Introduction to Computer Science
Jacobs University Bremen
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Module: CH-232
Date: 2022-09-30
Due: 2022-10-07

ICS 2022 Problem Sheet #4

Problem 4.1: *sets and relations in a coffee bar* (1+1+1 = 3 points)

A coffee bar is offering different kinds of coffee to their customers. Customers order their coffee at the cashier, who then notifies the barrister about the order so that she can brew the coffee requested by a customer. A customer may have to wait until the coffee is ready. During this time the cashier may accept additional orders. Customers may place a gratituity, which are shared among all employees. The distribution of the tips is organized by the barrister since she owns the coffee shop.

a) Identify at least five sets (entities) that play a role in the coffee bar scenario. Introduce suitable notation.

b) Identify at least five relations between the sets (entities) that you have identified. Define the relations using suitable mathematical notation.

c) Identify at least five endorelations including at least one equivalence relation, one partial order relation, and one strict partial order relation. Define the relations using suitable mathematical notation. Try to cover different sets (entities).

Problem 4.2: *function composition* (2 points)

Given the functions $f(x) = x + 1.$ $g(x) = 2x$, and $h(x) = x^2$, determine an expression for the following function compositions:

a) $f \circ g$

b) $f \circ h$

c) $g \circ f$

d) $g \circ h$

e) $h \circ f$

f) $h \circ g$

g) $f \circ (g \circ h)$

h) $h \circ (g \circ f)$

Problem 4.3: *b-complement* (1+1+1 = 3 points)

We plan to use a fixed size b-complement number system with the base $b = 9$ and $n = 4$ digits.

a) What are the smallest and the largest numbers that can be represented and why?

b) What is the representation of -1 and -8 in b-complement notation?

c) Add the numbers -1 and -8 in b-complement notation. What is the result in b-complement representation? Convert the result from b-complement representation back into the decimal number system.

Problem 4.4: *munged passwords (haskell)* (1+1 = 2 points)

Some people try to create stronger passwords through character substitution. The substitutions can be anything the user finds easy to remember. We use the following substitution:

character	a	b	c	d	e	f	g	h	i	l	o	q	s	x	y
substitution	@	8	(	6	3	#	9	#	1	1	0	9	$	%	?

Using this table, the string `hello world` is munged into the string `#3110 w0r16`.

a) Using pattern matching, implement a function `sub` that takes a character and returns either the character or a substitution of it. Write down the type signature of your function followed by its definition.

b) Using pattern matching, implement a function `munge` that takes a string and returns a string with all character substitutions applied. Write down the type signature of your function followed by its definition.

Submit your Haskell code plus an explanation (in Haskell comments) as a plain text file.