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Softwaretechnik

http://proglang.informatik.uni-freiburg.de/teaching/swt/2013/

Exercise Sheet 10

Exercise 1

Consider the Java class *IntegerInterval* that represents an interval of integer values.

```
class IntegerInterval {
   int getLowerBound() { ... }
   int getUpperBound() { ... }
   void doSomething (int i) { ... }
}
```

The methods of the class *IntegerInterval* have the following specifications:

- getLowerBound(): **@pre:** *true*; **@post:** $0 <= getLowerBound() < getUpperBound()$
- getUpperBound(): **@pre:** *true*; **@post:** $0 <= getLowerBound() < getUpperBound()$
- doSomething (int i): **@pre:** $getLowerBound() <= i < getUpperBound()$; **@post:** *true*;

Additionally, consider the class *NegativeIntegerInterval* that extends *IntegerInterval* as follows.

```
class NegativeIntegerInterval extends IntegerInterval {
   void doSomething (int i) {
  super.doSomething (-i);
   }
}
```

The method *doSomething* in the class *NegativeIntegerInterval* has the following specification:

- doSomething(int i): **@pre:** $this.getLowerBound() <= -i < this.getUpperBound()$; **@post:** *true*

Consider the class *Run* that uses the *NegativeIntegerInterval* class as follows.

```
class Run {
   public static void main (String[] a) {
  IntegerInterval c = new NegativeIntegerInterval();
  c.doSomething(-42);
  c.doSomething(42);
   }
}
```

Analyze the code and identify whether contract violations may occur during run-time.

Exercise 2

Let $n, m \in \mathbb{N}_0$. Are the following Hoare Triples valid? Provide a proof in the Hoare Calculus and explain in each proof step which axiom or rule has been applied.

1. $\{m = 2 \cdot n + 1\}\ n = 2 \cdot n;\ \{m = n + 1\}$
2. $\{m \geq n\}\ if(m > n)\ n = n + 1\ else\ m = m + 1\ \{m \geq n\}$
3. $\{m = n\}\ while(m \geq n)\ m = m + 1\ \{m = m + n\}$

Exercise 3

Consider the following program P:

```
m = 0;
while (x >= y) {
   m = m + 1;
   x = x - y;
}
```

Let $x, y, m \in \mathbb{N}_0$. Write down the basic paths and the verification conditions for the Hoare Triple

$$\{x \geq 0\ \wedge\ y > 0\ \wedge\ x_0 = x\}\ P\ \{m = x_0/y\}$$

Compute the weakest preconditions and conclude if the program is correct with respect to its specification or not. Remember: x/y stands for integer division.

Exercise 4

Consider the following program P:

```
m = 0;
while (x >= y) {
   m = m + 1;
   x = x - y;
}
```

Let $x, y, m \in \mathbb{N}_0$. Prove that the Hoare Triple

$$\{x \geq 0\ \wedge\ y > 0\ \wedge\ x_0 = x\}\ P\ \{m = x_0/y\}$$

is valid. Therefore, find a suitable loop invariant for the while loop in P and give a proof in the Hoare Calculus. Remember: x/y stands for integer division.