Homework 1

Please submit your solutions via email. Please submit only ASCII text or PDFs. Every solution should be preceeded by the corresponding question, like:

Qn:	**…a difficult question from me…**
A:	**…an answer from you …**
Q$n+1$	**…another difficult question…**
A:	**…another brilliant answer from you…**

Solutions will only be accepted until 30th December! Please send only one homework per email.

1. **(Optional)** If you want to run the code presented in the lectures, install the Scala programming language available (for free) from

   http://www.scala-lang.org

   If you want to follow the code I present during the lectures, read the handout about Scala.

2. **(Optional)** Have a look at the crawler programs. Can you find a usage for them in your daily programming life? Can you improve them? (For example in cases there are links that appear on different recursion levels, the crawlers visit such web-pages several times. Can this be avoided?)

3. Read the handout of the first lecture and the handout about notation. Make sure you understand the concepts of strings and languages. In the context of the AFL-course, what is meant by the term *language*?

4. Give the definition for regular expressions. What is the meaning of a regular expression? (Hint: The meaning is defined recursively.)

5. Assume the concatenation operation of two strings is written as $s_1 @ s_2$. Define the operation of *concatenating* two sets of strings. This operation is also written as $\_ @ \_$. According to this definition, what is $A @ \{\}$ equal to?

6. Assume a set A contains 4 strings and a set B contains 7 strings. None of the strings is the empty string. How many strings are in $A @ B$?

7. How is the power of a language defined? (Hint: There are two rules, one for $\_^0$ and one for $\_^{n+1}$.)

8. Let $A = \{[a], [b], [c], [d]\}$. (1) How many strings are in A^4? (2) Consider the case of A^4 where one of the strings in A is the empty string, for example $A = \{[a], [b], [c], []\}$.

9. How many basic regular expressions are there to match the string *abcd*? (ii) How many if they cannot include **1** and **0**? (iii) How many if they are also not allowed to contain stars? (iv) How many if they are also not allowed to contain $\_ + \_$?

10. When are two regular expressions equivalent? Can you think of instances where two regular expressions match the same strings, but it is not so obvious that they do? For example $a + b$ and $b + a$ do not count…they obviously match the same strings, namely $[a]$ and $[b]$.