

Exercise Sheet 8

Due date: December 20th. You can hand in your solutions at the start of the exercise class.

Remark: We started uploading solutions to previous exercises. The password to access the solutions on our website will be announced in the next exercise class.

Hint: Notation is as in the lecture. That is, c is a program, b a Boolean expression, σ a program state, etc.

Task 1: Timed Correctness (5 Points)

Use the Hoare calculus for times correctness to prove that the following programming has a runtime that is at most quadratic in x .

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

Task 2: Scoping (2 Points)

Give the value of variable x in the final state of each of the following programs in case of both static and dynamic scoping.

<i>a)</i>	<i>b)</i>	<i>c)</i>	<i>d)</i>
$x := 3;$	$x := 3;$		begin
begin	begin	begin	var $x;$
var $x;$	var $x;$	var $x;$	proc P is $x := 1$ end;
$x := 2;$	$x := 2;$	proc P is $y := x$ end;	proc Q is call P end;
$y := x;$	$y := x;$	begin	begin
begin	begin	var $x;$	var $x;$
var $x;$	var $x; \text{ var } y;$	$x := 2;$	proc P is $x := 2$ end;
$x := 1;$	$x := 1;$	call $P;$	$x := 3;$
$y := x;$	$y := x;$	end	call $Q;$
end;	end;	end	$y := x;$
end	end		end
			end

Task 3: Operational Semantics of Procedure Calls (3 Points)

A naive version of the operational semantics of procedure calls might be defined as follows:

$$\frac{(\rho, \pi) \vdash \langle c, \sigma \rangle \rightarrow \sigma' \quad \pi(P) = (c, \rho, \pi)}{(\rho, \pi) \vdash \langle \text{call } P, \sigma \rangle \rightarrow \sigma'}$$

Construct a program c with procedures that illustrates the difference between the above rule and the call-rule from the lecture (Definition 14.2).

Validate your claim by constructing two different derivation trees (one using the above rule, one using the rule from the lecture) for c and a suitable initial program state.