Quizzes for General CS II (320102) Fall 2013

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For Course Purposes Only

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Contents

1 Assignment 1 (Introductory Quiz) – Given Sep. 9. 2013

Problem 1.1 (GenCS Grading)
State the components of the overall grade of the GenCS course and discuss their intention. 4pt

Problem 1.2 (What is an algorithm?)
What is an algorithm? Give 3 examples of algorithms and explain them (be creative and make sure that at least two of them are not on the slides!). 8pt

2 Assignment 2 (Peano axioms and Induction) – Given Sep. 16. 2013

Problem 2.1 (Peano's induction axiom)
State Peano's induction axiom and discuss what it can be used for. 6pt

Problem 2.2 (Zero is not one)
Prove or refute that $s(o)$ is different from o. 6pt

Note: Please use **only** the Peano Axioms for this proof.

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3 Assignment 3 (Mathtalk and Sets) – Given Sep. 23. 2013

Problem 3.1 (Addition Definition)

Give the two basic rules that define the "addition" operation. Provide an example for each rule. Use the unary representation of numbers (e.g. o for 0, $s(o)$ for 1 and so on). 2pt

Problem 3.2 (Talking about Sets) 10pt

Given the following sets

1. $A = \{a, b, c, d, e\}$
2. $B = \{d, f, h\}$
3. $C = \{d, f, g, i\}$

Define each of the following operations on sets **in math talk** and apply it to the given sets:

1. intersection:$S \cap T :=$
   e.g. $A \cap B =$
2. union: $S \cup T :=$ e.g. $B \cup C =$
3. set difference: $S \backslash T :=$ e.g. $A \backslash B =$
4. n-fold Cartesian product: $S_1 \times \ldots \times S_n :=$ e.g. the size $\#(A \times B \times C) =$

4 Assignment 4 (Relations & SML Pattern Matching) – Given Sep. 30. 2013

Problem 4.1 Given $A := \{1, 2, 3, 4\}$, $B := \{5, 6, 7\}$ and following relations: 4pt

$$R_1 \subseteq A \times A, \quad R_1 := \{(1,1), (2,2), (3,3), (1,4), (4,3), (1,3)\}$$

$$R_2 \subseteq B \times B, \quad R_2 := \{(5,5), (6,6), (7,7), (5,6), (6,5), (6,7), (7,6)\}$$

Determine for these relations whether they are reflexive, symmetric, and transitive. If they are not, give counterexamples (i.e. examples, where the given property is violated).

Problem 4.2 (Pattern Matching in SML)

You are typing to the SML interpreter and it replies: 8pt

```
- val unittriple = (1,1,1);
  val unittriple = (1,1,1) : int * int * int
```

1. you continue with

   ```
   - val (_,x,_) = unittriple;
   ```

   What will the system reply? Explain briefly.
2. write an SML function fourth that given a quadruple of reals (members of the SML type real) extracts the last (fourth) component.

5 Assignment 5 (SML Data Types) – Given Oct. 7. 2013

Problem 5.1 (Temperatures)

You are given the following SML datatype temp that represents temperatures in Fahrenheit and Celsius. 12pt

```
datatype temp = Celsius of real | Fahrenheit of real;
```

Write an SML function find : temp list -> temp that returns the lowest temperature in a list. For instance,

```
- find([Celsius(12.0), Fahrenheit(52.0), Celsius(32.0)]);
val it = Fahrenheit 52.0 : temp
```

Note: You can use the following formula for transforming Fahrenheit into Celsius: $t_C = (t_F - 32) \cdot \frac{5}{9}$

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6 Assignment 6 (Abstract Data Types) – Given Oct. 28. 2013

Problem 6.1 (Abstract Data Type for given Ground Terms)
Suppose the expressions $f(g(a,b),c)$ and $h(g,f(a,b))$ are both ground terms. 6pt

1. Write one appropriate abstract data type for both of them.
2. Are the expressions $f(a,b,c), h(g,a)$ and $h(f,b)$ ground terms of your abstract data type too? Justify your answer.

Problem 6.2 (An abstract procedure)
Given the following ADT for lists of unary natural numbers 6pt

$$L := \langle \{\mathbb{L}, \mathbb{N}\}, \{[o\colon \mathbb{N}], [s\colon \mathbb{N} \to \mathbb{N}], [nil\colon \mathbb{L}], [cons\colon \mathbb{N} \times \mathbb{L} \to \mathbb{L}]\}\rangle$$

and an abstract procedure for appending two lists,

$$\langle @::\mathbb{L} \times \mathbb{L} \to \mathbb{L}\,;\, \{@(cons(n, L_1), L_2) \rightsquigarrow cons(n, @(L_1, L_2)), @(nil, L_2) \rightsquigarrow L_2\}\rangle$$

Provide an abstract procedure for reversing lists!

7 Assignment 7 (Mutual Recursion) – Given Nov. 4. 2013

Problem 7.1 (Mutual recursion in SML**)**
Implement functions for the following recursive/ mutually recursive functions: 12pt

- the Hofstadter male and female sequences:

$$male(n) = \begin{cases} 0 & \text{if } n = 0 \\ n - female(male(n-1)) & \text{if } n>0 \end{cases}$$

$$female(n) = \begin{cases} 1 & \text{if } n = 0 \\ n - male(female(n-1)) & \text{if } n>0 \end{cases}$$

8 Assignment 8 (String code) – Given Nov. 11. 2013

Problem 8.1 (String codes)

Given the alphabet $A := \{1, 2, \ldots, 2008, 2009\}$ and $B := \{a, b\}$: 12pt

1. Construct a character code $c\colon A \to B^+$ whose extension is a string code
2. Prove that the extension is a string code.

Note: You can use the theorems provided in class if you state them.

9 Assignment 9 (Evaluating Boolean Expressions) – Given Nov. 18. 2013

Problem 9.1 (CNF and DNF)
Using the assignment $\varphi = [F/x_1], [T/x_2], [T/x_3], [F/x_4]$ evaluate the expression: 12pt

$$x_2 + \overline{(x_1 + x_4) * (x_2 + x_3)} * x_4$$

10 Assignment 10 (Boolean Expressions) – Given Nov. 25. 2013

Problem 10.1 (Boolean Evaluation)
Use boolean equivalences to simplify the expression 12pt

$$(\overline{x_1 + x_4} + \overline{\overline{x_4} + x_1}) + \overline{x_2 * (x_3 + x_2)}$$

as much as possible and then evaluate it using the variable assignment

$$\varphi := [\mathsf{T}/x_1], [\mathsf{F}/x_2], [\mathsf{T}/x_3], [\mathsf{F}/x_4]$$

and the interpretation

$$\mathcal{I} = \{0 \mapsto \mathsf{F}, 1 \mapsto \mathsf{T}, \mathsf{+} \mapsto \vee, \mathsf{*} \mapsto \wedge, \mathsf{-} \mapsto \neg\}]$$