Exercise Sheet 9

Due date: July 5th. Please hand in your solutions at the start of the exercise class.

Task 1: Procedures and Scoping (30)

Consider the following program c:

$$\begin{array}{l}\mathsf{begin\ var}\ x;\ \mathsf{proc}\ P\ \mathsf{is}\ x := 0\ \mathsf{end};\\ \quad x := 7;\ \mathsf{begin\ var}\ x;\ x := 5; \mathsf{call}\ P\ \mathsf{end}\\ \mathsf{end}\end{array}$$

Determine $\mathfrak{C}''[\![c]\!]\,\rho\,\pi\,\sigma$, where $\sigma(l) \neq \bot$ for all $l < 12$ and $\sigma(l) = \bot$ for all $l \geq 12$.

Task 2: Correctness of Recursive Procedures (30)

Let P be the following procedure:

$$\begin{array}{l}\mathsf{proc}\ P\ \mathsf{is}\\ \quad \mathsf{if}\ x = 1\ \mathsf{then}\\ \quad\quad y := 2\\ \quad \mathsf{else}\\ \quad\quad x := x - 1;\\ \quad\quad \mathsf{call}\ P;\\ \quad\quad y := 2 \cdot y\\ \quad \mathsf{end}\\ \mathsf{end}\end{array}$$

Prove in Hoare logic:

$$\vdash \{i = 2^x\} y := 1; \mathsf{call}\ P \{y = i\}$$

Task 3: Semantics of Procedures with Parameters (40)

In this task, all procedures are assumed to be non-recursive. We modify procedure declarations in order to incorporate a *call-by-value* parameter:

$$p ::= \quad \mathsf{proc}\ P(x)\ \mathsf{is}\ c\ \mathsf{end};\ p \ \mid\ \epsilon$$

(a) Modify the type of procedure environments accordingly.

(b) Modify function upd_p accordingly.

(c) Define $\mathfrak{C}''[\![\mathsf{call}\ P(x)]\!]\,\rho\,\pi\,\sigma$.