CSCI 340 — Homework 12

Professor Killian

Due: May 5, 2019 @ 11:59PM

1. Consider the grammar:

   PROD 1 $S \rightarrow ABS \mid \Lambda$
   PROD 2 $AB \rightarrow BA$
   PROD 3 $BA \rightarrow AB$
   PROD 4 $A \rightarrow a$
   PROD 5 $B \rightarrow b$

   - [4pts each] Derive the following words: *abba* , *babbaaab*
   - [4pts] Prove every word generated by this grammar has equal number of *a*'s and *b*'s (EQUAL)

2. [4pts] Find a grammar that generates all words with more *a*'s than *b*'s (MOREA)

3. [4pts] Find a grammar that generates all words **not** in EQUAL

4. [10pts] Construct a Turing Machine that accepts a number in unary and converts it to binary

5. [5pts] Describe how you would construct a Turing Machine that applies unary number exponentiation. For example, input of the form `aaabaa` should yield 9 *a*'s and `aabaaaaa` should yield 32 *a*'s on the tape.

6. [5pts] Trace the function application of `MULT(N2)(N3)(SUCC)(0)` until a single value is produced. *N2 and N3 are Church numerals representing the values of 2 and 3.* The first few substitutions are made below:

```
m => n => f => x => m(n(f))(x)
n => f => x => N2(n(f))(x)        m -> N2
f => x => N2(N3(f))(x)            n -> N3
x => N2(N3(SUCC))(x)              f -> SUCC
N2(N3(SUCC))(0)                   x -> 0
N3(SUCC)(N3(SUCC)(0))             N2(y)(z) -> y(y(z))
```