AspectJ – AOP for Java

Tom Janofsky

- Instructor at Penn State Abington
- Consultant with Chariot Solutions
- JUG Member

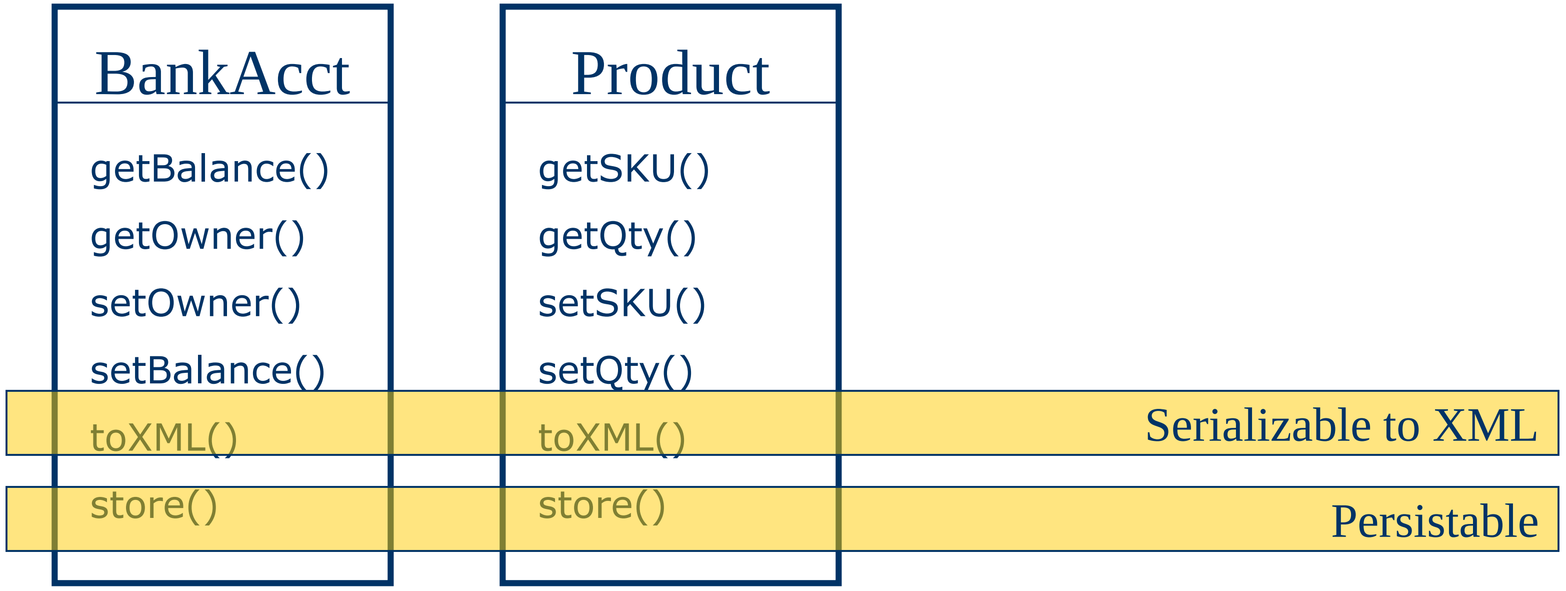
Agenda

- What is AOP?
- AspectJ
- Join points
- Pointcuts
- Advice
- Introductions
- Practical Uses
- Conclusions

What is AOP

- Aspect Oriented Programming
- Not an OO replacement
- Technique for handling ‘Crosscutting concerns’
- Tries to eliminate code-scattering and tangling
- Examples: log all exceptions, capture all SQL statements, authenticate users before access

Cross Cutting



Why AOP?

- Some things cannot be modeled well in object hierarchies
- Similarities in XDoclet,Dynamic Proxies, CLR (& JSR 201) meta data, EJB/JSP Containers
- Wants to
  - Separate concerns
  - Provide language for designating crosscuts

How can it be used?

- Still unclear
- Development
  - Check contracts, Logging
  - Ensure good coding practices
  - Tracing, Testing
- Optional runtime components
  - Debugging, profiling
- Implement core system features
  - Caching, Security

How do you do AOP?

- Write your components
- Write your aspects
- Weave
  - Compile (AspectJ 1.0)
  - Link (AspectJ 1.1)
  - Load (Classloader)
  - Run (VM)

What is AspectJ?

- An open source language
- 100% Java compatible
- An AOP implementation
- Extension to Java, new syntax
- Started at Xerox, now Eclipse project

Definitions

- AOP
- Aspect
- AspectJ
- Join point
- Pointcut
- Advice
- Introduction (Inter-type declaration)

Getting and installing

- Download from eclipse.org/aspectj
- Run executable JAR
- Use aspectjrt.jar on classpath
- Includes structure browser, debugger

Writing an aspect

- Write the class
- Write the aspect (.java or .aj)
- Weave with ‘ajc’ compiler
- Must have aspectjrt.jar for compile and runtime

Join points

- Points in a programs execution
  - Method call
    - call(public void setOwner(String))
  - Constructor call
    - initialization (BankAccount.new())
  - Method call execution
  - Constructor call execution
  - Field get
  - Field set

Join points (cont.)

- Exception handler execution
- Class initialization
- Object initialization
- No finer join points in AspectJ (loops, if checks)

Join point patterns

- Names can be matched with *
- call (* * BankAccount.*(*))
  - Matches all calls on BankAccount, regardless of visibility or return type, with one argument
- call (* *.(*))
  - Matches all method calls with 1 parameter
- call (* * .(..))
  - Matches all method calls

Join Point Patterns Cont

- Subtypes can be matched with a +
  - call (public void BankAccount+(..))
- Can also match on throws patterns
  - call (public void BankAccount+(..) throws Exception+)
- Watch out for infinite recursion!
  - Aspects match aspects too
  - Use ! within()

Pointcuts

- Structure for selecting join points in a program and collecting context (args, target, source)
- Declaring a named pointcut
  - pointcut changeBalance() : call (public void BankAccount.setBalance(java.math.BigDecimal));
- Can be combined with logical (set) operators, &&, ||, and !

Pointcuts cont.

- Valid on interfaces and classes
- Syntax
  - pointcut name ([parameters]) : designator (ajoinpoint);
  - Name will be used to handle actions
  - ajoinpoint is a signature match
  - Designator decides when this join point will match

Set Operators

```
public aspect BankAspectOr {
 pointcut change() :
     call (public void
   setBalance(java.math.BigDecimal))
  || call (public void setOwner(String));
 before() : change() {
   System.out.println(thisJoinPoint.getSignature())
   ;
 }
}
```

Available pointcuts

- call
- execution
- initialization
- handler
- get
- set
- this

Available pointcuts cont.

- args
- target
- cflow
- cflowbelow
- staticinitialization
- withincode
- within
- if
- adviceexecution
- preinitialization

Call pointcut

- Use when you are interested in the invocation of a method
- Control is still in calling object, use execution() for control in called object
- Format:
  - call (public void BankAccount.setOwner(String));

Handler pointcut

- Captures the execution of an exception handler anywhere in the primary application
- Format:
  - handler (ClassCastException)
- Remember + patterns apply here as well

State based designators

- Can be used to expose object to advice, or narrow pointcut selection
  - this,target,args
- Format:

```
pointcut setBalance(BankAccount b) :
   call(public void setBalance(*)) && target (b);
before (BankAccount b) : setBalance(b) {
   //b is accessible here
}
```

Other designators

- cflow,cflowbelow
  - Allow us to match join points within a certain program flow
- staticinitialization
  - Match class initialization
- within, withincode
  - Match class, method
- Dynamic
  - If, adviceexecution
- Pointcut Id (Can combine pointcuts using names and boolean operators)

Advice

- The second half of AOP
- Advice is what gets executed when a join point is matched
- Advice is always relative to a joinpoint
- Format
  - type ([parameters]) : join point id (param list) { … }

Advice Type

- before
  - excellent for preconditions
  - argument checking, setup code, lazy init
- after
  - can be qualified with: after returning, or after throwing
  - Cleanup of resources
  - checking/manipulating the return value
- around
  - the most powerful advice
  - can replace invocation, or just surround
  - use proceed() to call method

thisJoinPoint

- info about the join point that was just matched
  - the source location of the current join point
  - the kind of join point that was matched
  - various string representations of the join point
  - the argument(s) to the method selected by the join point
  - the signature of the method selected by the join point
  - the target object
  - the executing object
  - thisJoinPointStaticPart exposes args, target, and this if designated (no reflection required)

Accessing Objects

- Use target, args, and this similarly
- Can be done declaratively
  - Add a parameter to the pointcut declaration
  - Add && args(s) to the designator
  - Add parameter to advice designator
  - Add variable name to advice body
- Also all available reflectively

Exceptions and precedence

- Aspects can’t throw exceptions that the pointcuts they are advising don’t throw
  - Wrap in runtime
- Precedence
  - use the precedence keyword in an aspect:
    - declare precedence : A , B;
  - Sub aspects execute before parents.
  - Otherwise undefined.
- Multiple advice in an aspect:
  - natural order (before, after)
  - order of declaration

Inter-type Declarations

- AspectJ can be used to change the structure of existing code
  - add members (id fields, dirty flag)
  - add methods (toXML, storeToJDBC)
  - add types that extend existing types or implement interfaces
  - declare custom compilation errors or warnings
  - convert checked exceptions to unchecked
- Can use from aspects, or regular code
- Write normal variable and methods in your aspect, but prefix them with your class name

Inter-type declarations cont.

- Very powerful
- Can do wacky things
  - Add concrete fields & methods to interfaces (no constructors)
  - Modify aspects
  - Make an existing class dynamically implement an interface
  - Make an existing class extend another

Problems

- Difficult to know is code is advised
  - Helped by tool support?
- Crossing component boundaries
- Patent nonsense?
- How will we model?
- When usages are appropriate?
- Not a JSR, integration questions

Conclusions

- Powerful, but is it a good idea?
- Tool support is in:
  - Eclipse, JBuilder, Forte, IDEA 4.0?
- Other implementations
  - AspectWerkz (XML)
  - Nanning (Java)
  - HyperJ (IBM)