x	term variable
f	function declaration?
cnt	program counter
n	index variable
k	index variable

v	::=		values
	|	$\mathbf{c}$	numeric value
	|	$\mathbf{a}$	bytearray
e	::=		expressions
	|	x	variable
	|	$\mathbf{c}$	numeric value
	|	$\mathbf{a}$	bytearray
	|	$x[e]$	array access
	|	$\sim e$	unary operation
	|	$e_1 \oplus e_2$	binary operation
	|	$f(e_1, .., e_n)$	function application
s	::=		statements
	|	$\mathbf{skip}$	skip
	|	$s_1; s_2$	sequence
	|	$\mathbf{def}\, x := e$	variable declaration
	|	$x := e$	variable assignment
	|	$x[e_1] := e_2$	array assignment
	|	$\mathbf{for}\, x\, \mathbf{from}\, v_1\, \mathbf{to}\, v_2 : s$	for loop
	|	$\mathbf{return}\, e$	return statement
$fdef$	::=		function definitions
	|	$fdef\, f(x_1, .., x_n) : s$	
$program$	::=		program
	|	$fdef_1; ..; fdef_n; \mathbf{expose}\, fdef$	list of fdefs
fm	::=		function store
	|	$\emptyset_{fm}$	empty function store
	|	$fm, f(v_1, .., v_k) = s; \mathbf{return}\, e$	define function
m	::=		memory
	|	$\emptyset_m$	empty memory
	|	$m[x := v]$	add/update variable
	|	m/x	remove variable

$\boxed{\{fm, m, cnt\}e \longrightarrow \{fm', m', cnt'\}e'}$ e reduces to e'

$$\frac{\begin{array}{c} m = m'[x := v] \\ cnt' = cnt + 1 \end{array}}{\{fm, m, cnt\}x \longrightarrow \{fm, m, cnt'\}v} \quad \textsc{Exr\_var}$$

$$\frac{\{fm, m, cnt\}e \longrightarrow \{fm, m, cnt'\}e'}{\{fm, m, cnt\}x[e] \longrightarrow \{fm, m, cnt'\}x[e']} \quad \textsc{Exr\_arr\_get\_expr}$$

$$\frac{\begin{array}{l} m = m'[x := \mathbf{a}] \\ v' = a[v] \\ cnt' = cnt + 1 \end{array}}{\{fm, m, cnt\}x[v] \longrightarrow \{fm, m, cnt'\}v'} \quad \textsc{Exr\_arr\_get\_val}$$

$$\frac{\{fm, m, cnt\}e \longrightarrow \{fm, m, cnt'\}e'}{\{fm, m, cnt\} \sim e \longrightarrow \{fm, m, cnt'\} \sim e'} \quad \textsc{Exr\_unop\_expr}$$

$$\frac{\begin{array}{l} v' \equiv [\![\sim v]\!] \\ cnt' = cnt + 1 \end{array}}{\{fm, m, cnt\} \sim v \longrightarrow \{fm, m, cnt'\}v'} \quad \textsc{Exr\_unop\_val}$$

$$\frac{\{fm, m, cnt\}e_1 \longrightarrow \{fm, m, cnt'\}e_1'}{\{fm, m, cnt\}e_1 \oplus e_2 \longrightarrow \{fm, m, cnt'\}e_1' \oplus e_2} \quad \textsc{Exr\_binop\_l}$$

$$\frac{\{fm, m, cnt\}e_2 \longrightarrow \{fm, m, cnt'\}e_2'}{\{fm, m, cnt\}v \oplus e_2 \longrightarrow \{fm, m, cnt'\}v \oplus e_2'} \quad \textsc{Exr\_binop\_r}$$

$$\frac{\begin{array}{l} v_3 \equiv [\![v_1 \oplus v_2]\!] \\ cnt' = cnt + 1 \end{array}}{\{fm, m, cnt\}v_1 \oplus v_2 \longrightarrow \{fm, m, cnt'\}v_3} \quad \textsc{Exr\_binop\_val}$$

$$\frac{\{fm, m, cnt\}e_1 \longrightarrow \{fm, m, cnt'\}e_1'}{\{fm, m, cnt\}f(v_1, .., v_k, e_1, e_2, .., e_n) \longrightarrow \{fm, m, cnt'\}f(v_1, .., v_k, e_1', e_2, .., e_n)} \quad \textsc{Exr\_fn\_expr}$$

$$\frac{fm = fm', f(v_1, .., v_k) = s;\ \mathbf{return}\ e}{\{fm, m, cnt\}f(v_1, .., v_k) \longrightarrow \{fm, m, cnt'\}e} \quad \textsc{Exr\_fn\_call}$$

$\boxed{\{fm, m, cnt\}s \longrightarrow \{fm', m', cnt'\}s'}$ s reduces to s'

$$\frac{}{\{fm, m, cnt\}\mathbf{skip};\ s \longrightarrow \{fm, m, cnt\}s} \quad \textsc{Str\_skip}$$

$$\frac{\{fm, m, cnt\}s_1 \longrightarrow \{fm, m', cnt'\}s_1'}{\{fm, m, cnt\}s_1; s_2 \longrightarrow \{fm, m', cnt'\}s_1'; s_2} \quad \textsc{Str\_seq}$$

$$\frac{\{fm, m, cnt\}e \longrightarrow \{fm, m, cnt'\}e'}{\{fm, m, cnt\}\mathbf{def}\ x := e \longrightarrow \{fm, m, cnt'\}\mathbf{def}\ x := e'} \quad \textsc{Str\_def\_expr}$$

$$\frac{\begin{array}{l} cnt' = cnt + 1 \\ m' = m[x := v] \end{array}}{\{fm, m, cnt\}\mathbf{def}\ x := v \longrightarrow \{fm, m', cnt'\}\mathbf{skip}} \quad \textsc{Str\_def\_val}$$

$$\frac{\{fm, m, cnt\}e \longrightarrow \{fm, m, cnt'\}e'}{\{fm, m, cnt\}x := e \longrightarrow \{fm, m, cnt'\}x := e'} \quad \textsc{Str\_assign\_expr}$$

$$\frac{\begin{array}{l} cnt' = cnt + 1 \\ m' = m[x := v] \end{array}}{\{fm, m, cnt\}x := v \longrightarrow \{fm, m', cnt'\}\mathbf{skip}} \quad \textsc{Str\_assign\_val}$$

$$\frac{\{fm, m, cnt\}e_1 \longrightarrow \{fm, m, cnt'\}e_1'}{\{fm, m, cnt\}x[e_1] := e_2 \longrightarrow \{fm, m, cnt'\}x[e_1'] := e_2} \quad \textsc{Str\_arr\_assign\_expr\_l}$$

$$\frac{\{fm, m, cnt\}e_2 \longrightarrow \{fm, m, cnt'\}e_2'}{\{fm, m, cnt\}x[v_1] := e_2 \longrightarrow \{fm, m, cnt'\}x[v_1] := e_2'} \quad \textsc{Str\_arr\_assign\_expr\_r}$$

$$\frac{\begin{array}{l} cnt' = cnt + 1 \\ m' = m[x := \mathbf{a}] \end{array}}{\{fm, m, cnt\}x[v_1] := v_2 \longrightarrow \{fm, m', cnt'\}\mathbf{skip}} \quad \textsc{Str\_arr\_assign\_val}$$

$$\frac{\begin{array}{l} v_1 < v_2 \\ v_1' = v_1 + 1 \\ \neg(m = m'[x := v']) \\ m'' = m[x := v_1] \end{array}}{\{fm, m, cnt\}\mathbf{for}\, x\, \mathbf{from}\, v_1\, \mathbf{to}\, v_2 : s \longrightarrow \{fm, m'', cnt\}s; \mathbf{for}\, x\, \mathbf{from}\, v_1'\, \mathbf{to}\, v_2 : s} \quad \textsc{Str\_for}$$

$$\frac{\begin{array}{l} v_1 = v_2 \\ m' = m/x \end{array}}{\{fm, m, cnt\}\mathbf{for}\, x\, \mathbf{from}\, v_2\, \mathbf{to}\, v_2 : s \longrightarrow \{fm, m', cnt\}\mathbf{skip}} \quad \textsc{Str\_for\_base}$$

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Definition rules:        21 good    0 bad
Definition rule clauses: 53 good    0 bad
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