Domain-Specific Languages for Composable Editor Plugins

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The Framework is the Language

The IDE is the Language

Implementing IDEs: The Two Faces of Eclipse

Eclipse platform:

- Cross-platform, open-source
- People *have* it
- People *use* it
  - Java, ...

Implementing IDEs: The Two Faces of Eclipse

Huge, low-level API

- SWT widgets
- synchronization
- I/O
- regexes

```
private static String[] keywords = { "module", "imports", "constructors",
        "overlays", "where", "rules", "signature", "strategies", "sorts",
        "if", "then", "else", "end", "let", "in", "rec", "switch", "case"};
...
public StrategoCodeScanner() {
    ...

    rules.add(new MultiLineRule("\"", "\"", string, '\\', true));

    // FIXME: OMG, how this is ugly!
    rules.add(new MultiLineRule(" '", "'", string, '\\', true));
    rules.add(new MultiLineRule("\t'", "'", string, '\\', true));
    rules.add(new MultiLineRule("\n'", "'", string, '\\', true));
    rules.add(new MultiLineRule("('", "'", string, '\\', true));
    rules.add(new MultiLineRule("['", "'", string, '\\', true));

    rules.add(new WhitespaceRule(new StrategoWhitespaceDetector()));
    rules.add(new StrategoDeclarationParametersRule(parameterDecl, this));
    rules.add(new StrategoDeclarationRule(ruleDecl, ruleDecl, ruleDecl,
```

Implementing IDEs: The Two Faces of Eclipse

Weakly typed interfaces

- XML
- java.lang.Object, IAdaptable
- CoreException

  "*A checked exception representing a failure.*"

II.

Composable Languages

DSLs and Language Extensions

Domain-specific

- Database queries
- Regular expressions
- XML processing
- Matrices
- Complex numbers
- …

```
void browse() {
   List<Book> books =
     <| SELECT *
        FROM books
        WHERE price < 100.00
      |>;

   …

   for (int i = 0; i < books.size(); i++)
      books.get(i).title =~ s/^The //;
}
```

Meta-programming with Concrete Object Syntax

- Program transformation
- Stratego with WebDSL, Java, XML

```
webdsl-action-to-java-method:
  |[ action x_action(farg*) { stat* } ]| ->
  |[ public void x_action(param*) { bstm* } ]|
  with param* := <map(action-arg-to-java)> farg*;
       bstm*  := <statements-to-java> stat*
```

III.

Introducing Spoofax/IMP

IDE development environments

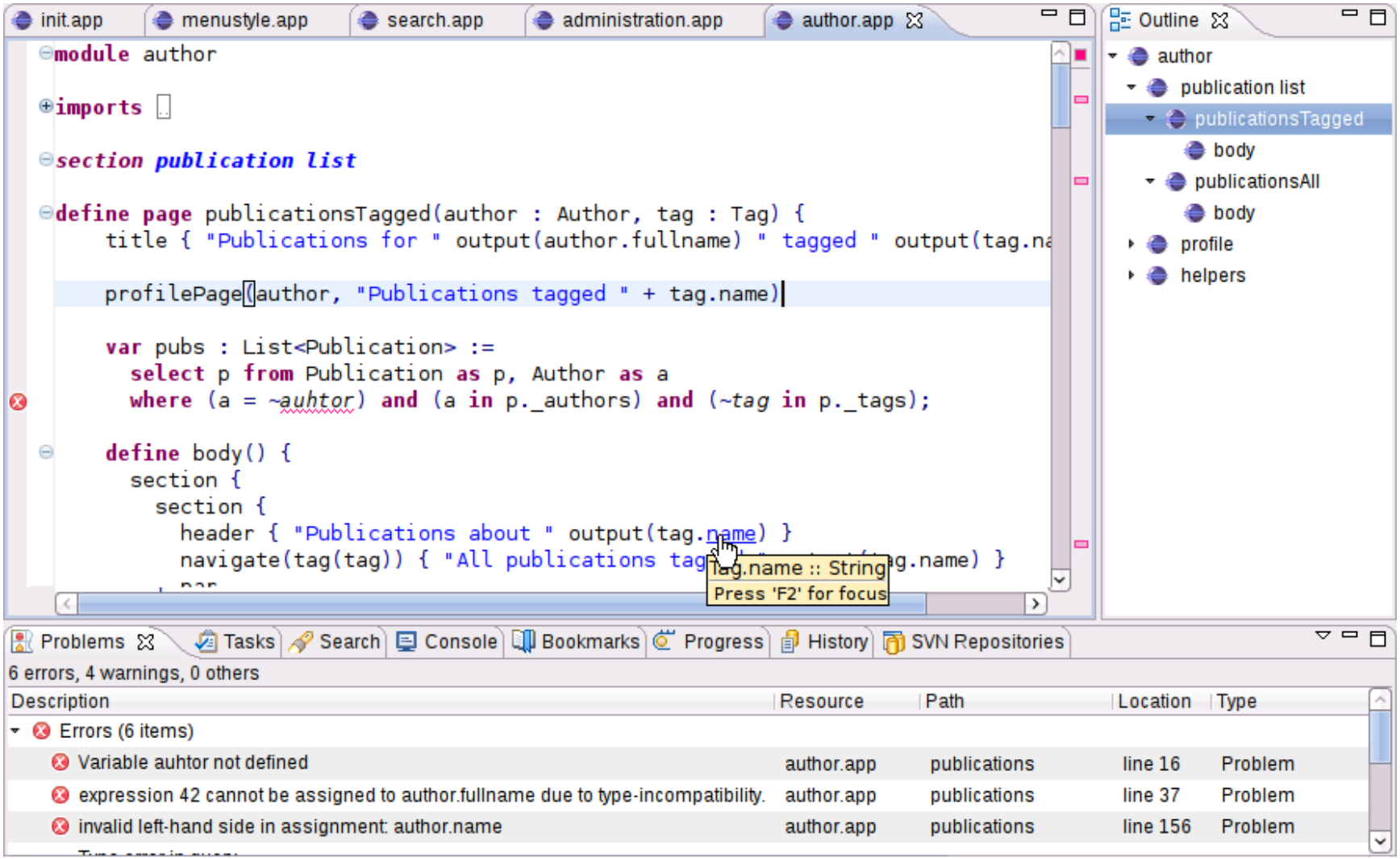
(Or: How to Learn to Stop Worrying and Love Eclipse)

- Abstraction
  - avoid Eclipse framework complexity
- Modularity
  - separation of concerns
  - reuse
- Extensibility and customization
  - integration with existing compilers, tools

Introducing Spoofax/IMP

- Three pillars:
  - SDF grammars
  - DSLs for service descriptors
  - Implemented using Spoofax and IMP frameworks (“SAFARI”)

An IDE plugin created with Spoofax/IMP



SDF and SGLR (1)

- Unified lexical and context-free syntax

```
module WebDSL
imports MixHQL[HQL] AccessControl ...
exports
  lexical syntax
    [a-zA-Z][a-zA-Z0-9\_]* → Id
    ...
  context-free syntax
    "module" Id Section*                  → Unit     {cons("Module")}
    "section" SectionName Def*            → Section  {cons("Section")}
    "define" Mod* Id "{" Element* "}" → Def      {cons("SimpleDef")}
    ...
```

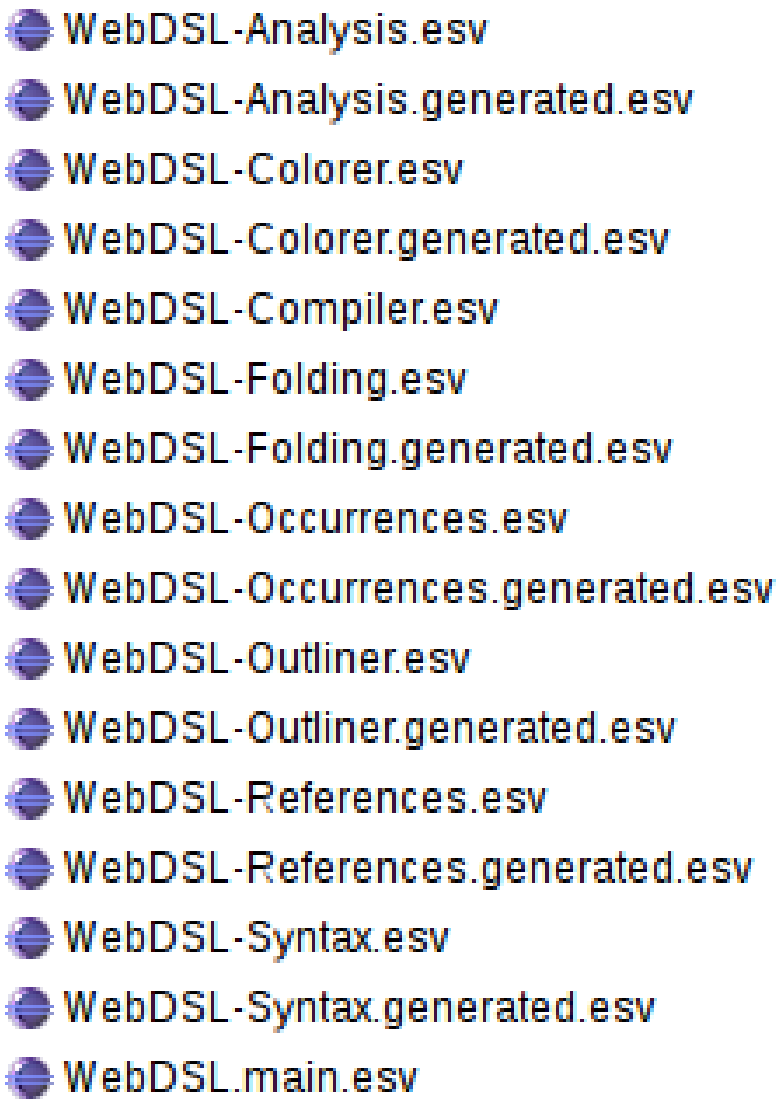
SDF and SGLR (2)

- Scannerless Generalized-LR Parsing
  - Full class of context-free grammars
  - Compositional
  - Declarative disambiguation filters

```
module Stratego-WebDSL-Java-XML
imports
  Stratego-Java-15
  Stratego-WebDSL
  Stratego-XML
```

Modular Editor Service Definitions

- Main file
- Definition for each service
- Generated definitions



Reuse and Modularity in IDE plugins

Stratego + *WebDSL editor* =
StrategoWebDSL editor

- Declarative specifications
- (Backdoor available)

Creating a brand new IDE plugin

Requires:

- Syntax definition
- Language name
- File extension(s)

Gives you:

- Service templates
- Generated services
- plugin.xml, ...

And:

- Basic IDE functionality:
  Coloring, outline, folding

In the Beginning: WebDSL.main.esv

```
module WebDSL.main

imports
  WebDSL-Analysis WebDSL-Colorer WebDSL-...

language Description

  name    : WebDSL
  aliases : WebDiesel
  id      : org.strategoxt.imp.generated.webdsl

  description : "Spoofax/IMP-generated editor for the WebDSL language"
  url         : http://strategoxt.org

language Files and parsing

  [...]
```

In the Beginning: WebDSL.main.esv

module WebDSL.main

imports
  WebDSL-Analysis WebDSL-Colorer WebDSL-...

language *Description*

  [...]

language *Files and parsing*

  extensions : app
  table : include/WebDSL.tbl
  start symbols : Unit

In the Beginning (2): Generated Services

- Based on heuristics
- Rapid prototyping
- Starting point
  - functioning as an example
  - self-documenting

```
module WebDSL-Colorer.generated

// ...documentation...

colorer Default highlighting rules
  keyword : "Keywords" = magenta bold
  string  : "Strings"  = blue
  number  : "Numbers"  = darkgreen
  ...
```

Example: The colorer service

```
rules

  webdsl-action-to-java-bean:
    |[ action x_action(farg*) {stat* } ]|
    |[ package pkgname;

       import pkgname2.*;

       @Stateful @Name("~x_actionBean")
       public class x_ActionBean implement

         @Logger private Log log = initLog

         RuleManager rules;

         @PersistenceContext(type = EXTEND
         private EntityManager entityManag

         public String x_action() {

         @Remove @Destroy
         public void destroy() {}
       }
     ]|
     where pkgname       := <BeanPackage>;
           pkgname2      := <DomainPackage>
           bstm*         := <statements-to-
```

module Stratego-WebDSL-Colorer

imports
Stratego
WebDSL

colorer *Variables*

_.Var : green **italic**

colorer *Concrete syntax*

environment _.ToMetaExpr:
_ gray

environment _.FromMetaExpr:
_ white

Example: The folding service

```
rules

  webdsl-action-to-java-bean:
    |[ action x_action(farg*) {stat* } ]|
    |[ package pkgname;

       import pkgname2.*;

       @Stateful @Name("~x_actionBean")
       public class x_ActionBean implement

         @Logger private Log log = initLog

         RuleManager rules;

         @PersistenceContext(type = EXTEND
         private EntityManager entityManag

         public String x_action() {

         @Remove @Destroy
         public void destroy() {}
       }
     ]|
     where pkgname       := <BeanPackage>;
           pkgname2      := <DomainPackage>
           bstm*         := <statements-to-
```

module Java-Folding

imports
Java-Folding.generated

folding *Customization*

CompilationUnit
NewInstance
QNewInstance

ImportDec* **(folded)**
Block **(disable)**

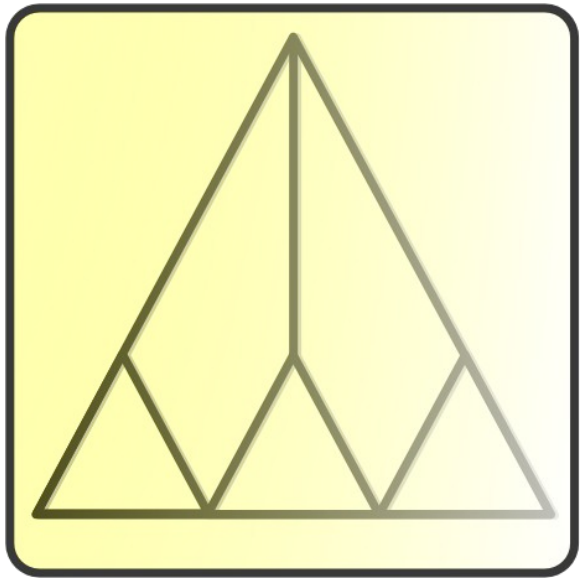
Syntactic Editor Services

- Syntax errors
- Code folding
- Outline view
- Brace matching
- Comments
- Source code formatting

Semantic Editor Services

- Error reporting
- Reference resolving
- Reference info
- Occurrence highlighting

Stratego integration



Stratego:

- Rewrite rules
- Strategies to control their application
- Used for e.g., WebDSL, Stratego, Java [OOPSLA'08]

Interfacing with Stratego

- Interface based on rewrite rules
- Adapted primitives for parsing, caching

Offending term + message tuples

[(Var("auhtor"), "undeclared"), ...]

```
editor-analyze:
  (ast, path, fullpath) -> (errors, warnings, infos)
  with
    ...
    (errors, warnings, infos) := <collect-all-markers> ast
    ...
```

Interfacing with Stratego

- Interface based on rewrite rules
- Adapted primitives for parsing, caching

Referenced declaration

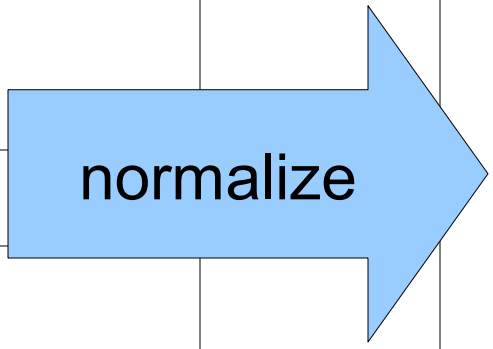
Property(“author”, ...)

```
reference-resolve:
  (ast, path, fullpath, reference) -> declaration
  with
    ...
    declaration := <find-decl> reference
    ...
```

Using Stratego:
A Global-to-Local Transformation

```
entity User {
  username :: String (id)
  password  :: Secret
  isAdmin     :: Bool
}
```

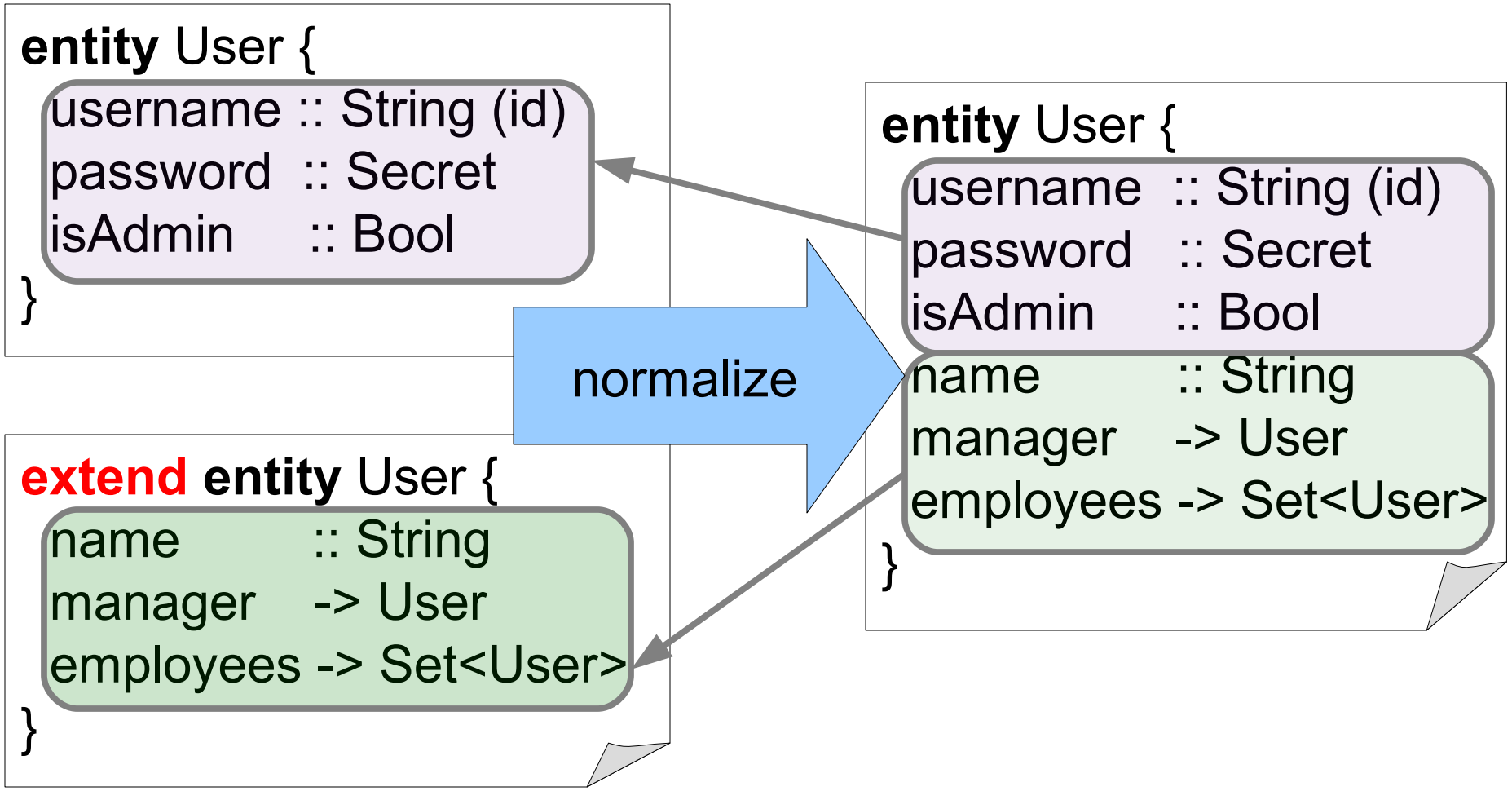
```
extend entity User {
  name         :: String
  manager    -> User
  employees -> Set<User>
}
```




```
entity User {
  username  :: String (id)
  password   :: Secret
  isAdmin      :: Bool
  name          :: String
  manager     -> User
  employees -> Set<User>
}
```

Term Rewriting with Origin Tracking

[Van Deursen et al 1993]



Program Object Model (POM) adapter

[Kalleberg et al, LDTA'07]

Interpret term operations as API calls

- Using Spoofax interpreter
- Intercept applications of rewrite rules in strategies
- Override term building, 'all', 'some', and 'one' for origin tracking

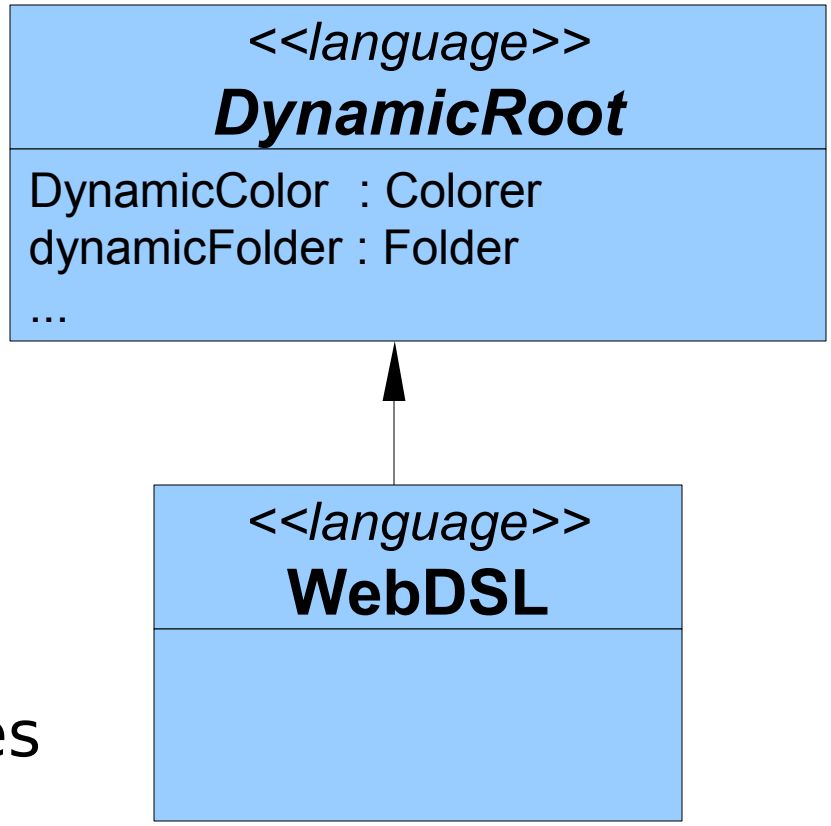
The Ubiquitous Eclipse

Dynamic Building and Loading: The Editor Service Builder

- Verifies all service descriptors
  - Syntax
  - Existing sorts
  - ...
- Updates plugin.xml, etc.
- Builds parse tables

Dynamic Building and Loading: Dynamically Loading Editor Services

- IMP provides:
  - static, XML-based editor declarations
  - language inheritance
- Base language
  - Defines default services
  - May be overridden by dynamic or “backdoor” implementations



Looking back

LDTA'07: Spoofax

Looking back

LDTA'08: sdf2imp

No:

- Semantic services
- Dynamic loading
- Modular definitions

```
rules

  webdsl-action-to-java-bean:
    |[ action x_action(farg*) {stat* } ]| ->
    |[ package pkgname;

       import pkgname2.*;

       @Stateful @Name("~x_actionBean")
       public class x_ActionBean implements x_Action {

         @Logger private Log log = initLog();

         RuleManager rules;

         @PersistenceContext(type = EXTENDED)
         private EntityManager entityManager;

         public String x_action() {

         @Remove @Destroy
         public void destroy() {}
       }
     ]|
     where pkgname       := <BeanPackage>;
           pkgname2      := <DomainPackage>;
           bstm*         := <statements-to-java> stm*;
```

Looking forward (to)

- Complete Stratego-based DSL environment
  - compiler for Java
  - SDF bundle
- Expansion of editor services
  - e.g. content completion

Looking forward (to)

- Integration with Aster [CC 2009]
- Better interactive parser
  - performance
  - error handling
  - content completion

Concluding Remarks

- Declarative DSLs
  - Avoid Eclipse API complexity
  - Specialized syntax
  - Compositionality
  - Co-evolution of language and IDE

Domain-Specific Languages for Composable Editor Plugins.
Lennart C. L. Kats, Karl T. Kalleberg, and Eelco Visser. *LDTA 2009*.

http://www.strategoxt.org/Stratego/Spoofax-IMP