

## CS323 Assignment 3

### 1 Requirements

You are expected to complete all required homework exercises and encouraged to complete the optional ones (if there are). For submission, please put all your answers in a single PDF file and submit it via the assignment channel on Blackboard. The name of the file should follow the format “**studentID\_A#**” (e.g., 30003554\_A3). **The submission deadline is 10:00 PM, November 26, 2023.** Late submissions are allowed within one week after the deadline (grace period). If you submit your assignment during the grace period, your score will be 80% of the score you could get if the submission was made in time. Assignment submitted after the grace period will not be graded.

### 2 Required Exercises (100 points)

**Exercise 1 (Grammar Basics):** Consider the following context-free grammar  $G$ :

$$S \rightarrow SS + \mid SS - \mid a$$

1. Is the string “ $a + a - a$ ” a valid sentence in  $L(G)$ ? [3 points]
2. Give a leftmost derivation for the string  $aa - a + a - a +$ . [3 points]
3. Give a rightmost derivation for the string  $aa - a + a - a +$ . [3 points]
4. Give a parse tree for the string  $aa - a + a - a +$ . [3 points]

**Exercise 2 (Top-Down Parsing):** Consider the following grammar  $G$ :

$$S \rightarrow aB$$

$$B \rightarrow S * B \mid \epsilon$$

1. Construct the predictive parsing table for  $G$ . Please put down the detailed steps, including the calculation of FIRST and FOLLOW sets. [15 points]
2. Is the grammar LL(1)? [3 points]
3. Can an LL(1) parser accept the input string  $aaaa^{***}$ ? If yes, please list the moves made by the parser; otherwise, state the reason. Before parsing, please resolve conflicts in the parsing table if any. [8 points]

**Exercise 3 (Bottom-Up Parsing):**

1. Construct the shift-reduce parsing table for the above grammar  $G$  using each of the following algorithms: (1) SLR, (2) CLR, and (3) LALR. Please put down the detailed steps, including the calculation of item sets. For the calculation of closures, GOTO targets, and FIRST/FOLLOW sets, you may choose not to put down the details. [45 points]
2. Is the grammar SLR(1)? Is the grammar LR(1)? Is the grammar LALR(1)? [9 points]
3. Can an LALR(1) parser accept the input string  $aaaa^{***}$ ? If yes, please list the moves made by the parser; otherwise, state the reason. Before parsing, please resolve conflicts in the parsing table if any. [8 points]

### 3 Optional Exercise (15 bonus points)

1. Consider the following context-free grammar:

$$\text{Phrase} \rightarrow \text{Human} \mid \text{Animal} \mid \text{Phrase Verb Phrase}$$

$$\text{Verb} \rightarrow \text{like} \mid \text{hate}$$

$$\text{Human} \rightarrow \text{Tom} \mid \text{Jerry} \mid \text{Spike}$$
$$\text{Animal} \rightarrow \text{cat} \mid \text{mouse} \mid \text{dog}$$

The grammar can produce sentences such as “Tom like dog”. Is the grammar ambiguous? Why? [2 points for the yes/no answer and 8 points for the explanation]

2. For the grammar  $G$  in Required Exercise 1, give an equivalent grammar without immediate left recursions. [5 points]