TAKE – A Derivation Rule Compiler for Java

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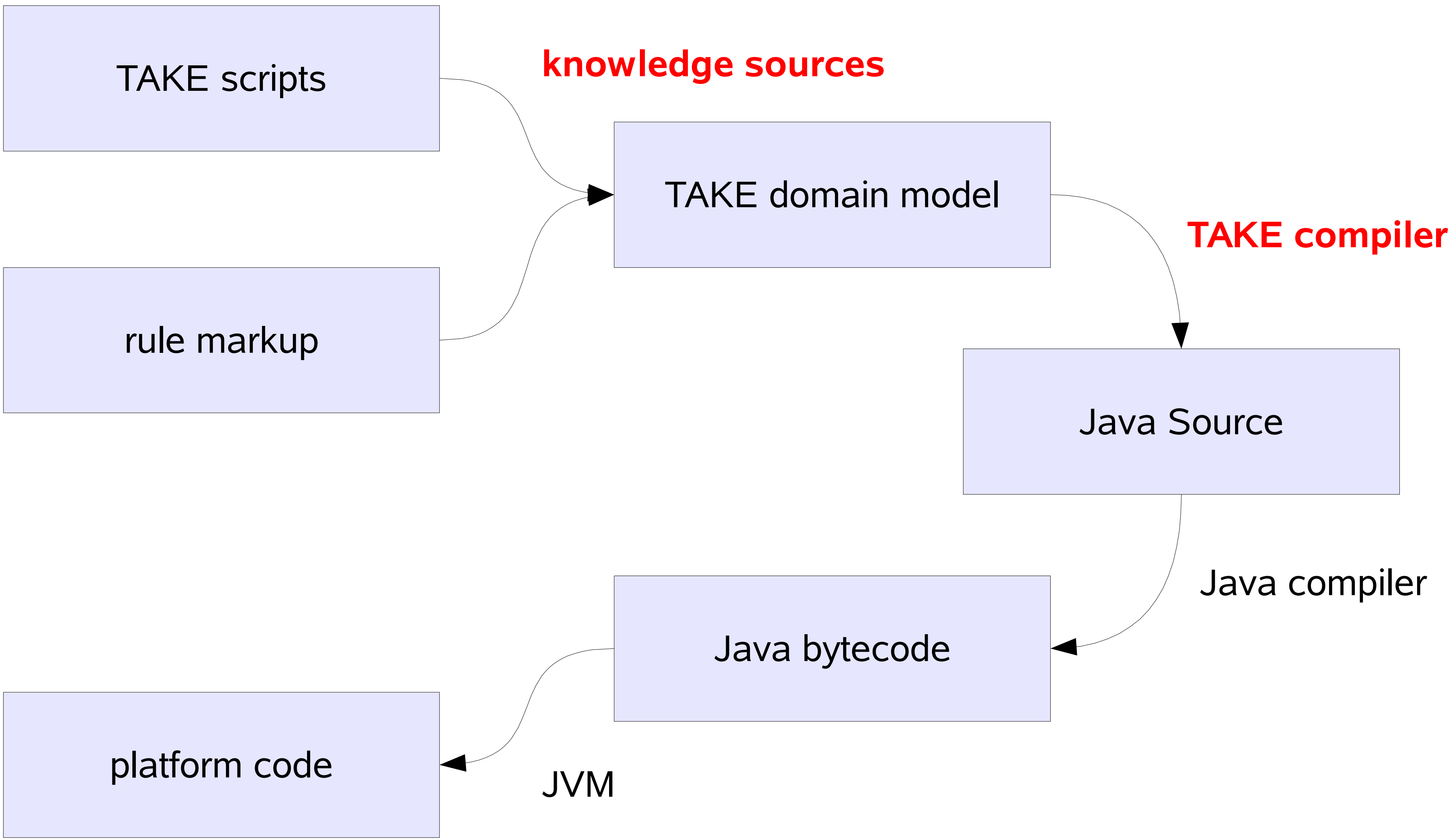
Why Derivation Rules

- Query driven.
- Well defined semantics.
- Non state changing.
- Easy integration into pull based applications (http requests, DB queries).
- No need to replicate (keep and keep up-to-date) facts in memory – fetch as needed, cache if you want
- Good scalability in scenarios with large fact bases and small or medium sized (up to thousands) rule bases.

Rule Engines vs Rule Compilers

- Rule engine: interpret rules at runtime.
- Rule compiler: convert rules into executable code.
- Advantages: speed + free verification by underlying compiler.
- Disadvantages:
  - compilation happens at build time - application must be redeployed if rules change.
  - rules not available at runtime, they are "compiled away" and cannot be referenced to explain computation
- But: runtime compilation and deployment is possible and supported by standards (JSR-199) (used for applications like JSPs)
- Problems with derivation rules: compiler must handle backtracking and variable binding (unification)

Compilation



Deployment

Option1 - static
1. Compile rules into classes
2. Build application
3. Deploy application

Option2 - dynamic
1. Compile rules into interfaces
2. Build application
3. Deploy application
4. Compile rules into classes
5. Deploy (+undeploy) rules into running applications

Writing Rules

- TAKE scripting language – easy to use, slightly prologish
- TAKE R2ML adapter (beta) – imports rules from REWERSE R2ML markup language

TAKE scripts

- Java type references
- Java object references (by name, must be bound)
- global (rule base) and local (rule) annotation
- aggregations
- fact stores
- queries
- rules and facts

TAKE example

```
// example
@@dc:creator=jens dietrich
@@dc:date=27/05/2007
var example.nz.org.take.compiler.eurent.RentalCar car
var example.nz.org.take.compiler.eurent.Rental rental
var example.nz.org.take.compiler.eurent.Branch branch
@take.compilerhint.class=IsAvailable
@take.compilerhint.slots=car,branch
@take.compilerhint.method=isAvailable10
query availableAt[in,out]
// rules
rule1: if storedAt[car,branch] and not isScheduledForService[car]
  and not assignedTo[car,rental] then availableAt[car,branch]
```

annotations
(meta data)

variables,
types are
Java classes

more annotations,
names used by compiler

query,
defines the
public
methods to
be
generated

rules

Generated Code

- Generates simple PLOJO classes for predicates
- Central main class with interface for queries
- Actual code in fragment classes referenced by main query class for scalability
- Call backs to Java methods in domain model
- Large parts of the generated code are template based

Generated Data Structure

- PLOJOs are generated for all referenced predicates

```
public class IsAvailable {
    public example.nz.org.take.compiler.eurent.RentalCar car;
    public example.nz.org.take.compiler.eurent.Branch branch;

    public IsAvailable() {
        super();
    }
}
```

The Resource Iterator Pattern

- Iterator - GangOf4 pattern – iterate over collections without knowing their internals
- Resource Iterator – Iterator + close – suitable to iterate over resources not necessarily available in memory (fetch as needed)
- Performance can be boosted by caching and background prefetching if needed

External Fact Stores

- Describe where facts are supplied by external resources like databases and web services
- Compiler will generate interface that produces iterators
- Interfaces can be implemented to access facts
- Bound to implementation class when KB is instantiated

Query API

- Iterator based– pull results as needed.
- Iterators are called “ResultSets”
- result sets have API to extract rules used

Generated Query API

```
public class KB {

    public Map<String, String> getAnnotations(String id) {..}
    public Map<String, String> getAnnotations() {..}

    public ResultSet<IsAvailable> isAvailable10(RentalCar car) {
    ..
    }
}
```

name can be set in annotation

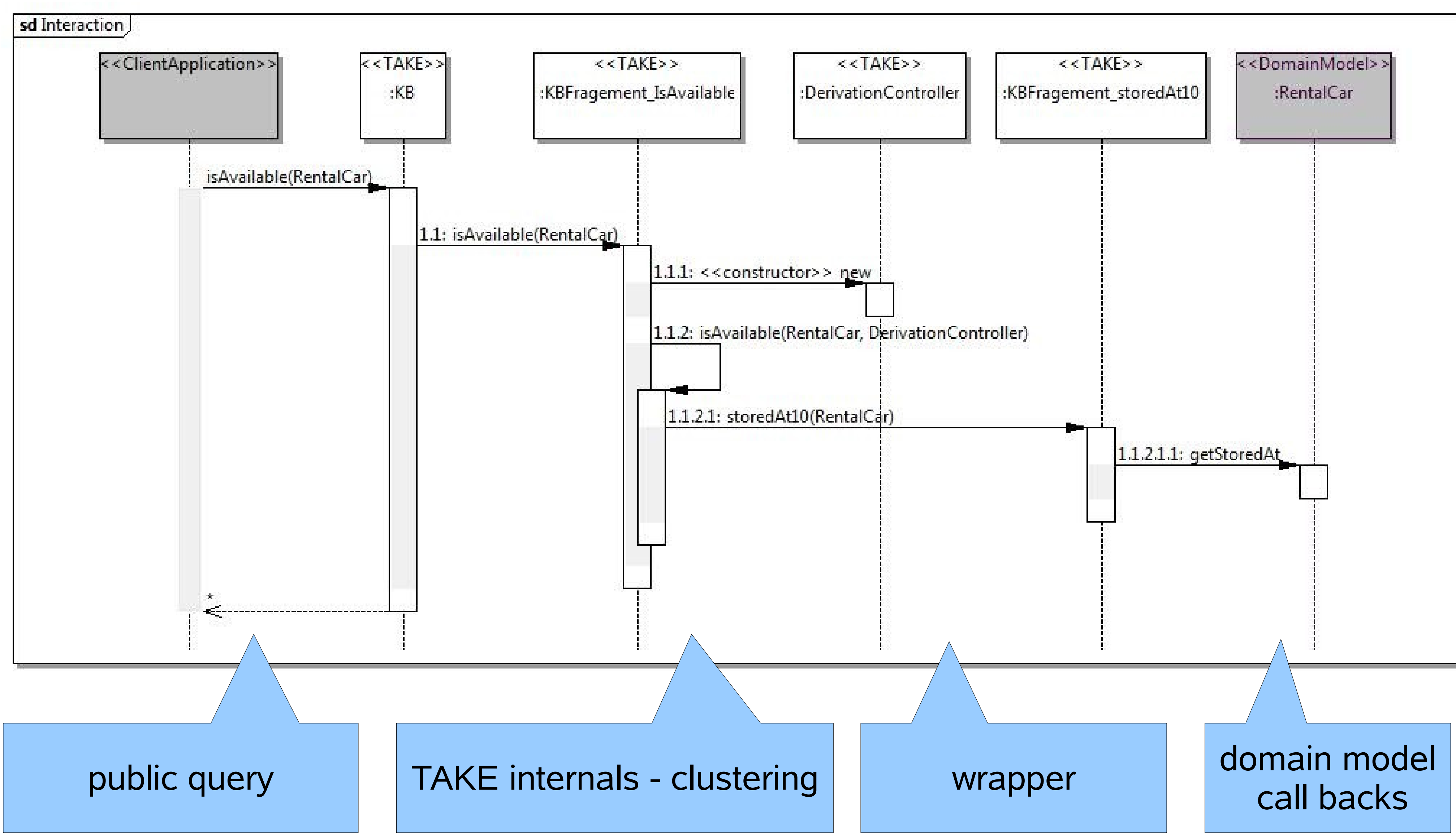
runtime access to annotations

method generated for query, ResultSet is iterator

Code Generated for Rules

- Use Iterator "algebra"
- Similar to Apache Commons Collections library
- Multiple rules supporting the same query – use chained iterator
- Evaluate prerequisites within a rule – use nested iterators
- Single supporting fact – use singleton iterator
- false – use empty iterator

Generated Code (ctd)



Semantic Reflection

- Generated code is reflective
- Information about rules used to generate application is accessible at runtime
- Similar to reflection is OO – but reflection is only about syntax
- API keeps not rules but only rule ids, and supports querying meta data by id
- Examples: creator, date modified, description .. standard vocabularies (DC) should be used
- Addresses many business use cases, such as tracing code to requirements
- Alternative to dominating black box principle

Example: Application API

```
RentalCar c = ...;
Branch b = ...;
Rental r = ...;
KB kb = new KB();
ResultSet<IsAvailable> rs = kb.isAvailable10(c);
IsAvailable result = rs.next();
List<DerivationLogEntry> log = rs.getDerivationLog();
System.out.println(result.branch.getName());
for (DerivationLogEntry e:log) {
    Map<String,String> annotations = kb.getAnnotations(e.getName());
    if (annotations!=null){
        System.out.println(annotations.get("take.auto.date"));
        System.out.println(annotations.get("take.auto.creator"));
        System.out.println(annotations.get("take.auto.tostring"));
    }
}
```

Validation

- UServ Product Derby Case Study
- execute by clicking on link on TAKE home page http://code.google.com/p/take/
- 69 rules -> 111 source code files, 354 classes
- Compilation takes 2567 ms on a system with a 2.0GH T5600 dual core processor, 2.0GB of RAM running on Ubuntu 7.10 with Java 1.6.
- Handicaps: logging and code pretty printing enabled
-

Using TAKE

Project Home:
http://take.googlecode.com/svn/trunk/take/

Subversion:
http://take.googlecode.com/svn/

Example App (WebStart):
http://www-ist.massey.ac.nz/jbdietrich/userv/userv.jnlp

License: LGPL

Next Steps

- **Tool support (Eclipse plugin)**
- Better integration with rule markup languages.
- Use concurrency in compiler.
- **Use in MDA scenario to generate code for derived associations.**