Mining Operational Preconditions

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aspectj

crosscutting objects for better modularity

bug.aj

```
@interface A {}

aspect Test {
   declare @field : @A int var* : @A;
   declare @field : int var* : @A;

   interface Subject {}

   public int Subject.vara;
   public int Subject.varb;
}

class X implements Test.Subject {}
```

```
  private static void ajc$postClinit()    org.aspectj.weaver.AjAttribute$AjSynth
etic@abfbc6
:
                    NEW Test   (line 1)
                    DUP
                    INVOKESPECIAL Test.<init> ()V
                    PUTSTATIC Test.ajc$perSingletonInstance LTest;
                    RETURN
  end private static void ajc$postClinit()
end public class Test


Exception thrown from AspectJ 1.5.3

This might be logged as a bug already -- find current bugs at
  http://bugs.eclipse.org/bugs/buglist.cgi?product=AspectJ&component=Compiler

Bugs for exceptions thrown have titles File:line from the top stack,
e.g., "SomeFile.java:243"

If you don't find the exception below in a bug, please add a new bug
at http://bugs.eclipse.org/bugs/enter_bug.cgi?product=AspectJ
To make the bug a priority, please include a test program
that can reproduce this exception.
```

ajc Stack Trace

```
java.util.NoSuchElementException
   at java.util.AbstractList$Itr
      .next(AbstractList.java:427)
  at org.aspectj.weaver.bcel.BcelClassWeaver
      .weaveAtFieldRepeatedly
      (BcelClassWeaver.java:1016)
```

ajc Stack Trace

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java.util.NoSuchElementException
   at java.util.AbstractList$Itr
      .next(AbstractList.java:427)
  at org.aspectj.weaver.bcel.BcelClassWeaver
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```

weaveAtFieldRepeatedly

```
for (Iterator iter = itdFields.iterator();
     iter.hasNext();) {
    ...
    for (Iterator iter2 = worthRetrying.iterator();
         iter.hasNext();) {
        ...
    }
}
```

weaveAtFieldRepeatedly

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for (Iterator iter = itdFields.iterator();
     iter.hasNext();) {
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        ...
    }
}
```

should be iter2

weaveAtFieldRepeatedly

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for (Iterator iter = itdFields.iterator();
     iter.hasNext();) {
    ...
    for (Iterator iter2 = worthRetrying.iterator();
         iter.hasNext();) {
        ...
    }
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```

should be iter2

- Invalid iterator usage:
  hasNext() should precede next()

Preconditions

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- Invoking next() with no next element violates a *precondition*
- Traditional preconditions are axiomatic – describing the state of the system
- How do we reach this state?

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```
close(int fildes)
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  with read() and write() calls in between

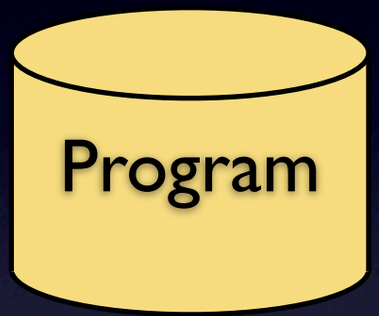
Preconditions

`close(int fildes)`

- Axiomatic: *fildes* is a valid file descriptor
- Operational: *fildes* stems from a call to *open*()
  with read() and write() calls in between
- Can we check operational preconditions?

OP-Miner

OP-Miner



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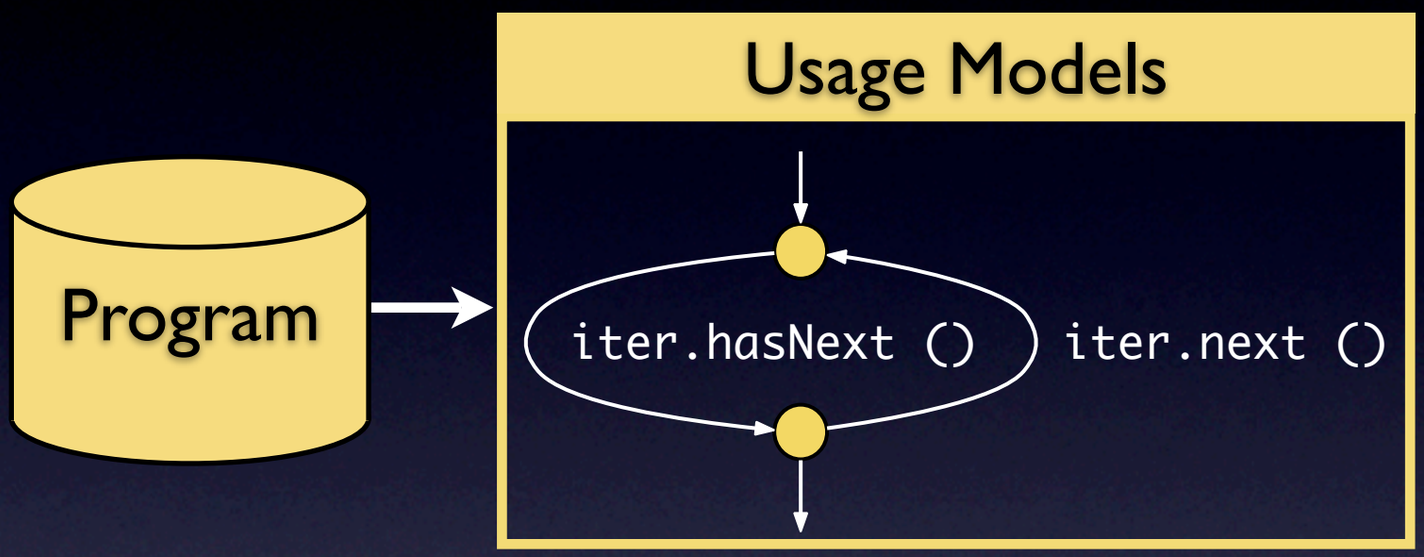

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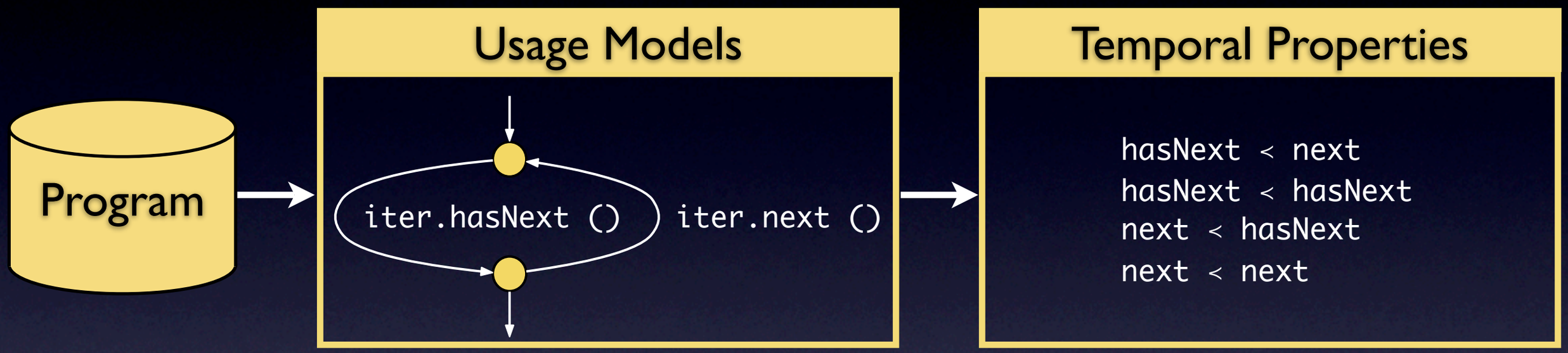
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iter.hasNext ()
iter.next ()
Temporal Properties
hasNext ≺ next
hasNext ≺ hasNext
next ≺ hasNext
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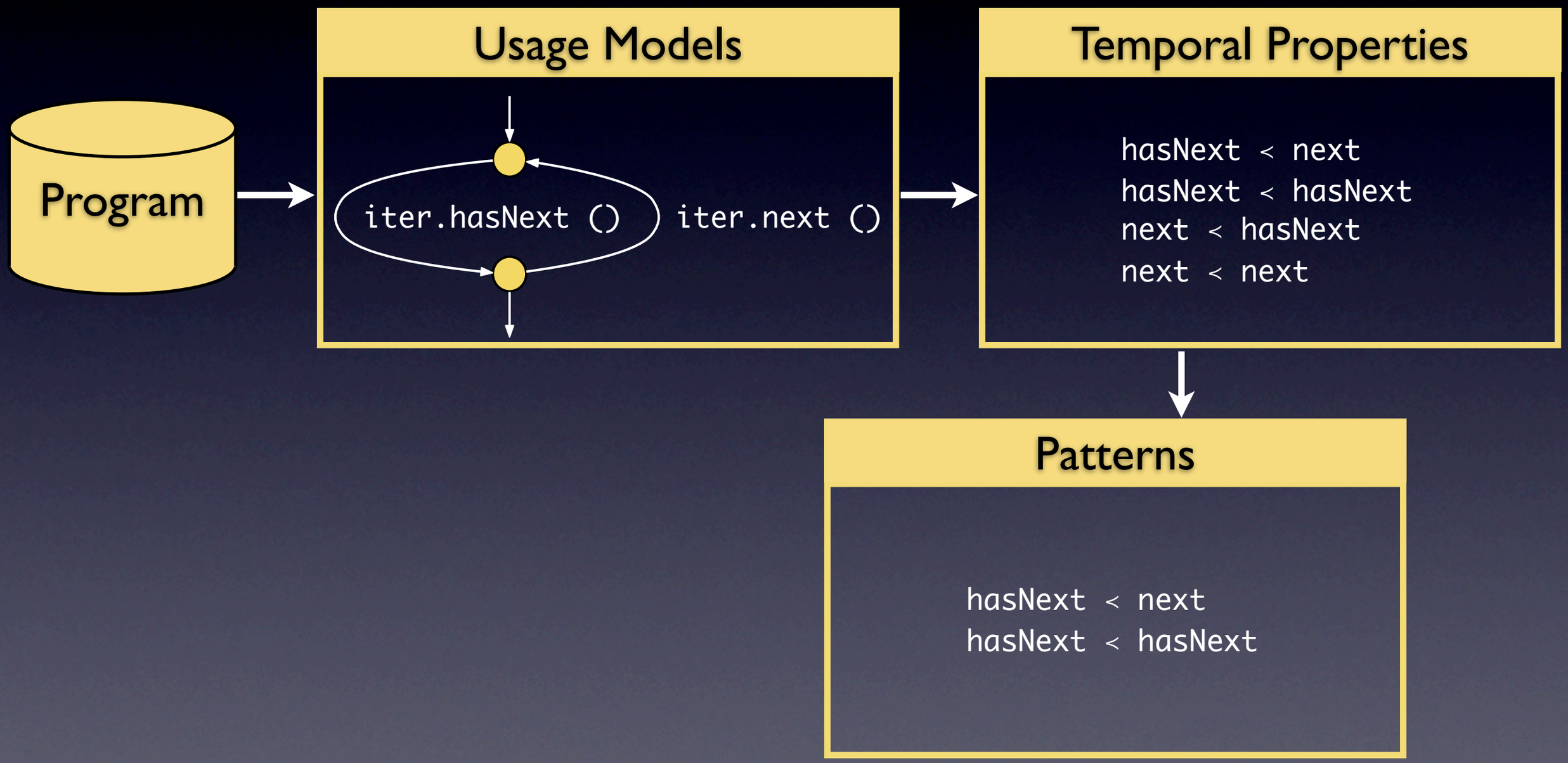
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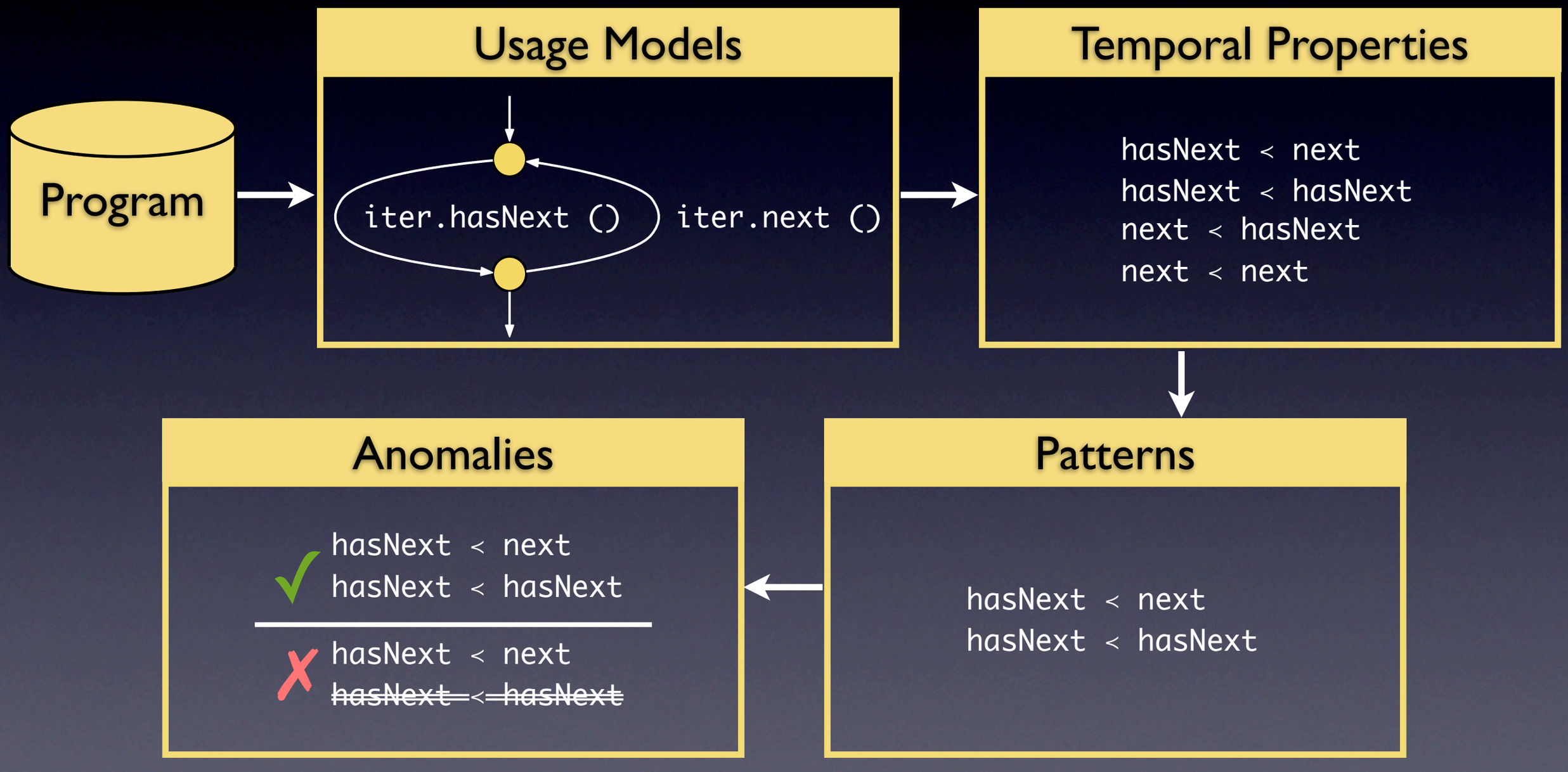
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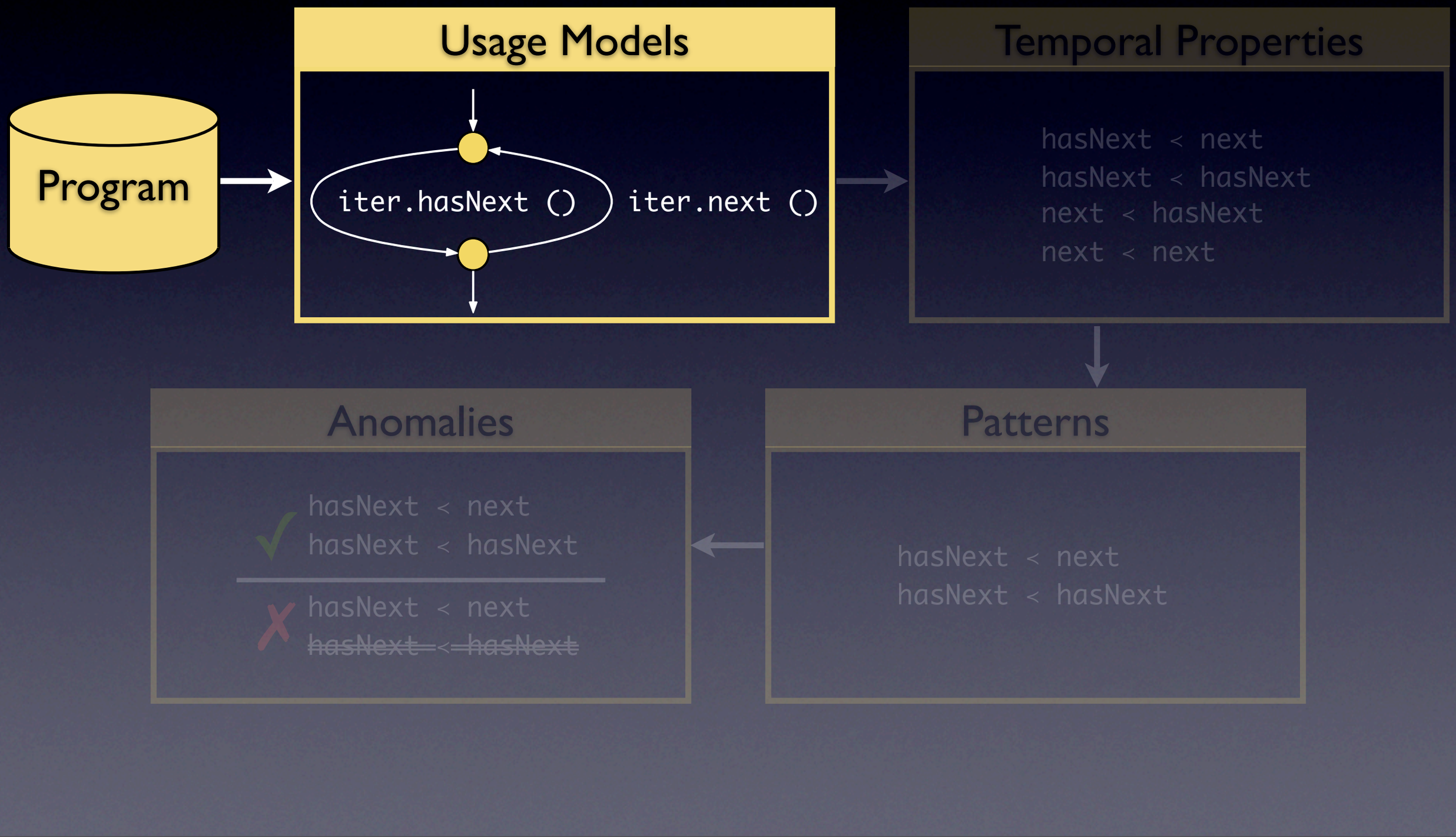
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Method Models

```
public Stack createStack () {
  Random r = new Random ();
  int n = r.nextInt ();
  Stack s = new Stack ();
  int i = 0;
  while (i < n) {
    s.push (rand (r));
    i++;
  }
  s.push (-1);
  return s;
}
```

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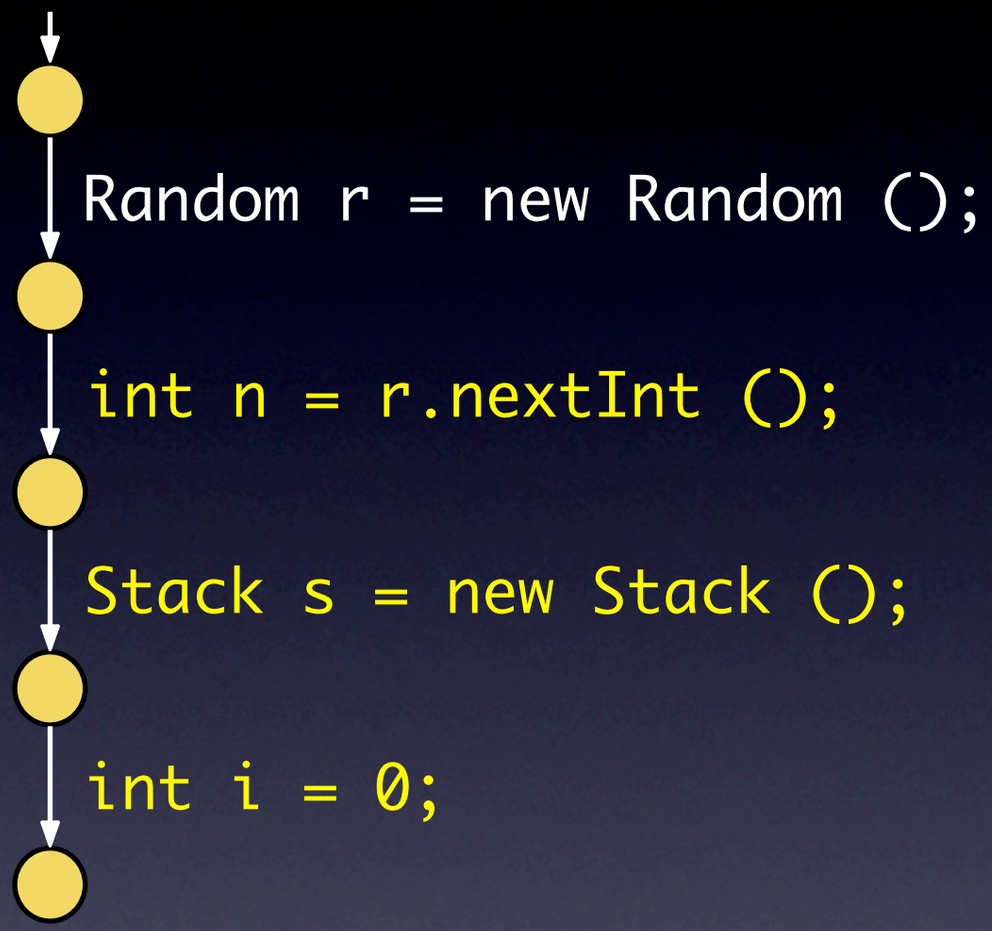

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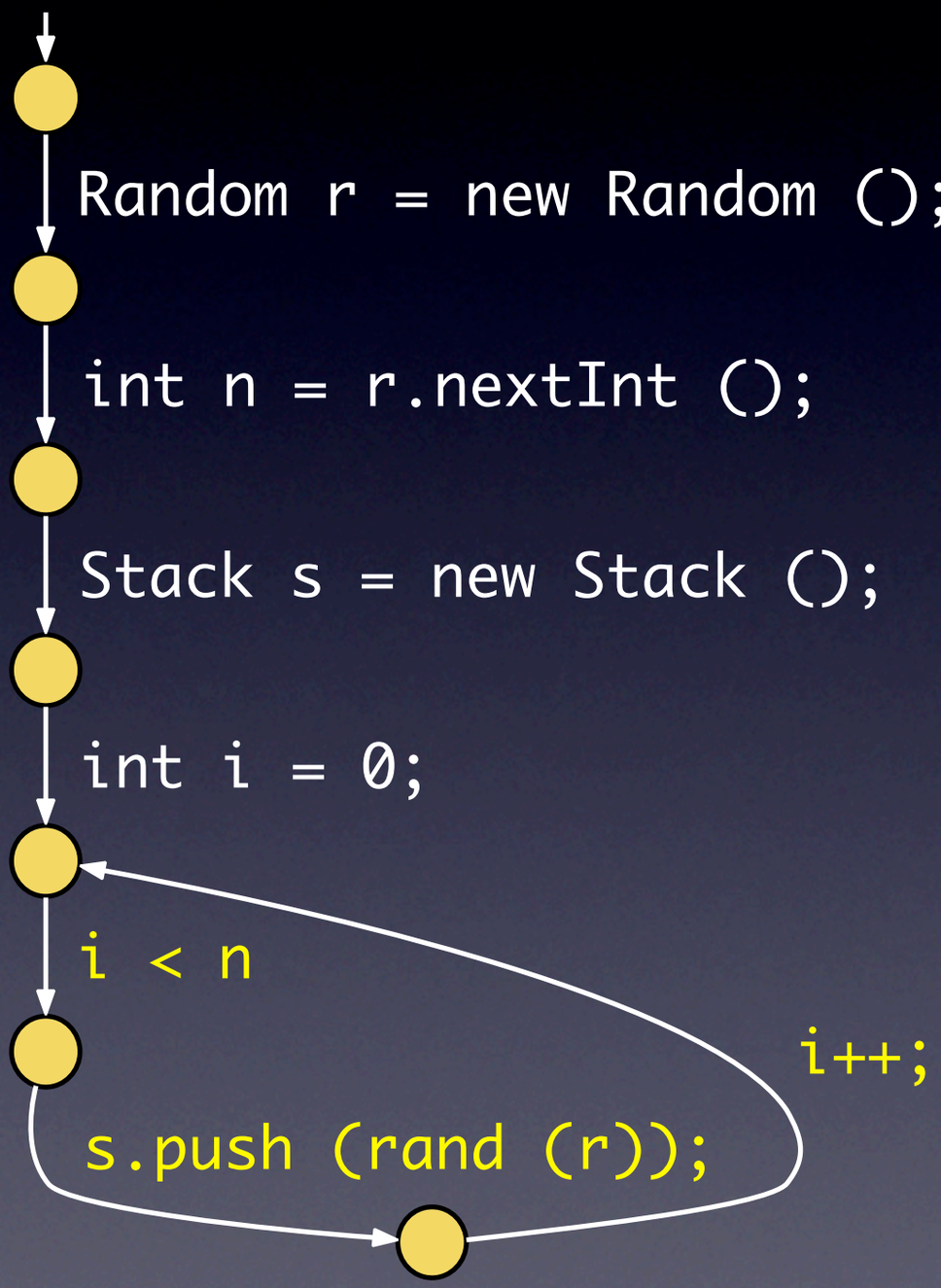

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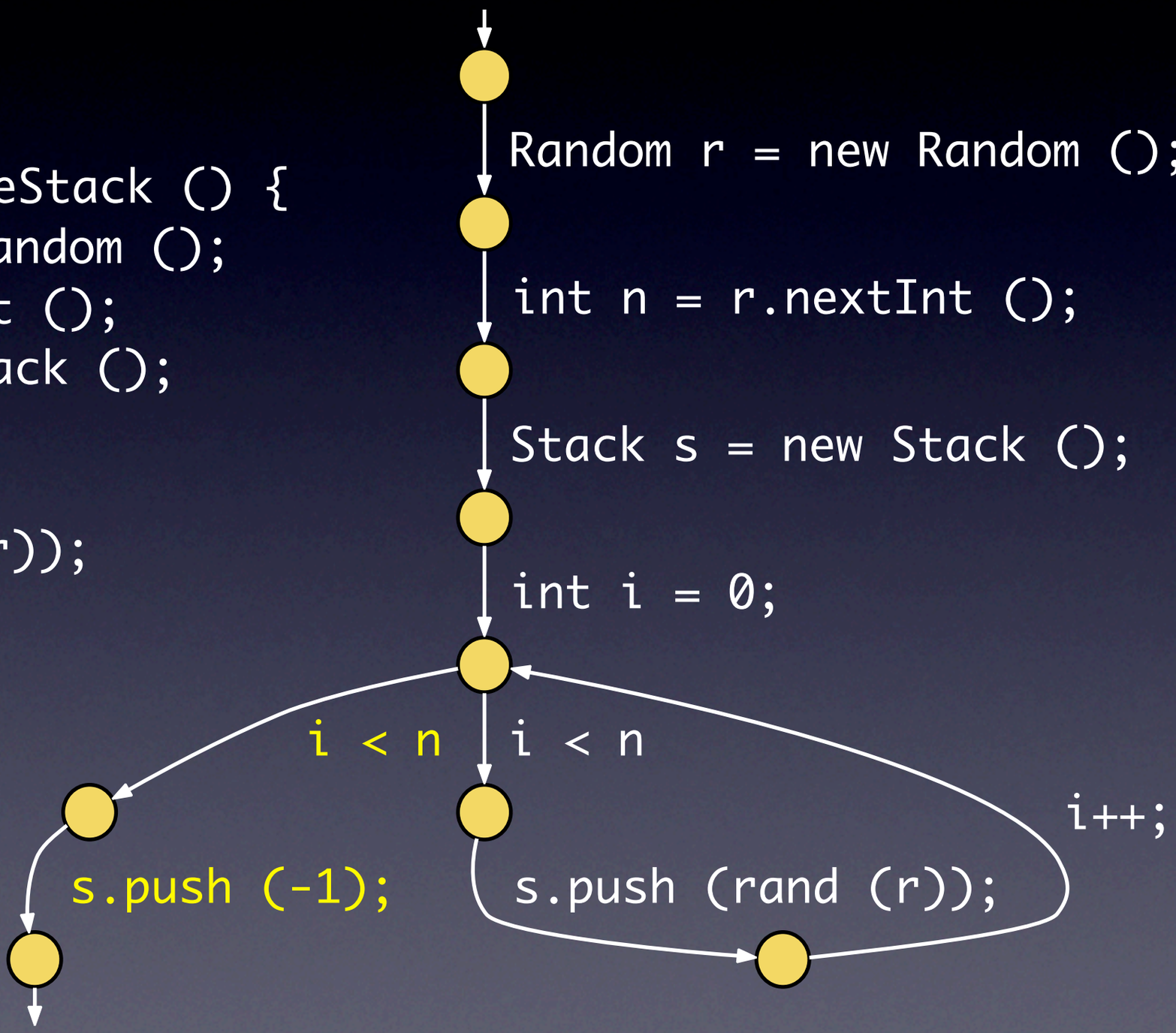

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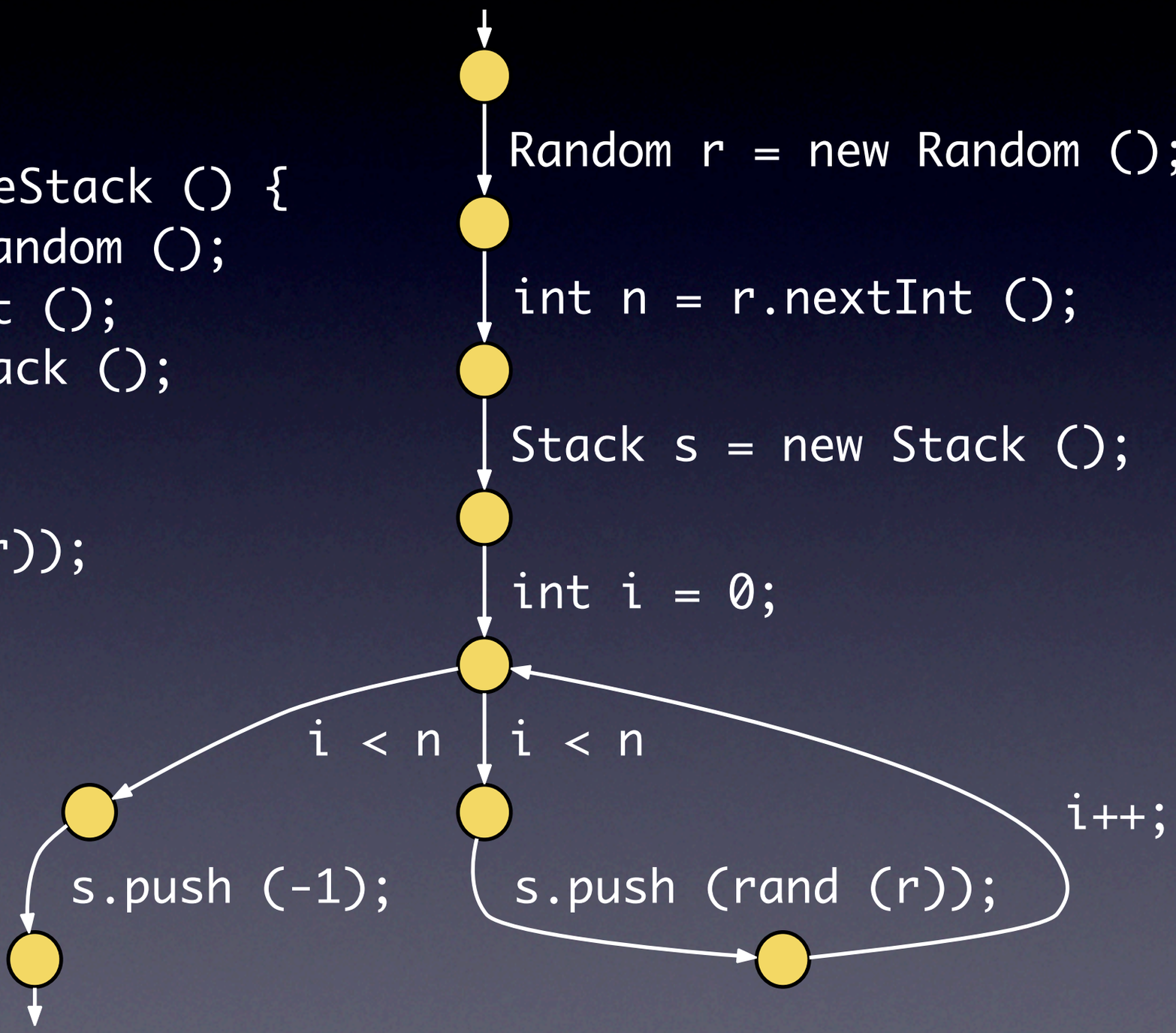

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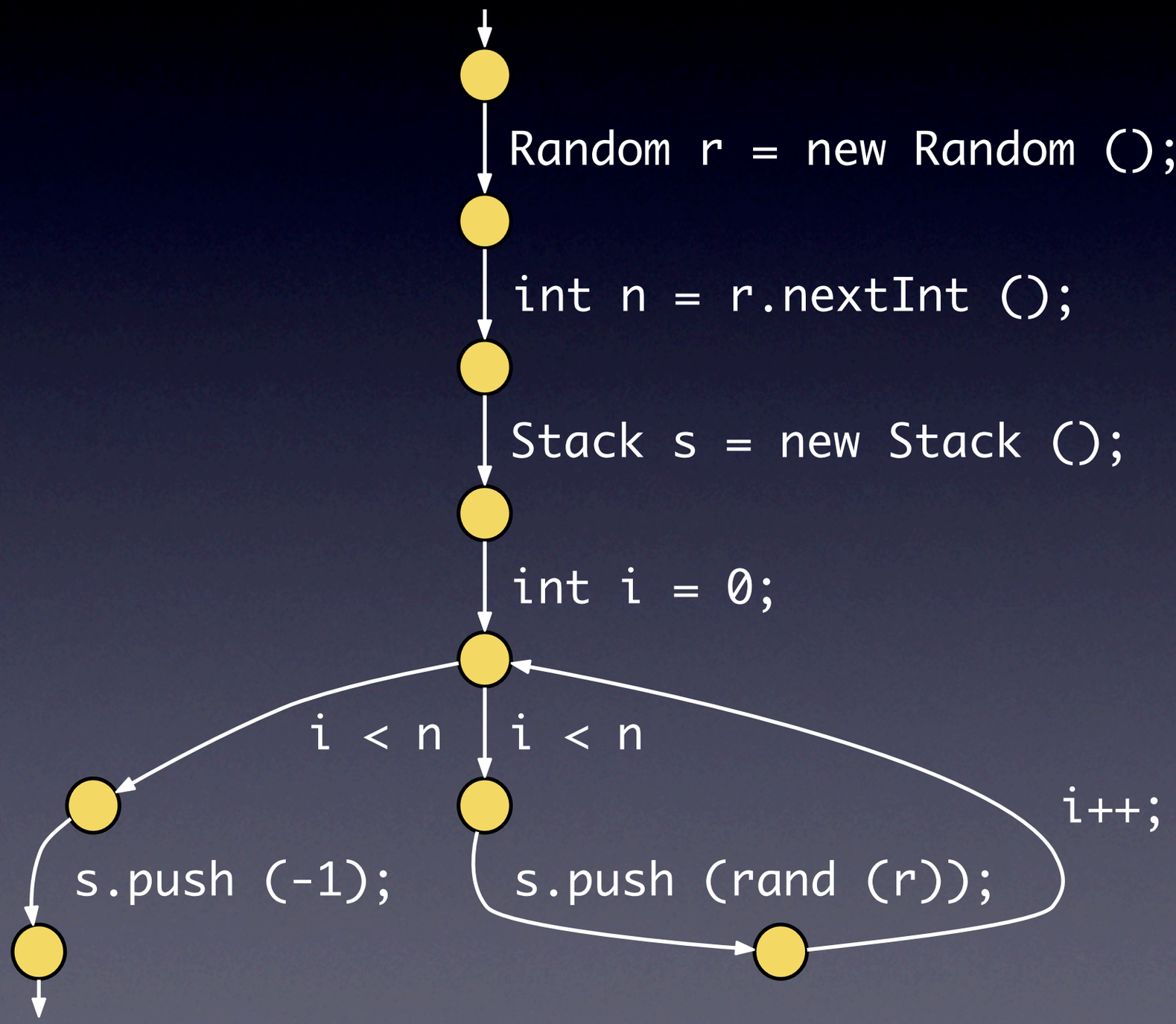

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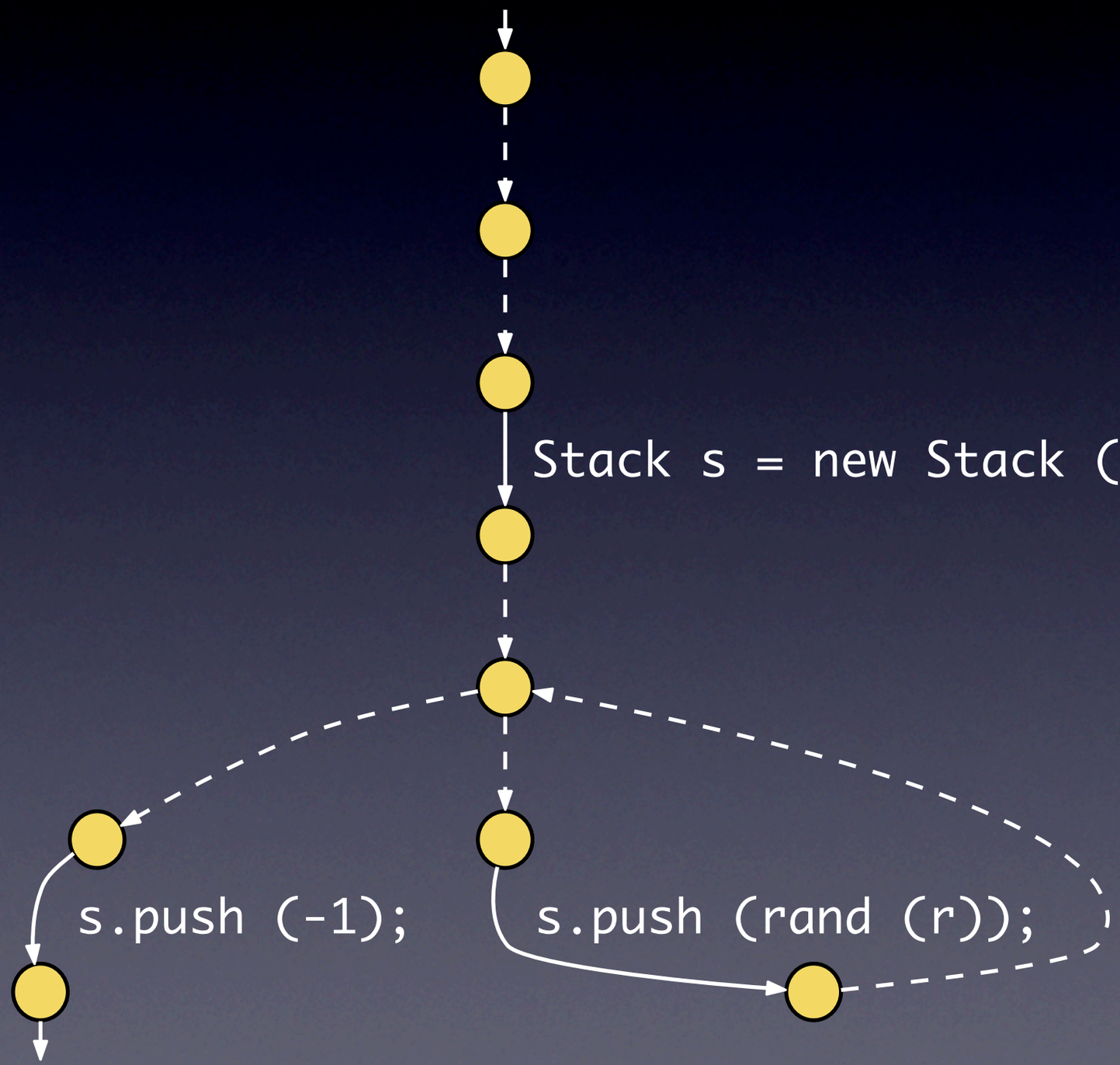

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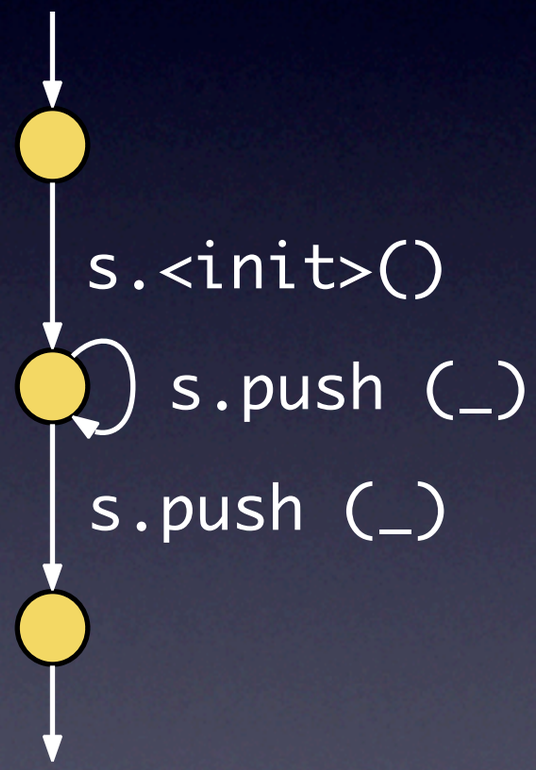

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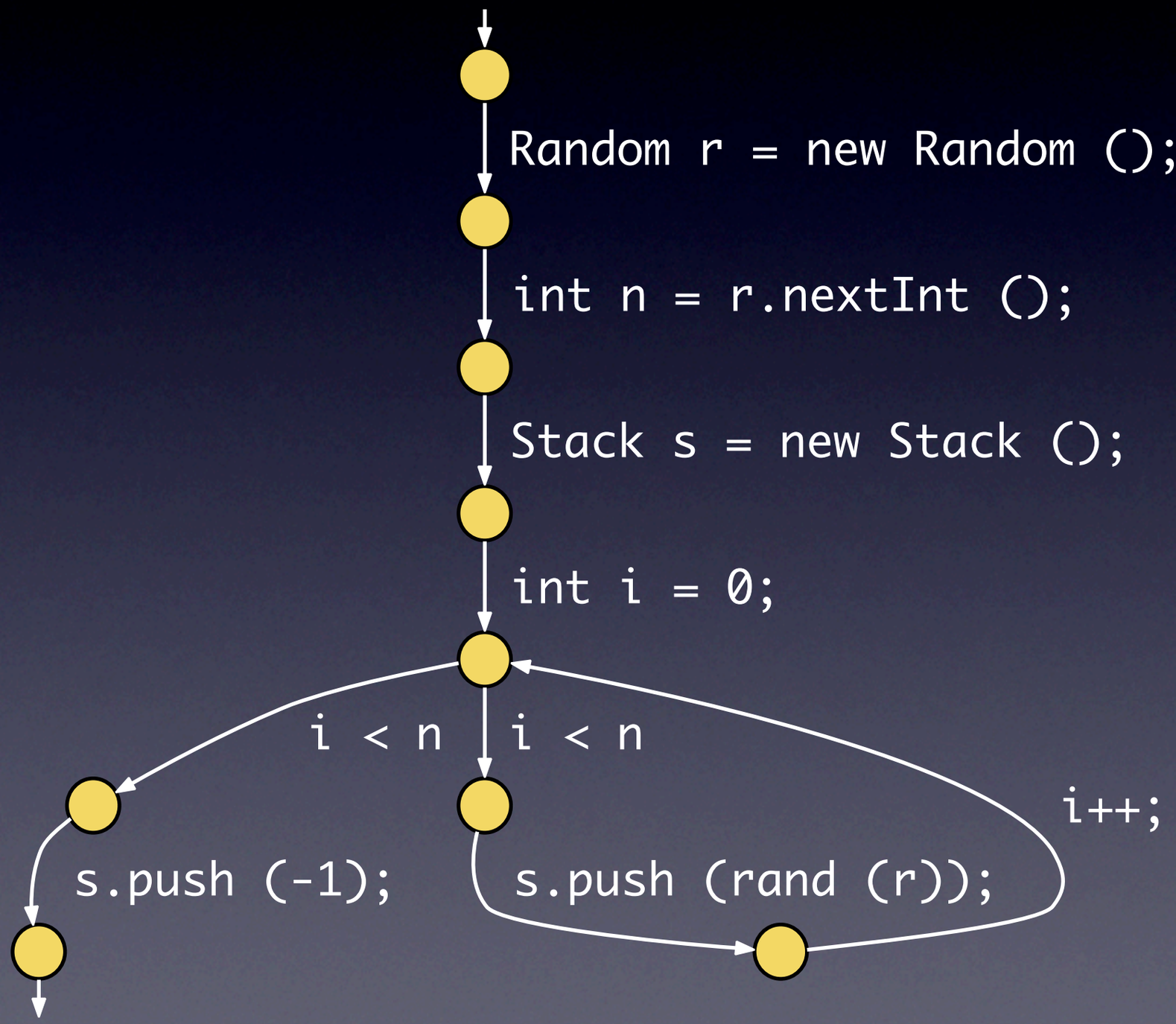

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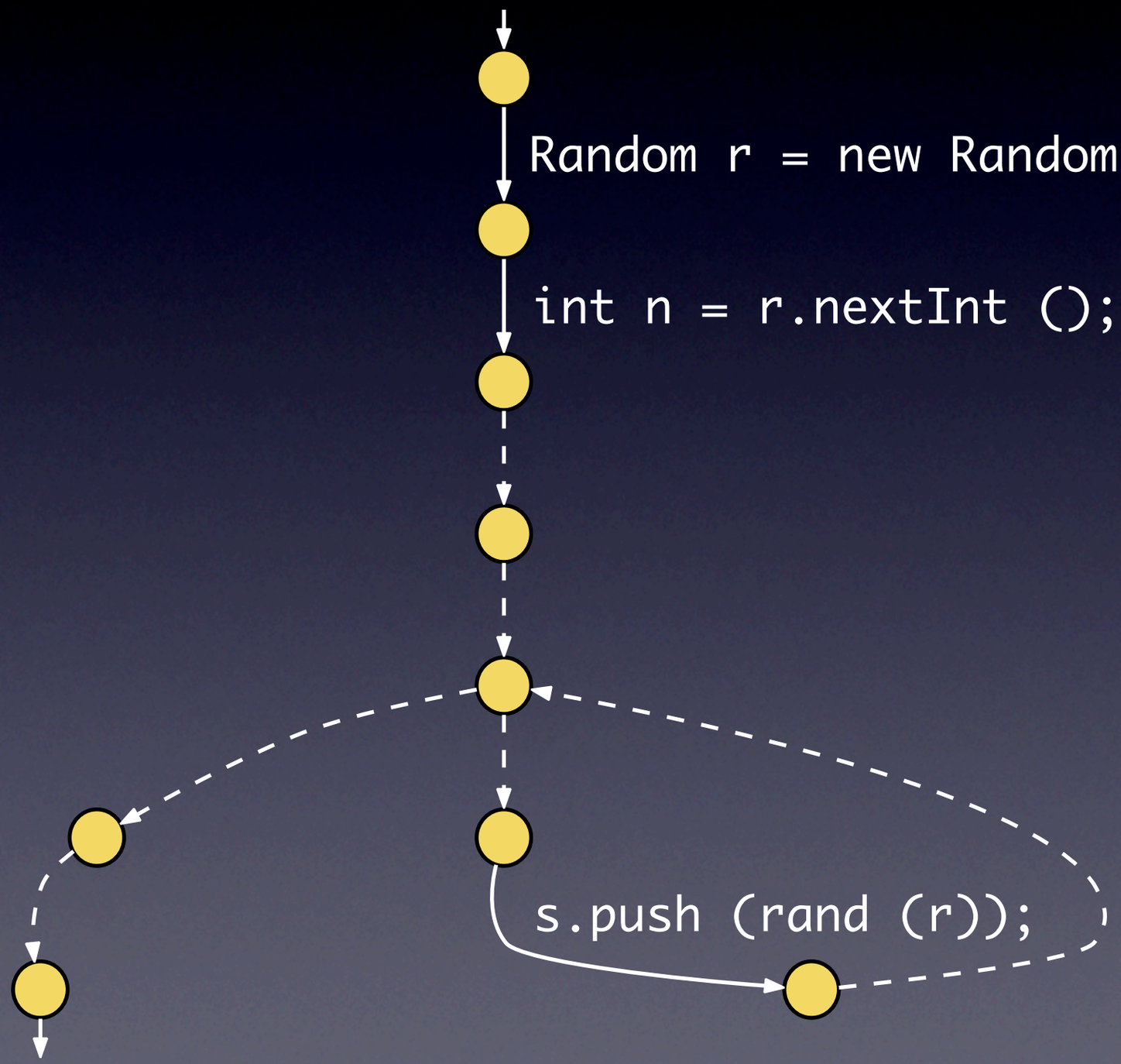

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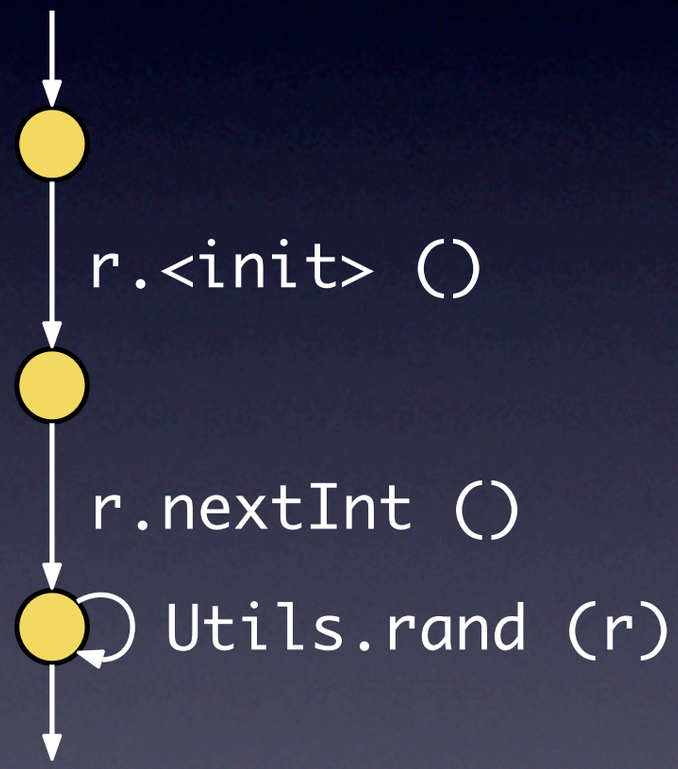
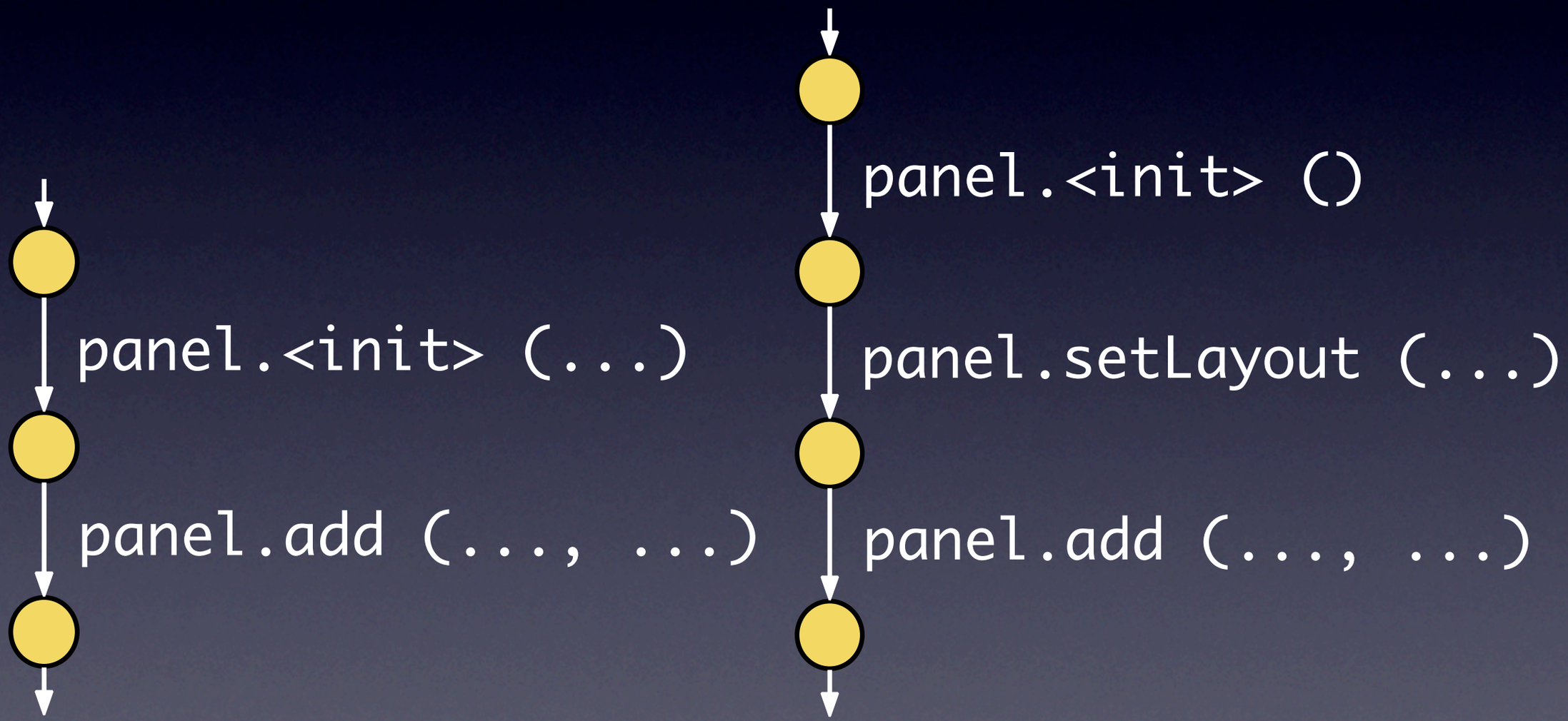


JPanel.add()



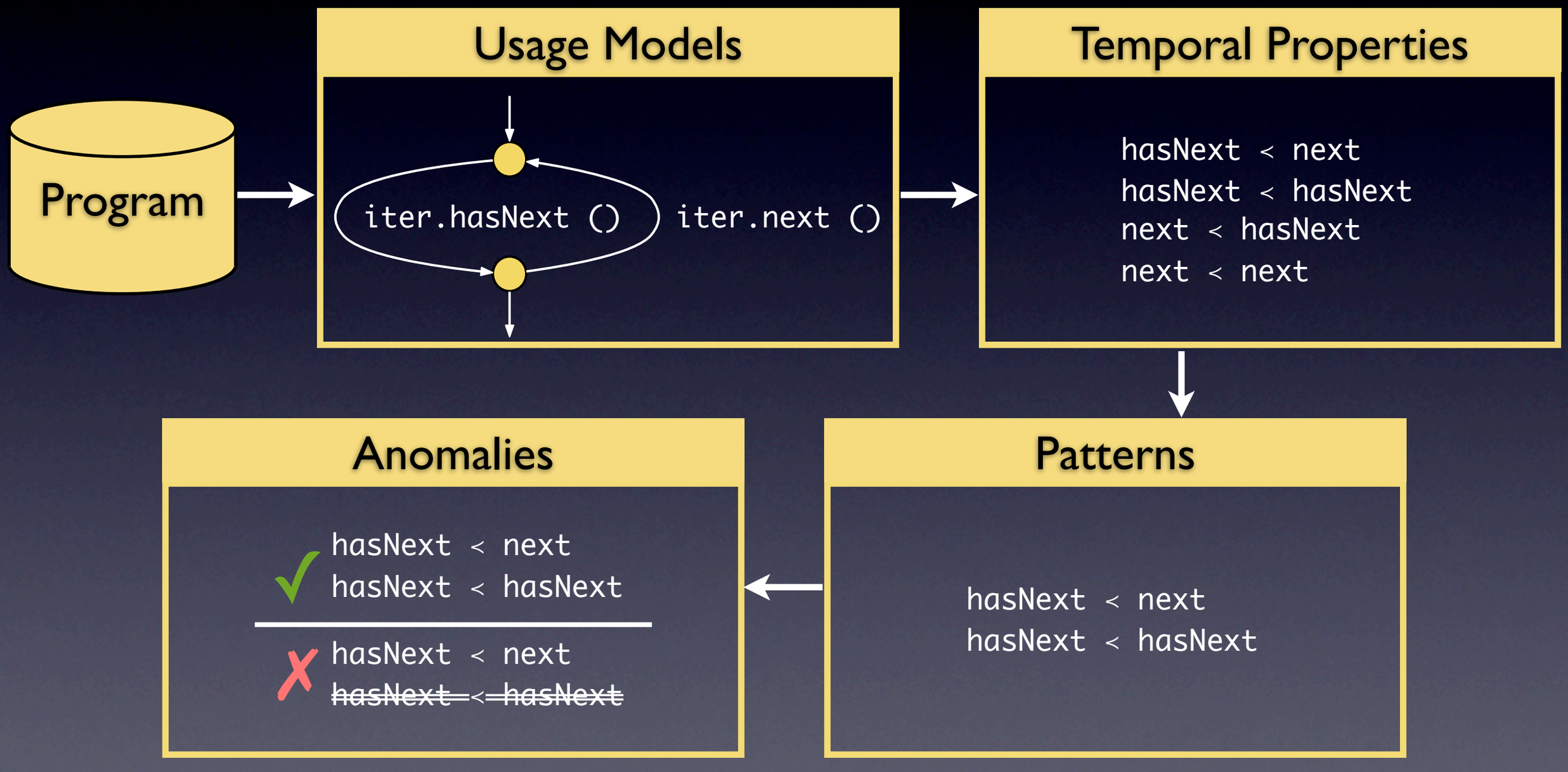
ASTNode.reapPropertyList()

Resource.getFlags()

```
resource.getResourceInfo (..., ...)

resource.getFlags (...)
```

OP-Miner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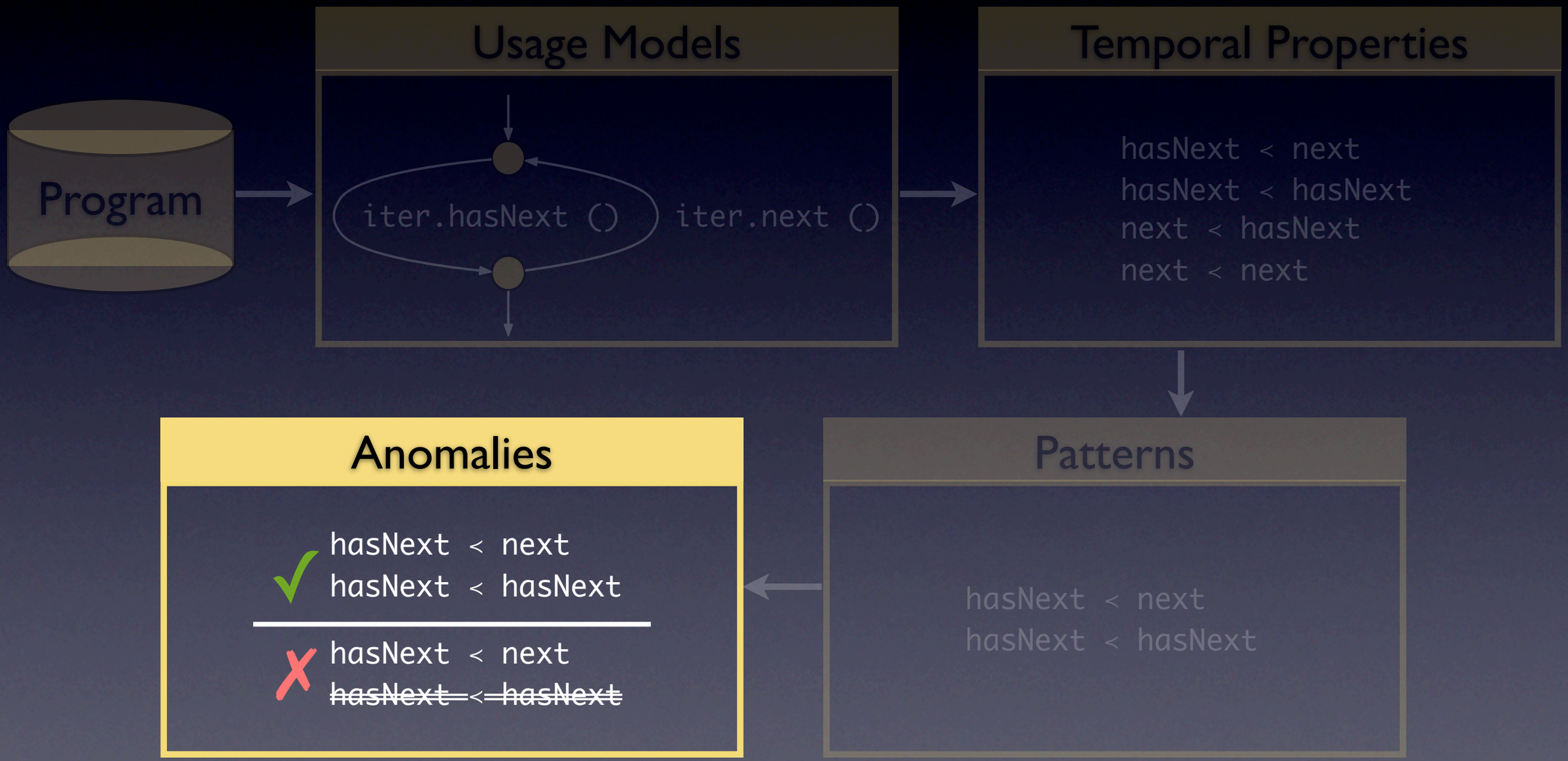
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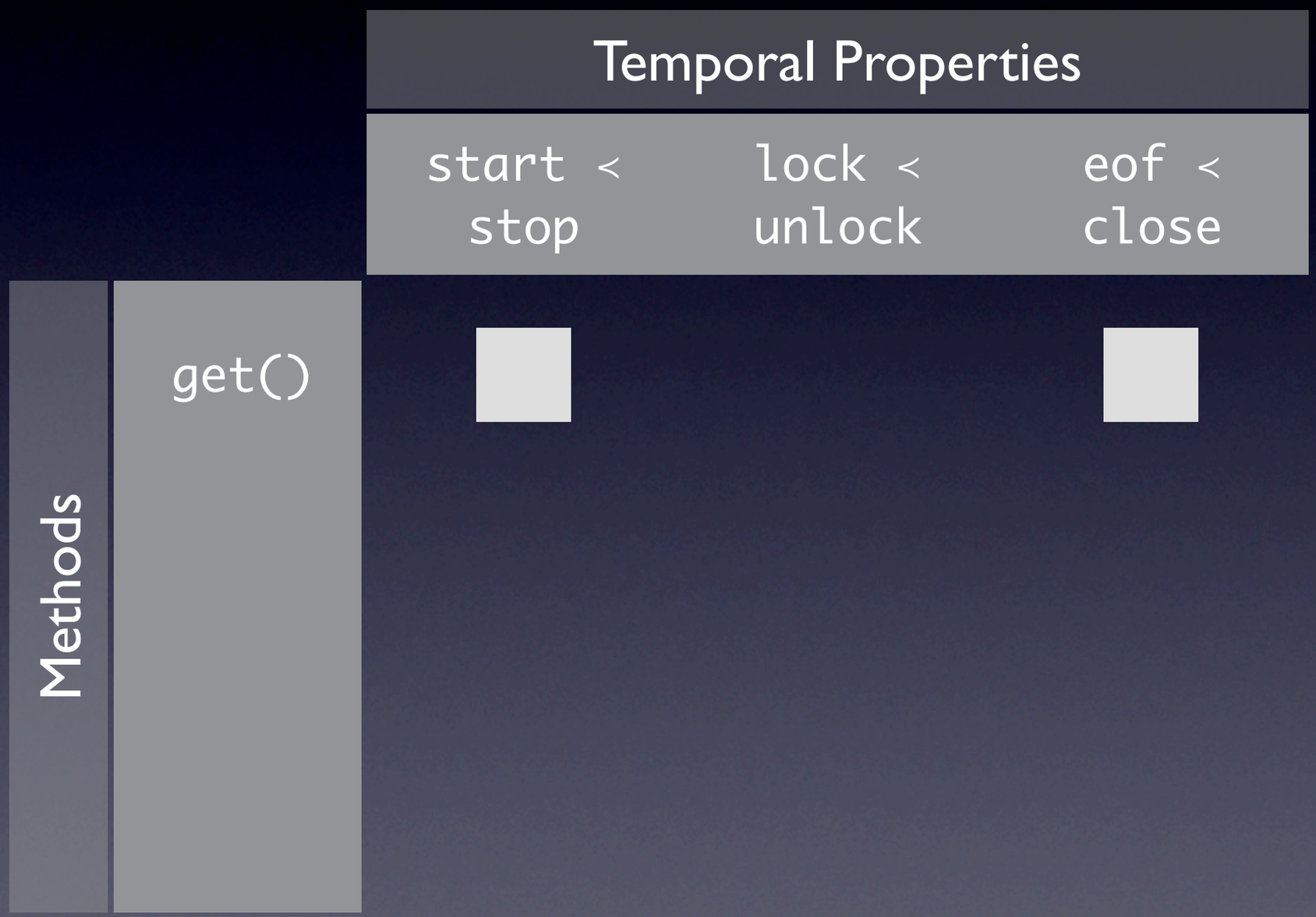
Methods vs. Properties

Temporal Properties		
`start <` `stop`	`lock <` `unlock`	`eof <` `close`

Methods

Methods vs. Properties



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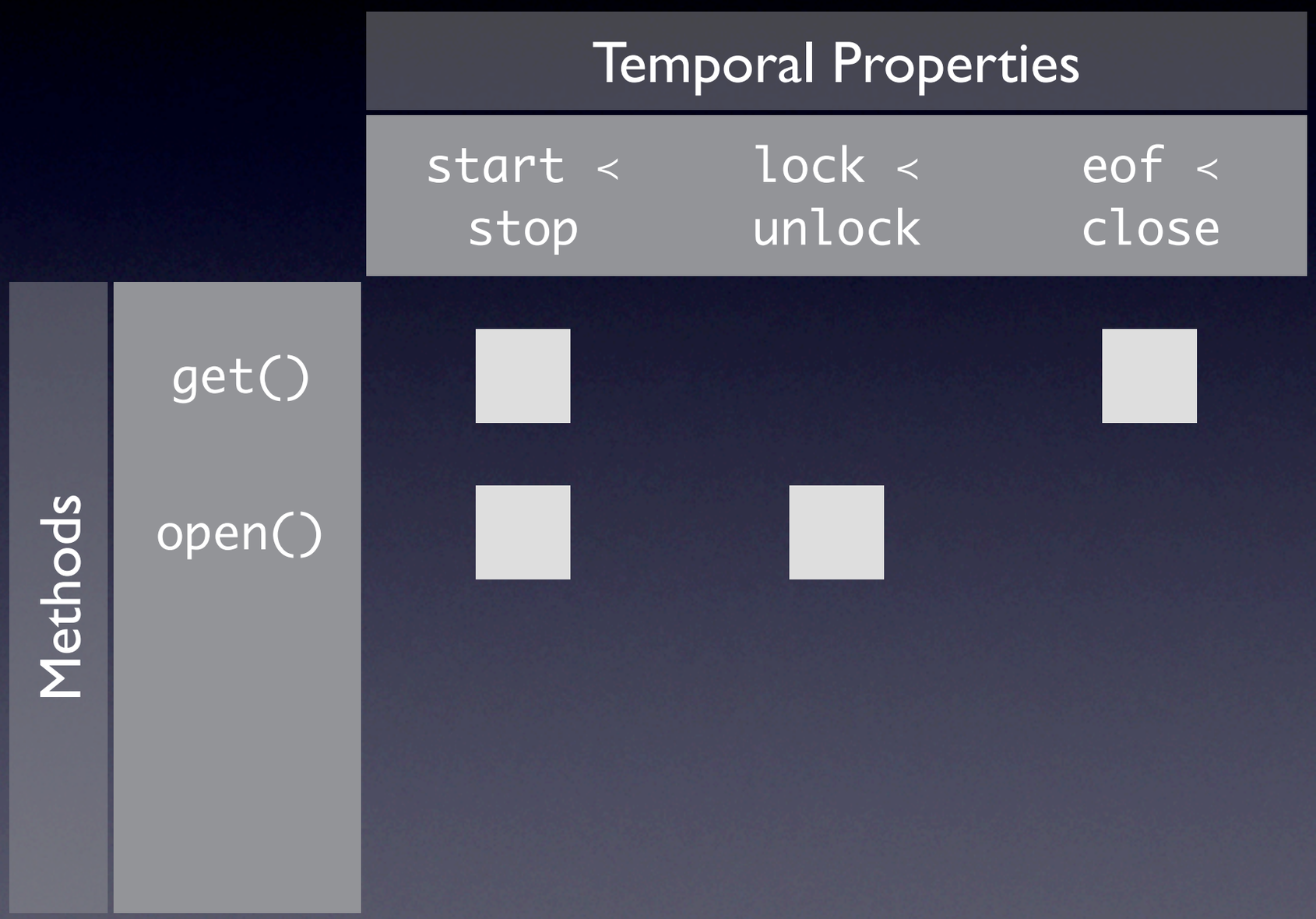

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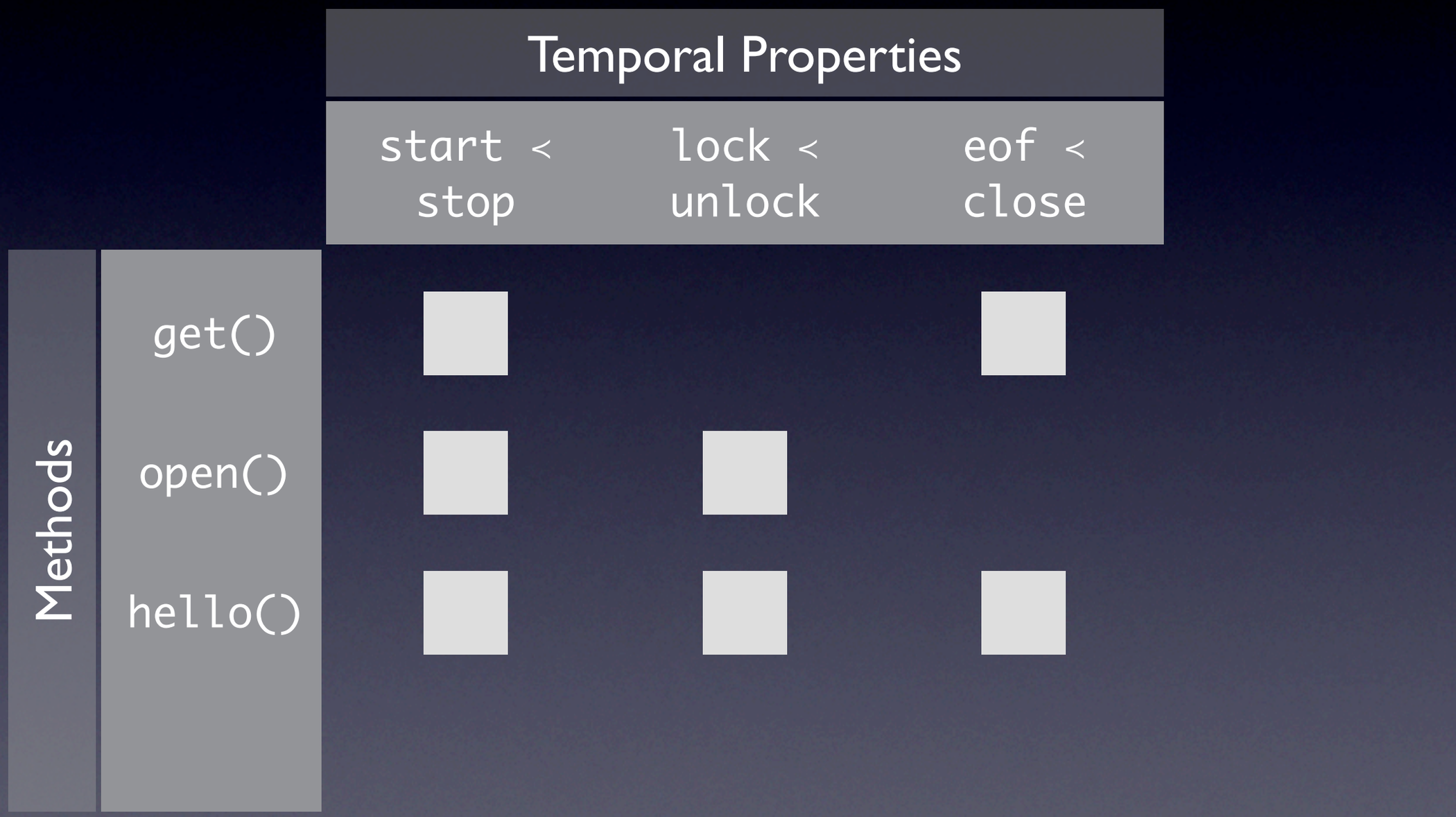

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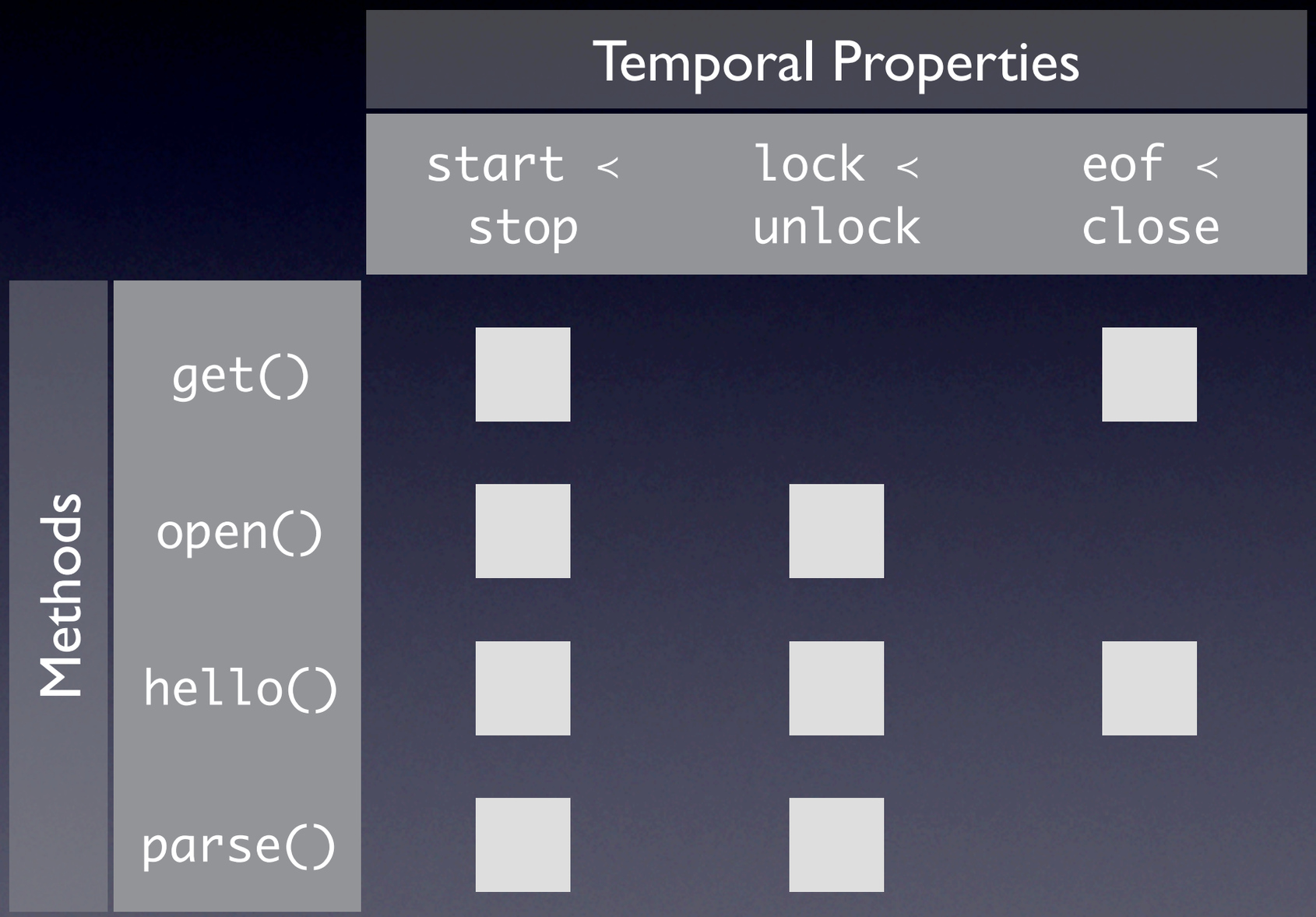

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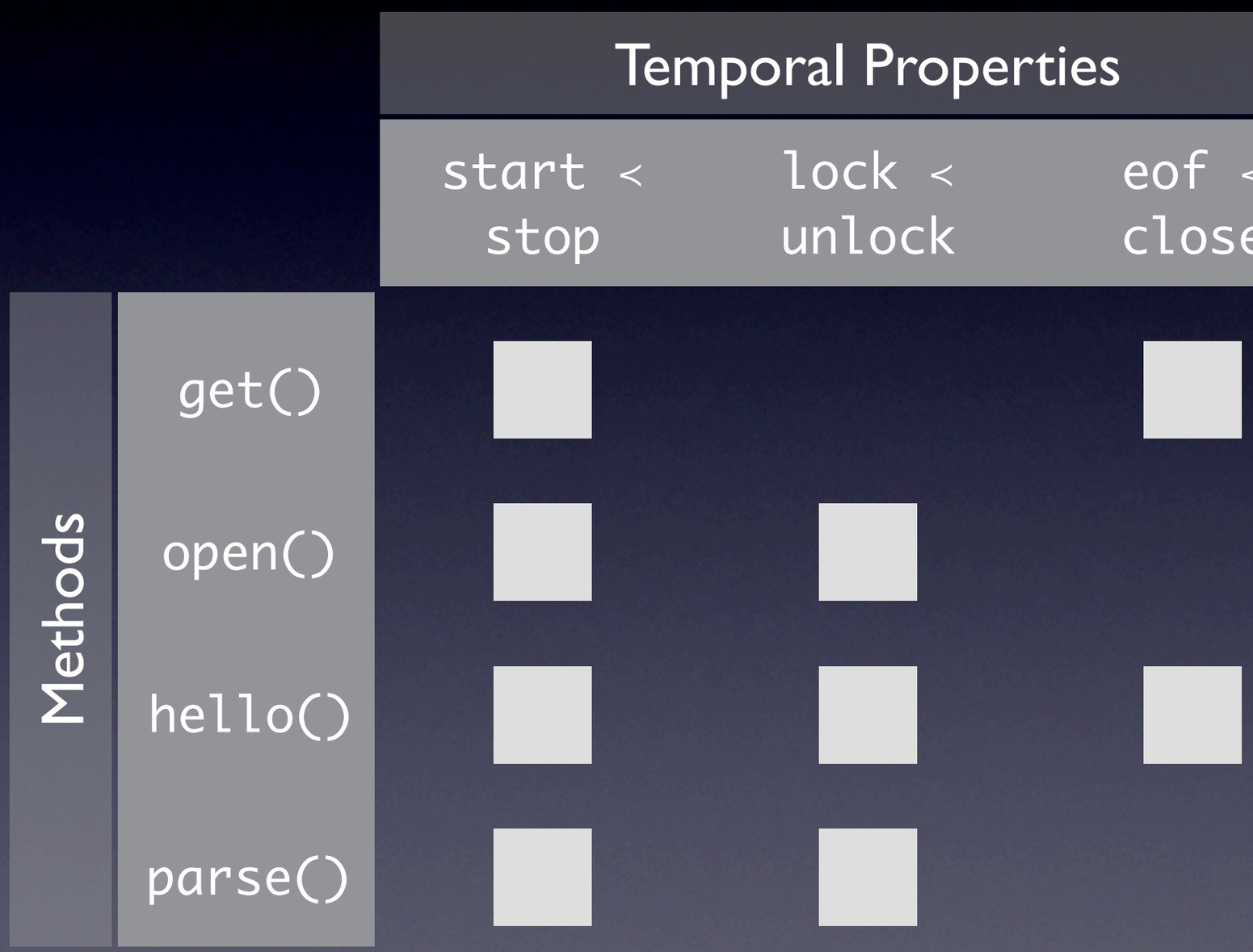

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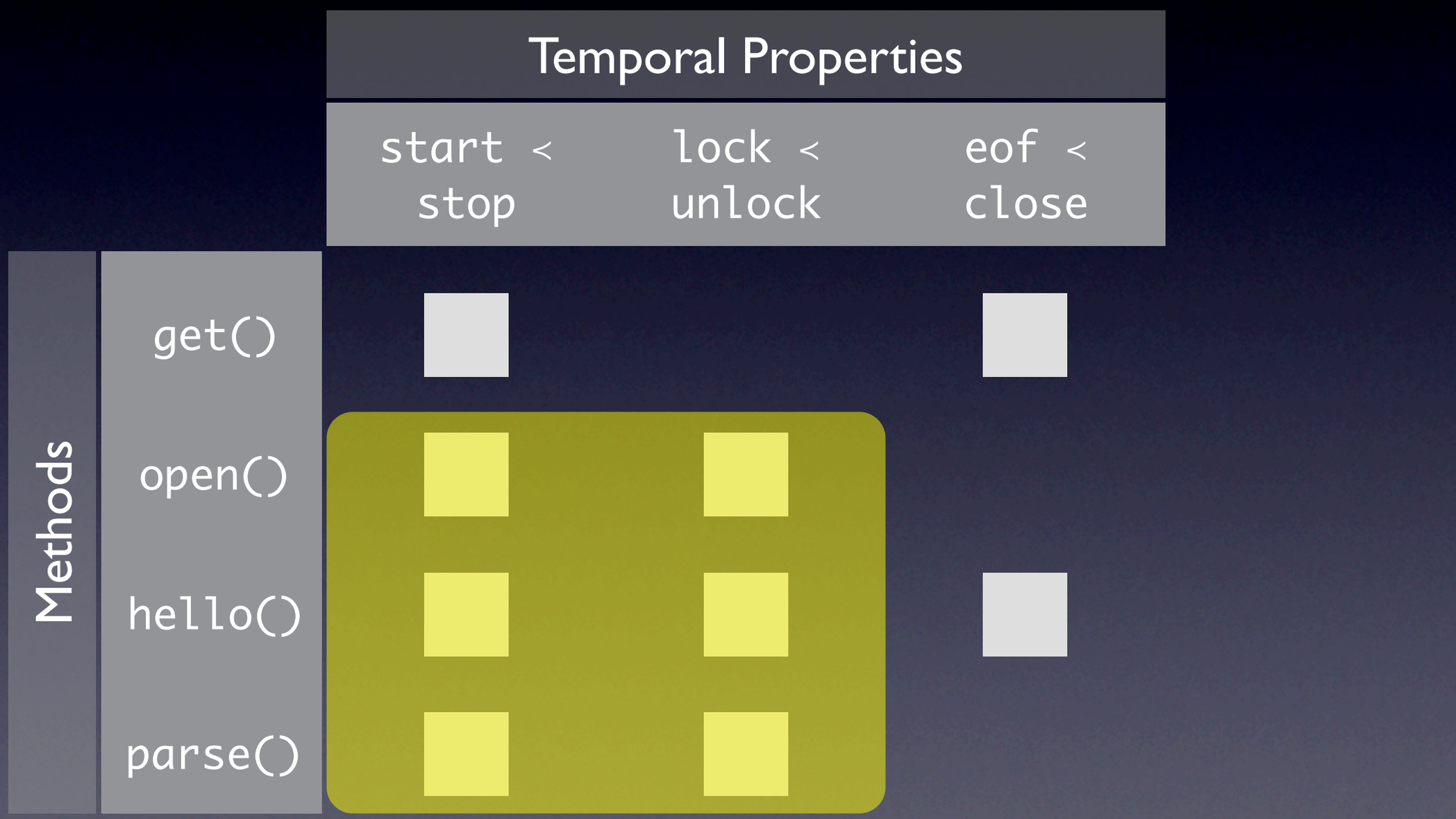

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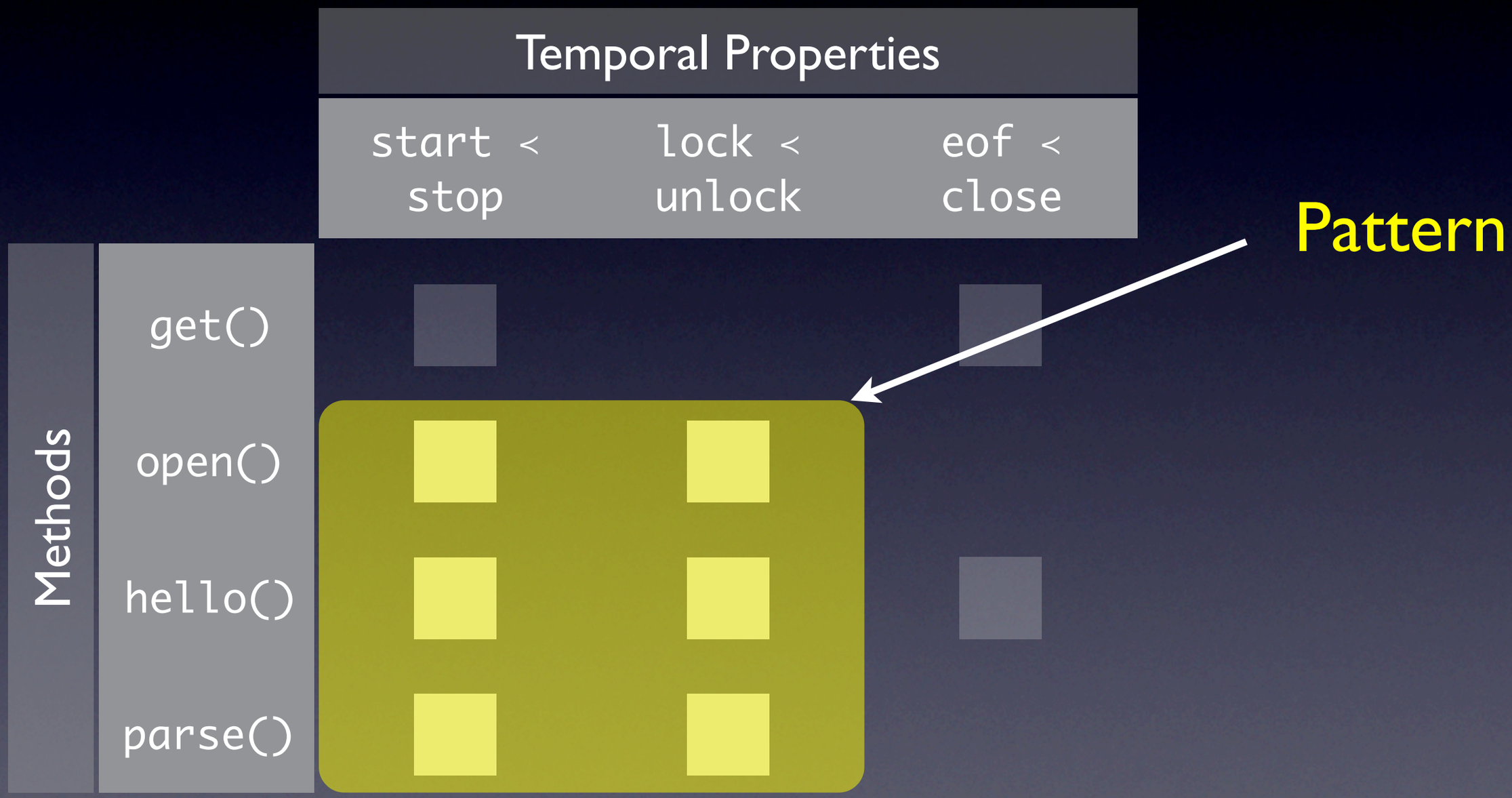

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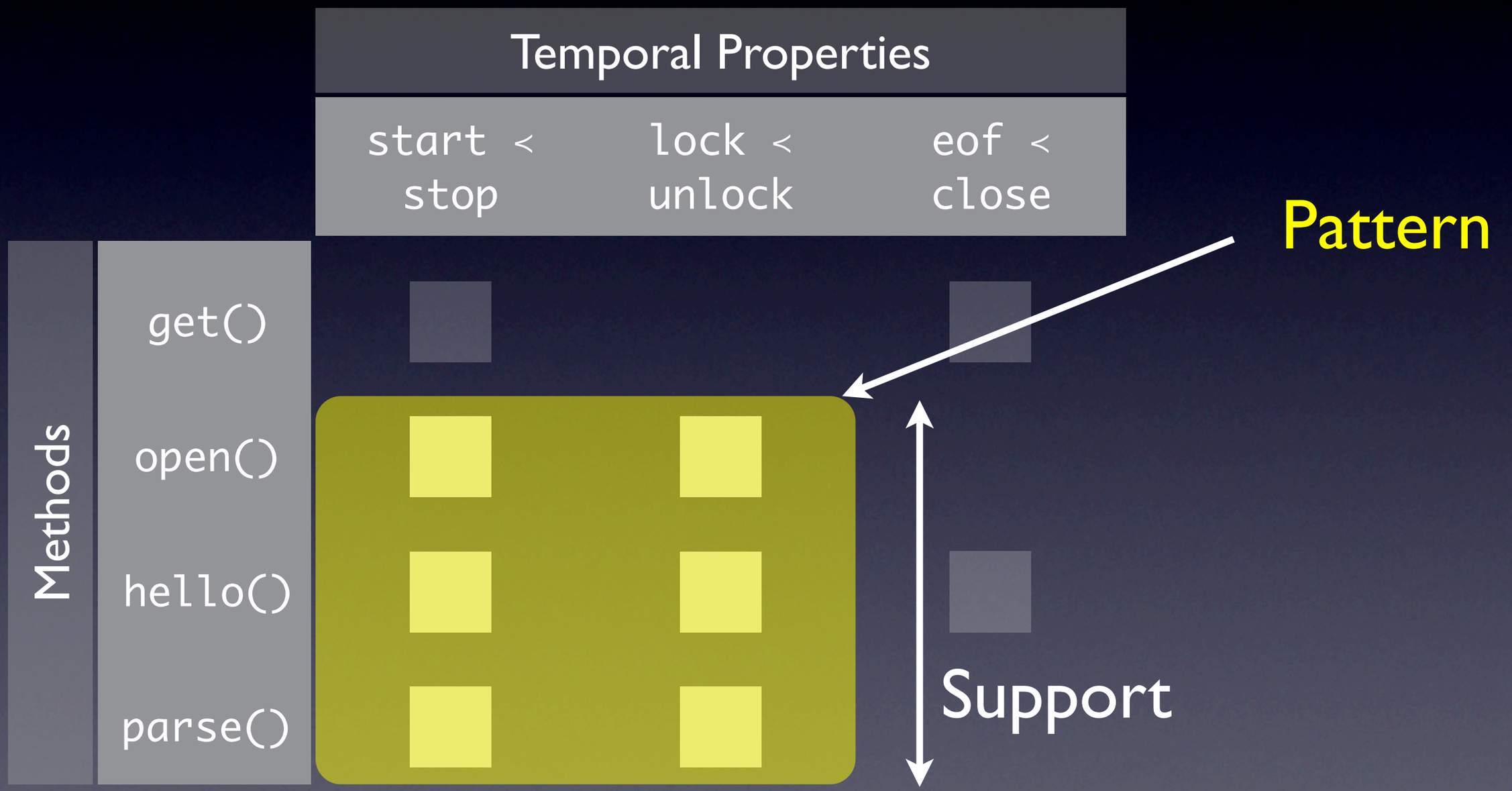
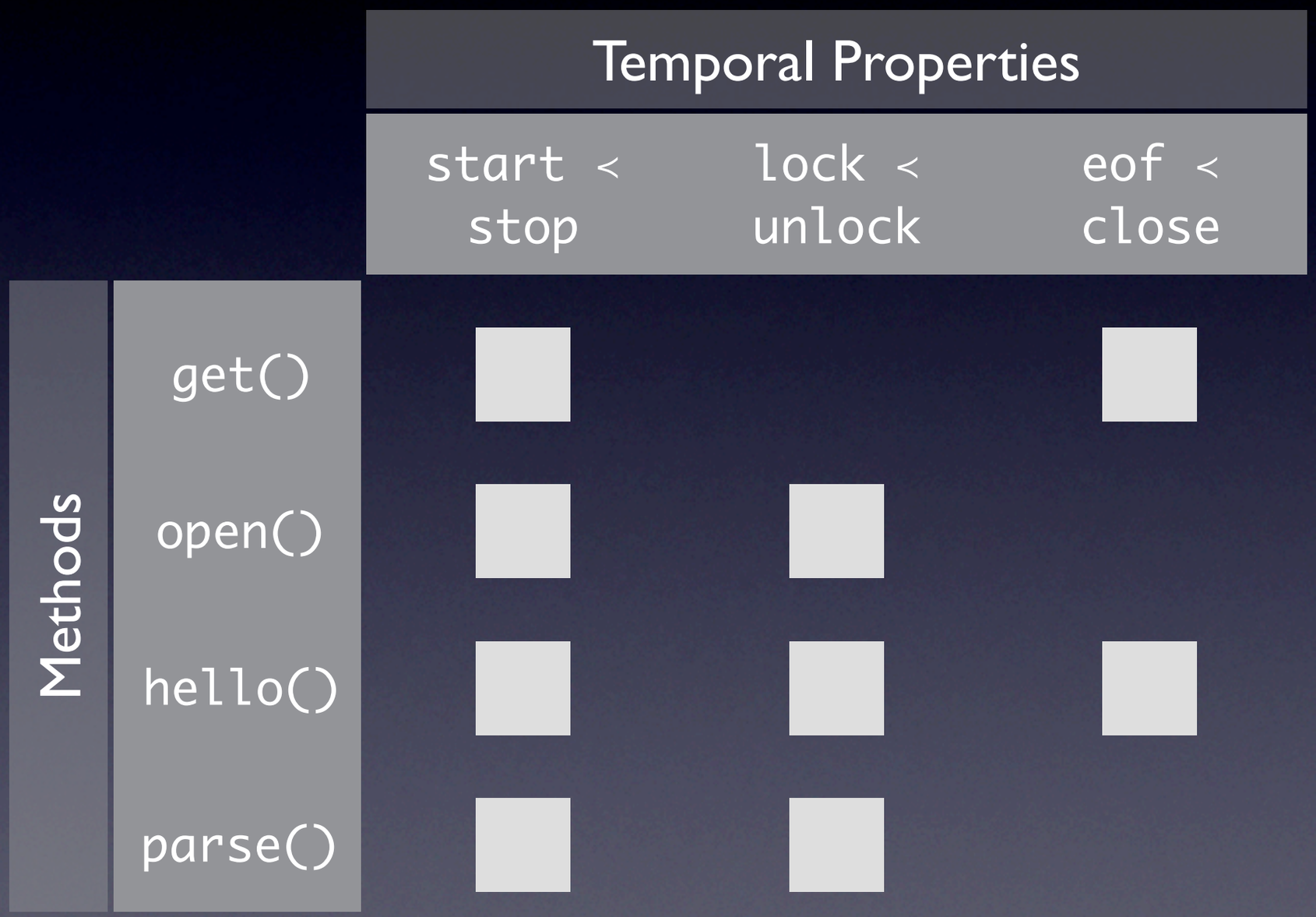


Discovering Anomalies



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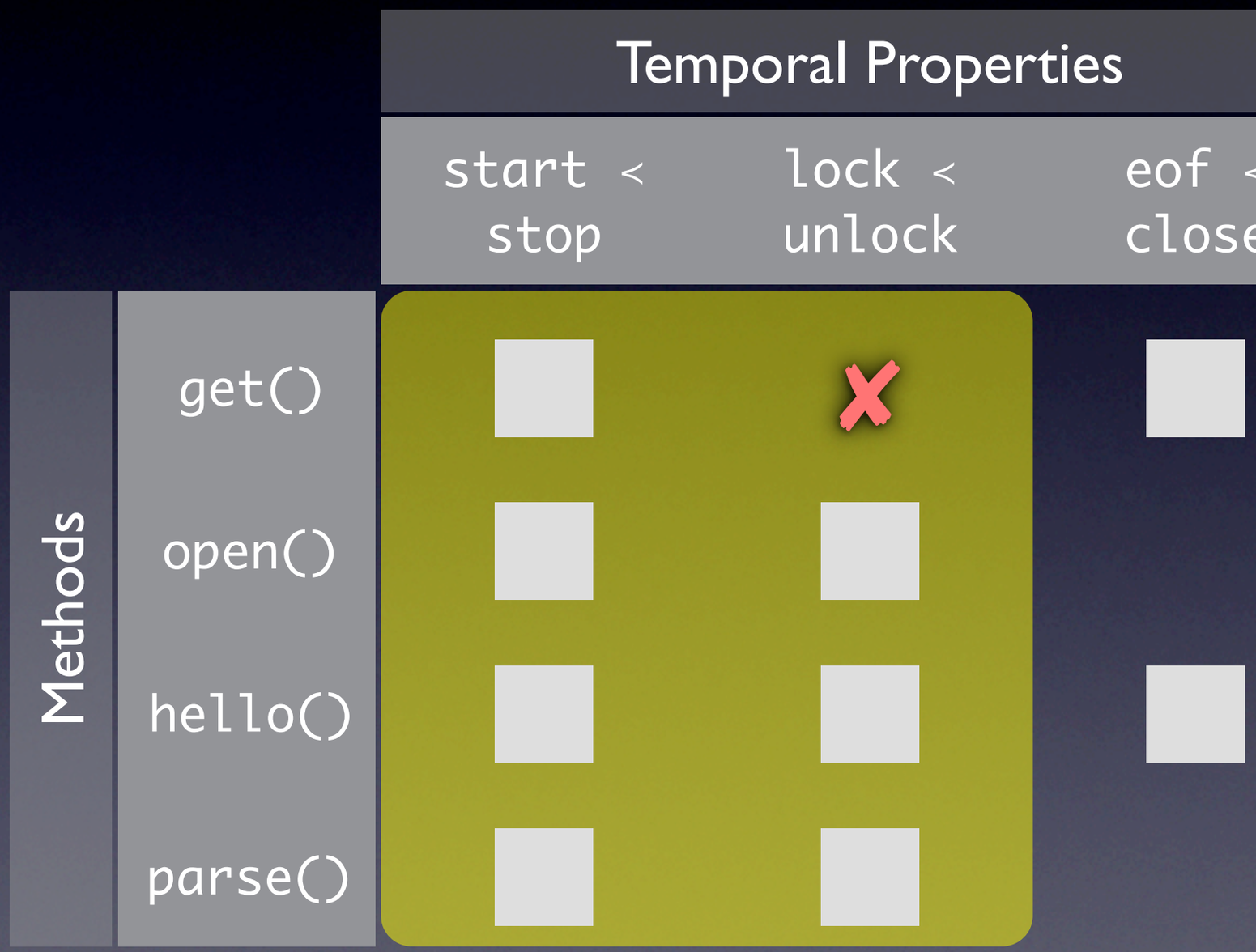

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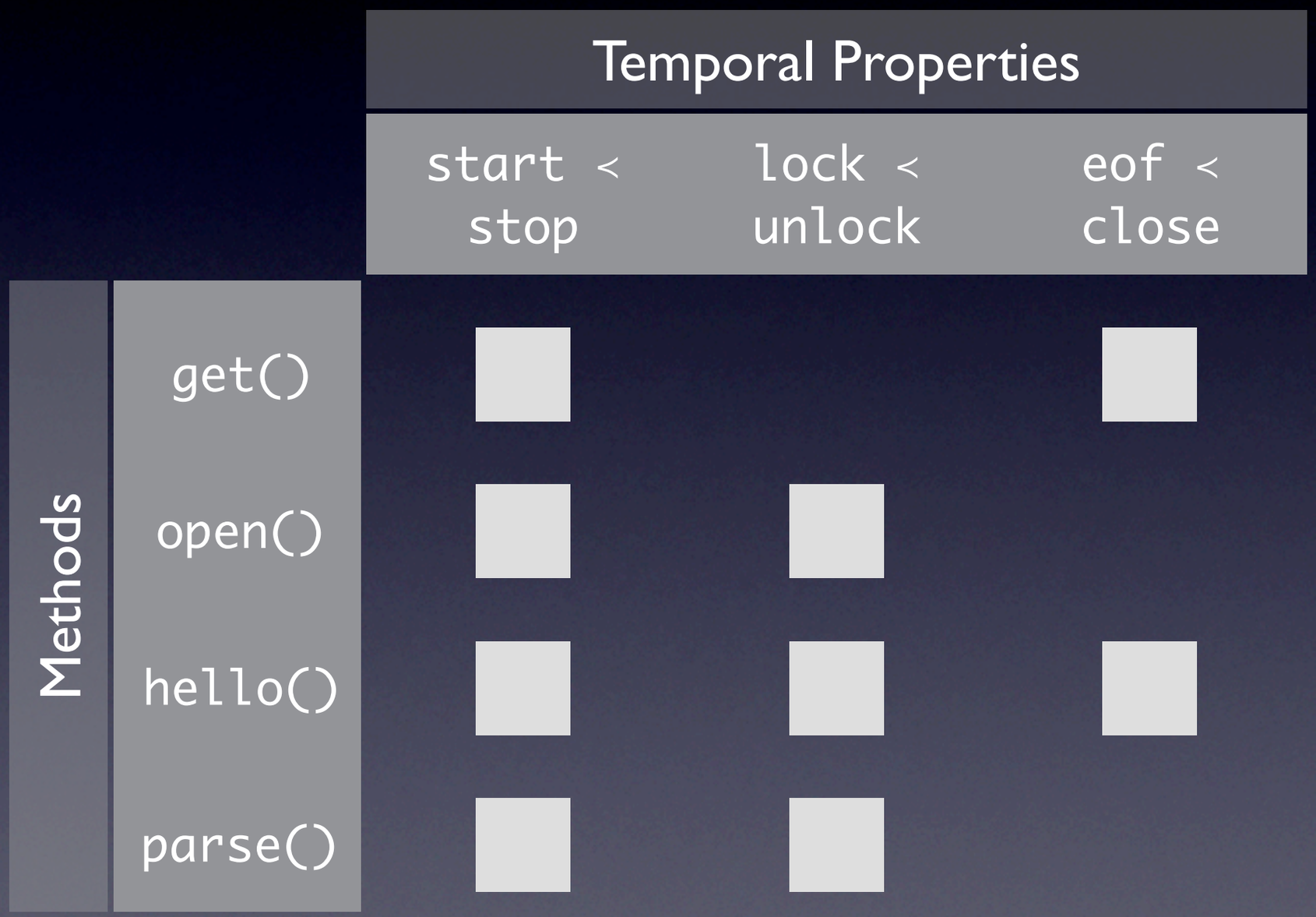

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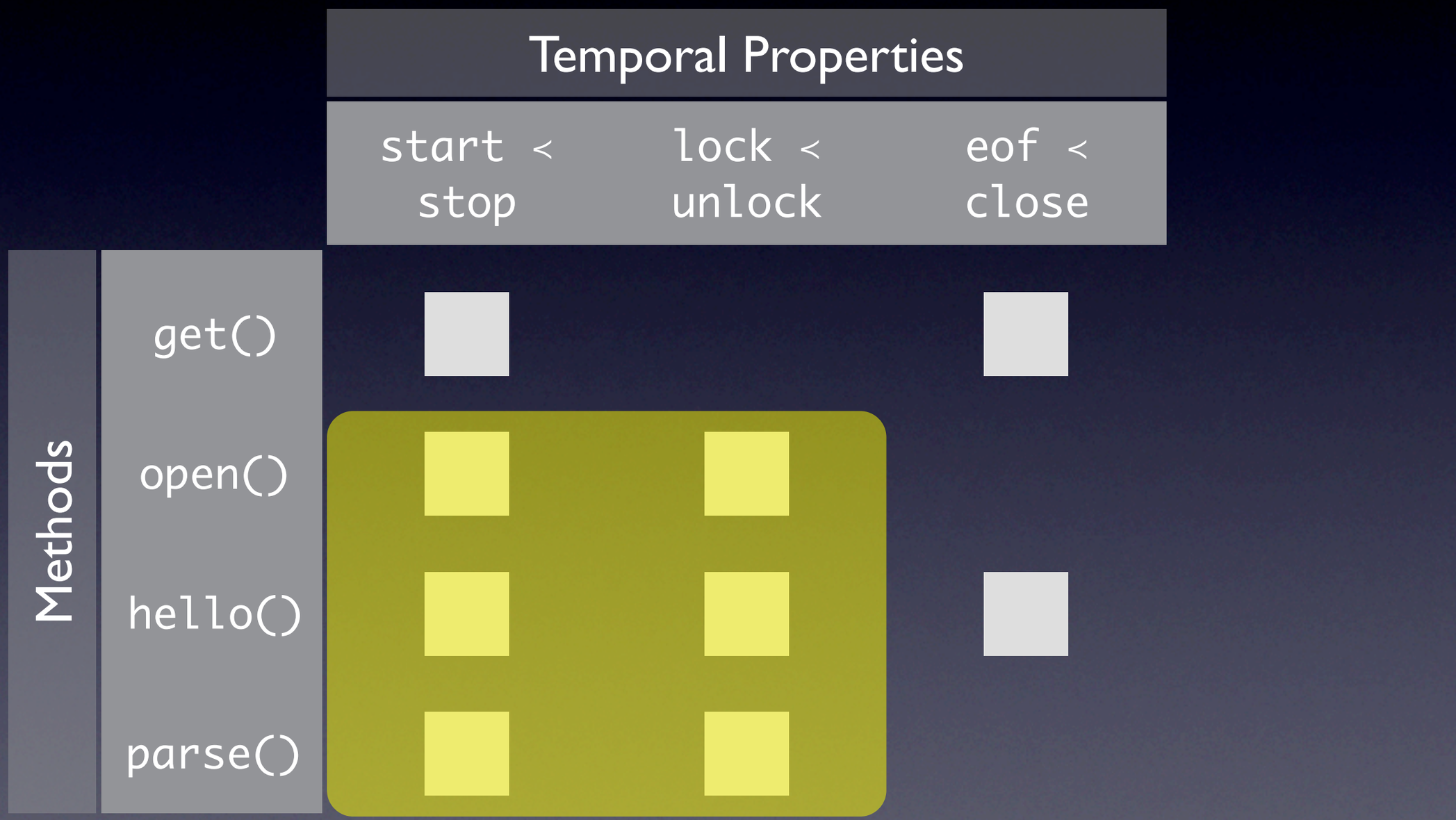

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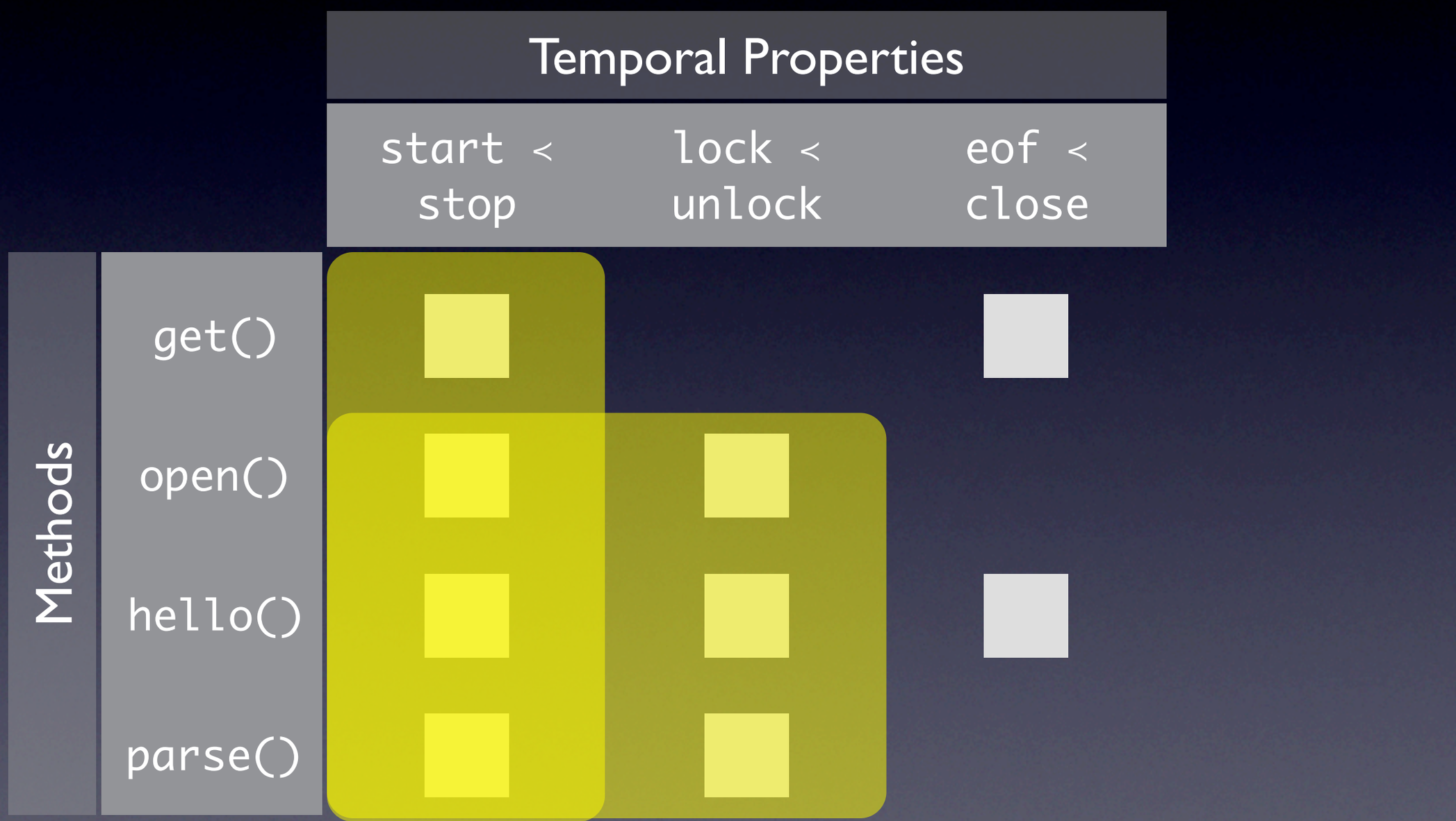

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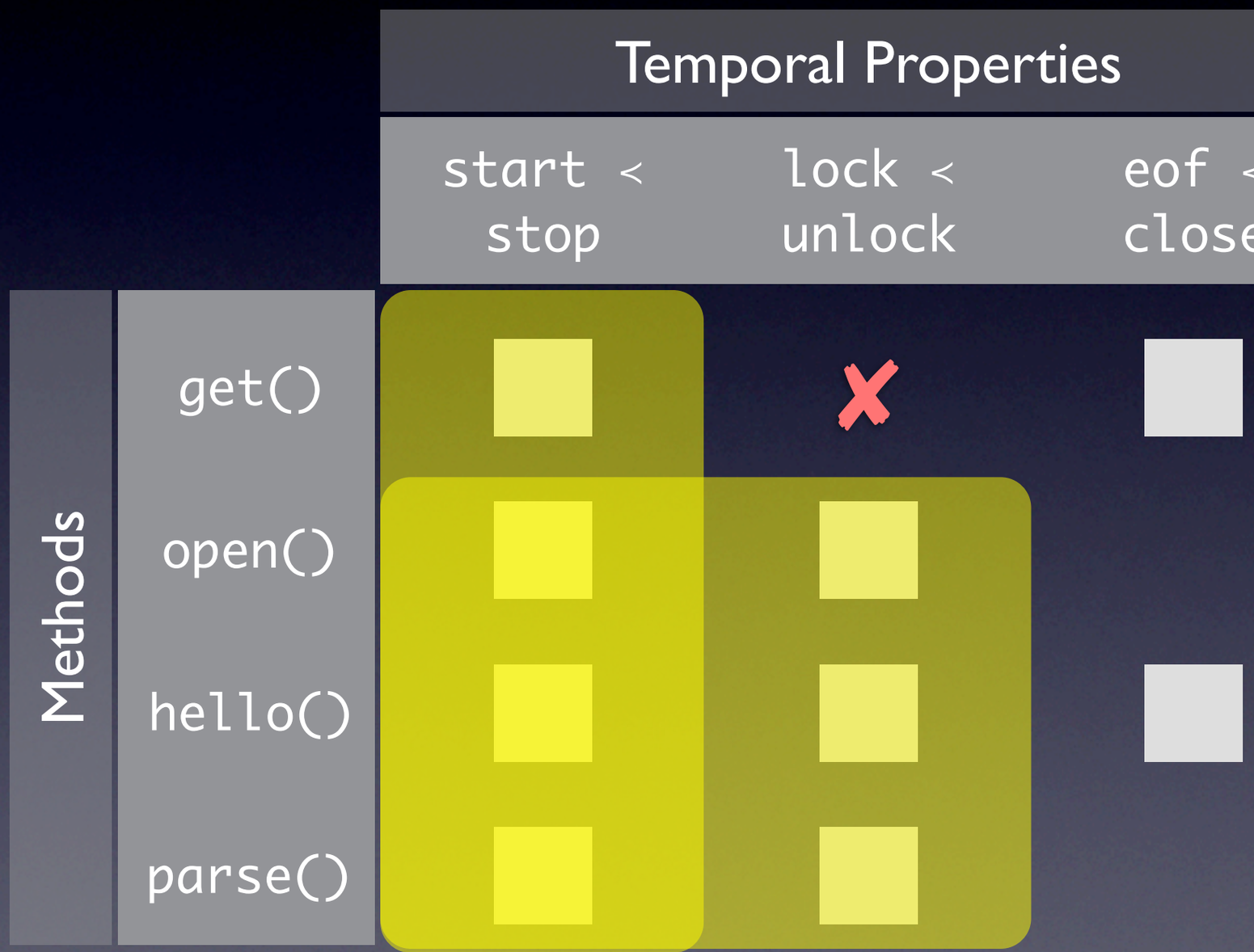

Case Study: AspectJ

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- 300 violations found in 8 minutes

Case Study: AspectJ

- 2,954 classes
- 36,045 methods
- 1,154 methods with OP support ≥ 20
- 300 violations found in 8 minutes
- Examined every single one

A Defect

```
for (Iterator iter = itdFields.iterator();
     iter.hasNext();) {
    ...
    for (Iterator iter2 = worthRetrying.iterator();
         iter.hasNext();) {
        ...
    }
}
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should be iter2

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should be iter2

bug.aj

```
@interface A {}

aspect Test {
  declare @field : @A int var* : @A;
  declare @field : int var* : @A;

  interface Subject {}

  public int Subject.vara;
  public int Subject.varb;
}

class X implements Test.Subject {}
```

Another Defect

```
public void visitNEWARRAY (NEWARRAY o) {
    byte t = o.getTypecode ();
    if (!((t == Constants.T_BOOLEAN) ||
          (t == Constants.T_CHAR) ||
           ...
          (t == Constants.T_LONG))) {
        constraintViolated (o, "(...) '+t+' (...)");
    }
}
```

Another Defect

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        constraintViolated (o, "(...)'+t+'(...)");
    }
}
```

should be double quotes

A False Positive

```
Name internalNewName (String[] identifiers)
    ...
    for (int i = 1; i < count; i++) {
        SimpleName name = new SimpleName(this);
        name.internalSetIdentifier(identifiers[i]);
        ...
    }
    ...
}
```

A False Positive

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Name internalNewName (String[] identifiers)
    ...
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        ...
    }
    ...
}
```

should stay as is

A Code Smell

```
public String getRetentionPolicy ()
{
   ...
   for (Iterator it = ...; it.hasNext();)
   {
        ... = it.next();
        ...
        return retentionPolicy;
   }
   ...
}
```

A Code Smell

```
public String getRetentionPolicy ()
{
   ...
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   {
      ... = it.next();
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      return retentionPolicy;
   }
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should be fixed

AspectJ

Defects Code smells False positives

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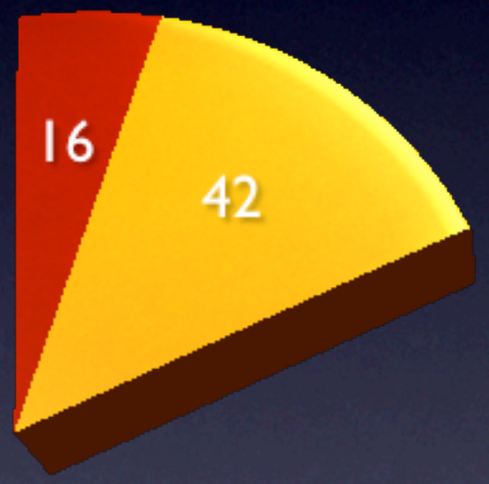
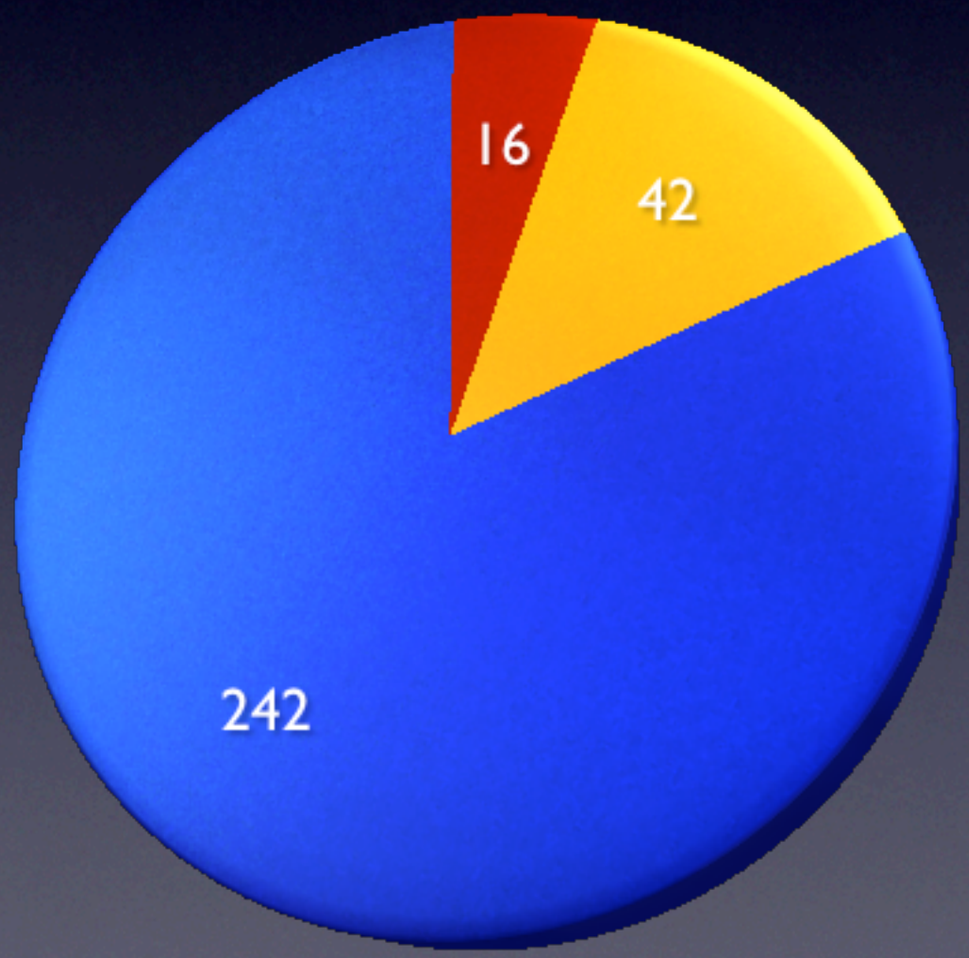


AspectJ

Defects Code smells False positives



More Results

Program	# Violations		# Defects	# Code smells	# False positives	Efficiency
	Total	Investigated				
Act-Rbot 0.8.2	25	25	2	13	10	**60%**
Apache Tomcat 6.0.16	55	55	0	9	46	**16%**
ArgoUML 0.24	305	28	0	12	16	**43%**
AspectJ 1.5.3	300	300	16	42	242	**19%**
Azureus 2.5.0.0	315	85	1	26	58	**32%**
Columba 1.2	57	57	4	15	38	**33%**
jEdit 4.2	11	11	0	4	7	**36%**
	1,068	**562**	**23**	**121**	**417**	**26%**

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  in particular in presence of low support
- Early programmer support
  in terms of recommendations and documentation

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- ★ Fully automatic
- ★ Found dozens of verified defects