

NAME:

CONTACT PERSON AT K.U.LEUVEN (IN CASE OF ERASMUS STUDENTS):

## Examination of Programming languages and Programming Methodologies

8 January 2016, 9h00 – 13h00

### General Guidelines

The examination is closed book and takes (at most) 4 hours.

Make sure that your handwriting is readable.

Write your name on every sheet you hand in. Write on one side of the sheet only.

When writing down predicates, add comments that describe their meaning. When using particular data structures, document them.

### Questions

1. Do the following queries succeed or fail? In case of success, give the bindings of the variables in the query. In case of failure, explain why.

1)  $?- [H \mid T] = [1, 2, [b, X]]$ .

✓2)  $?- L = [A, C] \text{ , } L = [a|B]$ .

✓3)  $?- L = [ [2, X] \mid T], D = L - T, L = [A, B]$ .

4)  $?- Y = 6, A = B, g(3 + Y, 9) = g(A, B)$ .

2. Consider the following Prolog program:

```
shuffle([], B, B).  
shuffle([H|A], [H|B], [H|S]) :- shuffle(A, B, S).  
shuffle([H|A], B, [H|S]) :- shuffle(B, A, S). % shuffle 2 arguments
```

Do the following queries succeed or fail? Sketch their execution by Prolog (e.g. by giving an execution tree). In case of success, indicate how many times it succeeds and give the bindings of the variables (if any) in the query. In case of failure, explain why.

1) ?- shuffle([1,2],[4,2],Res).

2) ?- shuffle(X,[2],[1,2]).

3. To add a little fun to the sweltering summer heat, 4Bs Boutique in downtown Knokke announced that they were sponsoring a swimsuit contest. Prizes would be awarded to the winners and judging would be held the following weekend. Interested contestants should sign up and the 4Bs clientele set up quite a buzz over it all, with speculation running high for both who would sign up and who would win, if they did sign up.

Write a predicate `swim` that determines the full name of the five winning contestants (one first name was Sarah and one last name was Sanford), the color of each winners bathing suit, if the winners wore a 1-piece suit or a 2-piece, and what place each won (1st to 5th).

- 1) Rachel Travers did not wear a red bathing suit but she did place one higher than the woman wearing the white 1-piece bathing suit.
- 2) Melonys last name was not James but she won 1st place.
- 3) The three who wore 1-piece suites were the woman in 2nd place, the one who wore the yellow bathing suit, and Amelia, whose last name was not West.
- 4) Rachel placed one higher than Ms. Couch but two places lower than the one who wore the blue bathing suit.
- 5) Julias last name was not Couch. Ms. James wore a 2-piece bathing suit.
- 6) The five women were, in no particular order, Ms. James, Julia, the woman who placed 5th, the woman who wore the black 2-piece bathing suit, and Ms. West.

Please use the numbers of the 6 hints to document your code. Indicate clearly whether you are using CLP(R), CLP(FD) or just normal Prolog.

4. You have to plan the shifts of the workers for the next quarter. They take shifts one after another. For each worker you are given his minimum and maximum number of shifts in the next quarter. In the planning for the next quarter, his number of shifts has to be between the minimum and the maximum.

1) Represent this information in two different ways: by Prolog facts and by Prolog terms. Use your 2 representations to represent the information that worker danny needs to do at least 3 shifts and at most 7. ?

2) Define for both cases the predicate possible that for a given subset of workers determines whether together they can form a team to deal with a sequence of s shifts.

Consider the case that danny needs to do at least 3 shifts and at most 7, and jef needs to do at least 2 shifts and at most 2, and ann needs to do at least 2 shifts and at most 4.

It is possible to make a plan for 5 shifts with danny and jef: namely danny, jef, danny, jef, danny. It is not possible to make a plan for 6 shifts with danny and jef. It is possible to make a plan for 6 shifts with danny and ann:

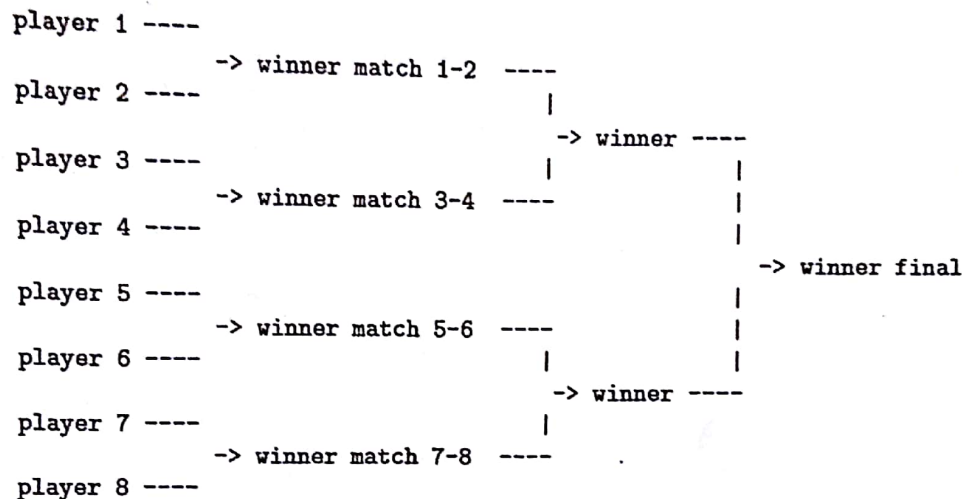
namely ann, danny, ann, danny, ann, danny.

$d(3,7)$   
 $j(2,2)$   
 $a(2,4)$

5. A single-elimination badminton tournament is organised with n players (where n is a power of 2). The people entering the tournament are numbered from 1 to n. For each potential badminton match between two players you know who would win the match. The relation is not necessarily transitive: it may be the case that person i beats person j, person j beats person k, and person k beats person i. There are n! (n factorial) ways to assign the players to the starting positions in the tournament. Different assignments may produce a different winner of the tournament.



A scheme for a tournament with 8 players with as initial sequence 1,2,3,4,5,6,7,8 is as follows:



- 1) How do you represent for a given  $n$ , the information about who beats who? Use your representation to represent that 1 beats 2,3,4,5, and 6 but is beaten by 7 and 8.
- 2) How do you represent an initial sequence of  $n$  players? Note that any permutation of the numbers 1,2,3,...,  $(n-1)$ , $n$  is a valid starting sequence.
- 3) Write a predicate `onematch` that for a given sequence of players determines the players that go to the next round (taking into account the given information about who beats who).  
Note that there is a match between the first and the second player in the sequence, and a match between the third and the fourth, and ...
- 4) Write a predicate `tournament` that for a given initial sequence of  $n$  players determines the winner of the tournament.
- 5) Write a predicate `numberwins` that determines for a given player in how many initial sequences that player wins the tournament.

Good luck.

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