# 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

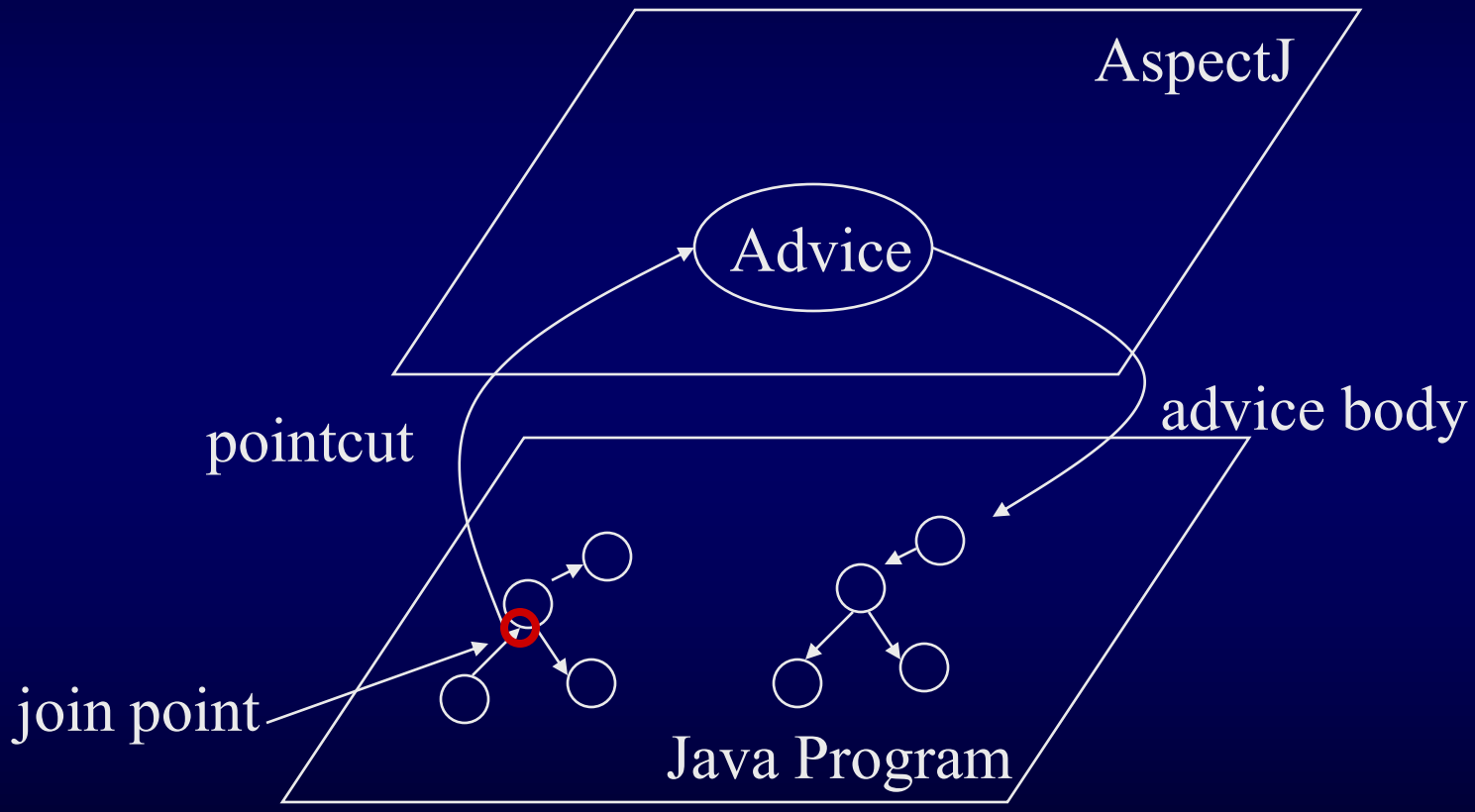
# Introduction to AspectJ

- 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

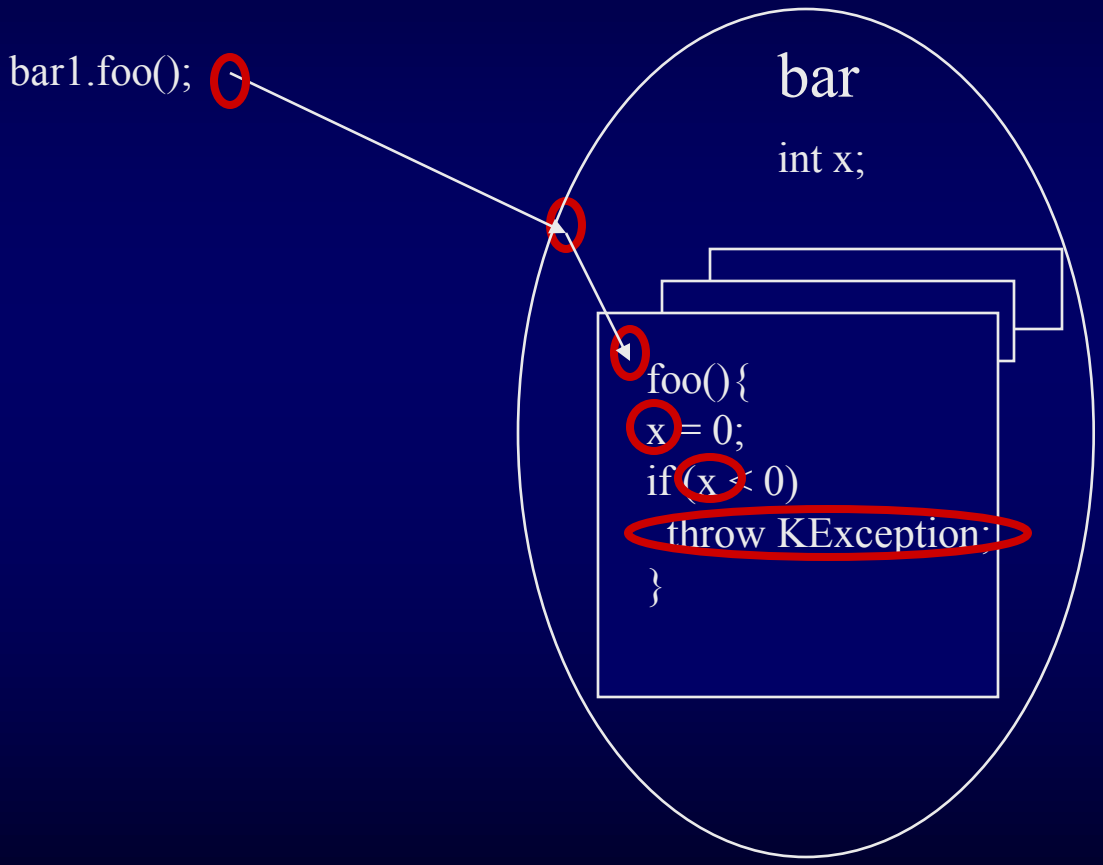
# Highlevel View of AspectJ



# 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



# 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));

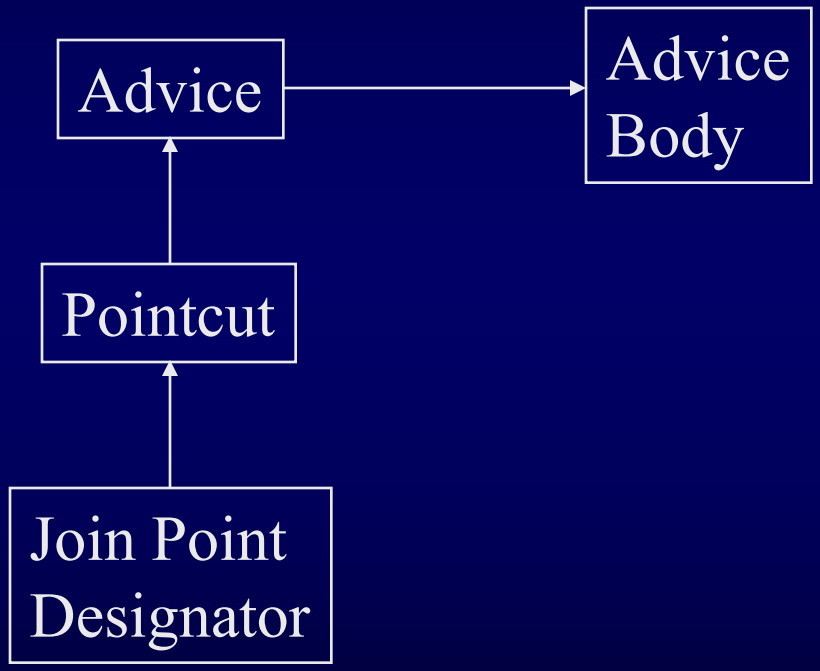
# Advice

- 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}

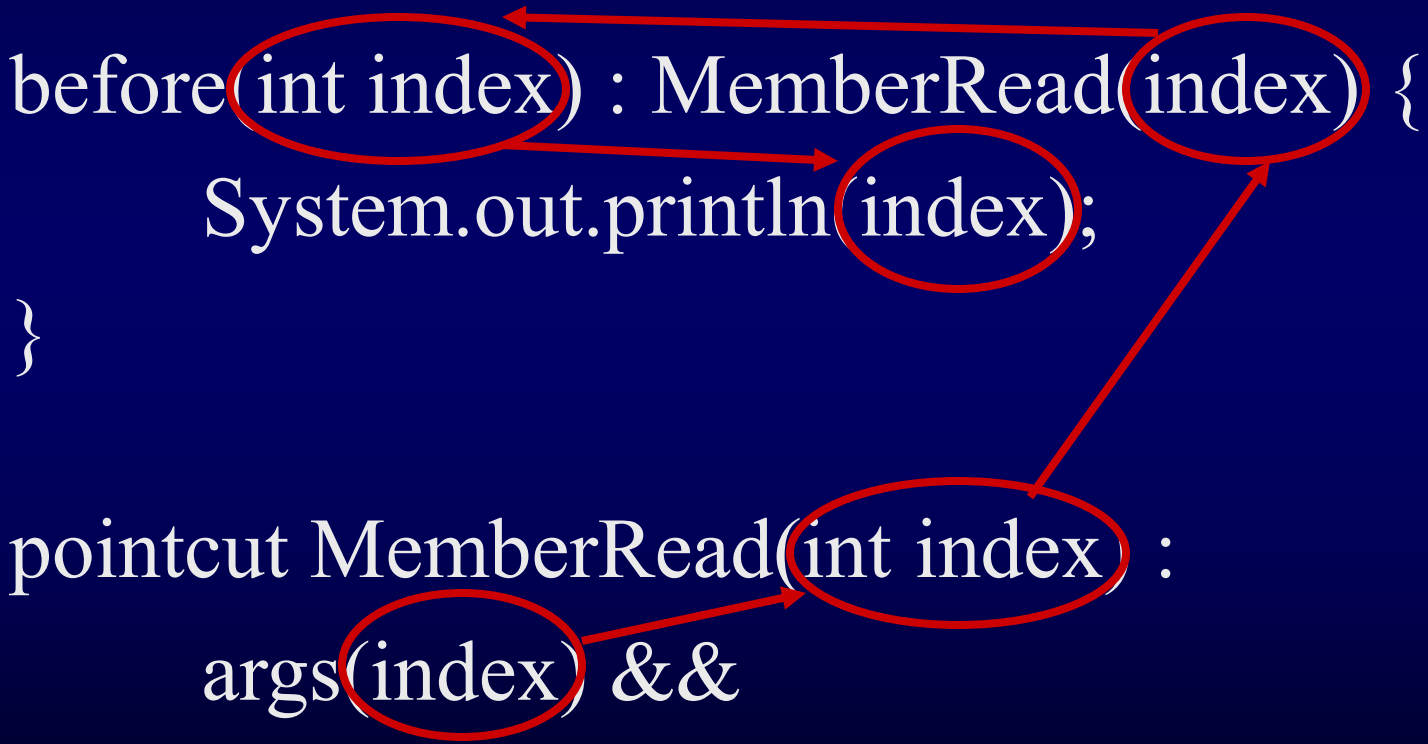
# Advice Examples

- 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()

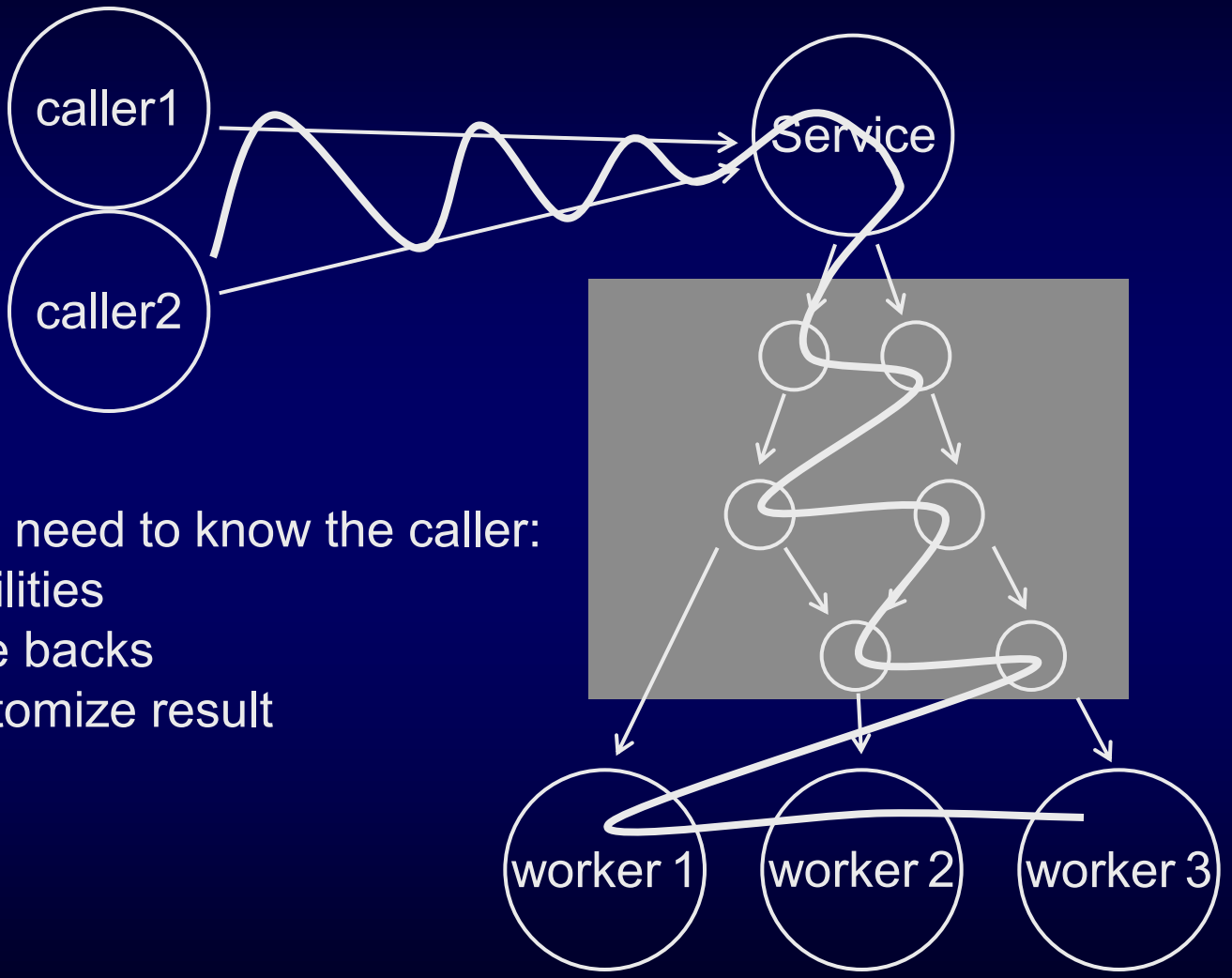
```
aspect TraceNonStaticMethods {

  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

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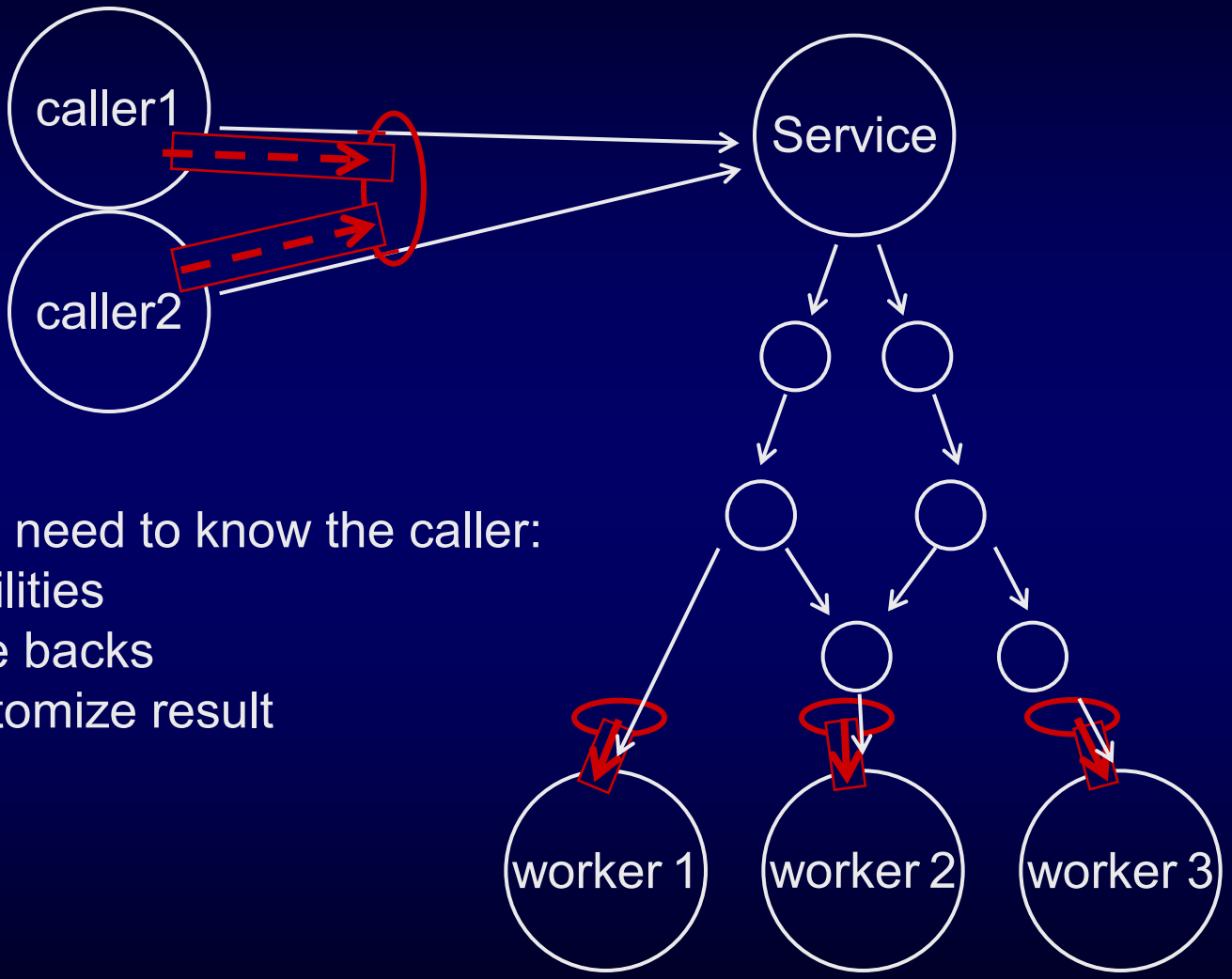
# context-passing aspects




workers need to know the caller:

- capabilities
- charge backs
- to customize result

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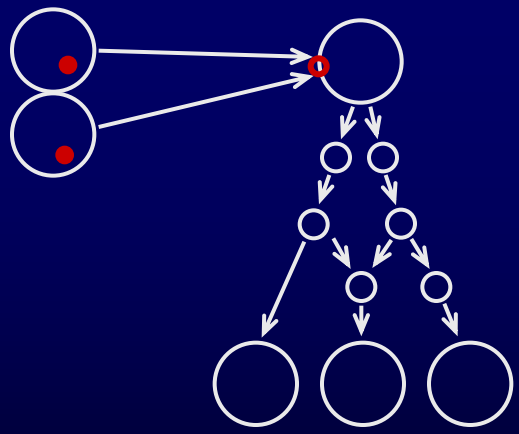
# context-passing aspects

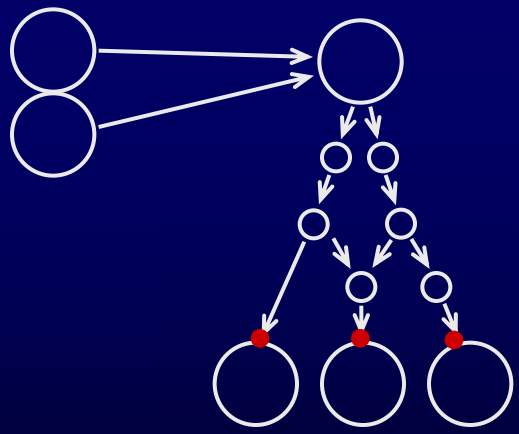
```
pointcut invocations(Caller c):
  this(c) && call(void Service.doService(String));
```



# 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));
```



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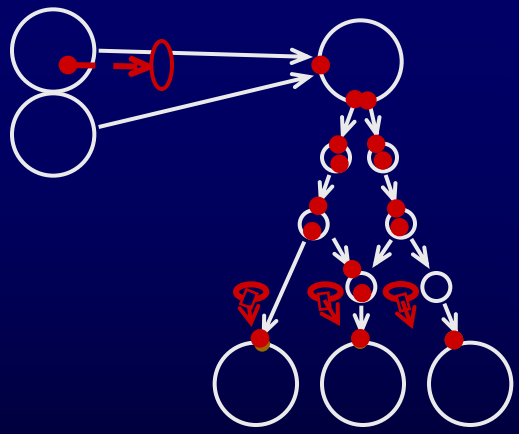
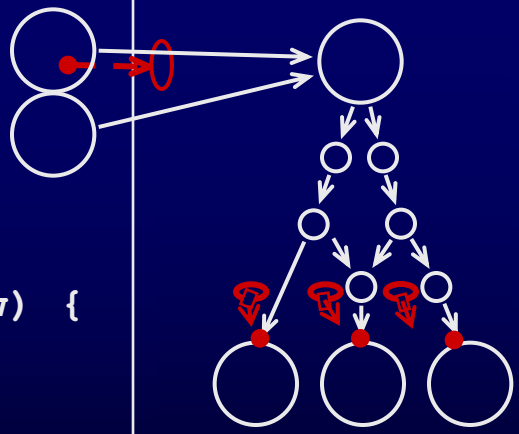
# context-passing aspects

```
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

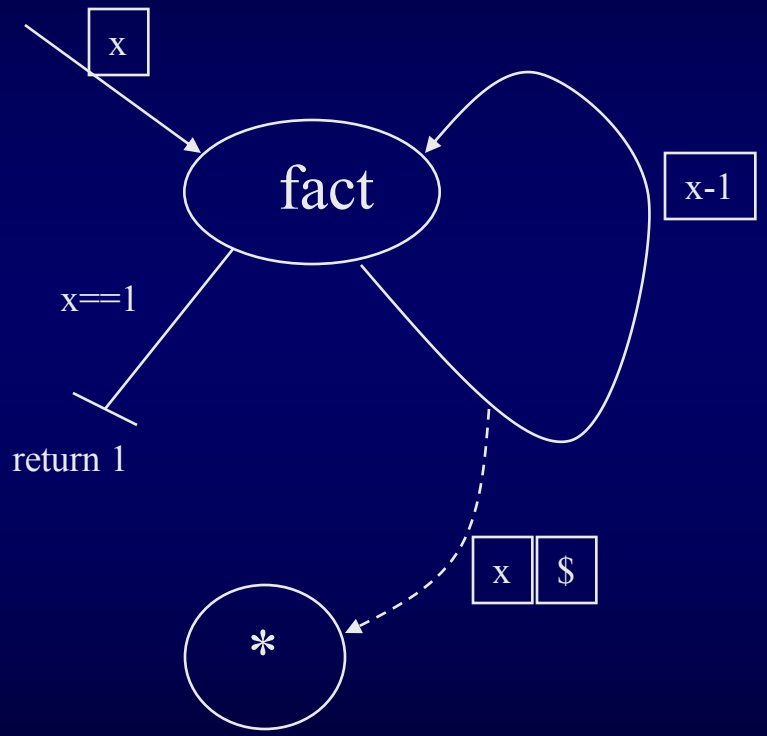
- AspectJ have similar concepts as Fred
  - Predicates on method calls and arguments
  - Bodies to be executed

# Factorial in Fred

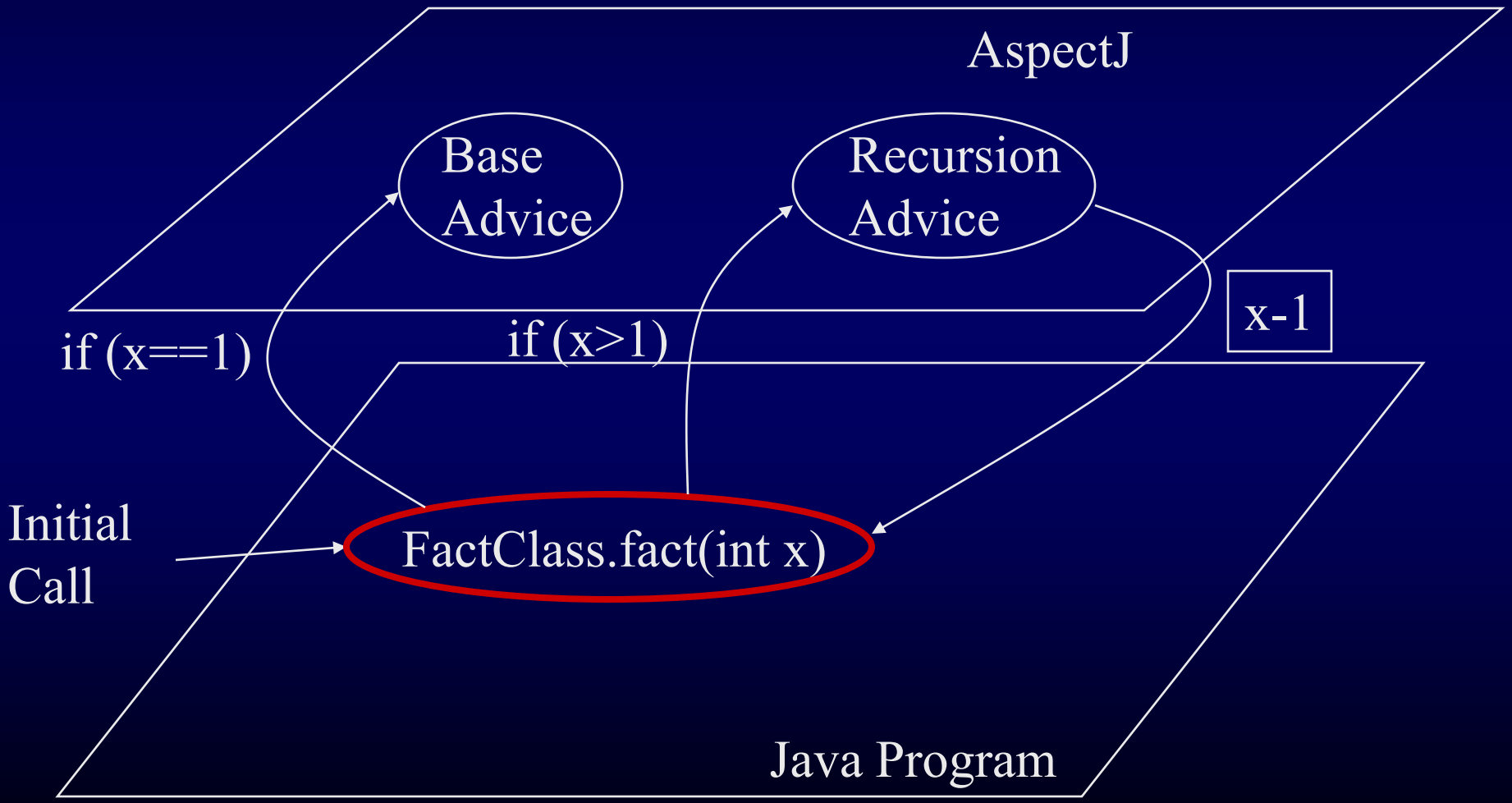
```
(define-msg fact)
```

```
(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;
    }
}
```

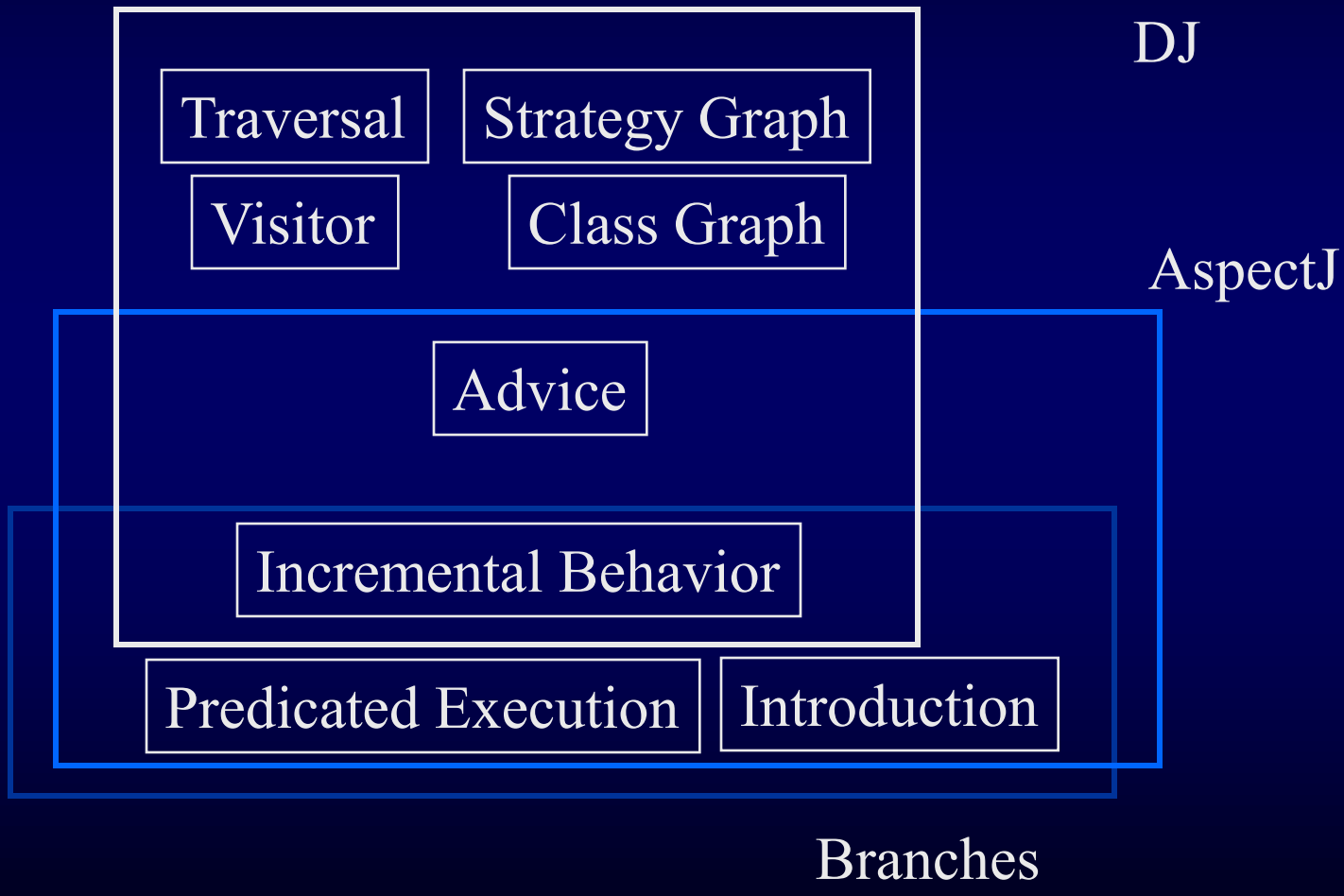
# Conceptual Analysis

- 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

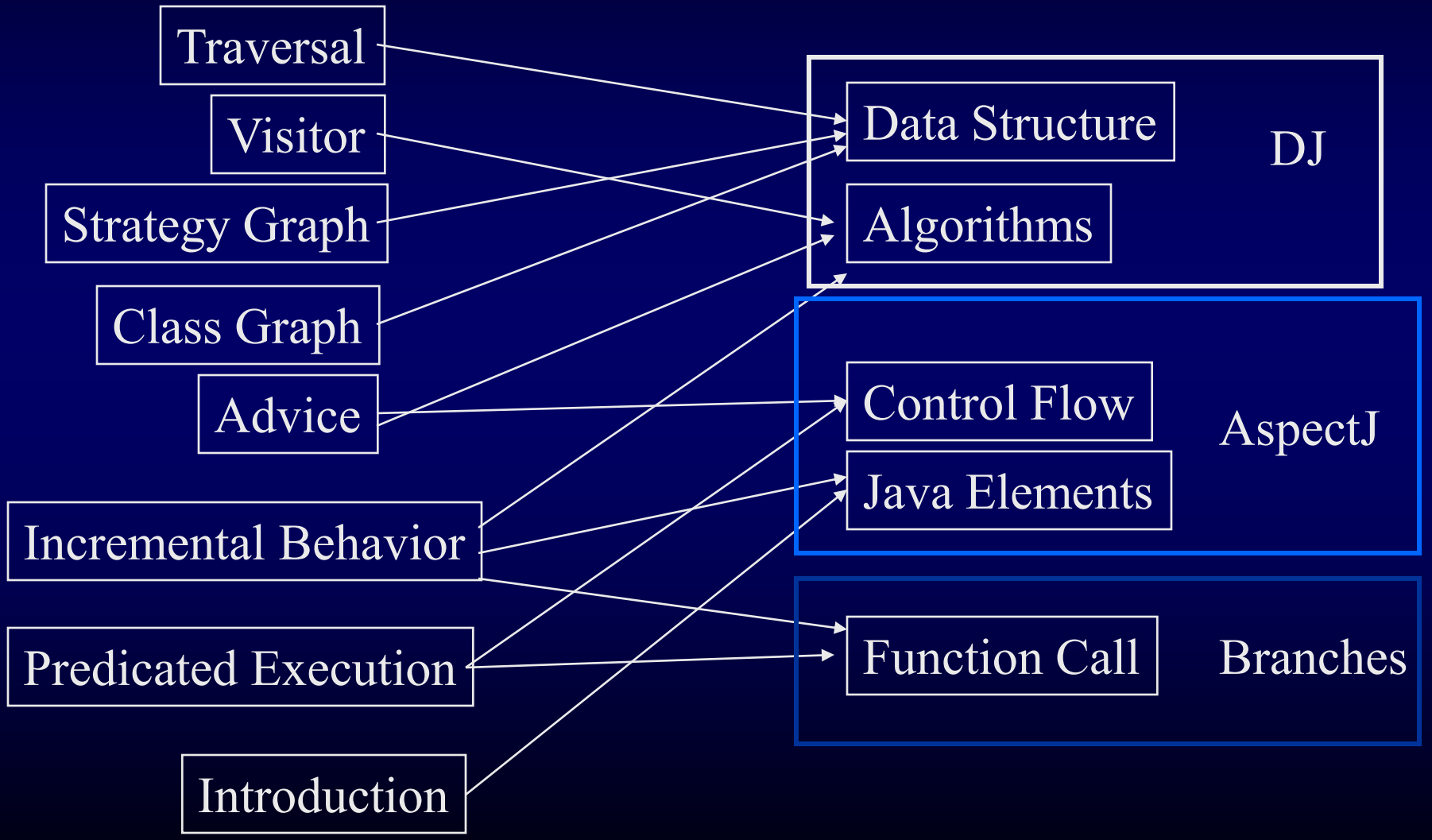
# AspectJ Conceptual Application

- 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
  - downloads, documentation, articles, examples
- aosd.net
  - collection of AO software development