# CPSC 510: Fall Midterm Exam

Robin Cockett

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This exam is worth 30% of the examination credit for this course.

Consider the following grammar (which is for lisp expressions) whose non-terminals are written in lower case and whose terminals are written in upper case:

```
s_expression -> atomic_symbol
              | LPAR s_expression end_s_expression RPAR.

end_s_expression -> DOT s_expression
                  | s_expressions.

s_expressions -> s_expressions s_expression
               |.

atomic_symbol -> LETTER atom_part.

atom_part -> LETTER atom_part
           | NUMBER atom_part
           |.
```

There are 50 marks available: answer all the questions below.

1. (10 points)

   Describe the main stages of a compiler and the inputs and outputs of each stage.

2. (20 points)

   Calculate the vital statistics of the above grammar:

   (a) Which non-terminals are nullable?

   (b) Which non-terminals are endable?

   (c) What are the first sets of each non-terminal?

   (d) What are the follow set of each non-terminal?

   Explain why this grammar is not LL(1). Transform this grammar to remove left recursion. Is this transformed grammar LL(1)?

3. (20 points)

   Consider the following grammar

```
s -> a A | B a C | D C | B D A.
a -> D.
```

   (a) Construct the DFA of LR(0) items for this language.

   (b) Is this grammar SLR(1)?

   (c) Is this grammar LALR(1)?