

# 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) (6 points) Describe the main stages of compiling a program. 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) Is it possible to decide whether two regular expressions describe the same language? Can this be done in polynomial time?
- (c) (1 point) Is it possible to decide whether two context free grammars describe the same language? Can this be done in polynomial time?
- (d) (1 point) Why is ambiguity an important issue for compilers? Is it possible to determine whether an LL(1) grammar is ambiguous?
- (e) (1 point) What is the difference between a parse tree and an (abstract) syntax tree?

2. (15 points)

Given the following grammar:

```
assign -> loc Assign exp.
loc -> Id
      | array.
array -> Id index.
index -> Lsqpar indexes Rsqpar
indexes -> Num more_indexes.
more_indexes -> Comma Num more_indexes
              |.
exp -> exp + term
     | term.
term -> term * factor
      | factor.
factor -> loc
        | Num
        | Lpar exp Rpar.
```

- (a) Give three examples of strings recognized by this grammar.
- (b) Calculate the vital statistics of the grammar: that is
  - 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 make it LL(1)?

3. (15 points)

Consider the following grammar:

$x \rightarrow y x X \mid Y.$

$y \rightarrow x y Y \mid X.$

(a) Give three examples of strings recognized by this grammar.

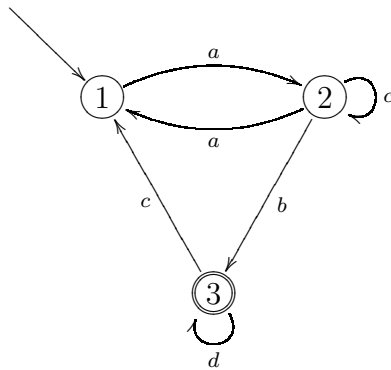
(b) Is the grammar LL(1)?

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

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

4. (10 points)

Is the following automata deterministic?



Derive a regular expression for the language recognized by the above automaton.