CSCE 330 Fall 2000

Homework 3—Denotational Semantics

Wednesday 00/9/20

Exercise 1. Specify mem for a program with identifiers x, y, and z, whose values are 2, 3, and 4, respectively. **Answer:** $\{<x,2>,<y,3>,<z,4>\}$

Exercise 2. In the program of the previous exercise, i is $<1,2,3>$ and o is $<5>$. Specify the state of computation of the program. Call it s_P. **Answer:** $s_P=<\{<x,2>,<y,3>,<z,4>\},<1,2,3>,<5>>$

Exercise 3. What is $dsem_{EX}(x+y,s_P)$? **Answer:** 5

Exercise 4. What is $dsem_{EX}(w,s_P)$? **Answer:** error

Exercise 5. What is $dsem_{AS}(x:=x+y,s_P)$? **Answer:** $<\{<x,5>,<y,3>,<z,4>\},<1,2,3>,<5>>$

Exercise 6. What is $dsem_{AS}(x:=x+w,s_P)$? **Answer:** error

Exercise 7. What is $dsem_{RD}(read(z),s_P)$? **Answer:** $<\{<x,2>,<y,3>,<z,1>\},<2,3>,<5>>$

Exercise 8. What is $dsem_{WR}(write(z),s_P)$? **Answer:** $<\{<x,2>,<y,3>,<z,4>\},<1,2,3>,<5,4>>$

Exercise 9. (This is a little more difficult.) Suppose that we want to extend our language with a new statement, $writeExp(E)$, which writes an expression to the output stream. Give the denotational semantics of $writeExp(E)$. **Answer:** Let WRE be the set of all legal writeExp statements.
$dsem_{WRE}: WRE \times S \rightarrow S \cup \{error\}$
$dsem_{WRE}(writeExp(E),s)=error$ if $dsemExp(E,S)=undef$
otherwise,
$dsem_{WRE}(writeExp(E,s)=<mem',i',o'>$, where $s=<mem,i,o>, mem'=mem, i'=i$, and $o'=dsem_{EX}(E,s)$

Exercise 10. What is $dsem_{SL}(x:=y;\ write(x),s_P)$? **Answer:** $<\{<x,3>,<y,3>,<z,4>\},<1,2,3>,<5,3>>$

Exercise 11. Let BOOL be the set of all Boolean (relational) expressions.
$dsem_{BOOL}: BOOL \times S \rightarrow \{true, false\} \cup \{undef\}$
is defined almost exactly as $dsem_{EX}$. Complete the specification of $dsem_{BOOL}$.
Answer: $dsem_{BOOL}(B,s)=error$ if $s=<mem,i,o>\ andmem(v)=undef$ for any $v \in Id$ (where Id is the set of identifiers in program P), otherwise:
$dsem_{BOOL}(B,s)=true$ if $s=<mem,i,o>$ and B evaluates to $true$ when each variable in B is substituted by $mem(v)$.

Exercise 12. What is $dsem(\mathrm{if}\ x<y\ then\ read(x)\ else\ read(y),s_P)$? **Answer:** $<\{<x,1>,<y,3>,<z,4>\},<2,3>,<5>>$