

## CS 3530: Assignment 2b

Fall 2023

### Exercise 2.9 (10 points)

#### Problem

Give a context-free grammar that generates the language

$$A = \{a^i b^j c^k \mid i = j \text{ or } j = k \text{ where } i, j, k \geq 0\}.$$

For all CFGs, describe the role that each rule performs as well as giving the actual rule.

#### Solution

splits into two CFGs, one for each 'or'

$$S \rightarrow S1 \mid S2$$

$i = j$ , so this CFG generates equal number of a's and b's

$$S1 \rightarrow S1c \mid E \mid \varepsilon$$

$$E \rightarrow aEb \mid \varepsilon$$

$j = k$ , so this CFG generates equal number of b's and c's

$$S2 \rightarrow aS2 \mid F \mid \varepsilon$$

$$F \rightarrow bFc \mid \varepsilon$$

either S1 or S2 can be used to generate a string using the language.

### Exercise 2.5be (10 points)

#### Problem

Give informal descriptions and state diagrams of pushdown automata for the languages in Exercise 2.4.

**b.**  $\{w \mid w \text{ starts and ends with the same symbol}\}$

**e.**  $\{w \mid w = w^R, \text{ that is, } w \text{ is a palindrome}\}$

#### Solution

$$a = 0, \varepsilon \rightarrow 0$$

$$b = 1, \varepsilon \rightarrow 1$$

$$c = 0, \varepsilon \rightarrow \varepsilon$$

$$d = 1, \varepsilon \rightarrow \varepsilon$$

$$e = 1, 1 \rightarrow \varepsilon$$

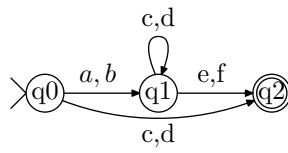
$$f = 0, 0 \rightarrow \varepsilon$$

$$g = \varepsilon, \varepsilon \rightarrow \varepsilon$$

$$h = \varepsilon, \varepsilon \rightarrow \text{"dollar sign"}$$

$$i = \varepsilon, \text{"dollar sign"} \rightarrow \varepsilon$$

b.



e.

