Assignment 6: Abstract Procedures

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1 Problem 1

1.1 Part 1

$$swap := \langle f :: \mathbb{T}x\mathbb{T} \to \mathbb{T}x\mathbb{T}; \{f(l(a), l(b) = \langle l(b), l(a)\rangle\}\rangle$$

1.2 Part 2

$and := \langle f :: \mathbb{B}x\mathbb{B} \to \mathbb{B}; \{f(T,T) = T, f(F,a) = F\}\rangle$
$if := \langle f :: \mathbb{B}x\mathbb{T}x\mathbb{T} \to \mathbb{T}; \{f(T,a,b) = a, f(F,a,b) = b\}\rangle$
$cmp := \langle f :: \mathbb{T}x\mathbb{T} \to \mathbb{B};$
$f(nil,t) = T, f(p(a),p(b)) = f(a,b), f(c(a),c(b)) = f(a,b), f(m(a),m(b)) = f(a,b), f(a,b) = F\}\rangle$
$include := \langle f :: \mathbb{T}x\mathbb{T} \to \mathbb{B}; \{$
$f(t,nil) = F, f(a,l(t)) = f(a,t),$
$f(a,m(t)) = if(cmp(a,m(t)),T,f(a,t)),$
$f(a,c(t)) = if(cmp(a,c(t)),T,f(a,t)),$
$f(a,p(t)) = if(cmp(a,c(t)),T,f(a,t))$
$\}\rangle$

1.3 Part 3

$$\begin{array}{l} equal := \langle f :: \mathbb{T}x\mathbb{T} \to \mathbb{B}; \{ \\ f(nil,t) = T, f(p(a),p(b)) = f(a,b), \\ f(c(a),c(b)) = f(a,b), \\ f(m(a),m(b)) = f(a,b), \\ f(l(a),l(b)) = f(a,b), f(a,b) = F \\ \}\rangle \end{array} \quad ll$$

1.4 Part 4

$$\begin{array}{l} samelen := \langle f :: \mathbb{T}x\mathbb{T} \to \mathbb{B}; \{ \\ f(nil,nil) = T, f(a,b(nil)) = F, \\ f(a(nil),b) = f, f(a(t1),b(t2)) = f(t1,t2) \\ \}\rangle \end{array}$$

Note that here $a, b \in \{l, m, p, c\}$ but where used in a generic way to avoid repeating the same over and over.

1.5 Part 5

$$
\begin{aligned}
&cons := \langle f :: \mathbb{T}x\mathbb{T} \to \mathbb{T}; \{ \\
&\quad f(t, nil) = t, f(nil, t) = t, f(m(a), b) = m(f(a, b)), \\
&\quad f(c(a), b) = c(f(a, b)), f(m(a), b) = m(t(a, b)), \\
&\quad f(l(a), b) = l(cons(a, b)) \\
&\}\rangle \\
&helper := \langle f :: \mathbb{T}x\mathbb{T}x\mathbb{T} \to \mathbb{T}; \{ \\
&\quad f(nil, h, t) = cons(h, t), f(l(a), h, t) = f(a, l(h), t), \\
&\quad f(c(a), h, t) = f(a, h, c(t)), f(m(a), h, t) = f(a, h, m(t)) \\
&\}\rangle \\
&\rho := \langle f :: \mathbb{T} \to \mathbb{T}; \{f(a) = helper(a, nil, nil)\}\rangle
\end{aligned}
$$