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CIS 425

# Assignment 1

1)

a. Yes, it is possible that the evaluation of $g$ will have to wait for the evaluation of the arguments to be completed first. ~~Here~~ This can happen when eith $e_1$ or $e_2$ is a function call. For example $g(g(0,5), 2)$ will require the evaluation of $g$ to wait until $e_1$ has been evaluated.

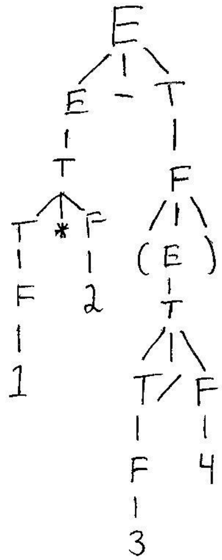
b. In lazy evaluation the call will return 1. This is because in lazy evaluation the arguments aren't evaluated until they are needed. The first line in $g$ ~~relies~~ relies on $e_1$ so $e_1$ will be evaluated, and as it is 0 the function will return 1 without ever evaluating $e_2$. If the function is evaluated in parallel then it will terminate in an error as $e_2$ will be evaluated at the same time and will cause an error.

c. If we evaluate $e_1$, $e_2$ and $g$ in parallel using lazy evaluation $g$ will be evaluated without evaluating $e_1$ and $e_2$ (even though these will be evaluated in a different concurrent thread) Thus it will take $e_1$ and return 1 without being affected by $e_2$. The $e_2$ ~~thr~~ evaluation thread will terminate in an error but it will not affect the output of $g$ as it will not need access to $e_2$.

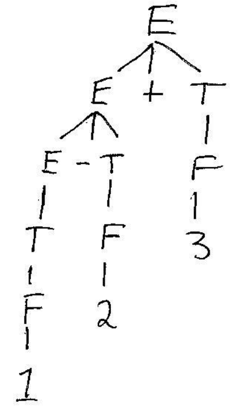
d. No, if there are side effects we will always have to evaluate $e_2$ before we can evaluate $e_1$ or else $e_1$ will take the value of the previous value in memory even though the evaluation of $e_2$ will change $e_1$. If there are side effects we have to use a strict order and we cannot evaluate in parallel.

2)

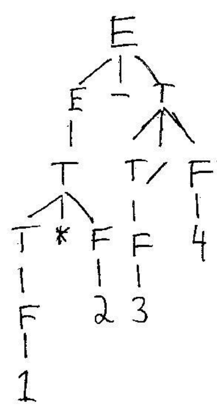
a.



b.

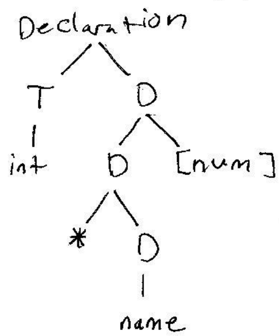


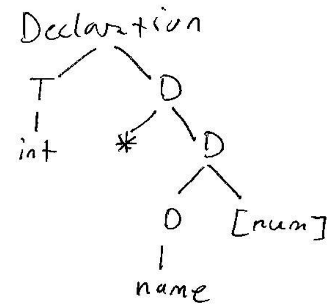
c.



3) In order to prove the syntactic ambiguity of the grammar I will show there exists two different parse trees for the Delaration int * name [num]

parse tree a: (Type = T, Declarator = D) Parse tree b:




Both parse trees produce the result int *name[num].
Thus it is syntactically ambiguous.

4) Consecutive ::= bbb letters | letters bbb | letters bbb letters | bbb
letters ::= char | char letters
char ::= a | b | c

5.

a) Rules:

$$\text{(IV)}\quad (\sigma(x),\sigma)\to(2,\sigma)$$

$$\text{(I)}\quad \frac{(a_1,\sigma)\to(a_1',\sigma)}{(a_1+a_2,\sigma)\to(a_1'+a_2,\sigma)}$$

$$\text{(V)}\quad (\sigma(y),\sigma)\to(3,\sigma)$$

$$\text{(II)}\quad \frac{(a_2,\sigma)\to(a_2',\sigma)}{(n+a_2,\sigma)\to(n+a_2',\sigma)}$$

$$\text{(IV)}\quad \frac{n+m=p}{(n+m,\sigma)\to(p,\sigma)}$$

$$\text{(III)}\quad (X,\sigma)\to(\sigma(X),\sigma)$$

$$\frac{(X,\sigma)\to(\sigma(x),\sigma)}{(x+y,\sigma)\to(\sigma(x)+y,\sigma)}\ \to\ \frac{(\sigma(x),\sigma)\to(2,\sigma)}{(\sigma(x)+y,\sigma)\to(2+y,\sigma)}$$

$$\to\ \frac{(y,\sigma)\to(\sigma(y),\sigma)}{(2+y,\sigma)\to(2+\sigma(y),\sigma)}\ \to\ \frac{(\sigma(y),\sigma)\to(3,\sigma)}{(2+\sigma(y),\sigma)\to(2+3,\sigma)}$$

$$\to\ \frac{2+3=5}{(2+3,\sigma)\to(5,\sigma)}$$

In this evaluation we started with rule (I) with $a_1=x$, $a_2=y$. In order to determine $a'$ we used rule (III). Then we used rule (I) again and used rule (IV) to let $(a_1')'=2$. Then we used rule (II) and rule (III) to evaluate $a_2'$. We then used rule (II) combined with rule (V) to let $(a_2')'=3$. Then we could use rule (IV) to get the ~~function~~ expression in its final state: $(5,\sigma)$.

b) Rules:

$$\text{(I)}\quad \frac{(a_1,\sigma)\to(a_1',\sigma')}{(a_1+a_2,\sigma)\to(a_1'+a_2,\sigma')}$$

$$\text{(II)}\quad \frac{(a_2,\sigma)\to(a_2',\sigma')}{(n+a_2,\sigma)\to(n+a_2',\sigma')}$$

(III) $(X = n, \sigma) \rightarrow (n, Put(\sigma, x, n))$

(VIII) $(X, \sigma) \rightarrow (\sigma(x), \sigma')$

$$\text{(IV)} \quad \frac{(e, \sigma) \rightarrow (e', \sigma')}{(X = e, \sigma) \rightarrow (X = e', \sigma')}$$

(V) $(\sigma(x), \sigma) \rightarrow (1, \sigma')$

$$\text{(VI)} \quad \frac{n + m = p}{(n + m, \sigma) \rightarrow (p, \sigma')}$$

(VII) $Put(\sigma, x, n) = \sigma'$

$$\frac{\dfrac{(X, \sigma) \rightarrow (\sigma(x), \sigma')}{(X + 3, \sigma) \rightarrow (\sigma(x) + 3, \sigma')}}{(X = x + 3, \sigma) \rightarrow (X = \sigma(x) + 3, \sigma')} \rightarrow \frac{\dfrac{(\sigma(x), \sigma') \rightarrow (1, \sigma'')}{(\sigma(x) + 3, \sigma') \rightarrow (1 + 3, \sigma'')}}{(X = \sigma(x) + 3, \sigma') \rightarrow (X = 1 + 3, \sigma'')}$$

$$\rightarrow \frac{\dfrac{1 + 3 = 4}{(1 + 3, \sigma'') \rightarrow (4, \sigma'')}}{(X = 1 + 3, \sigma'') \rightarrow (X = 4, \sigma'')} \rightarrow (X = 4, \sigma'') \rightarrow (4, Put(\sigma''', X, n))$$

$$\rightarrow (4, \sigma'''')$$

In this evaluation we start with rule (IV) which leads us to use rule (I) to find $e'$. Next we again start with rule (IV) which leads us to use rule (I) and rule (V) to assign $e'' = 1$. Next we again start with rule (IV) which which uses rule (VI) to evaluate $e'''$. Now finally we call rule (III) to asign $e'''' = 4$ and $\sigma'''' = Put(\sigma''', x, 4)$. We can then finish it off using rule (VII) to get $(4, \sigma'''')$.

c) ~~Rules: Use rules I, II, III, IV, VI, VII, VIII from part b Let rule IV~~

Use same rules from part (b)

$$\frac{(x=3,\sigma) \to (3, Put(\sigma,x,n))}{((x=3)+x,\sigma) \to (3+x, Put(\sigma,x,n))} \longrightarrow$$

$$(3+x, Put(\sigma,x,n)) \to (3+x,\sigma') \to$$

$$\frac{(x,\sigma) \to (\sigma(x),\sigma'')}{(3+x,\sigma') \to (3+\sigma(x),\sigma'')} \to \quad \frac{(\sigma(x),\sigma'') \to (1,\sigma''')}{(3+\sigma(x),\sigma'') \to (3+1,\sigma''')}$$

$$\to \frac{3+1=4}{(3+1,\sigma''') \to (4,\sigma''')}$$

In this evaluation we start with rule (I), in order to evaluate $a_1'$ we must use rule (III). Next we use rule (VII) to rewrite Put... in terms of $\sigma$. Next we use rule (II) and rule (VIII) to evaluate $a_2'$. We then again use (II) coupled with rule (V) to evaluate $a_2''$. Lastly we use rule (VI) to get the evaluation in final state.

d) Use same rules as part (b)

*1

$$\text{(I)}\ \cfrac{\text{(IV)}\ \cfrac{\text{(IV)}\ \cfrac{\text{(I)}\ \cfrac{\text{(VIII)}\ (x,\sigma) \to (\sigma(x),\sigma')}{(x+3,\sigma) \to (\sigma(x)+3,\sigma')}}{(x=x+3,\sigma) \to (x=\sigma(x)+3,\sigma')}}{(x=(x=x+3),\sigma) \to (x=(x=\sigma(x)+3,\sigma')}}{(x=(x=x+3)+(x=x+5),\sigma) \to (x=(x=\sigma(x)+3)+(x=x+5),\sigma')}$$

*2

$$
\dfrac{
  \dfrac{
    \dfrac{
      \dfrac{}{\theta(x) \rightarrow (1, \theta'')}\;(\mathrm{V})
    }{
      (\theta(x)+3, \theta') \rightarrow (1+3, \theta'')
    }\;(\mathrm{I})
  }{
    (x = \theta(x) + 3, \theta') \rightarrow (x = 1+3, \theta'')
  }\;(\mathrm{IV})
}{
  (x = (x = \theta(x) + 3) + (x = x+5), \theta') \rightarrow (x = (x = 1+3) + (x = x+5), \theta'')
}\;(\mathrm{I})
$$

*3

$$
\dfrac{
  \dfrac{
    \dfrac{
      \dfrac{1+3=4}{(1+3, \theta'') \rightarrow (4, \theta'')}\;(\mathrm{VI})
    }{
      (x = 1+3, \theta'') \rightarrow (x = 4, \theta'')
    }\;(\mathrm{IV})
  }{
    (x = (x = 1+3), \theta'') \rightarrow (x = (x = 4), \theta'')
  }\;(\mathrm{IV})
}{
  (x = (x = 1+3) + (x = x+5), \theta'' \rightarrow (x = (x = 4) + (x = x+5), \theta'')
}\;(\mathrm{I})
$$

*4

$$
\dfrac{
  \dfrac{
    \dfrac{}{(x = 4, \theta'') \rightarrow (4, Put(\theta'', x, 4))}\;(\mathrm{III})
  }{
    (x = (x = 4), \theta'') \rightarrow (x = 4, Put(\theta'', x, 4))
  }\;(\mathrm{IV})
}{
  (x = (x = 4) + (x = x+5), \theta'') \rightarrow (x = 4. + (x = x+5), Put(\theta'', x, 4))
}\;(\mathrm{I})
$$

(VII) *5 $((x=4) + (x = x+5), Put(\theta'', x, 4)) \rightarrow (x = 4 + (x = x+5), \theta''')$

*6

$$
\dfrac{
  \dfrac{}{(x = 4, \theta''') \rightarrow (4, Put(\theta''', x, 4)}\;(\mathrm{III})
}{
  (x = 4 + (x = x+5), \theta''') \rightarrow (4 + (x = x+5), Put(\theta''', x, 4))
}\;(\mathrm{I})
$$

(VII) *7 $(4 + (x = x+5), Put(\theta''', x, 4) \rightarrow (4 + (x = x+5), \theta'''')$

*8

$$
\dfrac{
  \dfrac{
    \dfrac{
      \dfrac{}{(x, \theta'''') \rightarrow (\theta(x), \theta'''')}\;(\mathrm{VIII})
    }{
      (x+5, \theta'''') \rightarrow (\theta(x)+5, \theta'''')
    }\;(\mathrm{I})
  }{
    (x = x+5, \theta'''') \rightarrow (x = \theta(x)+5, \theta'''')
  }\;(\mathrm{IV})
}{
  (4 + (x = x+5), \theta'''') \rightarrow (4 + (x = \theta(x)+5), \theta'''')
}\;(\mathrm{II})
$$

*9

$$
(\mathrm{II})\ \dfrac{(\mathrm{IV})\ \dfrac{(\mathrm{I})\ \dfrac{(\mathrm{V})\ (\sigma(x), \sigma''''') \to (4, \sigma''''')}{(\sigma(x)+5, \sigma''''') \to (4+5, \sigma''''')}}{(x=\sigma(x)+5, \sigma''''') \to (x=4+5, \sigma''''')}}{(4+(x=\sigma(x)+5), \sigma''''') \to (4+(x=4+5, \sigma''''')}
$$

*10

$$
(\mathrm{II})\ \dfrac{(\mathrm{IV})\ \dfrac{(\mathrm{VI})\ \dfrac{4+5=9}{(4+5, \sigma''''') \to (9, \sigma''''')}}{(x=4+5, \sigma''''') \to (x=9, \sigma''''')}}{(4+(x=4+5), \sigma''''') \to (4+(x=9), \sigma''''')}
$$

*11

$$
(\mathrm{II})\ \dfrac{(\mathrm{III})\ (x=9, \sigma''''') \to (9, Put(\sigma''''', x, 9))}{(4+(x=9), \sigma''''') \to (4+9, Put(\sigma''''', x, 9))}
$$

$$
(\mathrm{VII})\ {*}12\quad (4+9, Put(\sigma''''', x, 9)) \to (4+9, \sigma'''''')
$$

*13

$$
(\mathrm{VI})\ \dfrac{4+9 \to 13}{(4+9, \sigma'''''') \to (13, \sigma'''''')}
$$

Explanation: Placed rule number ~~instead~~ on the left side of each(———) bar. Rule applies for taking what is below the bar to what is above it. ~~Each~~ Each $*n \to *n+1$ (label for each step)