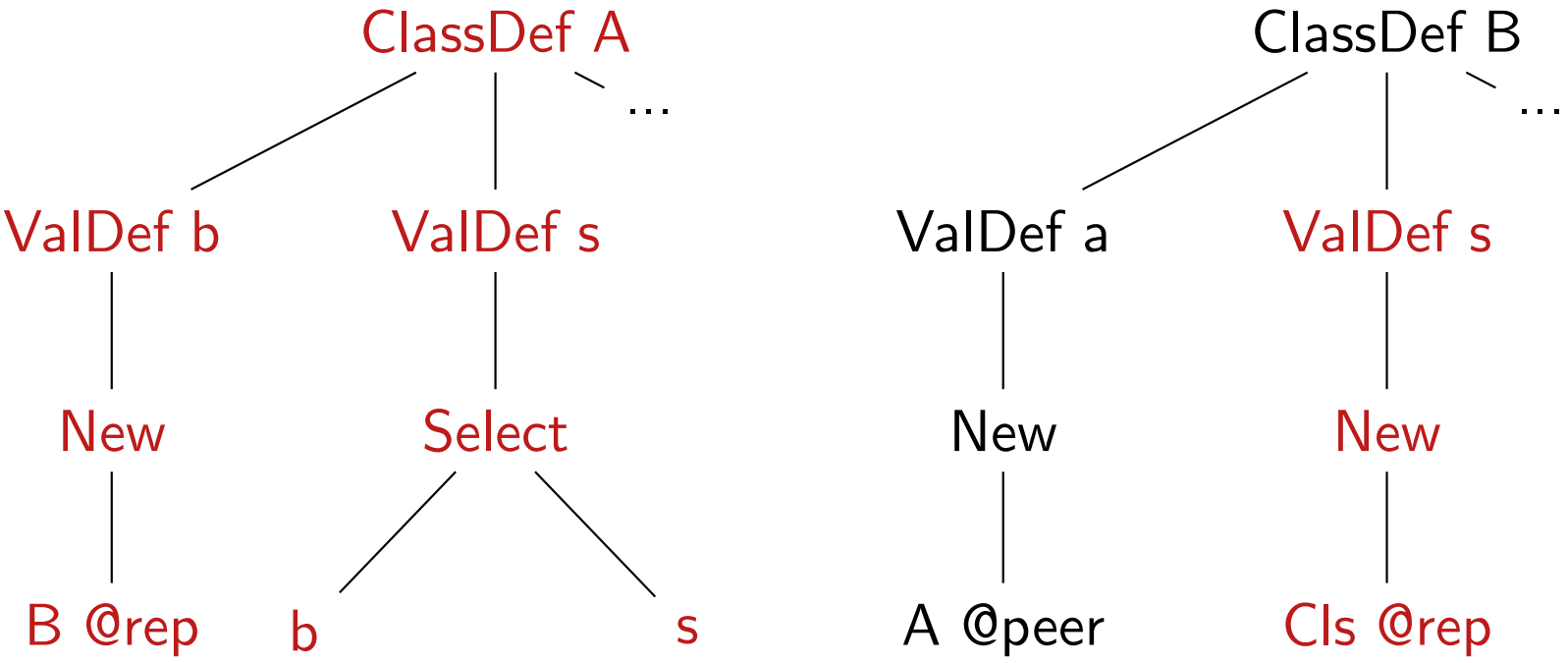

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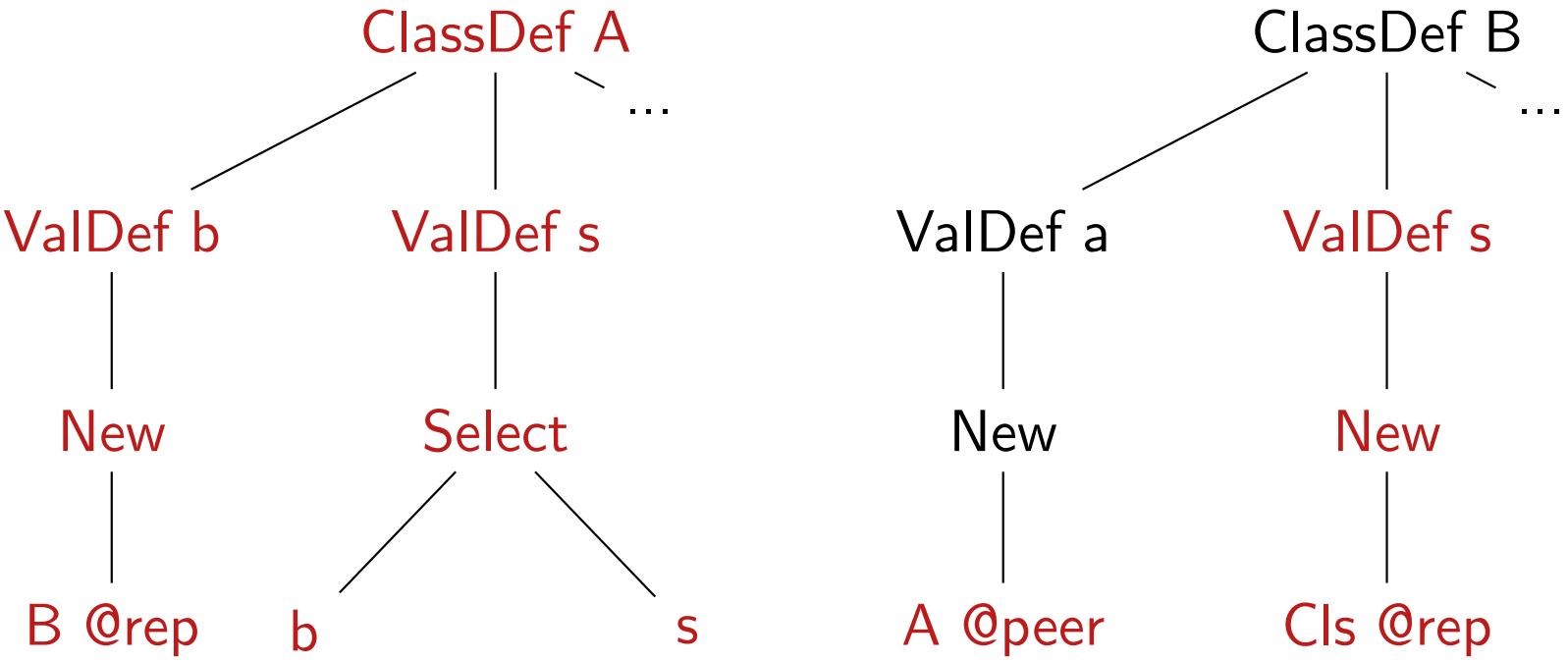

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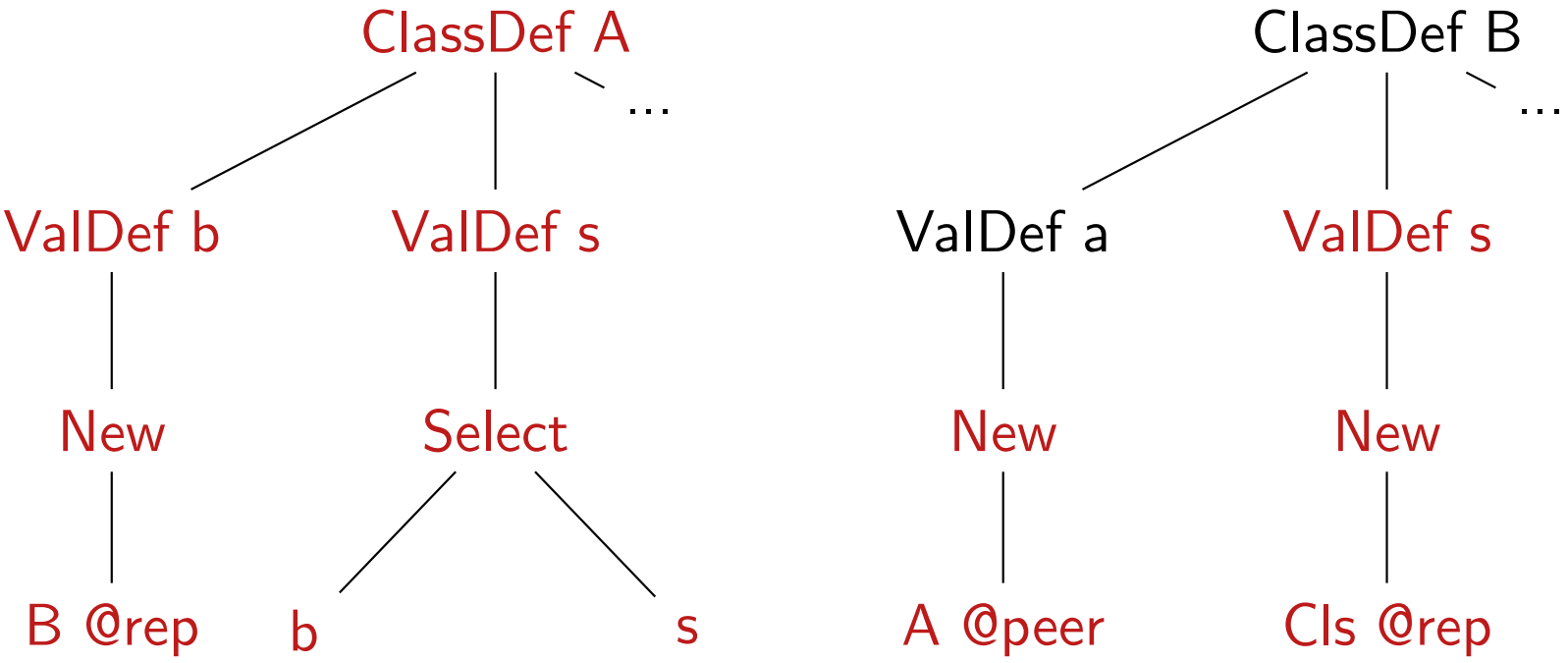

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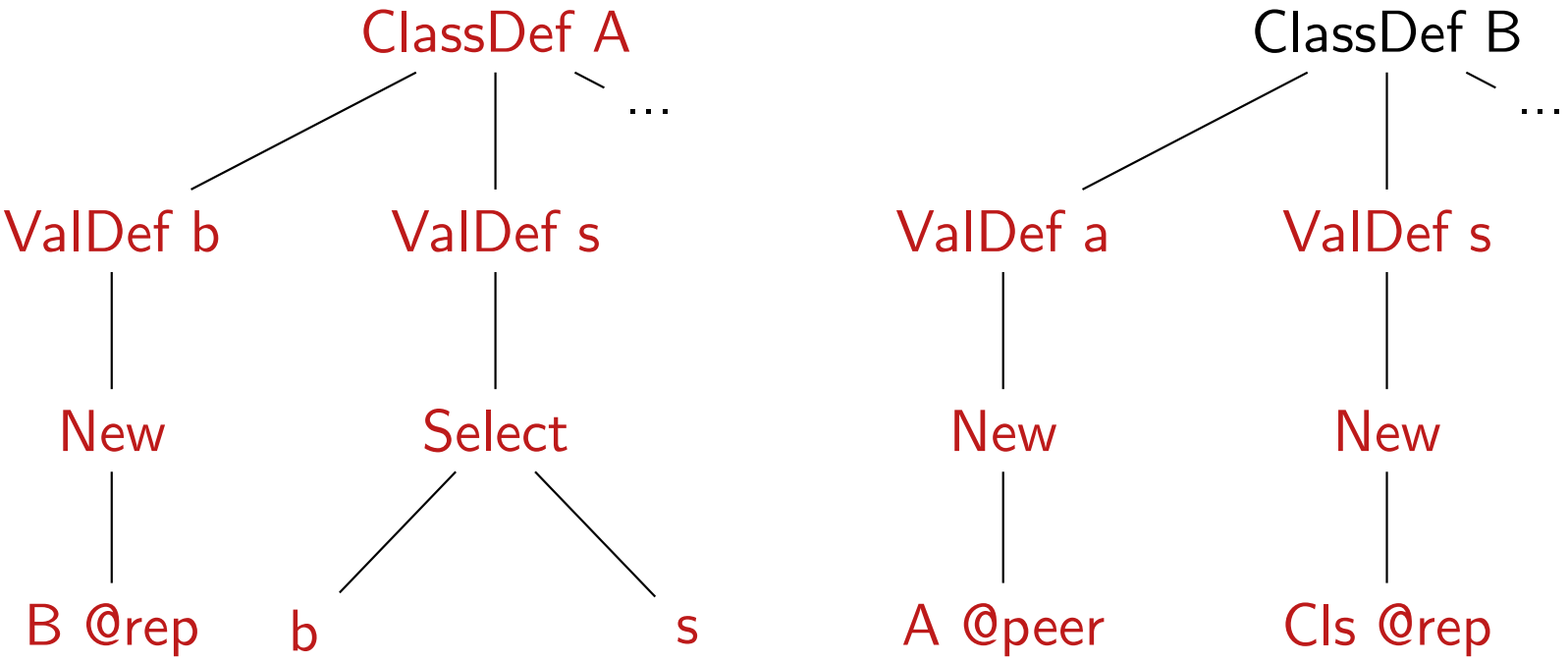

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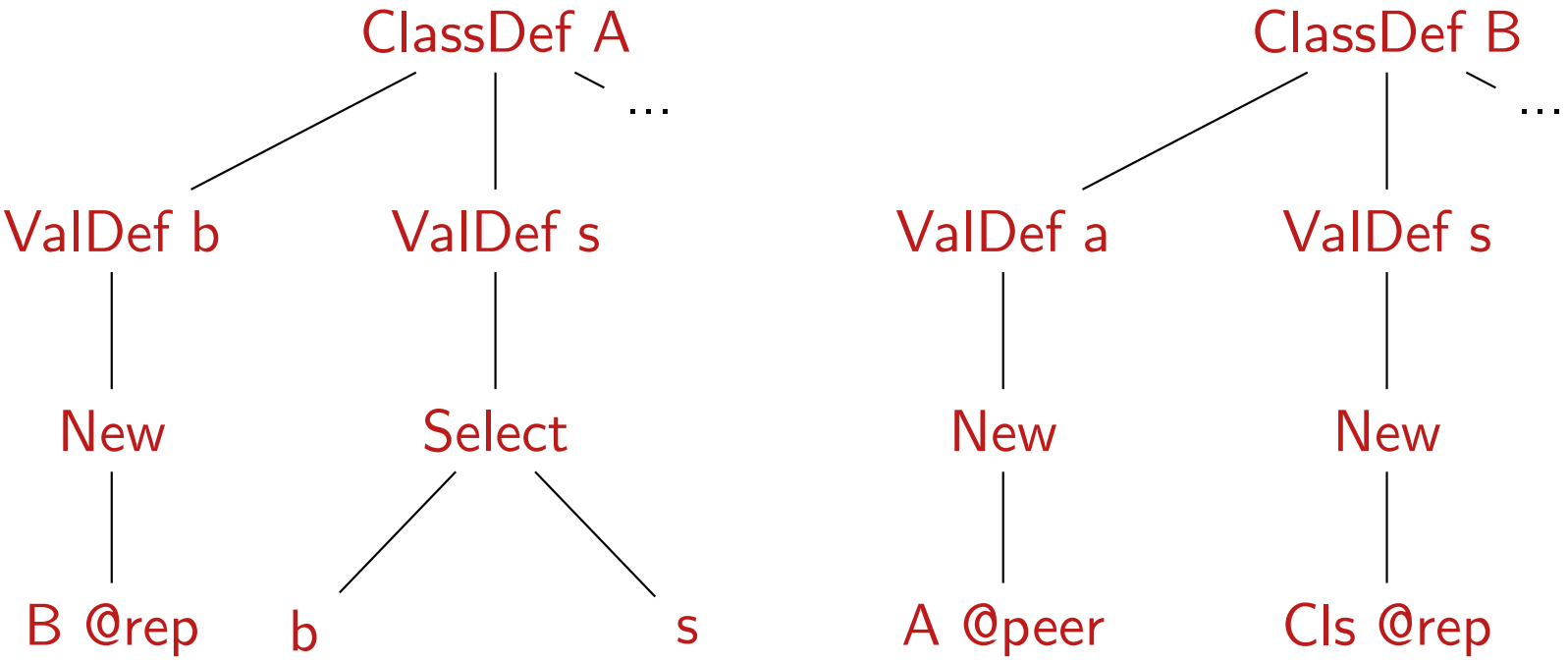

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- Finding good abstractions

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- Initial handling of annotated types in the Scala compiler

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Status and Next Steps

Status

- Superset of the language subset from [DDM07, Section 3.1] supported, including:
  - Constructors
  - Static objects
  - Inner classes
  - Basic variants of control structures
- Inference and propagation of Universe annotations works
- Inferred annotations are stored in the class files
- Basic runtime checks are added to the AST

Status and Next Steps

Next Steps

- Support for a broader set of Scala constructs:
  - Variance annotations for generics
  - Proper support for `if` and `match` control structures
- Case study with Scala Collection Library:
  - How far can I get with defaults and inference?
  - Which defaults require less hand-written annotations?
- Runtime support for generics
- Usage guide for the plugins, general report

References


W. Dietl, S. Drossopoulou, and P. Müller.
Generic Universe Types.
In E. Ernst, editor, *European Conference on Object-Oriented Programming (ECOOP)*, volume 4609 of *Lecture Notes in Computer Science*, pages 28–53. Springer-Verlag, 2007.


Daniel Schregenberger.
Runtime Checks for the Universe Type System, 2004.
Semester Thesis.

Basic Inference Algorithm

```
0  getMethodAndFieldSymbols(AST)

2  def process(AST) {
     if (access to untyped field/method symbol) {
4      inferType(symbol)
     }
6    propagateUniverseAnnotationsTo(AST)
   }
8
   def inferType(symbol) {
10   process(symbol.definition)
     copyUniverseAnnotations(symbol.definition,
       symbol)
12 }
```

Runtime Checks

- Basically a port of [Sch04] to Scala
- Store the owner of new objects during constructor execution
- Owner is stored in a hash table
- Additional checks are done on `isInstanceOf` and `asInstanceOf` calls