CMSC 330 Quiz 4 Spring 2022 Solutions

Q1. Loco Lists

Q1.1. Write a CFG to represent a list consisting of positive integers and other lists. These lists (and sublists) can have arbitrarily large dimensions.

Notes:

- An empty list is also a valid list.
- You can use `n` to denote a positive integer in the CFG. You don't have to worry about representing multidigit numbers since `n` encapsulates them all.
- To represent ϵ in the CFG, you can either write the word epsilon or just type the letter `e`.

Examples of Valid Lists:

```
[]
[[[]]]
[1,[[1,2],[4],56],[[[564]]]]
[1,2,3]
```

```
S -> [S] | [T] | []
T -> U,T | U
U -> n | S
```

Q1.2. Is the language defined by the grammar given above regular? Yes/No

Q2. Context-Free Grammars

My friend Hamza with a peculiar lexicon likes modifying common acronyms in his speech and texting as defined by the following CFG:

```
S -> A | B
A -> loL
L -> l | l out loud | A
B -> smH
H -> h | h my head | B
```

Can the grammar above be parsed by a LL1 recursive descent parser (like Project 4)? Justify your answer.

No. The first sets are not disjoint.

Q3. Ambiguity

Prove that the following grammar is ambiguous:

```
S -> bS | Sb | T
T -> Sa | Sb | Sc | ϵ
```

```
S -> bS -> bT -> b
S -> Sb -> Tb -> b
```

Any other valid ambiguous productions i.e., same string generated with different paths are correct.

Q4. Operational Semantics

Using the gives rules, fill in the blanks the complete the derivation below:

$$\frac{}{A;\ \mathrm{n} \Rightarrow \mathrm{n}} \qquad \frac{A(\mathrm{x}) = \mathrm{v}}{A;\ \mathrm{x} \Rightarrow \mathrm{v}}$$

$$\frac{A;\ \mathrm{e}_1 \Rightarrow \mathrm{v}_1 \qquad A, \mathrm{x} : \mathrm{v}_1;\ \mathrm{e}_2 \Rightarrow \mathrm{v}_2}{A;\ \text{let } \mathrm{x} = \mathrm{e}_1 \text{ in } \mathrm{e}_2 \Rightarrow \mathrm{v}_2}$$

$$\frac{A;\ \mathrm{e}_1 \Rightarrow \mathrm{v}_1 \qquad A;\ \mathrm{e}_2 \Rightarrow \mathrm{v}_2 \qquad \mathrm{v}_3 \text{ is } \mathrm{v}_1 \wedge \mathrm{v}_2}{A;\ \mathrm{e}_1 \wedge \mathrm{e}_2 \Rightarrow \mathrm{v}_3}$$

$$\frac{\dfrac{}{A;\ \text{"cmsc"} \Rightarrow \text{"cmsc"}} \qquad \dfrac{\dfrac{\dfrac{(\#4)}{A, \mathrm{x} : \text{"cmsc"}, \mathrm{y} : \text{"330"};\ \mathrm{x} \Rightarrow \text{"cmsc"}} \quad \dfrac{(\#5)}{A, \mathrm{x} : \text{"cmsc"}, \mathrm{y} : \text{"330"};\ \mathrm{y} \Rightarrow \text{"330"}}}{A, \mathrm{x} : \text{"cmsc"}, \mathrm{y} : \text{"330"};\ (\#3) \Rightarrow \text{"cmsc330"}}\ (\#6)}{A, \mathrm{x} : \text{"cmsc"};\ \text{let y} = \text{"330" in x} \wedge \mathrm{y} \Rightarrow \text{"cmsc330"}}\ (\#2)}{A;\ (\#1) \text{ in let y} = \text{"330" in x} \wedge \mathrm{y} \Rightarrow \text{"cmsc330"}}$$

Blank #1: `let x = “cmsc”`

Blank #2: `A, x:“cmsc”; “330” ⇒ “330”`

Blank #3: `x ^ y`

Blank #4: `A, x:“cmsc”, y:“330”(x) = “cmsc”`

Blank #5: `A, x:“cmsc”, y:“330”(y) = “330”`

Blank #6: `“cmsc330” is “cmsc” ^ “330”`