Prolog Exam
15 August 2008

The grade is "the number of points + 10" divided by 10.

Question:	1	2	3	4	5
points:	15	20	20	15	20

Good luck!

Question 1: Unification & operators (15 points)

(a) Give for each of the following goals whether they are successful or fail. In case of success give the variable-bindings and in case of failure give a brief explanation.

```
?- p(f(X,Y),Z) = p(f(b,Z),Y).
?- p(X,Y,Z) = q(A,2,C).
?- p(f(X,X),Y) = p(f(Y,b),a).
?- [1, [2,3] | [4,5]] = [A|B].
?- [f(X),X,f(Y)] = [f(1)|Z].
?- [1,3,5] = [X,Y].
?- X + Y * Z = *(A,B).
?- X + Y * Z = +(A,B).
?- f(A,B)==f(3,Z).
?- f(g(X,Y), h(X)) =.. L.
```

(b) Represent the list [1, [2, 3], 4] in a tree representation.

Question 2: Programming Techniques (20 points)

The behaviour of the predicate `listing(P,N)` is as follows: `listing(P,N)` prints all present clauses of the predicate `P` in the database with `N` arguments. If such predicate is not in the database then `listing(P,N)` fails. Thus for example the query `?:- listing(member,2)` prints the clauses of predicate `member`, but `listing(member,1)` fails.

Write two versions of this predicate:

(a) with the use of the build-in predicate `bagof`

(b) without use of the build-in predicate `bagof`.

Question 3: recursion (20 points)

(a) Write a recursive procedure `last` that computes the last element of a list.

(b) The SWI-Prolog system has the predicate `append(L1,L2,L3)` as build-in predicate: putting `L2` after `L1` results in the list `L3`. Given this predicate, give a non-recursive definition of `last`.

Question 4: A database (15 points)

In a database of a bank are for each client the following information: name, address, account number, balance, and a list of services which the client uses. A name consists of a first name and a family name, and an address consists of a street, a number and a place. Possible services which clients can use are: creditcard (CC), chipcard (CH), pincode (PC), and personal loan (PL).

Name	Account	Balance	Address	Services
Theo Jansen	3980371	3572	Bachstraat 15, Zoetermeer	CH, PC
Dirk DeJong	2767712	-750	Uilenstede 325, Amsterdam	CH, PC, CC, PL
Thea Jansen	1730893	2753	Bachstraat 15, Zoetermeer	CC, CH, PL
...	...	...	...	...

(a) Give an appropriate Prolog representation for the database (think about a good data abstraction), and show the use of your representation by giving the following questions as a Prolog query using your representation.

- Does the database contain a client with a balance of more then 1000, and if so what is the first name of this client?
- Does the database contain a client with two accounts, and if so what is the total balance?
- What are the names of clients from Amsterdam who use at least 3 services?

(b) Write a Prolog program `total` that given a list `L` of client-names computes the total balance of the clients in `L`.

(c) Write a Prolog program `red` that computes from a given list `L` of client-names the sublist of all clients `L` which have a negative balance.

Question 5: Derivation tree (20 points)

(a) Give the complete derivation tree for the computation of all answers (thus inclusive backtracking) of the query
?- p(Y),w(Y)..

- write the rule-nr on each link of the tree
- write fail if a branch fails
- make explicit which path(s) is(are) cut by the !-operator.

```
(1) p(X):-q(X),r(X),!.
(2) p(foo).
(3) q(a).
(4) q(b).
(5) q(c).
(6) r(b).
(7) r(c).
(8) s(b).
(9) s(c).
(10) w(U):-s(U).
```

(b) Explain in words the difference between a "red cut" and a "green cut". Is the cut in the program above a "red cut" or a "green cut"? Motivate your answer.

End exam