

TECHNICAL UNIVERSITY OF DENMARK (DTU)

Written Sample-Exam-9, 2021

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Course: Logical Systems and Logic Programming

Course number: 02156

Exam duration: 2 hours

Aids allowed: All written works of reference

Weighting: Stated for each problem

The following basic predicates can be used when writing Prolog programs:

```
member(H, [H|_]).  
member(H, [_|T]) :- member(H,T).  
  
append([], U, U).  
append([H|T], U, [H|V]) :- append(T, U, V).
```

Here `member(?Elem, ?List)` succeeds if and only if `Elem` can be unified with one of the members of `List` and `append(?List1, ?List2, ?List3)` succeeds if and only if `List3` unifies with the concatenation of `List1` and `List2`.

Standard predicates like `is`, `fail`, `write`, `nl` and `findall` can also be used.

In the following a Prolog program is said to be deterministic if and only if it does not succeed more than once.

Assume available a deterministic predicate `sort(+List, ?Sorted)` that can be used to sort a list. Duplicates are merged as shown in the following example:

```
?- sort([3,1,4,1,2], S).
```

```
S = [1, 2, 3, 4]
```

Yes

Assume also available a predicate `length(+List, ?Integer)` that can be used to calculate the number of elements in a list.

Problem 1 (40%)

Consider the following fragment of a database for items and names:

```
entry(item1,name1).  
entry(item1,name2).  
entry(item1,name3).  
entry(item2,name4).  
entry(item3,name1).  
entry(item4,name1).  
entry(item4,name4).
```

Question 1.1

Write a deterministic Prolog program `count(?Integer)` that counts the total number of (different) items in the database. A sample query:

```
?- count(I).
```

I = 4

Yes

Question 1.2

Write a deterministic Prolog program `details(+List)` that prints the full entry (both item and name) in the database for all items with a name in `List`, hence for the above fragment for example:

```
?- details([name1,name2,name3]).  
item1 name1  
item1 name2  
item1 name3  
item3 name1  
item4 name1
```

Yes

```
?- details([]).
```

Yes

Question 1.3

Write a deterministic Prolog program `collect(?List)` that succeeds if and only if `List` is the sorted list of items in the database, hence for the above fragment for example:

```
?- collect(S).
```

```
S = [item1, item2, item3, item4]
```

Yes

Question 1.4

A name is ambiguous if it appears in the database more than once as a name.

Write a deterministic program `multi(?List)` that succeeds if and only if `List` is the sorted list of ambiguous names in the database, hence for the above fragment for example:

```
?- multi(S).
```

```
S = [name1, name4]
```

Yes

Problem 2 (30%)

Consider the following formula: $(\forall x \exists y (p(x) \wedge \neg p(y))) \rightarrow \neg q(a)$

Question 2.1

Use refutation and the systematic construction of a semantic tableau. State whether this shows that the formula is valid or not.

Question 2.2

Use refutation, skolemization and the general resolution procedure. State whether this shows that the formula is valid or not.

Problem 3 (30%)

In the following a semicolon (;) is used to separate the solutions to a query. This corresponds to the common use of the semicolon in an interactive Prolog session.

Question 3.1

State the remaining solutions to the following query:

```
?- append([_,_|_],L,[1,2,3,4,5,6]), append(_, [X,Y|_],L).
```

```
L = [3, 4, 5, 6]
```

```
X = 3
```

```
Y = 4 ;
```

```
L = [3, 4, 5, 6]
```

```
X = 4
```

```
Y = 5 ;
```

```
...
```

Question 3.2

State the solutions to the following query:

```
?- append(X,Y,[1,2,[1],[1,2]]), \+ member(X,Y).
```

Question 3.3

Consider the following Prolog program:

```
main(N) :- member(L,[[1,2,3],[],[3],[2],[1]]), fun(L,N).
```

```
fun(L,N) :- member(N,L), N > 1, !.
```

```
fun(_, -1).
```

State the solutions to the following query:

```
?- main(N).
```