

For this homework assignment, submit your answers on paper at the start of the lecture on the due date.

Late homework assignments will not be accepted, unless you have a valid written excuse (medical, etc.). You must do this assignment alone. No team work or "talking with your friends" will be accepted. No copying from the Internet. Cheating means zero.

Note: EXPLAIN your answers in DETAIL for all the questions below.

Consider the following context-free grammar for arithmetic expressions:

```
E -> E + E
E -> E * E
E -> id
```

where '+', '*', and 'id' are tokens.

1) Augment the grammar with a new nonterminal E'.

2) Use the Sets-of-Items Construction Algorithm to construct the sets of LR(0) items for the augmented grammar of Question 1. Construct at the same time the corresponding DFA. Explain in detail every step.

Note: during the construction of the sets of items and the DFA, always consider the grammar symbols in the following order: +, *, id, E. You will lose points if you consider grammar symbols in a different order.

3) Construct the SLR(1) parsing table, based on the results of Question 2. Explain in detail.

Note: grammar symbols at the top of the table must appear in the following order from left to right: +, *, id, \$, E. You will lose points if you use a different order. State numbers start from zero.

4) What is the problem with the SLR(1) parsing table you constructed in Question 3? What is the original cause of the problem?

5) Manually modify the SLR(1) parsing table of Question 3 to solve the problem. The resulting table must encode the usual behavior for arithmetic expressions (+ and * are left-associative, and * has precedence over +). Justify in detail each of your modifications.

Hint: as you try to solve the problem, look at the sets of items, the DFA, and the parsing table. Remember that, when a parser uses the parsing table, the content of the parser's stack corresponds to a path in the DFA.

6) Use the modified SLR(1) parsing table from Question 5 to parse the following input:

```
id + id + id * id * id
```

7) Construct a derivation and a parse tree based on the results of Question 6. Verify that the shape of the parse tree is coherent with the way you modified the SLR(1) parsing table in Question 5. Explain how you verify that.