Smaller Models

EECS 4315

www.cse.yorku.ca/course/4315/

Counter Class

```
public class Counter extends Thread
{
  private int value;

  public Counter()
  {
    this.value = 0;
  }

  ...

 }
```

Counter Class

```
public void run()
{
  this.value++;
}
```

```
0: aload_0
1: dup
2: getfield
5: iconst_1
6: iadd
7: putfield
10: return
```

Main Class

```
public class Main
{
  public static void main(String[] args)
  {
    Counter one = new Counter();
    Counter two = new Counter();
    one.start();
    two.start();
  }
}
```

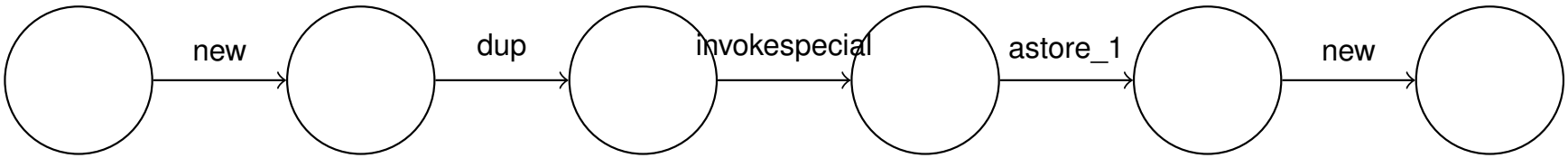
```
0: new           11: dup           20: aload_2
3: dup           12: invokespecial 21: invokevirt
4: invokespecial 15: astore_2      24: return
7: astore_1      16: aload_1
8: new           17: invokevirtual
```

State-Transition Diagram

Question

Draw the corresponding state-transition diagram.

State-Transition Diagram



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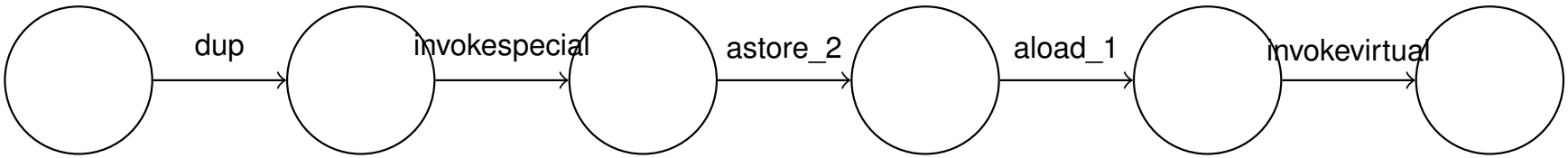

A Smaller Model

Combine the first ten transitions into one.

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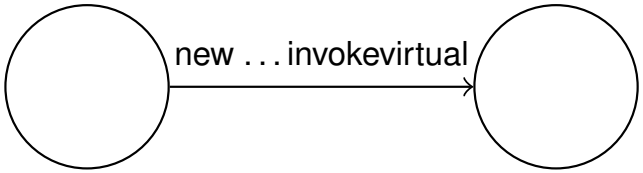
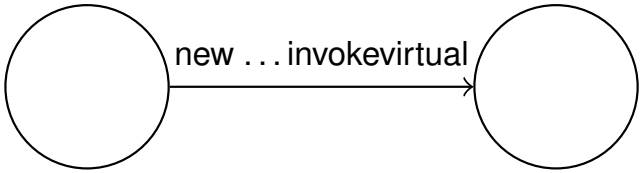


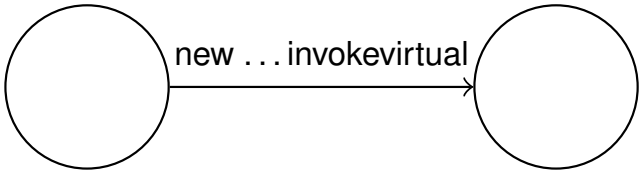
A Smaller Model

Combine the first ten transitions into one.



The actions of the labelled transition system are sequences of bytecode instructions.

State-Transition Diagram



Next instructions for the main thread:

```
20: aload_2
21: invokevirtual
24: return
```

Next instructions for the thread `one`:

```
0: aload_0
1: dup
2: getfield
5: iconst_1
6: iadd
7: putfield
```

State-Transition Diagram

Question

Can the bytecode instructions corresponding to the `run` invocation be modelled as a single transition?

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Yes.

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Why?

State-Transition Diagram

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Can the bytecode instructions corresponding to the `run` invocation be modelled as a single transition?

Answer

Yes.

Question

Why?

Answer

Because the execution of this method does not impact the other threads.

Combining Bytecode Instructions

- We combine the first ten bytecode instructions since there is only one thread.
- We combine the bytecode instructions corresponding to the `run` invocation because those do not impact the other threads.

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General idea

Combine those bytecode instructions that do not impact other threads.

Combining Bytecode Instructions

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Given all the bytecode instructions, determine for a specific instruction whether it impacts other threads.

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Impossible!

Proving Impossibility

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Which other problems cannot be solved?

Proving Impossibility

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Which other problems cannot be solved?

Answer

The halting problem: given code and input for that code, determine whether the code terminates.

Proving Impossibility

Problem

Given all the bytecode instructions, determine for a specific instruction whether it impacts other threads.

Question

Prove that the problem cannot be solved.

Combining Bytecode Instructions

General idea

Combine those bytecode instructions for which we can prove that they do not impact other threads.

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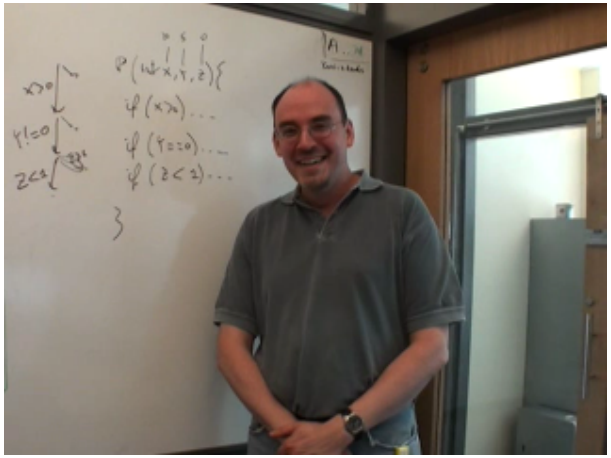
Examples of invisible actions

- Reading or writing an attribute that can be proved to be not shared.
- Reading or writing a local variable.
- ...

Patrice Godefroid

- Ph.D. degree in Computer Science from the University of Liege, Belgium
- Worked at Bell Laboratories.
- Currently at Microsoft Research.



Source: Patrice Godefroid

State Space Diagrams

Java PathFinder can generate state space diagrams in the form of dot files.

```
Target=Main
classpath=.
listener=gov.nasa.jpf.listener.SimpleDot
```

State Space Diagrams

Java PathFinder can generate state space diagrams in the form of dot files.

```
Target=Main
classpath=.
listener=gov.nasa.jpf.listener.StateSpaceDot
```

Semaphore

A semaphore is a nonnegative integer, say s, with two atomic operations:

- V(s): increment s by 1.
- P(s): decrement s by 1 as soon as the result is nonnegative.

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The Java package `java.util.concurrent` contains the class `Semaphore`. The operations V and P are represented by the methods `release` and `acquire`.