Aspect-Oriented Programming with AspectJ™

"Those are not independent coincidences." -- A Tangled Tale, L.C.

credits

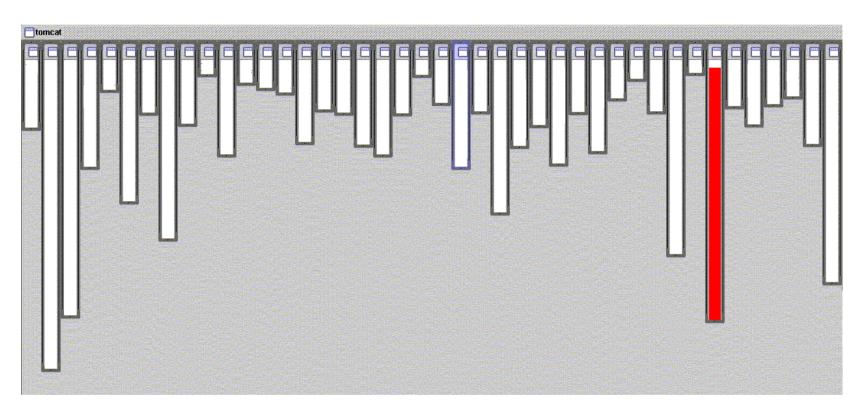
This talk is based on work done by the AspectJ team at Xerox PARC.

Bill Griswold, Erik Hilsdale, Jim Hugunin, Mik Kersten, Gregor Kiczales, Jeffrey Palm

slides, compiler, tools & documentation are available at aspectj.org

good modularity

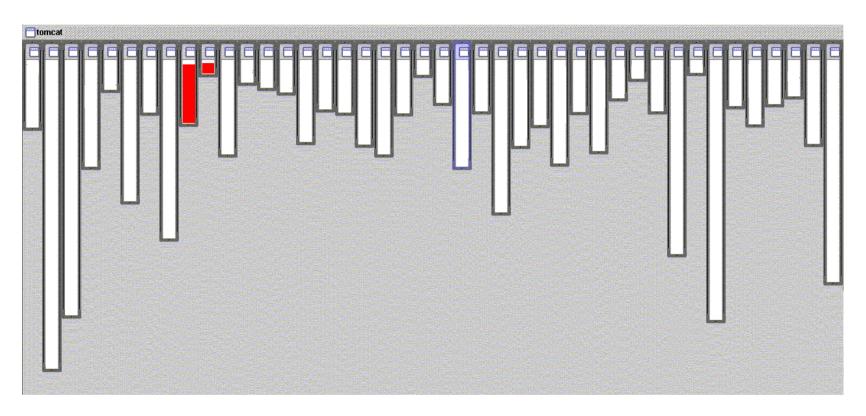
XML parsing



- XML parsing in org.apache.tomcat
 - red shows relevant lines of code
 - nicely fits in one box

good modularity

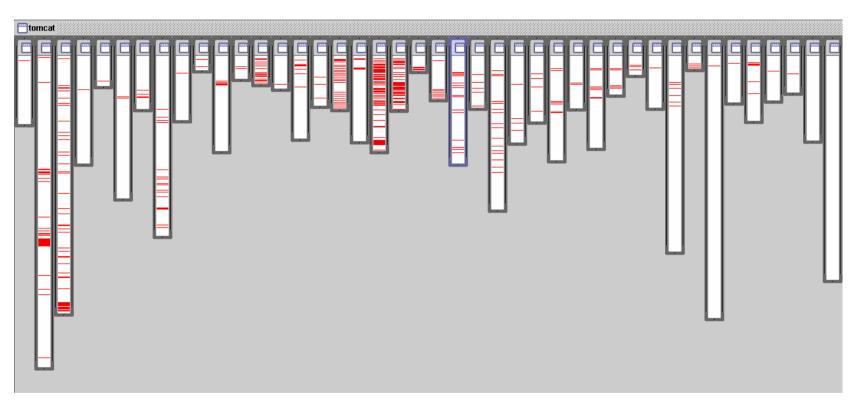
URL pattern matching



- URL pattern matching in org.apache.tomcat
 - red shows relevant lines of code
 - nicely fits in two boxes (using inheritance)

modularity problems

logging is not modularized



where is logging in org.apache.tomcat

- red shows lines of code that handle logging
- not in just one place
- not even in a small number of places

modularity problems

session expiration is not modularized

ApplicationSession





StandardSession

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modularity problems

session tracking is not modularized

HTTPRequest

getCookies()
getRequestURI()(doc)
getSession()
getRequestedSessionId()

HTTPResponse

getRequest()
setContentType(contentType)
getOutptutStream()
setSessionId(id)

SessionInterceptor

requestMap(request)
beforeBody(req, resp)

...

Session

getAttribute(name) setAttribute(name, val) invalidate()

...

Servlet

the cost of tangled code

redundant code

same fragment of code in many places

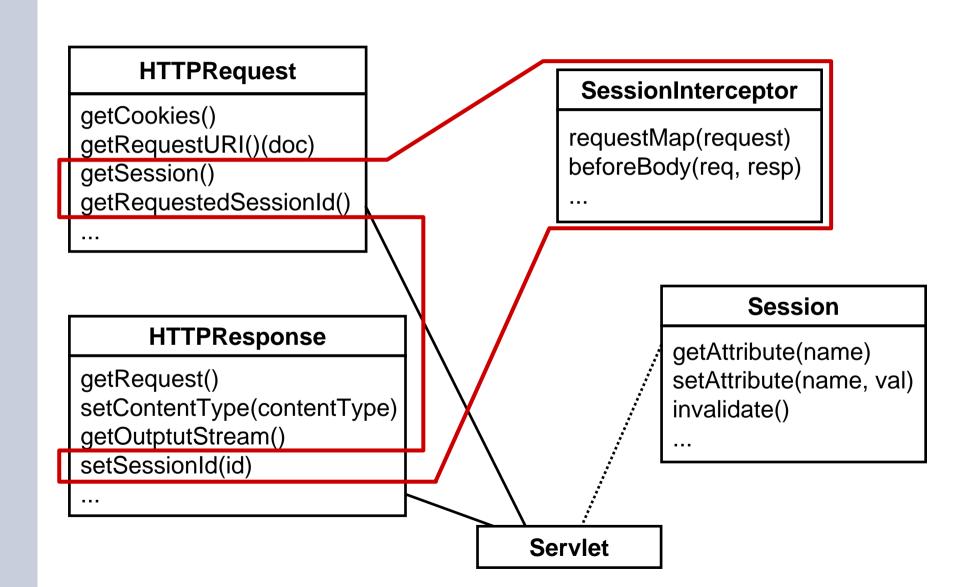
difficult to reason about

- non-explicit structure
- the big picture of the tangling isn't clear

difficult to change

- have to find all the code involved
- and be sure to change it consistently
- and be sure not to break it by accident

crosscutting concerns



the AOP idea

aspect-oriented programming

- crosscutting is inherent in complex systems
- crosscutting concerns
 - have a clear purpose
 - have a natural structure
 - defined set of methods, module boundary crossings, points of resource utilization, lines of dataflow...
- so, let's capture the structure of crosscutting concerns explicitly...
 - in a modular way
 - with linguistic and tool support
- aspects are
 - well-modularized crosscutting concerns

language support to...

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ApplicationSession

ServerSession

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StandardSession

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SessionInterceptor

ServerSessionManager

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StandardSessionManager



modular aspects

HTTPRequest

getCookies()
getRequestURI()(doc)

getSession()

getRequestedSessionId()

. . .

HTTPResponse

getRequest()

setContentType(contentType)
getOutptutStream()

setSessionId(id)

. . .

SessionInterception

requestMap(request)
beforeBody(req, resp)

. .

Session

getAttribute(name)
setAttribute(name, val)
invalidate()

. . .

Servlet

talk contents

- aspect-oriented programming (AOP)
 - crosscutting concerns and aspects
- AspectJTM
 - simple AOP extension to the Java programming language
- how AspectJ works to solve
 - difficult program modularity problems
 - structure, code "tangling", reusability
 - program development problems
 - design, coding, debugging
- a technical talk
 - will show code, language details, demo tools

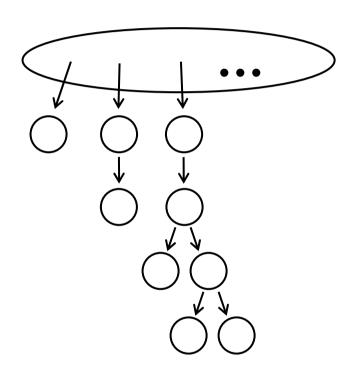
problem 1 – change tracking

collection of objects

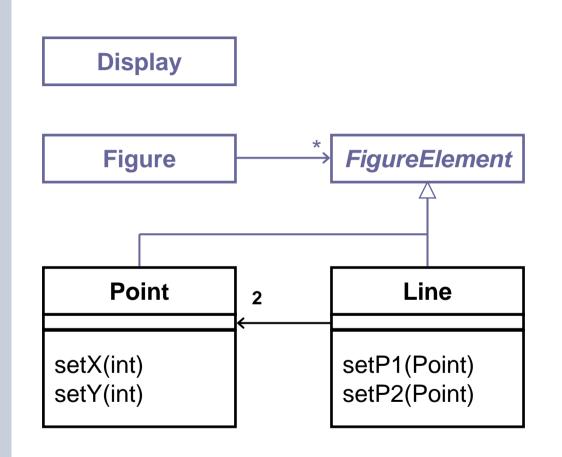
- that change periodically
- must monitor changes to maintain centralized state
- collection can be complex
 - hierarchical
 - asynchronous events

for example

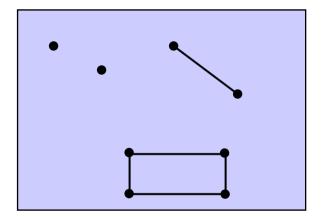
- session liveness
- image redisplay
- value caching



a simple figure editor



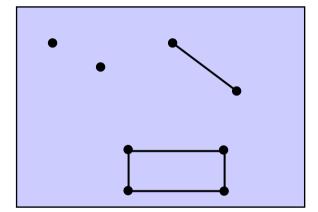
display must be updated when objects move



a simple figure editor

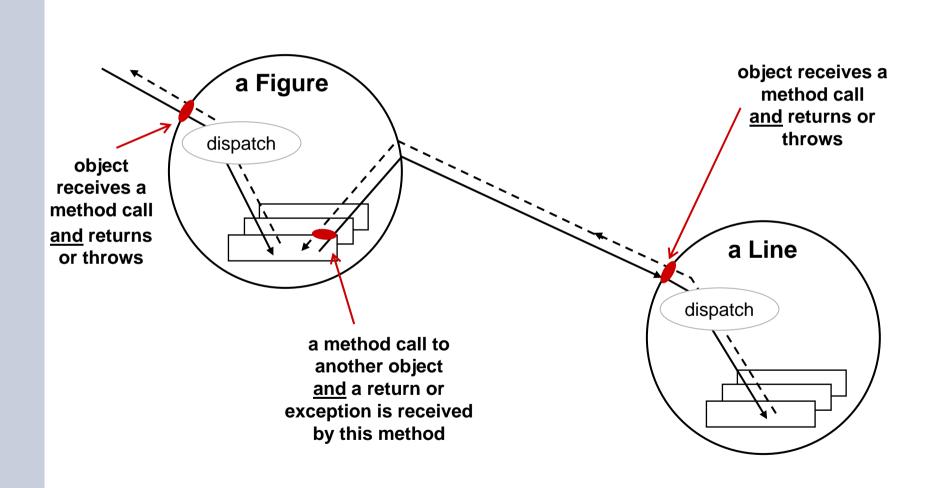
```
class Line {
 private Point _p1, _p2;
 Point getP1() { return _p1; }
  Point getP2() { return _p2; }
  void setP1(Point p1) { _p1 = p1; }
  void setP2(Point p2) { _p2 = p2; }
class Point {
 private int _x = 0, _y = 0;
  int getX() { return _x; }
  int getY() { return _y; }
  void setX(int x) { _x = x; }
  void setY(int y) { _y = y; }
```

display must be updated when objects move



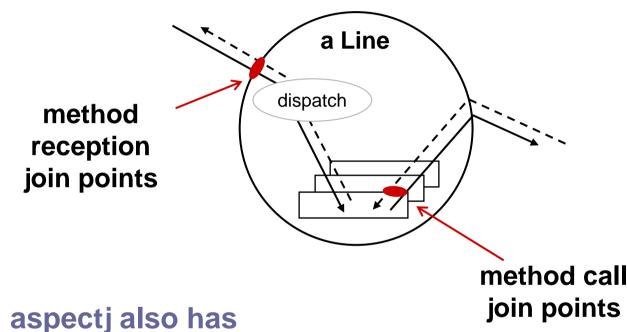
join points

key points in dynamic call graph



join point terminology

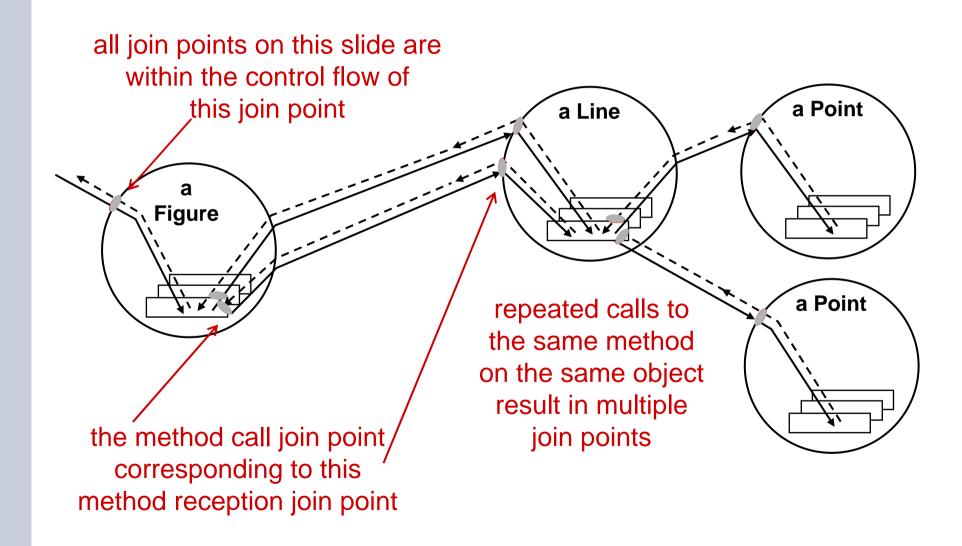
key points in dynamic call graph



- method execution join points
- constructor call reception join points
- constructor execution join points
- field access join points
- exception handler execution join points

join point terminology

key points in <u>dynamic</u> call graph



the pointcut construct

names certain join points

each time a Line receives void setP1(Point)" or "void setP2(Point)" method calls

pointcut designators

```
pointcut moves():
    call(void Line.setP1(Point)) ||
    call(void Line.setP2(Point));

    primitive pointcut designator
    also:
        - calls, executions - instanceof,
        - gets, sets - within, withincode
        - handles - cflow
```

after advice

action to take after computation under join points

```
pointcut moves():
    call(void Line.setP1(Point)) ||
    call(void Line.setP2(Point));

after(): moves() {
    <runs after moves>
}
```

a simple aspect

MoveTracking v1

```
aspect TrackMoves {
 private static boolean flag = false;
 public static boolean testAndClear() {
   boolean result = flag;
   flag = false;
   return result;
  pointcut moves():
    call(void Line.setP1(Point)) | |
    call(void Line.setP2(Point));
  after(): moves() {
    flag = true;
```

aspect defines a special class that can crosscut other classes

box means complete running code

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	The second of th	The second secon
	The second of th	The control of the co

SessionInterceptor | Comparison | Compariso

StandardSessionManager

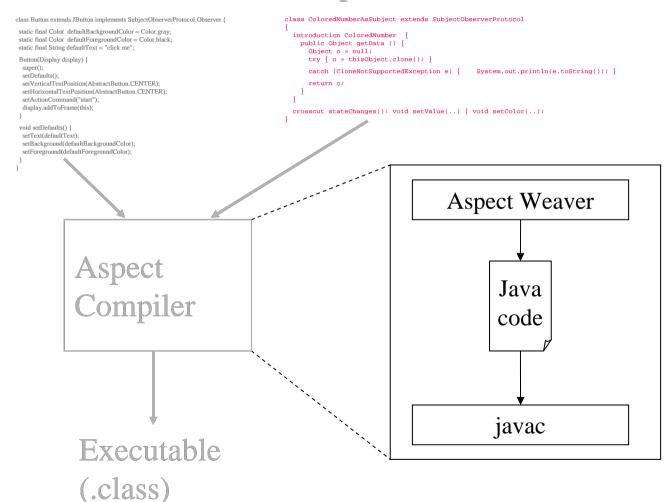
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Aspect processing (Weaving)

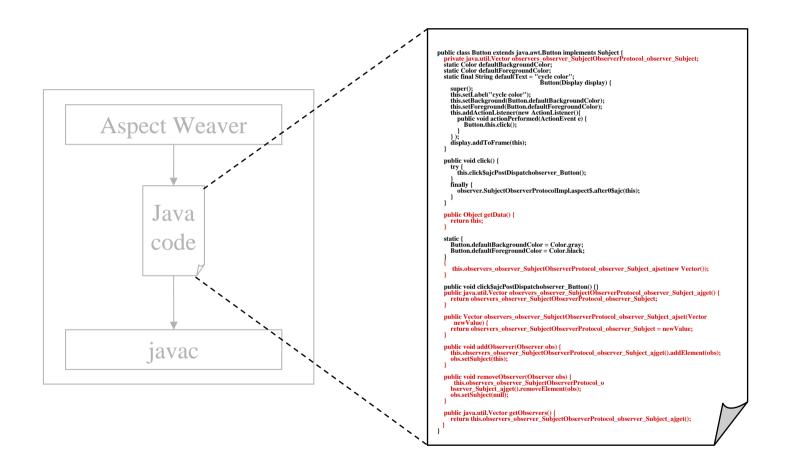
Source (.java)

Aspects

Classes



Aspect processing (Weaving)



the pointcut construct

can cut across multiple classes

```
pointcut moves():
    call(void Line.setP1(Point)) ||
    call(void Line.setP2(Point)) ||
    call(void Point.setX(int)) ||
    call(void Point.setY(int));
```

a multi-class aspect

MoveTracking v2

```
aspect MoveTracking {
 private static boolean _flag = false;
 public static boolean testAndClear() {
   boolean result = flag;
   flag = false;
   return result;
 pointcut moves():
    call(void Line.setP1(Point))
    call(void Line.setP2(Point))
    call(void Point.setX(int))
    call(void Point.setY(int));
  after(): moves() {
    flag = true;
```

using context in advice

- pointcut can explicitly expose certain values
- advice can use value

typed variable in place of type name

multi-class aspect with context

MoveTracking v3

```
aspect MoveTracking {
 private static Set movees = new HashSet();
 public static Set getMovees() {
   Set result = movees;
   movees = new HashSet();
   return result;
 pointcut moves(FigureElement figElt):
    instanceof(figElt) &&
    (call(void Line.setP1(Point))
     call(void Line.setP2(Point))
     call(void Point.setX(int))
     call(void Point.setY(int)));
  after(FigureElement fe): moves(fe) {
    movees.add(fe);
```

```
class Line {
 private Point _p1, _p2;
 Point getP1() { return p1; }
 Point getP2() { return _p2; }
 void setP1(Point p1) {
   _p1 = p1;
 void setP2(Point p2) {
   _{p2} = p2;
class Point {
  private int x = 0, y = 0;
 int getX() { return _x; }
 int getY() { return _y; }
 void setX(int x) {
   _{\mathbf{x}} = \mathbf{x};
 void setY(int y) {
   _y = y;
```

TrackMoves v1

```
class Line {
 private Point p1, p2;
 Point getP1() { return p1; }
 Point getP2() { return p2; }
 void setP1(Point p1) {
   _p1 = p1;
   TrackMoves.setFlag();
 void setP2(Point p2) {
   p2 = p2;
   TrackMoves.setFlag();
class Point {
  private int x = 0, y = 0;
 int getX() { return x; }
 int getY() { return y; }
 void setX(int x) {
   _x = x;
 void setY(int y) {
   _y = y;
```

```
class TrackMoves {
  private static boolean _flag = false;

  public static void setFlag() {
    _flag = true;
  }

  public static boolean testAndClear() {
    boolean result = _flag;
    _flag = false;
    return result;
  }
}
```

TrackMoves v2

```
class Line {
 private Point p1, p2;
 Point getP1() { return p1; }
 Point getP2() { return p2; }
 void setP1(Point p1) {
   p1 = p1;
   TrackMoves.setFlag();
 void setP2(Point p2) {
   p2 = p2;
   TrackMoves.setFlag();
class Point {
  private int x = 0, y = 0;
 int getX() { return x; }
 int getY() { return y; }
 void setX(int x) {
   x = x;
  TrackMoves.setFlag();
 void setY(int y) {
   _y = y;
   TrackMoves.setFlag();
```

```
class TrackMoves {
  private static boolean _flag = false;

public static void setFlag() {
    _flag = true;
  }

public static boolean testAndClear() {
    boolean result = _flag;
    _flag = false;
    return result;
  }
}
```

TrackMoves v3

```
class Line {
  private Point p1, p2;
  Point getP1() { return p1; }
 Point getP2() { return p2; }
  void setP1(Point p1) {
    p1 = p1;
   TrackMoves.collectOne(this);
  void setP2(Point p2) {
    p2 = p2;
   TrackMoves.collectOne(this);
class Point {
  private int x = 0, y = 0;
  int getX() { return x; }
  int getY() { return y; }
  void setX(int x) {
   x = x;
   TrackMoves.collectOne(this);
  void setY(int y) {
   _y = y;
   TrackMoves.collectOne(this);
```

```
class TrackMoves {
  private static Set _movers = new HashSet();

  public void collectOne(Object o) {
    _movers.add(o);
  }

  public static Set getMovers() {
    Set result = _movers;
    _movers = new HashSet();
    return result;
  }
}
```

evolution is cumbersome

- changes in all three classes
- have to track all callers
 - change method name
 - add argument

with AspectJ

```
class Line {
 private Point _p1, _p2;
 Point getP1() { return p1; }
 Point getP2() { return _p2; }
 void setP1(Point p1) {
   _p1 = p1;
 void setP2(Point p2) {
   _p2 = p2;
class Point {
  private int _x = 0, _y = 0;
 int getX() { return _x; }
  int getY() { return _y; }
 void setX(int x) {
   _{\mathbf{x}} = \mathbf{x};
 void setY(int y) {
   _{y} = y;
```

with AspectJ

```
class Line {
 private Point p1, p2;
 Point getP1() { return p1; }
 Point getP2() { return p2; }
 void setP1(Point p1) {
   _p1 = p1;
 void setP2(Point p2) {
   _p2 = p2;
class Point {
  private int _x = 0, _y = 0;
 int getX() { return _x; }
 int getY() { return y; }
 void setX(int x) {
   _{x} = x;
 void setY(int y) {
   _y = y;
```

```
aspect MoveTracking {
  private static boolean _flag = false;
  public static boolean testAndClear() {
    boolean result = _flag;
    _flag = false;
    return result;
  }

  pointcut moves():
    call(void Line.setP1(Point)) ||
    call(void Line.setP2(Point));

  after(): moves() {
    _flag = true;
  }
}
```

with AspectJ

```
class Line {
 private Point p1, p2;
 Point getP1() { return p1; }
 Point getP2() { return p2; }
 void setP1(Point p1) {
   _p1 = p1;
 void setP2(Point p2) {
   _p2 = p2;
class Point {
  private int _x = 0, _y = 0;
 int getX() { return x; }
 int getY() { return _y; }
 void setX(int x) {
   _{x} = x;
 void setY(int y) {
   _y = y;
```

```
aspect MoveTracking {
  private static boolean _flag = false;
  public static boolean testAndClear() {
    boolean result = _flag;
    _flag = false;
    return result;
  }

  pointcut moves():
    call(void Line.setP1(Point)) ||
    call(void Line.setP2(Point)) ||
    call(void Point.setX(int)) ||
    call(void Point.setY(int));

  after(): moves() {
    _flag = true;
  }
}
```

with AspectJ

```
class Line {
 private Point p1, p2;
 Point getP1() { return p1; }
 Point getP2() { return p2; }
 void setP1(Point p1) {
   p1 = p1;
 void setP2(Point p2) {
   p2 = p2;
class Point (
  private int _x = 0, _y = 0;
 int getX() { return x; }
 int getY() { return _y; }
 void setX(int x) {
   _x = x;
 void setY(int y) {
   _y = y;
```

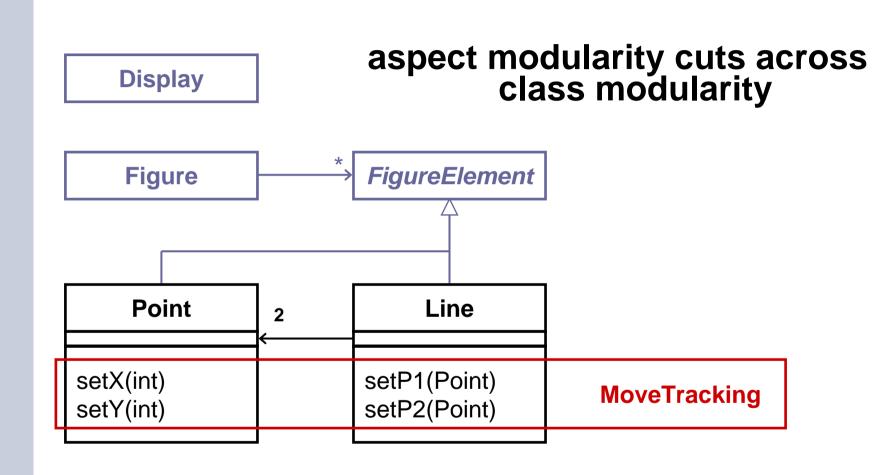
```
aspect MoveTracking {
  private static Set _movees = new HashSet();
  public static Set getmovees() {
    Set result = _movees;
    _movees = new HashSet();
    return result;
  }

  pointcut moves(FigureElement figElt):
    instanceof(figElt) &&
    (call(void Line.setP1(Point)) ||
    call(void Line.setP2(Point)) ||
    call(void Point.setX(int))
    call(void Point.setY(int)));

  after(FigureElement fe): moves(fe) {
    _movees.add(fe);
  }
}
```

- evolution is more modular
 - all changes in single aspect

aspects crosscut classes



context sensitive aspects

```
aspect MoveTracking {
 pointcut moveCalls(Object mover, FigureElement movee):
   instanceof(mover) &&
     (lineMoveCalls(movee) | pointMoveCalls(movee));
 pointcut lineMoveCalls(Line ln):
   call(void ln.setP1(Point)) || call(void ln.setP2(Point));
 pointcut pointMoveCalls(Point pt):
   after(Object mover, FigureElement movee):
       moveCalls(mover, movee) {
   movers.add(mover);
   movees.add(movee);
```

without AspectJ

```
class Line {
 private Point p1, p2;
 Point getP1() { return p1; }
 Point getP2() { return p2; }
 void setP1(Point p1) {
   p1 = p1;
  MoveTracking.collectOne(this);
 void setP2(Point p2) {
   p2 = p2;
  MoveTracking.collectOne(this);
class Point {
  private int x = 0, y = 0;
 int getX() { return x; }
 int getY() { return y; }
 void setX(int x) {
   x = x;
  MoveTracking.collectOne(this);
 void setY(int y) {
  MoveTracking.collectOne(this);
```

```
class MoveTracking {
  private static Set _movees = new HashSet();
  private static Set _movers = new HashSet();

  public static void collectMove(Object o1, Object o2) {
    _movees.add(o1);
    _movers.add(o2);
  }

  public static Set getmovees() {
    Set result = _movees;
    _movees = new HashSet();
    return result;
  }
  ...
}
```

```
class Foo {
    ...

public void mumble(Line 1) {
    MoveTracking.collectMove(this, 1);
    1.setP1(new Point());
    ...
}
...
}
```

without AspectJ

```
class MoveTracking {
class Line {
  private Point p1, p2;
                                          private static Set movees = new HashSet();
                                          private static Set movers = new HashSet();
   class XYZZY {
                                          public static void collectMove(Object o1, Object o2) {
                                            movees.add(o1);
                                            movers.add(o2);
     public void moveit(Point p) {
       MoveTracking.collectMove(this, p);
             class Bar {
                                                 tatic Set getmovees() {
                                                 sult = movees;
                                                 s = new HashSet(); class AnotherClass {
               public void mumble(Line 1) {
                                                  result:
                 MoveTracking.collectMove(this, 1);
                 1.setP1(new Point());
                                                                    public void frotz(Point p) {
class Ba
                                                                      MoveTracking.collectMove(this, p);
                                                                      p.setY(42);
 public void mumble(Line I) {
                                 public void mumble(Line 1) {
   MoveTracking.collectMove(this, 1);
                                    MoveTracking.collectMove(thi
                                    1.setP1(new Point());
                                                                  public void mbar(Line 1) {
                                                                    MoveTracking.collectMove(this, 1);
              MoveTracking.collectMove(this, 1);
                                                                    1.setP1(new Point());
  void set
              1.setP1(new Point());
    y = y
```

context sensitive aspects

```
aspect MoveTracking {
  private static Set _movees = new HashSet();
  public static Set getMovees() {
   Set result = movees;
   movees = new HashSet();
   return result:
  pointcut moves(FigureElement figElt):
    instanceof(figElt) &&
     (receptions(void Line.setP1(Point))
      receptions(void Line.setP2(Point))
      receptions(void Point.setX(int))
      receptions(void Point.setY(int)));
  pointcut topLevelMoves(FigureElement figElt):
    moves(figElt) && !cflow(moves(figElt));
  after(FigureElement fe): topLevelMoves(fe) {
    movees.add(fe);
```

problem 2 – pre- and/or post-conditions

pre-conditions

- test values of parameters
 - are point coordinates legal?
- test object and/or global state

post-conditions

test whether operation worked properly

condition enforcement

coerce parameters to be legal

advice is

additional action to take at join points

- before before proceeding at join point
- after returning a value to join point
- after throwing a throwable to join point
- after returning to join point either way
- around on arrival at join point gets explicit control over when&if program does proceed

pre-condition

using before advice

```
aspect PointBoundsPreCondition {
 before(Point p, int newX):
        receptions(void p.setX(newX)) {
    assert(newX >= MIN X);
    assert(newX <= MAX X);</pre>
  before(Point p, int newY):
        receptions(void p.setY(newY)) {
    assert(newY >= MIN Y);
    assert(newY <= MAX Y);</pre>
  static void assert(boolean v) {
    if (!v)
      throw new RuntimeException();
```

post-condition

using after advice

```
aspect PointBoundsPostCondition {
  after(Point p, int newX):
        receptions(void p.setX(newX)) {
    assert(p.getX() == newX);
  after(Point p, int newY):
        receptions(void p.setY(newY)) {
    assert(p.getY() == newY);
  static void assert(boolean v) {
    if (!v)
      throw new RuntimeException();
```

condition enforcement

using around advice

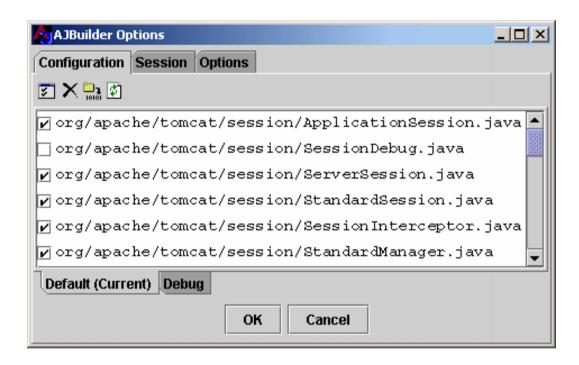
```
aspect PointBoundsEnforcement {
  around(Point p, int newX) returns void:
        receptions(void p.setX(newX)) {
    proceed(p, clip(newX, MIN X, MAX X));
  around(Point p, int newY) returns void:
        receptions(void p.setY(newY)) {
    proceed(p, clip(newY, MIN_Y, MAX_Y));
  static int clip(int val, int min, int max) {
    return Math.max(min, Math.min(max, val));
```

problem 3 – debugging support

//From ContextManager

```
public void service( Request rrequest, Response rresponse ) {
// log( "New request " + rrequest );
try {
                                                        // log( "New request " + rrequest );
         System.out.print("A");
   rrequest.setContextManager( this );
   rrequest.setResponse(rresponse);
   rresponse.setRequest(rrequest);
                                                        // System.out.print("A");
   // wront request - parsing error
   int status=rresponse.getStatus();
   if( status < 400 )
 status= processRequest( rrequest );
   if(status==0)
 status=authenticate( rrequest, rresponse );
   if(status == 0)
 status=authorize( rrequest, rresponse );
   if( status == 0 ) {
 rrequest.getWrapper().handleRequest(rrequest,
       rresponse):
 // something went wrong
 handleError( rrequest, rresponse, null, status );
                                                        // System.out.print("B");
} catch (Throwable t) {
   handleError( rrequest, rresponse, t, 0 );
// System.out.print("B");
try {
   rresponse.finish();
                                                        if(debug>0)
   rrequest.recycle();
   rresponse.recycle();
                                                                log("Error closing request " + ex);
} catch( Throwable ex ) {
   if(debug>0) log( "Error closing request " + ex);
// log( "Done with request " + rrequest )
// System.out.print("C");
                                                              log("Done with request " + rrequest);
return;
                                                        // System.out.print("C");
```

pluggable aspects



plug and debug

- can be used for profiling, logging
- easy to be sure it is off

property-based crosscutting

```
package my.package;
public class C2 {

package my.package;
public class C1 {
    ...
    public void foo() {
        A.doSomething(...);
        ...
    }
    ...
}

public int frotz() {
        A.doSomething(...);
        ...
    }
    ...
}

public int bar() {
        A.doSomething(...);
        ...
}

...
}

...
}

...
}

public int bar() {
        A.doSomething(...);
        ...
}

...
}

...
}
```

- crosscuts of methods with a common property
 - public/private, return a certain value, in a particular package
- logging, debugging, profiling
 - log on entry to every public method

wildcarding in pointcuts

```
"*" is wild card
                                     ".." is multi-part wild card
instanceof(Point)
instanceof(graphics.geom.Point)
                                    any type in graphics.geom
instanceof(graphics.geom.*)
                                    any type in any sub-package
instanceof(graphics..*)
                                    of graphics
receptions(void Point.setX(int))
                                    any public method on Point
receptions(public * Point.*(..))
                                    any public method on any type
receptions(public * *..*.*(..))
receptions(void getX())
receptions(void getY())
receptions(void get*())
                                    any getter
receptions(new(int, int))
receptions(new(..))
                                    any constructor
```

property-based crosscutting

consider code maintenance

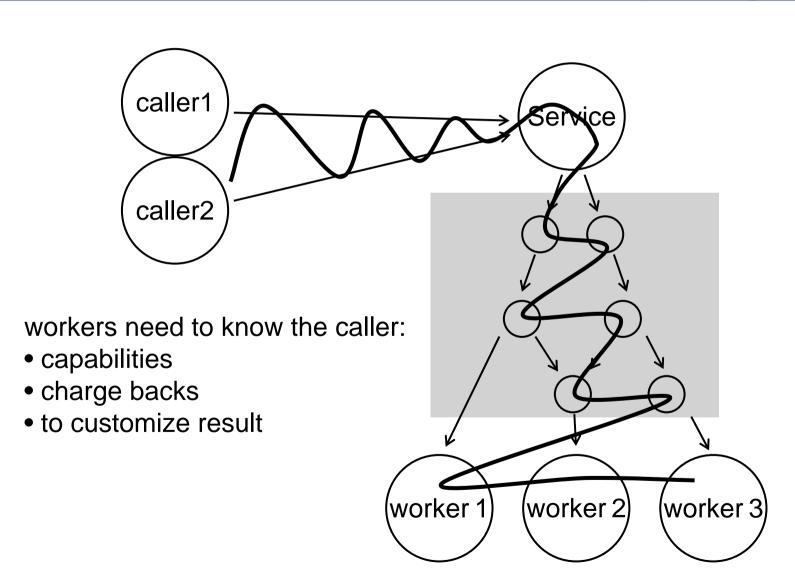
- another programmer adds a public method
 - i.e. extends public interface this code will still work
- another programmer reads this code
 - "what's really going on" is explicit
- decision to disable logging

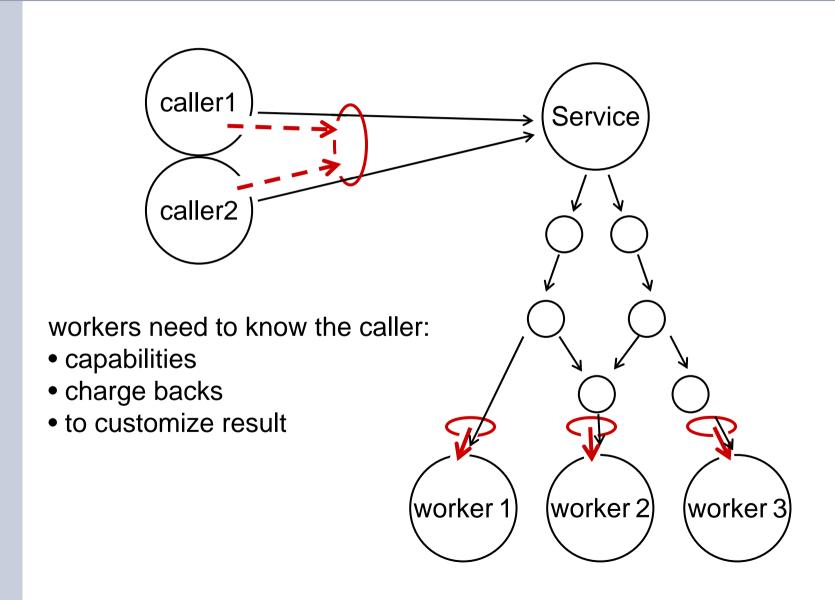
modular crosscutting

```
aspect PublicErrorLogging {
   static Log log = new Log();
   pointcut publicInterface ():
      receptions(public * com.xerox..*.*(..));
   after() throwing (Error e): publicInterface() {
      log.write(e);
   }
}
```

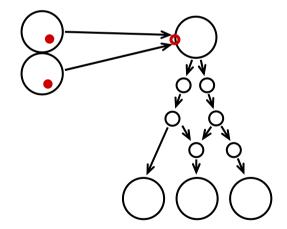
- crosscutting concerns
 - tangled implementation → complex, difficult to maintain
 - modular implementation → can be clear, easy to maintain
- crosscutting concerns per se are not complicated!

example 4



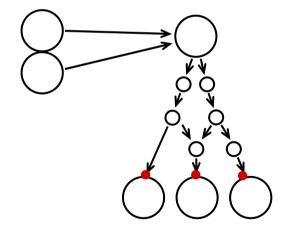


```
pointcut invocations(Caller c):
   instanceof(c) && calls(void Service.doService(String));
```



```
pointcut invocations(Caller c):
   instanceof(c) && calls(void Service.doService(String));

pointcut workPoints(Worker w):
   receptions(void w.doTask(Task));
```



```
pointcut invocations(Caller c):
    instanceof(c) && calls(void Service.doService(String));

pointcut workPoints(Worker w):
    receptions(void w.doTask(Task));

pointcut perCallerWork(Caller c, Worker w):
    cflow(invocations(c)) && workPoints(w);
```

```
aspect CapabilityChecking {
  pointcut invocations(Caller c):
    instanceof(c) && calls(void Service.doService(String));
  pointcut workPoints(Worker w):
    receptions(void w.doTask(Task));
  pointcut perCallerWork(Caller c, Worker w):
    cflow(invocations(c)) && workPoints(w);
 before (Caller c, Worker w): perCallerWork(c, w) {
   w.checkCapabilities(c);
```

```
aspect CapabilityChecking {
 pointcut invocations(Caller c):
    instanceof(c) && calls(void Service.doService(String));
 pointcut workPoints(Worker w):
    receptions(void w.doTask(Task));
 pointcut perCallerWork(Caller c, Worker w):
    cflow(invocations(c)) && workPoints(w);
 before (Caller c, Worker w): perCallerWork(c, w) {
   w.checkCapabilities(c);
```

inheritance & specialization

pointcuts can have additional advice

- aspect with
 - concrete pointcut
 - perhaps no advice on the pointcut
- in figure editor
 - moves() can have advice from multiple aspects
- module can expose certain well-defined pointcuts

abstract pointcuts can be specialized

- aspect with
 - abstract pointcut
 - concrete advice on the abstract pointcut

a shared pointcut

```
public class FigureEditor {
  public pointcut moves(FigureElement figElt):
    instanceof(figElt) &&
    (receptions(void Line.setP1(Point))
     receptions(void Line.setP2(Point))
     receptions(void Point.setX(int))
     receptions(void Point.setY(int)));
aspect TrackMoves {
  static after(FigureElement fe):
    FigureEditor.moves(fe) { ... }
```

a reusable exception handling aspect

```
public aspect JWAMRemoteExceptionLogger
    extends LogRemoteExceptions {
    pointcut rcptns():
        receptions(* RegistryServer.*(..)) ||
        executions(private * RMIMessageBrokerImpl.*(..);
}
```

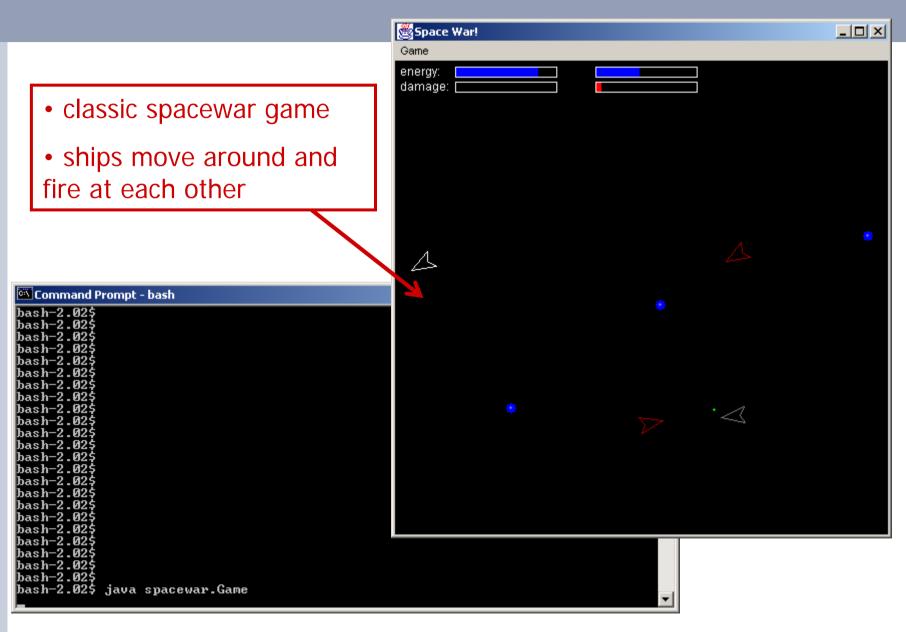
common questions

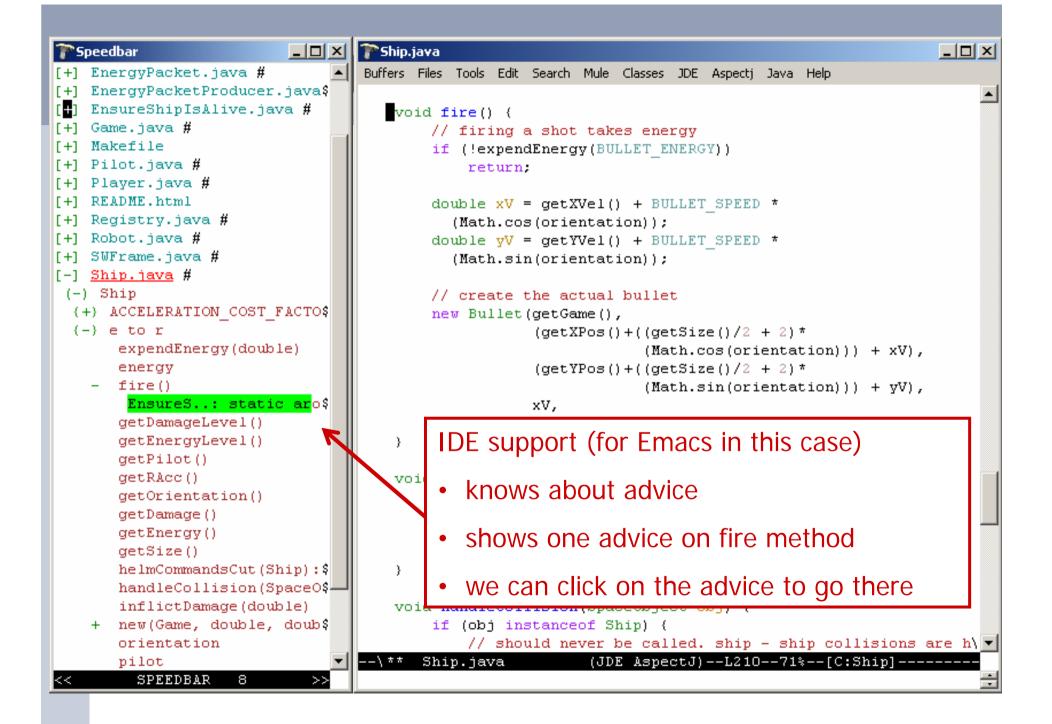
- Well if I use AOP, how will I know when I'm looking at the code what aspects apply?
 - IDE support

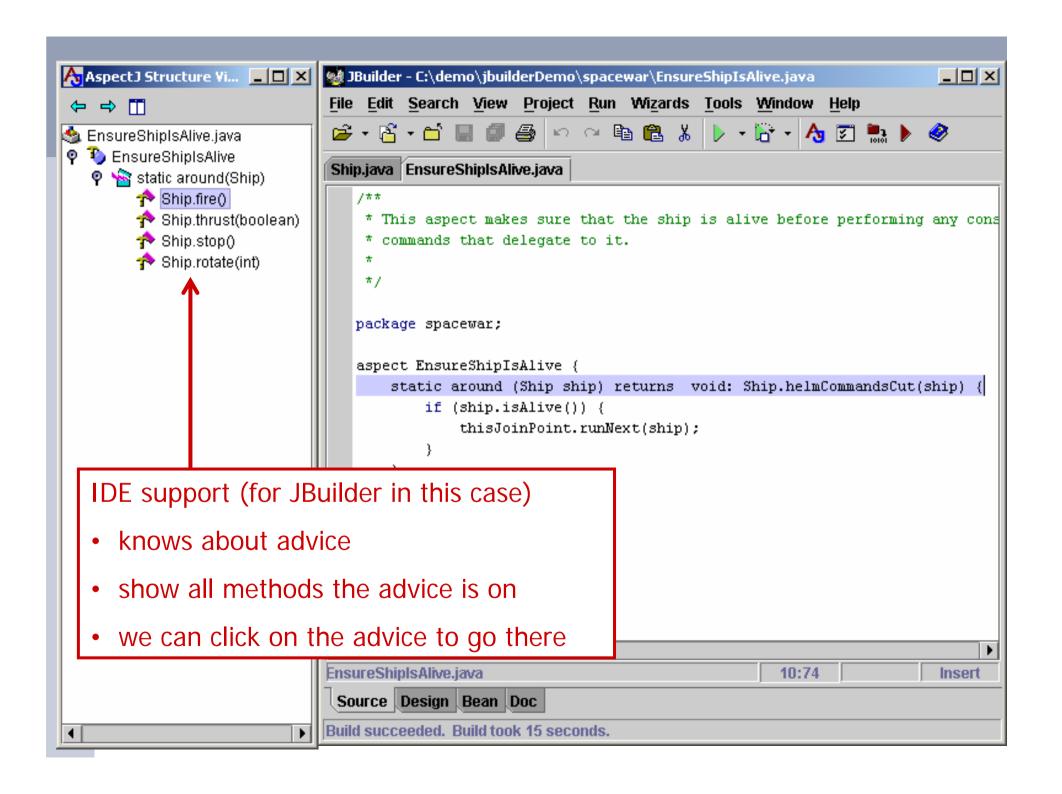
IDE demos

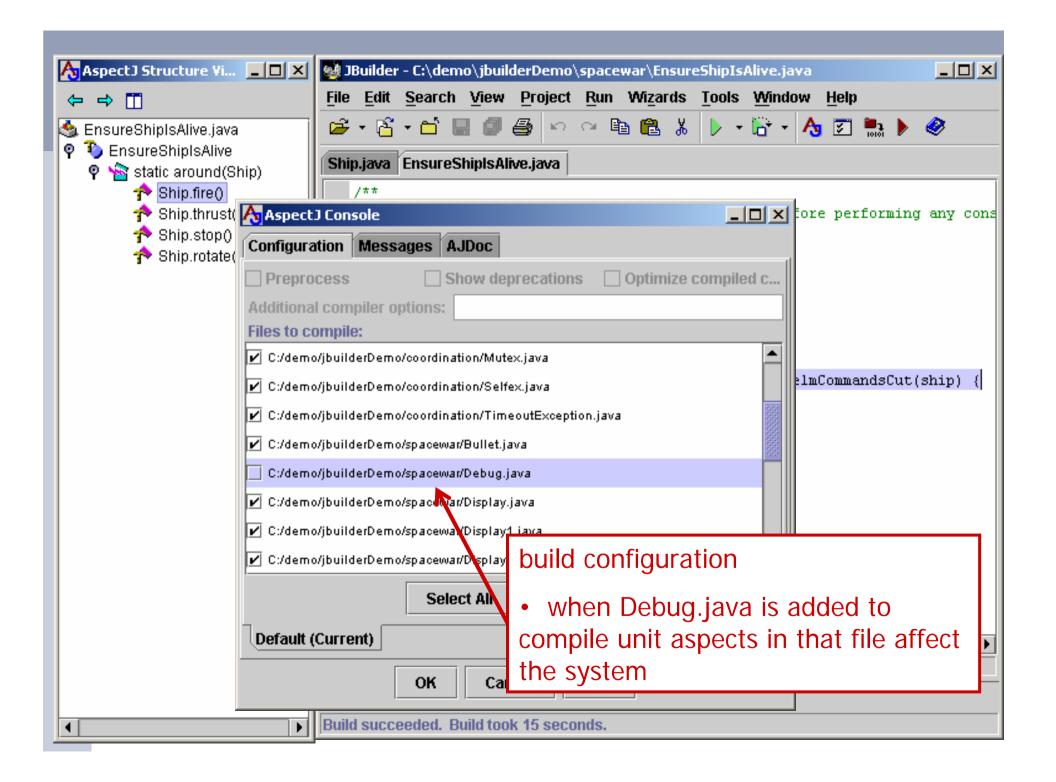
- basic support, in emacs, JBuilder™, Forte™4J
 - browsing program structure
 - editing
 - compiling
- debugger support
- extension to javadoc
- will expand by 1.0
 - more IDEs
 - more sophisticated browsing

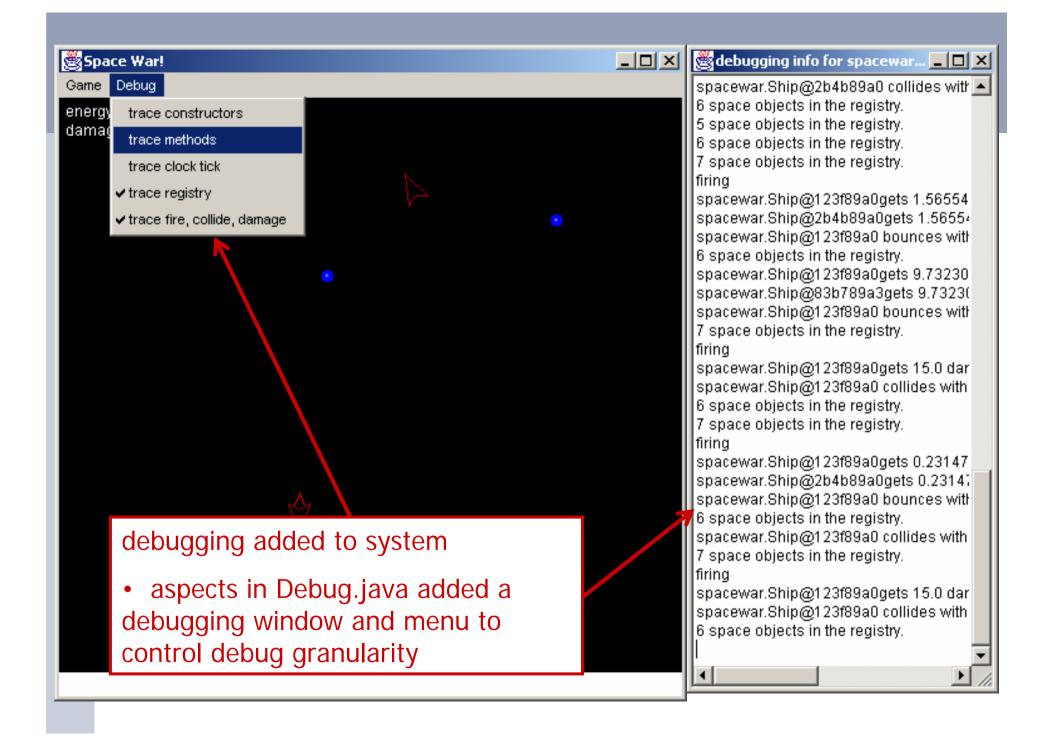
demonstration...

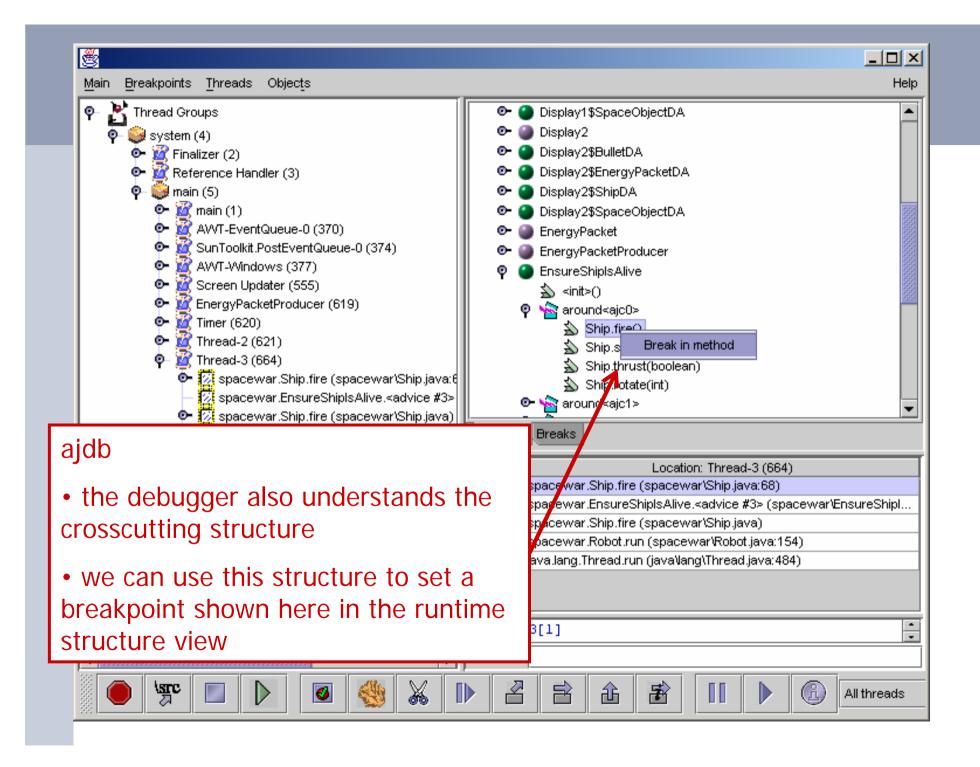


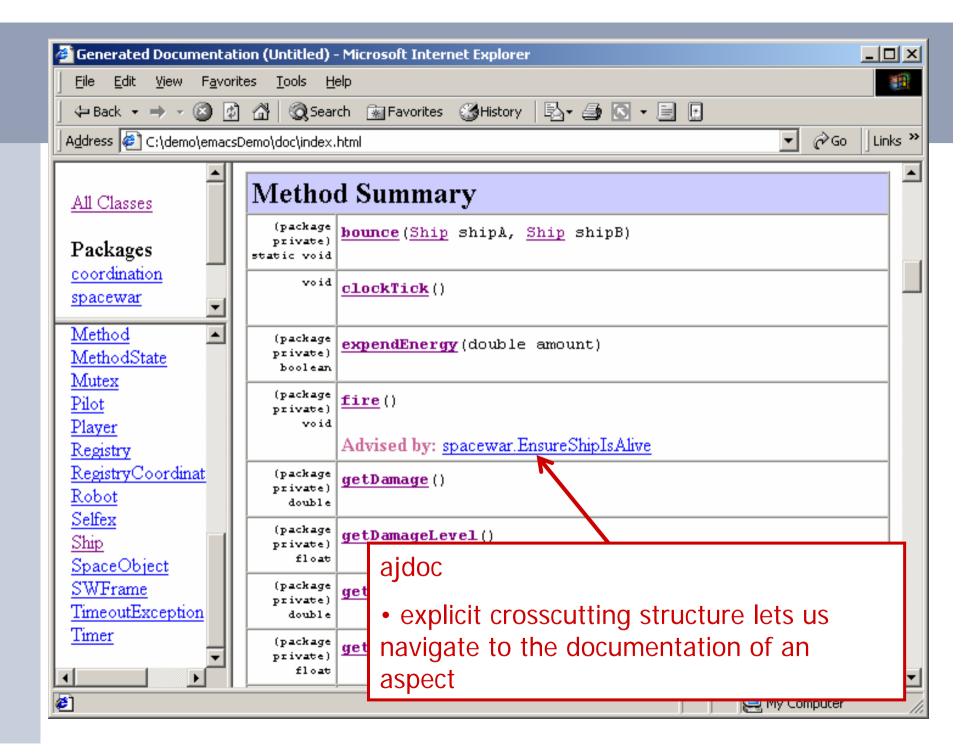












when are aspects appropriate?

is there a concern that:

- crosscuts the structure of several objects or operations
- is beneficial to separate out

common questions

- does this really help?
 - these examples are all simple

Case Study

- exception handling case study*
- framework w/ 600 classes, 44 KLOC
- reengineered with AspectJ 0.4

+	without aspects	with aspects
exception detection	2.1kloc pre-conditions .6kloc post-conditions	.6 KLOC pre-conditions .3 KLOC post-conditions
exception handling	2.1 kloc (414 catch statements)	.2 kloc (31 after throwing advice)
% of total loc	10.9%	2.9%

^{*} appeared in ICSE'2000

summary

- capture "the story" well
- may lead to good implementations, measured by
 - code size
 - tangling
 - coupling
 - etc.

learned through experience, influenced by taste and style

expected benefits of using AOP

- good modularity, even in the presence of crosscutting concerns
 - less tangled code, more natural code, smaller code
 - easier maintenance and evolution
 - easier to reason about, debug, change
 - more reusable
 - more possibilities for plug and play
 - abstract aspects

more info

more information on AOP and the AspectJ™ programming language can be found at:

http://aspectj.org/

http://www.parc.xerox.com/aop/

