

# CS 571

## Homework 3

**Due:** Nov 14

**100 points**

**Important Reminder:** As per the course Academic Honesty Statement, cheating of any kind will minimally result in receiving an F letter grade for the entire course.

To be submitted on paper in class.  
Justify all answers.

1. Given the following C program:

```
/* Introductory program */
int main() {
    printf("hello world\n");
    return 0;
}
```

Assuming that the comment on the first line starts at column 0:

- (a) List the lexemes which would be produced by a scanner for a compiler.
- (b) List the lexemes which would be produced by a scanner for a syntax-directed editor.

*10-points*

2. Is the Haskell `:` operator equivalent to the Scheme `cons` operator? *5-points*

3. The Haskell expression

```
map ($5) [\x->x + 3, \x->x - 3]
```

produces the result `[8,2]`, while the Haskell expression

```
map (5$) [\x->x + 3, \x->x - 3]
```

results in an error. Explain precisely how the former works and why the latter fails. *10-points*

4. In Haskell, `foldr` can be used on infinite lists but `foldl` cannot. Explain why. *10-points*
5. Discuss how you would represent a DFA in Haskell. Specifically:
- (a) Specifically, describe how you would use Haskell to represent *states*, *transitions*, and overall *dfas*.
  - (b) Show your representation for the DFA discussed around pg. 75 of the Scheme transparencies.
  - (c) Describe how you would hide the details of your representation from users of your representation.

Note that Haskell allows richer representations than S-expressions. *15-points*

6. Given two finite sets  $A$  and  $B$ . What can you say about the relative cardinalities of  $A$  and  $B$  when:
- (a) There is an injective total function  $f$  from  $A$  to  $B$ .
  - (b) There is a surjective total function  $f$  from  $A$  to  $B$ .
  - (c) There is a bijective total function  $f$  from  $A$  to  $B$ .

*15-points*

7. Given two finite sets  $A$  and  $B$ , how many bijective total functions are there from  $A$  to  $B$ ? Your answer should be given in terms of the cardinalities  $|A|$  and  $|B|$ . *10-points*

8. Which of the following propositional logic WFF's are tautologies. Please remember to justify your answers.

- (a)  $p \Rightarrow p \vee q$
- (b)  $p \Rightarrow p \wedge q$
- (c)  $p \vee q \Rightarrow p \wedge q.$
- (d)  $p \wedge q \Rightarrow p \vee q.$

*10-points*

9. Discuss the validities of the following statements:

- (a) A *circular structure* is a structure which contains a reference back to itself (directly or indirectly). Since Haskell does not support destructive assignment, it is impossible to represent circular structures in Haskell.
- (b) Haskell's `foldl` can be implemented in a tail-recursive manner.
- (c) Since Haskell allows infinite data structures, it is possible to show that there are more real numbers than natural numbers by simply comparing the length of the list of all real numbers with the length of the list containing all natural numbers.
- (d) All data types in Haskell can be compared for equality using the built-in `==` operator.
- (e) All functions are relations.

*15-points*