

CPSC 411: Winter Midterm Exam

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This exam is worth 25% of the credit for this course. There are 50 marks available: answer all the questions below.

1. (10 points)

- (a) (5 points) Describe the main stages of compiling. Be careful to describe the structure of the inputs and outputs, the complexity of each step, and the stages which can generate errors.
- (b) (1 point) What is the difference between a parse tree and an (abstract) syntax tree?
- (c) (1 point) Why are unambiguous grammars important in compilers? Is it possible to decide whether a grammar is unambiguous?
- (d) (1 point) Is it possible to decide whether two context free grammars describe the same language? Can this be done in polynomial time?
- (e) (1 point) Is it possible to decide whether two regular expressions describe the same language? Can this be done in polynomial time?
- (f) (1 point) Is it possible to enumerate all the unambiguous grammars?

2. (15 points)

Given the following grammar:

```
st -> loc := exp.
loc -> Id
    | array.
array -> Id [ indexes exp ].
indexes -> indexes exp ,
        | .
exp -> exp + term
    | term.
term -> term * factor
    | factor.
factor -> loc
        | Num
        | ( exp ).
```

- (a) Give three examples of strings recognized by this grammar.
- (b) Calculate the vital statistics of the grammar:
 - i. Which non-terminals are nullable?
 - ii. What are the first sets of each nonterminal?
 - iii. What are the follow sets of each nonterminal?
 - iv. Which non-terminals are endable?
 - v. Which nonterminals are left recursive?
- (c) Explain why this grammar is not LL(1).
- (d) Transform this grammar to remove left recursion. Is your transformed grammar LL(1)? Can you use left-factoring to make it LL(1)?

3. (15 points)

Consider the following grammar (which is a simplified version of the previous grammar):

```
st -> loc := exp.
loc -> id array.
array-> [ ind exp ].
ind -> ind exp ,
      | .
exp -> loc
      | Num.
```

(a) Give the LR(0) item automaton for this language.

(b) Is this grammar LR(0)? Is the grammar SLR(1)?

4. (10 points)

Determine whether the following two regular expressions

$$ab^*c(db^*c)^*db^*e \quad \text{and} \quad a(b|cd)^*e$$

recognize the same language.