Model Checking

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Lecture #9 out of 10
90 minutes

All videos are in this YouTube playlist.

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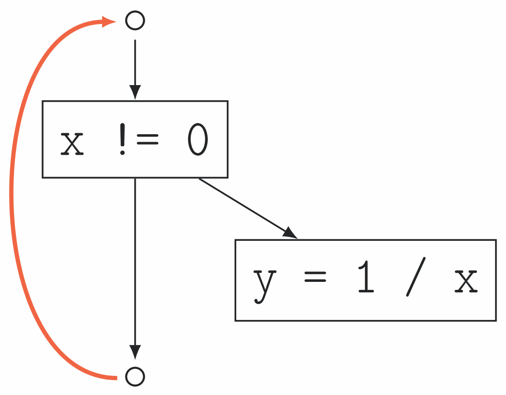
Chapter #1:

Motivating Example

Div by Zero

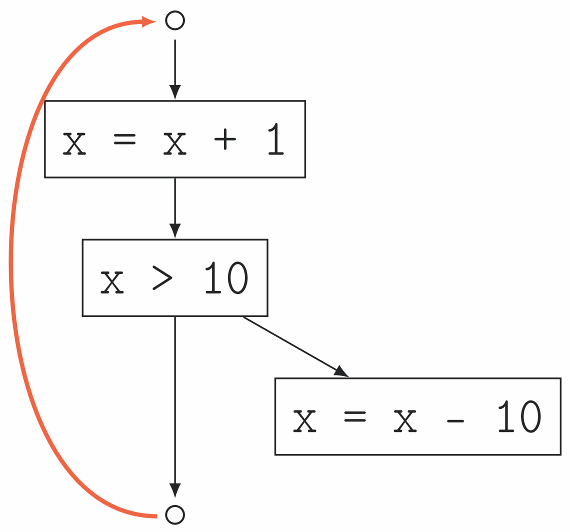
```
// Process no. 1:

extern int x;
extern double y;
int measure() {
  if (x != 0) {
    y = 1.0 / x;
  }
}
```



```
// Process no. 2:

extern int x;
void roll() {
  x += 1;
  if (x > 10) {
    x -= 10;
  }
}
```



Can we detect “division by zero” using symbolic execution? Is “division by zero” the only error here?

ProMeLa (Process Meta Language)

```
extern int x;
extern double y;
int measure() {
  if (x != 0) {
    y = 1.0 / x;
  }
}
void roll() {
  x += 1;
  if (x > 10) {
    x -= 10;
  }
}
```

```
int x; bool dbz;
active proctype measure() {
  do :: true ->
    if
    :: (x != 0) -> dbz = (x == 0)
    :: skip
    fi
  od
}
active proctype roll() {
  do :: true ->
    x = x + 1;
    if
    :: x > 10 -> x = x - 10
    :: skip
    fi
  od
}
```

SPIN (Simple ProMeLa Interpreter)

```
int x; bool dbz;
active proctype measure() {
  do :: true ->
    if
    :: (x != 0) -> dbz = (x == 0)
    :: skip
    fi
  od
}
active proctype roll() {
  do :: true ->
    x = x + 1;
    if
    :: x > 10 -> x = x - 10
    :: skip
    fi;
    printf("x = %d\n", x);
  od
}
```

```
$ spin main.pml | head
          x = 1
          x = 2
          x = 3
          x = 4
          x = 5
          x = 6
          x = 7
          x = 8
          x = 9
          x = 10
$ spin main.pml | tail
...
```

Just checkout this repo and run `make`, the `spin` binary will be compiled.

Monitoring Process

```
int x; bool dbz;
active proctype measure() {
  do :: true ->
    if
    :: (x != 0) -> dbz = (x == 0)
    :: skip
    fi
  od
}
active[2] proctype roll() {
  do :: true ->
    x = x + 1;
    if
    :: x > 10 -> x = x - 10
    :: skip
    fi
  od
}
```

```
active proctype monitor() {
  do :: true ->
    assert(!dbz);
    assert(x >= 0);
  od
}
```

Pay attention to the `[2]` suffix after the `active` keyword. It tells SPIN to start two instances of the `roll` process.

Model-less Checking

Fail on Assertion

```
int x; bool dbz;
active proctype measure() {
  do :: true ->
    if
    :: (x != 0) -> dbz = (x == 0)
    :: skip
    fi
  od }
active[2] proctype roll() {
  do :: true ->
    x = x + 1;
    if
    :: x > 10 -> x = x - 10
    :: skip
    fi
  od }
active proctype monitor() {
  do :: true -> assert(!dbz); assert(x >= 0); od
}
```

```
$ spin main.pml
spin: main.pml:22, Error: assertion violated
spin: text of failed assertion: assert((x>=0))
#processes: 4
    x = -9
    dbz = 0
584:  proc  3 (monitor:1) main.pml:22 (state 3)
584:  proc  2 (roll:1) main.pml:17 (state 7)
584:  proc  1 (roll:1) main.pml:18 (state 9)
584:  proc  0 (measure:1) main.pml:9 (state 8)
4 processes created
```

Chapter #2:

Model-less Checking

Java PathFinder

Further Reading/Watching

Introduction lecture by Joost-Pieter Katoen

A Primer on Model Checking by Mordechai Ben-Ari