## CS 81, Logic and Computability Problem Set 8: Context-Free Grammars

This problem set uses the Stanford CS 103 CFG developer: https://web.stanford.edu/class/archive/cs/cs103/cs103.1156/tools/cfg/.

#### Challenge 1: Grammar Youngling [60 Points]

Using the online CFG tool, construct an **unambiguous** CFG that produces all the strings of **just zeroes** that have an even number of zeroes, and produces no other strings. Then, test your CFG on the following strings:

**Notice**, the second item we test for is epsilon, the empty string. We test for that by including a blank line in our test box.

Include your grammar and a screenshot of the test results. The screenshot should look like Figure 2. For full points your grammar should only have unambiguous derivations for the strings in that language. Our sample solution uses two rules.

### Challenge 2: Grammar Padawan [35 Points]

Let  $L_1 = \{w \# x \mid w, x \in \{0, 1\}^* \land (|w| = |x|) \land (w \neq x^R)\}$ . Note that the input alphabet is  $\Sigma = \{0, 1, \#\}$  and recall that  $x^R$  denotes the string x in reverse order.

For example, the following strings are in  $L_1$ : 000#001, 1100#0001, 00#01. However, the following strings are not in  $L_1$ : 00#000, 001#100.

Construct a context-free grammar for  $L_1$  using the online tool and **include a screen-shot of the results for tests** of the following strings:

```
00#00

00#01

00#000

1100#001

001#100

0

000#001

1#0

0010#0

001#101
```

Please include your grammar and your screenshot of the test results. Ambiguous grammars are fine for this problem.

## Challenge 3: Grammar Jedi [5 Points]

This is a practice challenge, in case you want a more challenging problem to work on. It is only worth a small number of points, so don't sweat it if you can't figure it out.

Let P(w) be a predicate on the domain of strings in  $\{0,1\}^*$  where the interpretation of P(w) is that the number of 0's in w is different from the number of 1's in w. Consider the language  $L_2 = \{w \mid w \in \{0,1\}^* \land P(w)\}$ . For example, the following strings are in  $L_2$ : 000, 001, 100, 10110.

Construct a context-free grammar for  $L_2$  using the online tool, and **include a screen-shot of the results for tests** of the following strings:

Please include your grammar and your screenshot of the test results. Ambiguous grammars are fine for this problem.

# Answers

### Answer 1:

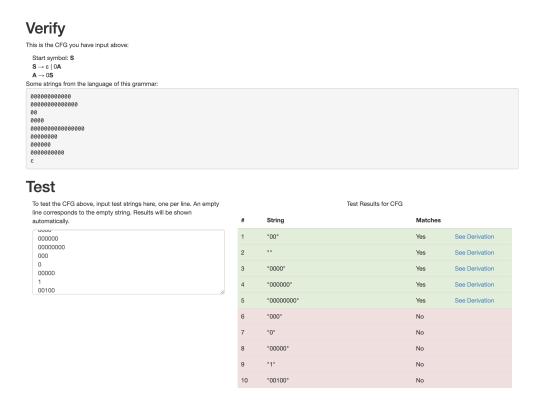


Figure 1: Screenshot of online tool tests.

## Answer 2:

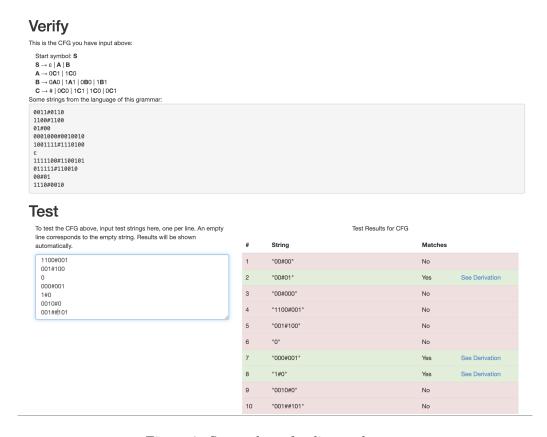


Figure 2: Screenshot of online tool tests.