



AspectJ

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# Presentation Assumptions

- Already know the concepts of AOP
- Know the problem AOP is attempting to solve.
- Have some knowledge of Java
- Familiar with OOD

# Outline

- Introduction to AspectJ
- Structure Shyness with Context Passing
- Implementing Branches with AspectJ
- Conceptual Analysis of DJ, AspectJ, Fred
- Master's Thesis

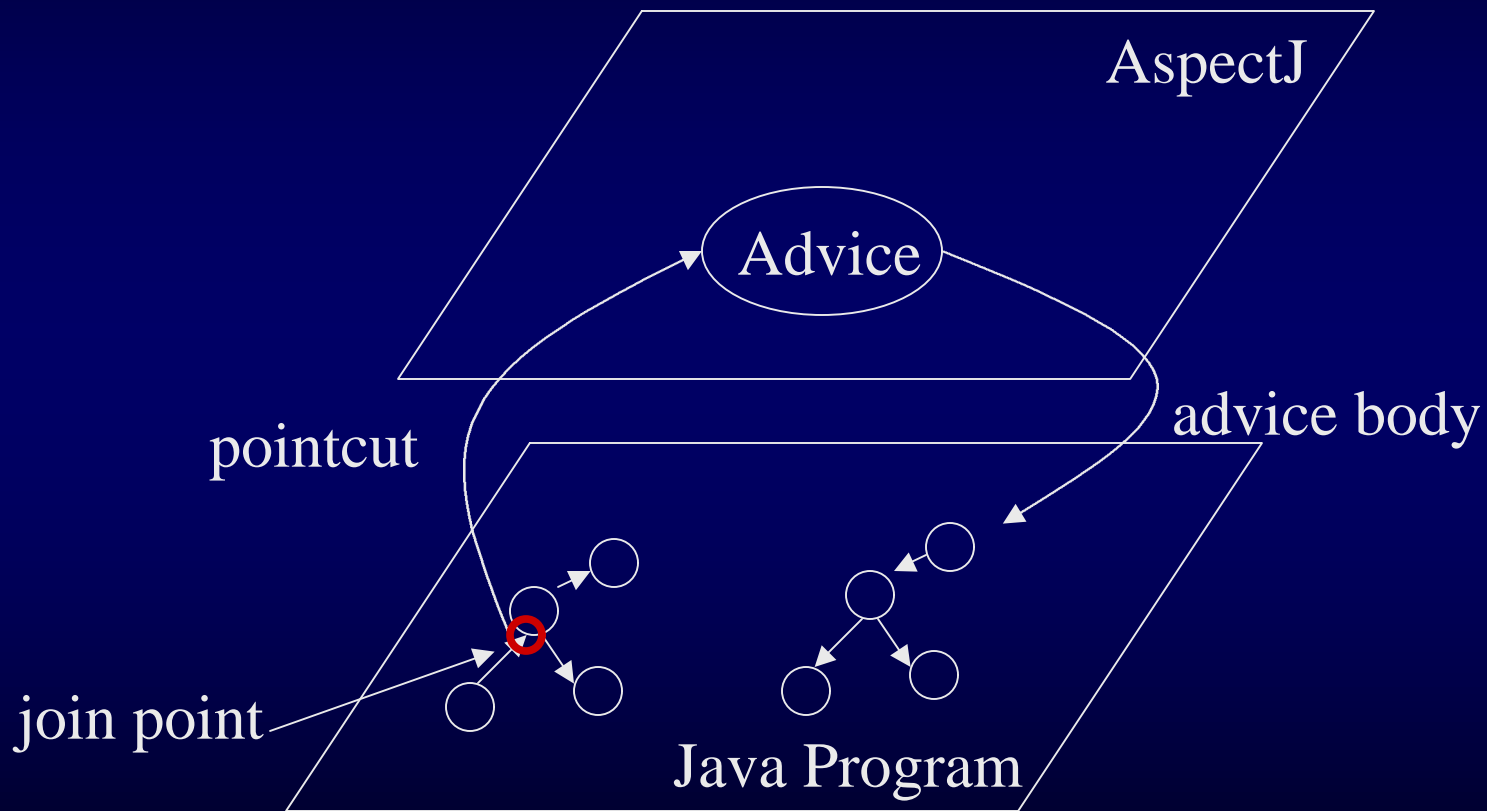
# Introduction to AspectJ

- Developed at Xerox PARC
- Launched in August 1998
- Provide AOP tool to programmers
- Build and support AspectJ community
- Improve AspectJ and AOP

# Concepts of AspectJ

- Join Points
- Pointcuts
- Advice
- Aspect

# Highlevel View of AspectJ

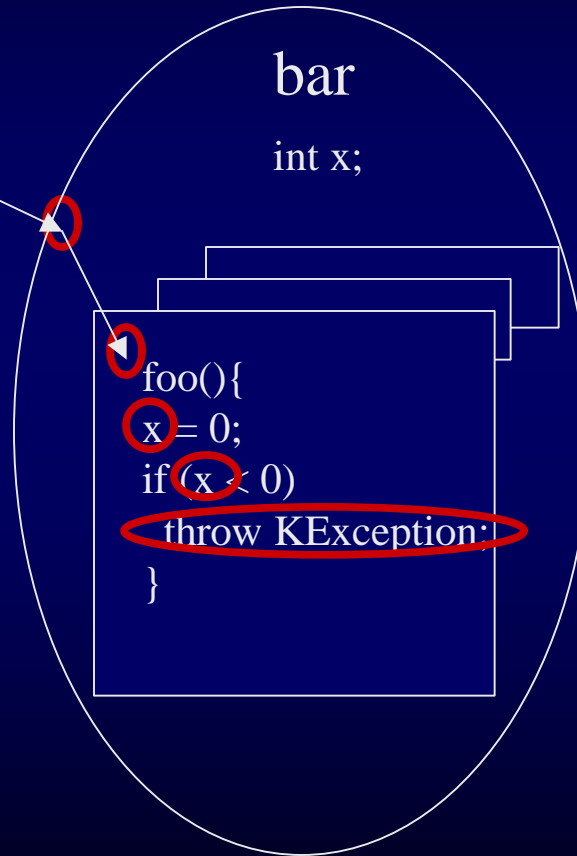


# Join Points

- Transition points or boundaries
  - Method Call
  - Class Boundary
  - Method Execution
  - Access or Modification of member variable
  - Exception Handlers
  - Static and Dynamic Initialization

# Graphical View of Join Points

bar1.foo();



# Specifying Join Points with Designators

- `call(method signature)`
- `handler(exception name)`
- `cflow(join point designator)`
- `this(type name)`
- `target(type name)`
- `within(class name)`
- `execution(method signature)`
- `get(signature), set(signature)`
- `initialization(signature), staticinitialization(type name)`

# Designators with Wildcards

- `call(* foo())`
- `call(public bar.*(..))`
- `call(void foo(..))`
- `call(* *(..))`
- `call(*.new(int, int))`
- `handler(File*Exception)`

# Pointcuts

- Set of join points
- Treats pointcut designators as predicates
- Can use `&&`, `||`, and `!` predicate modifiers
- Allows parameter passing from pointcut to the advice

# Generic Pointcuts

```
pointcut name(args) : pointcut_designators;
```

# Pointcut Examples

- `pointcut MemberRead() : call(* *get*(..)) || call(* *Get*(..));`
- `pointcut MemberReadOrWrite(): MemberRead() || call(* *set*(..)) || call(* *Set*(..));`
- `pointcut A1(int t2, String m1): !target(t2) && (call(* c*.foo*(..)) || * get(m1));`

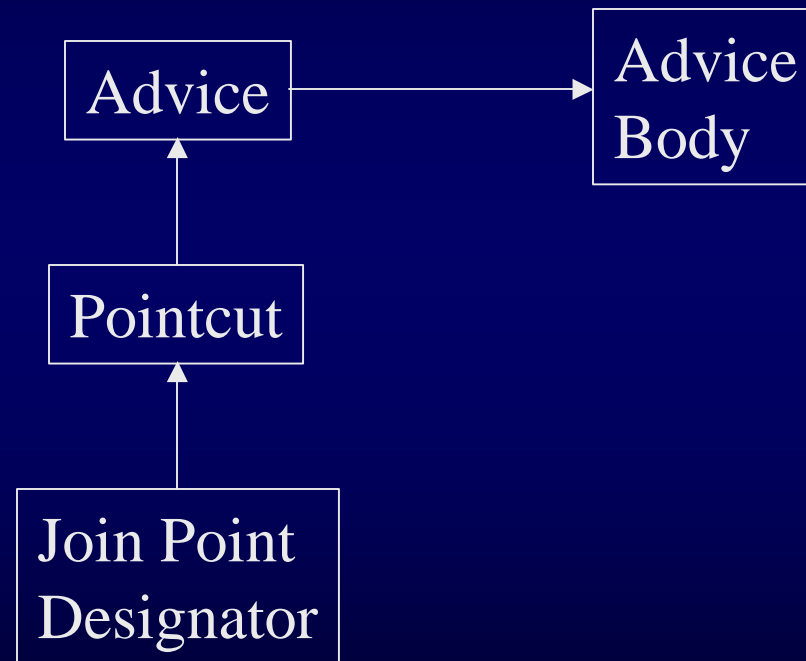
# Advice

- Action to take when pointcut holds
- Advice Forms
  - `before(param) : pointcut(param) {body}`
  - `after(param) : pointcut(param) {body}`
  - `after(param) returning []: pointcut(param) {body}`
  - `after(param) throwing []: pointcut(param) {body}`
  - `type around(param) [throws typelist] :  
pointcut(param) {body}`

# Advice Examples

- `before() : MemberRead() {...}`
- `after() : MemberReadOrWrite() {..}`
- `before(): MemberRead() && within(Lock)`  
`{..}`

# Parameter Information Flow



# Parameter Example

```
before(int index) : MemberRead(index) {  
    System.out.println(index);  
}
```

```
pointcut MemberRead(int index) :  
    args(index) &&  
    (call(*get*(..)) || call(*Get*(..)));
```

# Introduction

- Additions to a class
  - Data members
  - Methods
  - Inheritance and Interface Specification
- Easy to group different concerns within a program into aspects
  - Structure
  - Collaborations

# Introduction Examples

- `public int foo.bar(int x);`
- `private int foo.counter;`
- declare parents: `mammal extends animal;`
- declare parents: `MyThread implements MyThreadInterface;`

# Aspect

- Encapsulates an aspect
- Looks like a class definition in java
- `aspect aspect_name { ... }`
- Abstract aspects

# Reflection in AspectJ

- `thisJoinPoint`
- Similar to “this” in Java
- Able to find various information about the join point that triggered the advice.

# thisJoinPoint Example

- `thisJoinPoint.toString()`
- `thisJoinPoint.getArgs()`

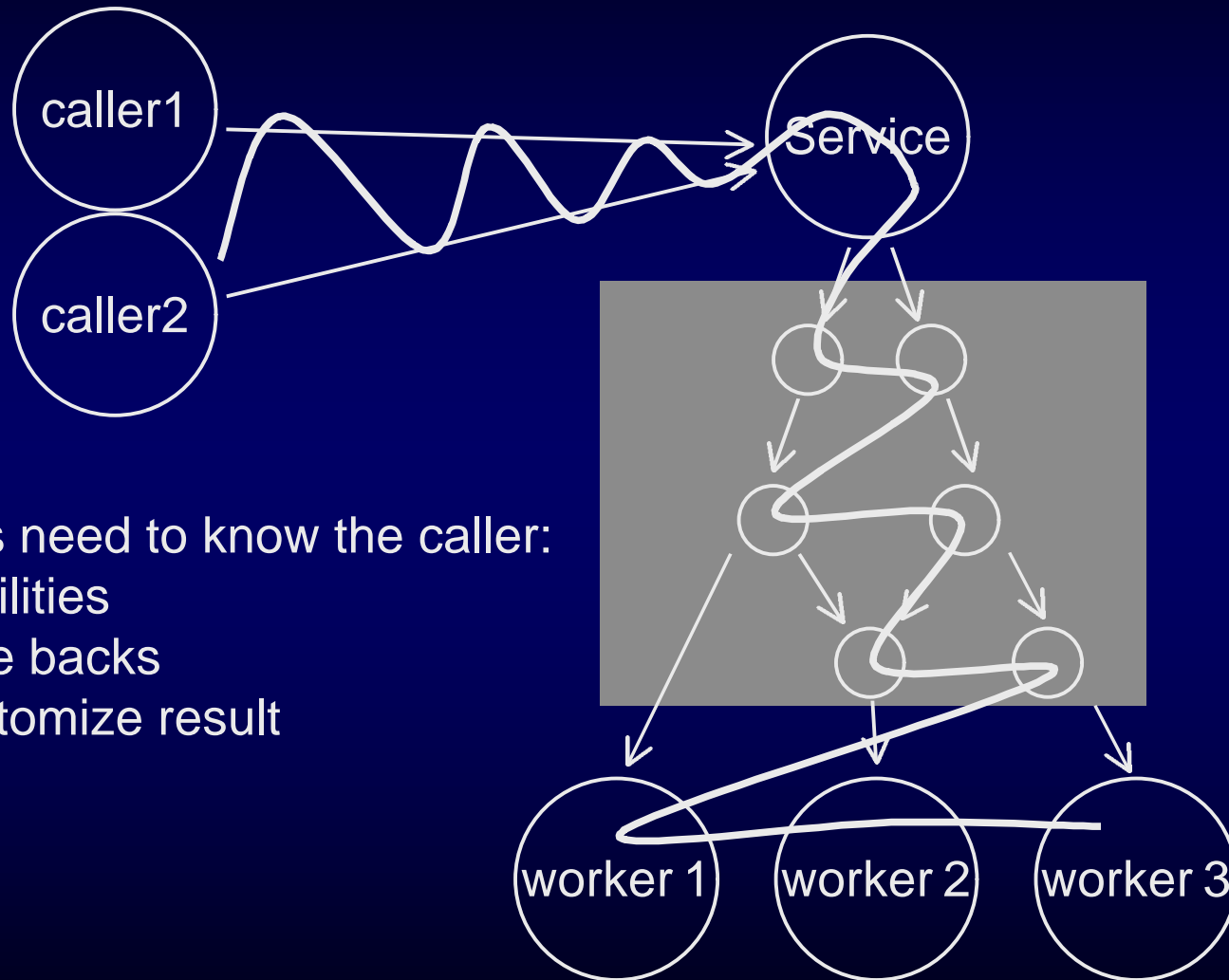
```
aspect TraceNonStaticMethods {
```

```
    before(Point p): target(p) && call(* *(..)) {  
        System.out.println("Entering " + thisJoinPoint + " in " + p);  
    }  
}
```

# Structure Shyness with Context Passing

- Need to add functionality to a method
- Need to add context to do it
- Traditional method
  - change signature of method or overload
  - change method body or add method body

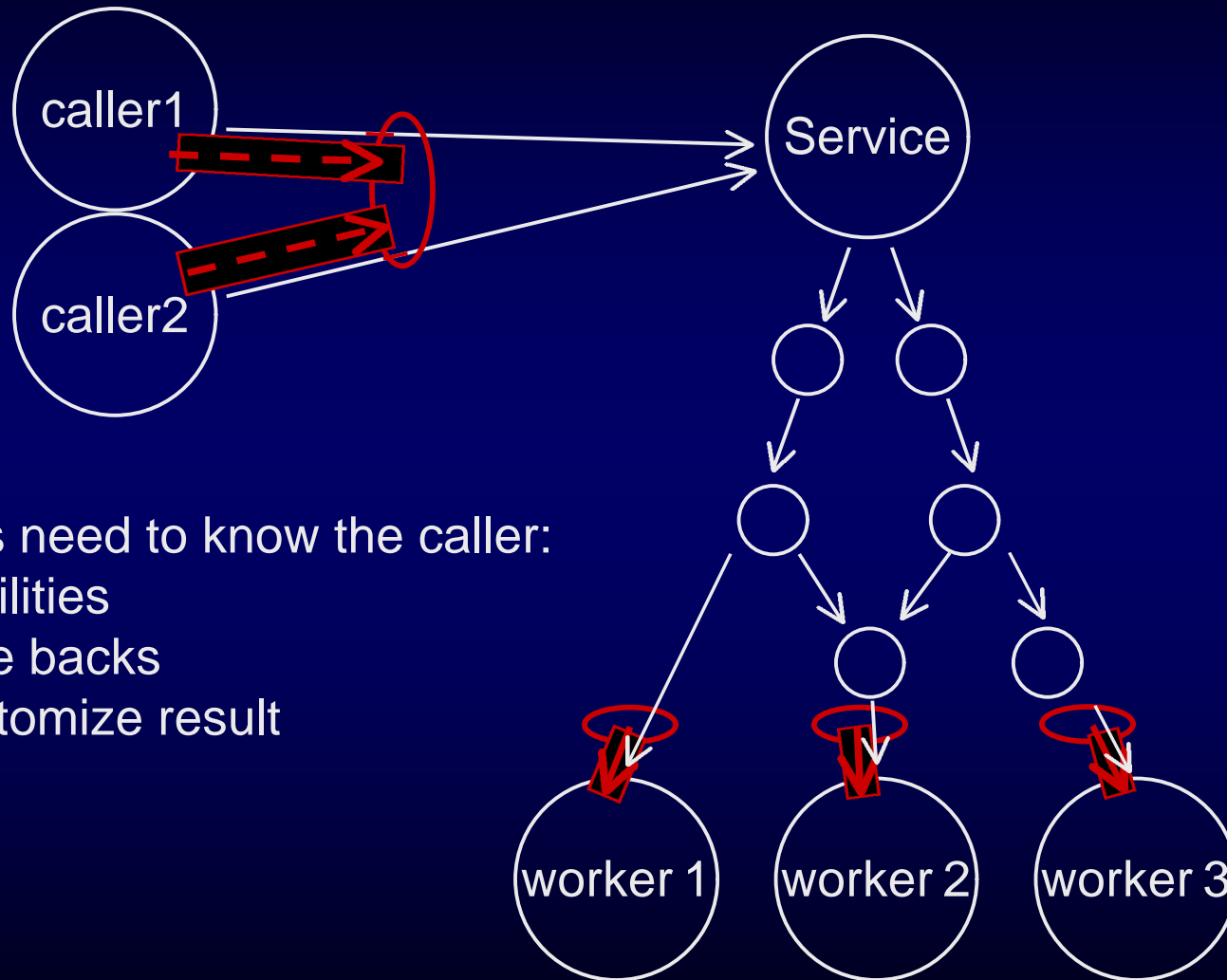
# example – context passing



workers need to know the caller:

- capabilities
- charge backs
- to customize result

# context-passing aspects

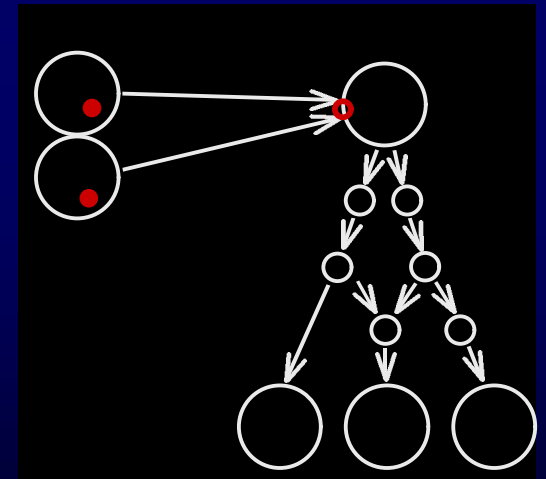


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# context-passing aspects

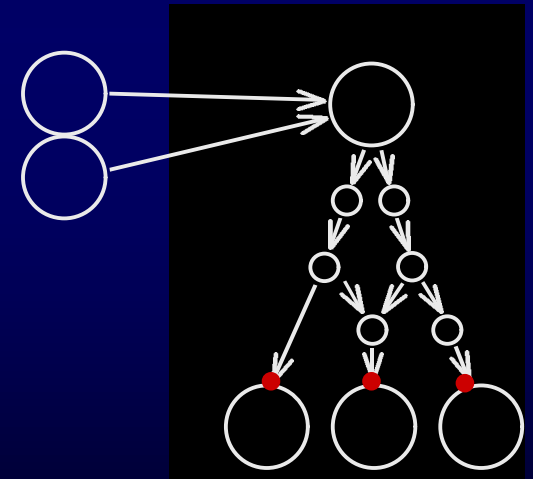
```
pointcut invocations(Caller c):  
    this(c) && call(void Service.doService(String));
```



# context-passing aspects

```
pointcut invocations(Caller c):  
    this(c) && call(void Service.doService(String));
```

```
pointcut workPoints(Worker w):  
    target(w) && call(void Worker.doTask(Task));
```

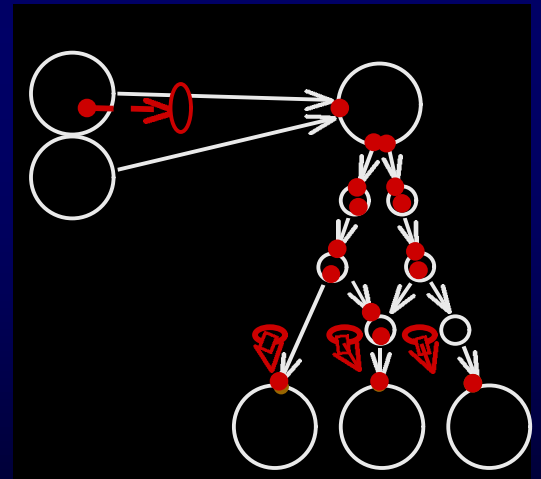


# context-passing aspects

```
pointcut invocations(Caller c):  
    this(c) && call(void Service.doService(String));
```

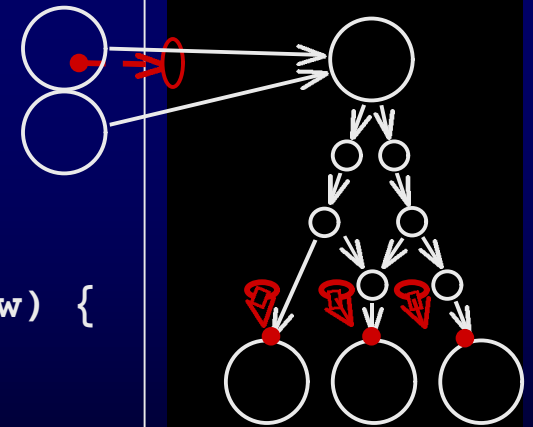
```
pointcut workPoints(Worker w):  
    target(w) && call(void Worker.doTask(Task));
```

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



# context-passing aspects

```
abstract aspect CapabilityChecking {  
  
    pointcut invocations(Caller c):  
        this(c) && call(void Service.doService(String));  
  
    pointcut workPoints(Worker w):  
        target(w) && call(void Worker.doTask(Task));  
  
    pointcut perCallerWork(Caller c, Worker w):  
        cflow(invocations(c)) && workPoints(w);  
  
    before (Caller c, Worker w): perCallerWork(c, w) {  
        w.checkCapabilities(c);  
    }  
}
```



# Branches using AspectJ

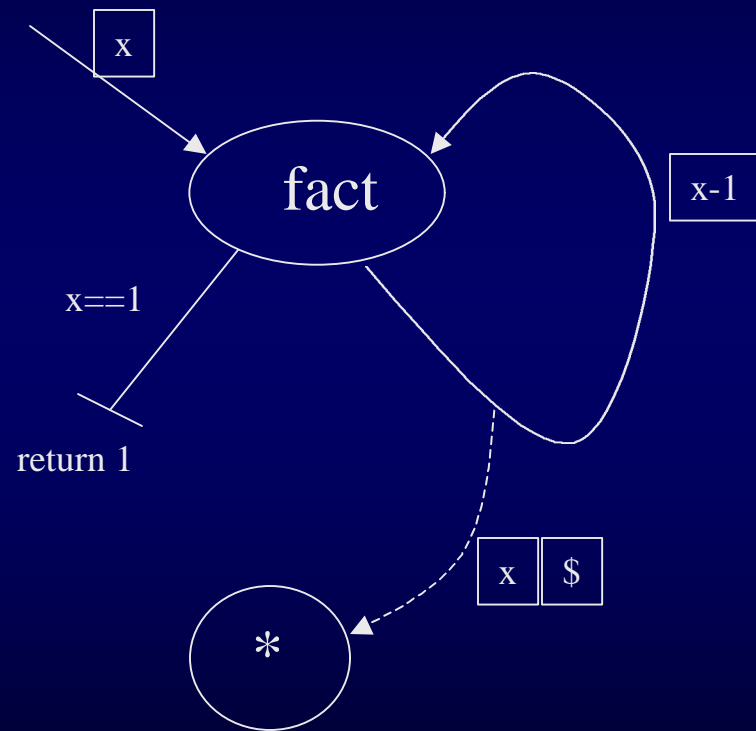
- AspectJ have similar concepts as Fred
  - Predicates on method calls and arguments
  - Bodies to be executed

# Factorial in Fred

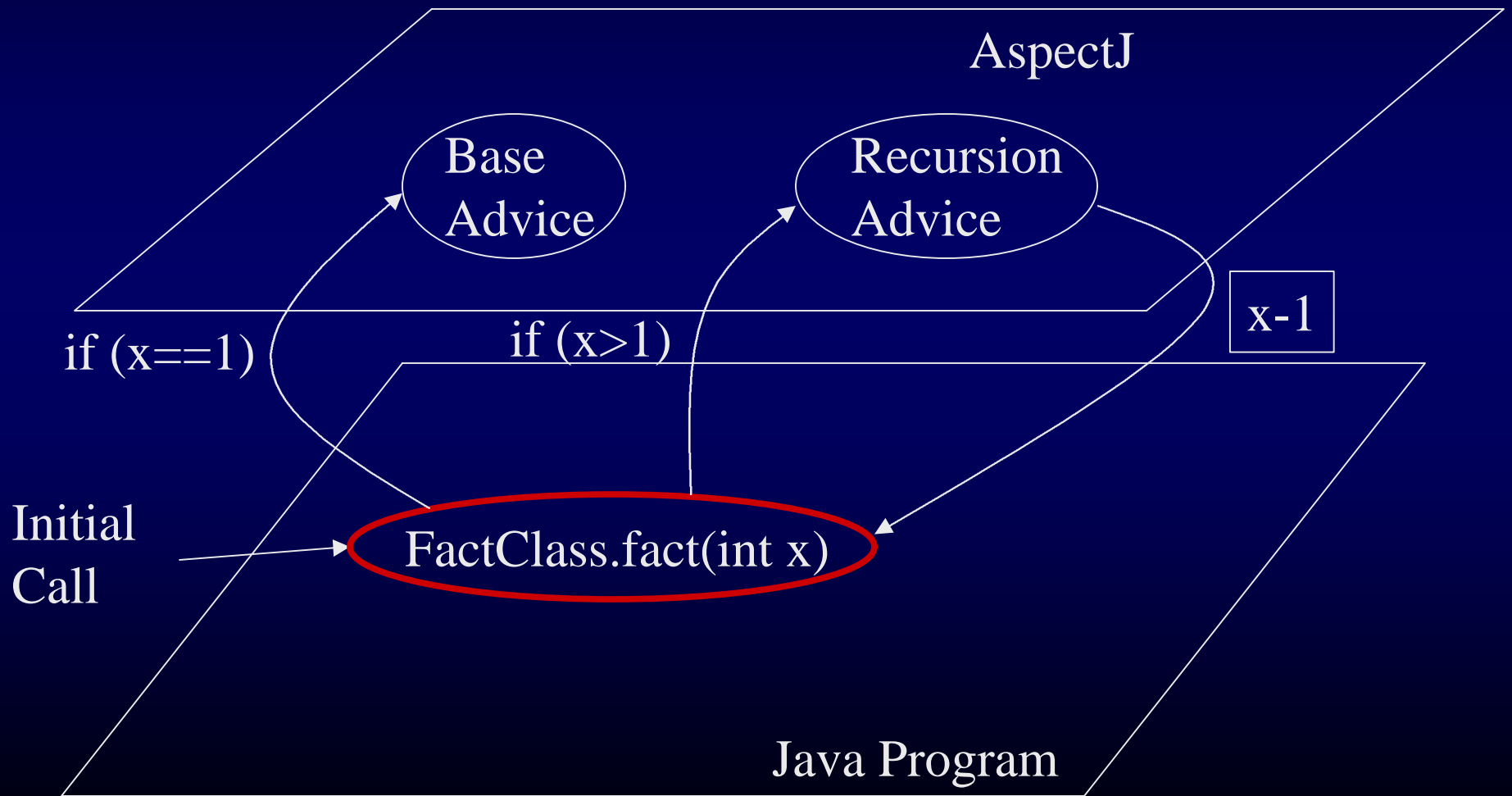
```
(define-msg fact)
```

```
(define-branch (and (eq? (dp-msg dp) fact)
                    (= (car (dp-args dp)) 1))
  1)
```

```
(define-branch (eq? (dp-msg dp) fact)
  (let ((x (car (dp-args dp))))
    (* x (fact (- x 1)))))
```



# Branches in AspectJ



# Branches in AspectJ

```
class FactClass { }
aspect FactExample {
    static int factReturn;
    static int FactClass.fact(int x) {
        return factReturn;
    }
    pointcut factRecursion(int x):
        args(x)
        && call(static int FactClass.fact(int))
        && if (x > 1);
    pointcut factBase(int x):
        args(x)
        && call(static int FactClass.fact(int))
        && if(x==1);
```

```
    before(int x) : factRecursion(x) {
        System.out.print("recurse x = ");
        System.out.println(x);
        factReturn = x * FactClass.fact(x-1);
    }

    before(int x) : factBase(x) {
        System.out.print("base x = ");
        System.out.println(x);
        factReturn = 1;
    }
}
```

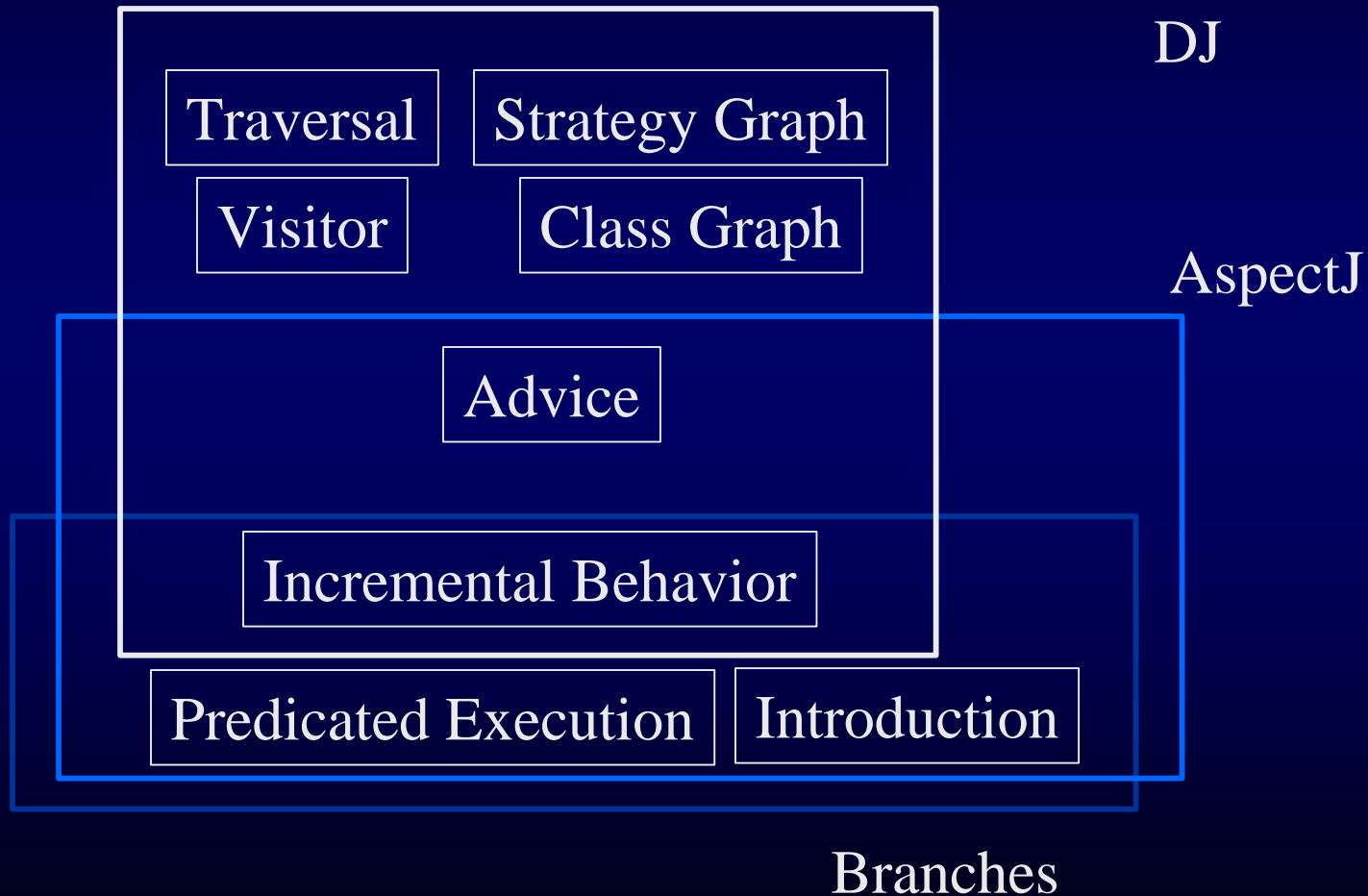
# Conceptual Analysis

- Why can I implement Branches in AspectJ?
- Taking a look at DJ, AspectJ and Branches
  - Describe different concepts used
  - Relationships between concepts
  - Possible future directions

# Conceptual Breakdown

- DJ
  - Traversals, Advice, Strategy Graph, Class Graph, Visitor, Incremental Behavior
- AspectJ
  - Introduction, Predicated Execution, Advice, Incremental Behavior
- Branches
  - Incremental Behavior , Predicated Execution

# Logical View of Concepts



# DJ Conceptual Application

- Concepts applied to data structure
- Concepts have bigger scope
  - Things are applied to bigger groups
- Incrementally add visitors

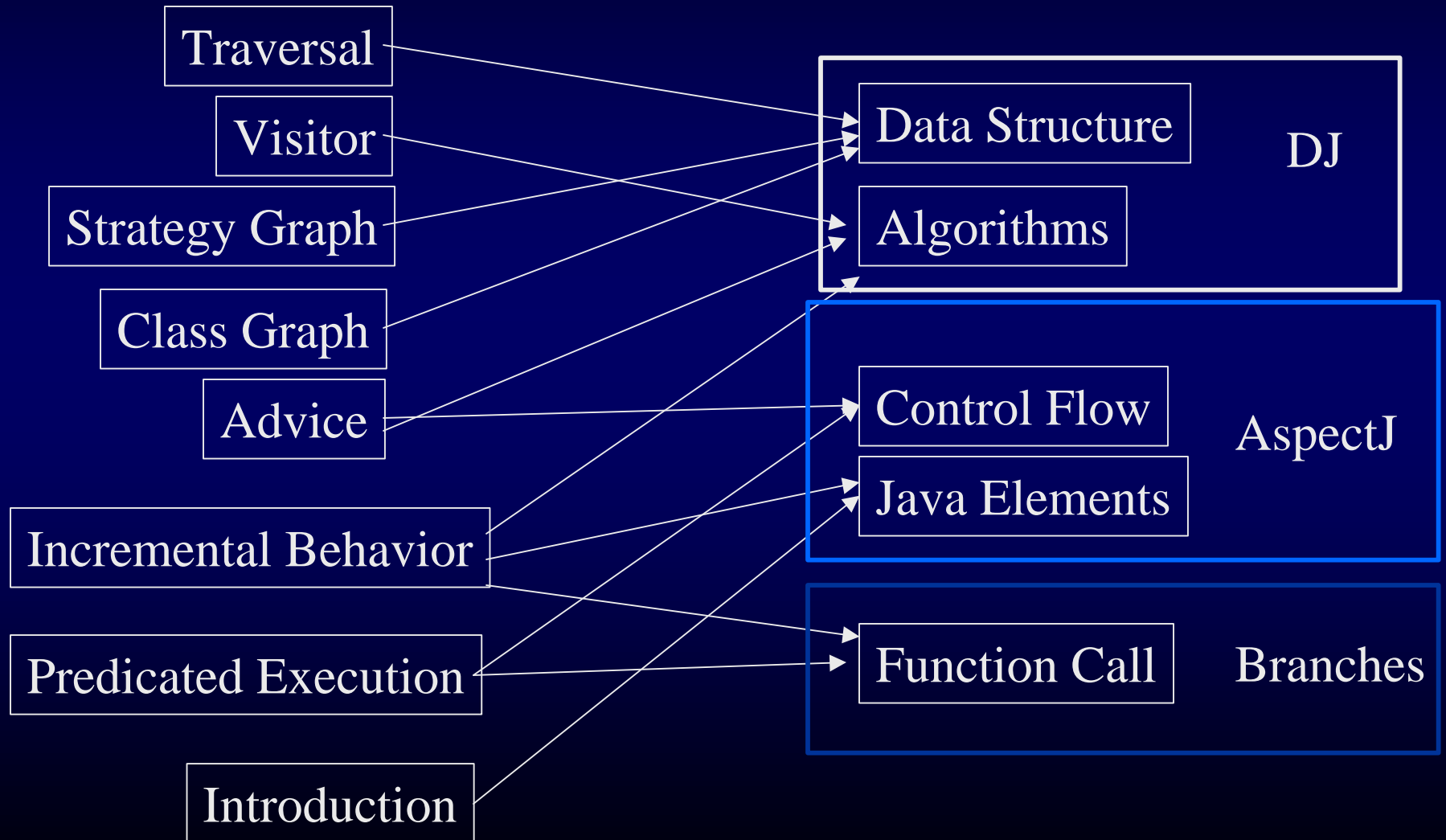
# AspectJ Conceptual Application

- Introduction of almost anything within a java class
  - Allows very flexible grouping of program
- Predicated execution on control flow
- Incrementally add aspects

# Branches Conceptual Application

- Each node is a function call
- Each exit from a node is a branch
- Predicated execution based on arguments on a branch
- Introduction of Branches and nodes
- Incrementally add functions and branches

# Conceptual Application



# Master's Thesis

- Attempt to implement AOP concepts using different AOP tools
- Mix different AOP tools together
- Generalized view of AOP tools and concepts

# AspectJ Resources

- [www.AspectJ.org](http://www.AspectJ.org)
  - downloads, documentation, articles, examples
- [aosd.net](http://aosd.net)
  - collection of AO software development