CSCI 235, Programming Languages, C^{++}
Exercise 4

Deadline: 15/17.10.2018 (the day of your assigned lab)

Do not forget to submit your solution into Moodle during your lab!

1. (a) We will be using SWI-prolog, which is installed in lab 7.422. Type `prolog` to start the interpreter. It will show a command prompt `?-` You can type `halt.` to leave Prolog.
   In order to read a file, type `consult( 'file' )`, or must `[ 'file' ].`. The interpreter will automatically look for files with extension `.pl`. In order to reload a file, use the same command. The interpreter will automatically forget the previous version of the programs in the file:
   Prepare a file **fact.pl** in your favourite editor, and write the factorial program:

   ```
   fact(0,1).

   fact( N, M ) :-
      N > 0, N1 is N - 1, fact(N1,M1), M is N * M1.
   ```

   On the command prompt, type `consult( 'fact' ).` After that, you can type `fact(10,X)` or `fact(100,X)`.
   It is important to know that Prolog interpreters do not accept whitespace between a function (or predicate) name and the following '('. So, typing `fact ( 4, X )` will result in an unpleasant error message, while `fact( 4, X )` will work.
   It is also useful to know that every command ends with a dot (`.`)

   (b) The purpose of the `is` predicate is to force computation. In the factorial program, replace `M is N * M1` by `M = N * M1`, and run the program. What is the difference?

2. The prolog program in file **royal.pl** models a part of the British royal family. Namely Queen Elizabeth, Prince Philip, their four children (Charles, Anne, Andrew, Edward), and the children of Charles and Andrew.

(a) type `mother(elizabeth,anne).`, to verify that Elizabeth is the mother of Anne.

(b) Type `mother(elizabeth,X).` to get all children of elizabeth. In order to get all of them, you have to answer each solution with `;`.

(c) Type `grandfather(philip,X).` to get all grand children of Philip. Reply with `;` in order to get all grand children. (The result is incomplete because the children of Anne and Edward do not occur in the program.)

(d) The program defines a sibling as a person who shares two distinct parents. Precisely: 'X is a sibling of Y if X and Y have two common parents who are not equal to each other'.

A brother is a sibling who is male. A sister is a sibling who is female.

Type `sister(X, beatrice).` to find out who are the sisters of Beatrice.

(e) In the previous answer, there are two problems: Beatrice is her own sister because she shares two distinct parents with herself. Secondly, she is mentioned twice. This is because the two parents can be listed as Andrew, Sarah, or as Sarah, Andrew.

In order to solve the first problem, modify the sibling predicate by adding an inequality `\=` that ensures that people are not sibling of themselves. (It must be last in the definition.)

(f) In order to solve the second problem, modify the sibling predicate by requiring that one of the shared parents is male, and the other is female.

(g) Define Sophie as female, and add the children of Edward and Sophie (Louise and James). Verify that James is a brother of Louise, and Louise a sister of James.