CS520: Homework 6  
Due date: Thursday, Oct 20, 2016  
Reading: Chapter 2.  
Also review from class handouts for Finite Automata Theory.  
Midterm is schedule in class (close book) on Tuesday, Oct 18, 2016.  
Please note that your reading assignment is an integral part of your homework.

1. In class we gave a context free grammar that generates all non-empty strings of equal numbers of a’s and b’s.  
\[(S \rightarrow aB \mid bA; A \rightarrow a \mid aS \mid bAA; B \rightarrow b \mid bS \mid aBB.\) 
Show that the grammar is ambiguous.

2. Give a CFG that generates all non-empty strings over \(\{0, 1\}\) that have the property that the number of 1’s is 2 times the number of 0’s.

3. Give a CFG that generates all strings over \(\{0, 1\}\) that have the property that the 2 times the number of 1’s is 3 times the number of 0’s.

4. 2.4. (part b, part c and part e.)

5. 2.6. (part b.)

6. 2.9.

7. Design a CFG that generates the arithmetic expressions, with +, −, *, (,), a, b, c, together with a new terminal symbol for exponentiation ↑. Your grammar should be unambiguous, properly associative. More specifically, it should be left associative for addition +, − and multiplication *, but right associative for the exponentiation ↑. (Recall that, being left associative for addition +, an expression such as \(a + b + c\) should have the unique parsing as the sum of \(a + b\) and \(c\).) It should also have precedence rule embedded in the grammar that is highest for exponentiation, second highest for multiplication, and finally for addition/subtraction. With addition and subtraction, whichever is left most gets precedence.

For example: for the expression
\[a + b - c * d * e ↑ f ↑ g\]

The only valid derivation should parse it as such: First, \(f ↑ g\), then \(e ↑ f ↑ g\); also, \(c * d ↑ e ↑ f ↑ g\); also \(a + b\) and then \(a + b - \cdots\).

(You don’t need to prove all the requirements here are satisfied. But if you correctly prove that all the requirements here are satisfied, you will earn extra credit.)

8. (extra credit for part (b)) 2.27.

Note: You should get on to your homework as soon as possible. Don’t delay to the last minute.