Homework 10

You have to submit your solutions as announced in the lecture.
Unless mentioned otherwise, all problems are due 2017-05-02, 8:00.
There will be no deadline extensions unless mentioned otherwise in the lecture.

Problem 10.1 *Records*

Points: 8

Represent the record type $\{name : string, age : int, profession : string\}$ and the record value $\{name =$ "$Alice$", $profession =$ "$Teacher$", $age = 30\}$ in the following languages

- using structs in C
- using records in SML
- using class and instances in some object-oriented languages
- using dictionaries in Python
- using JSON objects in Javascript

Naturally, untyped languages cannot handle record *types*. So you can skip the type for Javascript and Python.

Problem 10.2 *Monoids*

Points: 8

Implement

- the type $Matrix22$ of 2×2 matrices of (arbitrary-precision) integers,
- the matrix $F : Matrix22 = \begin{pmatrix} 1 & 1 \\ 1 & 0 \end{pmatrix}$,
- the data structure $Monoid[A]$ of monoids over a type A
- a concrete instance $Matrix22Multtiplication$ of type $Monoid[Matrix22]$

e.g., as indicated in the lecture.

Write a test program that computes the matrix $(F \cdot F) \cdot F$.

Problem 10.3 *Square-and-Multiply*

Points: 10

Implement the square-and-multiply algorithm to compute powers in an arbitrary monoid (as specified in the lecture notes).

Test your function by computing large Fibonacci numbers logarithmically using

$$fib(n) = (1, 0) \cdot sqmult(Matrix22Multtiplication, F, n)$$

for large n.