11 Lab
Advanced Exercises in Prolog

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a.a. 2024/2025

Lab 11: Outline

- Exercises with built-in numbers and lists
- Other exercises in Prolog, mostly using cut
- Supporting a new data structure (graphs)
- An advanced exercise
  - Generation of TicTacToe tables

Part 1: On built-in lists and numbers

- Implement new (or reimplement wrt previous lab) the following predicates, using built-in predicates for lists and numbers

Ex1.1: search2

```
% search2(Elem, List)
% looks for two consecutive occurrences of Elem
```

Ex1.2: search_two

```
% search_two(Elem,List)
% looks for two occurrences of Elem with any element in
    between!
```

- `search_two(a,[b,c,a,a,d,e]).` → no
- `search_two(a,[b,c,a,d,a,d,e]).` → yes

Part 1: On built-in lists and numbers

Ex1.3: size

```
% size(List, Size)
% Size will contain the number of elements in List
```

- is it fully relational?

Ex 1.4: sum

```
% sum(List,Sum)

?- sum([1,2,3],X).
yes.
X/6
```

Part 1: On built-in lists and numbers

Ex1.5: max and min

```
% max(List,Max,Min)
% Max is the biggest element in List
% Min is the smallest element in List
% Suppose the list has at least one element
```

Ex1.6: sublist

```
% split(List1, Elements, SubList1, SubList2)
% Splits a list into two sublists based on a given set
    of elements.
% example: split([10,20,30,40,50],2,L1,L2). -> L1
    /[10,20] L2/[30,40,50]
```

Part 1: On built-in lists and numbers

Ex1.7: rotate

```
% rotate(List, RotatedList)
% Rotate a list, namely move the first element to the
    end of the list.
% example: rotate([10,20,30,40], L). -> L/[20,30,40,10]
```

Ex 1.8 count_occurrences

```
% count_occurrences(Element, List, Count)
% Count is the number of times Element appears in List.
% example: count_occurrences(2,[1,2,3,2,4,2],Count). ->
    Count/3
```

Part 1: On built-in lists and numbers

Ex 1.9: dice

```
% dice(X)
% Generates all possible outcomes of throwing a dice.
% example: dice(X): X/1; X/2; ... X/6
```

Ex 1.10: three_dice

```
% three_dice(L).
% Generates all possible outcomus of throwing three dices
% example: three_dice(L). -> L/[1,1,3]; L/[1,2,2];...;L/[3,1,1]
```

Ex 1.11: distinct

```
% distinct(List, DistinctList)
% DistinctList contains all distinct elements from List.
% example: distinct([1,2,3,2,4,1],L). -> L/[1,2,3,4]
```

Part 2: basic cut operations

Ex 2.1: dropAny

```
% dropAny(?Elem,?List,?OutList)

dropAny(X, [X | T], T).
dropAny(X, [H | Xs], [H | L]) :- dropAny(X, Xs, L).
```

- Check the above code
- Drops any occurrence of element
  - `dropAny(10,[10,20,10,30,10],L)`
    - `L/[20,10,30,10]`
    - `L/[10,20,30,10]`
    - `L/[10,20,10,30]`

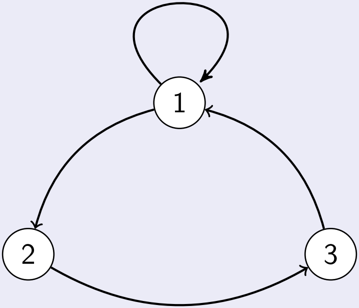
Ex2.2: other drops

- Implement the following variations, by using minimal interventions (cut and/or reworking the implementation)
  - `dropFirst`: drops only the first occurrence (showing no alternative results)
  - `dropLast`: drops only the last occurrence (showing no alternative results)
  - `dropAll`: drop all occurrences, returning a single list as a result

Part 3: Operations on graphs

Model

- list of couples (e.g `[e(1,1),e(1,2),e(2,3),e(3,1)]`)
- the order of elements in the list is not relevant
- we use numbers to label nodes just as example



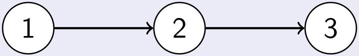
Part 3: Operations on graphs

Ex3.1: fromList

```
% fromList(+List,-Graph)

fromList([_],[]).
fromList([H1,H2|T],[e(H1,H2)|L]):- fromList([H2|T],L).
```

- Just analyse the code
- It creates a graph from a list
  - `fromList([1,2,3],[e(1,2),e(2,3)]).`
  - `fromList([1,2],[e(1,2)]).`
  - `fromList([1],[]).`



Ex3.2: outDegree

```
% outDegree(+Graph, +Node, -Deg)
%
% Deg is the number of edges which start from Node
```

- Implement it!
- `outDegree([e(1,2), e(1,3), e(3,2)], 2, 0).`
- `outDegree([e(1,2), e(1,3), e(3,2)], 3, 1).`
- `outDegree([e(1,2), e(1,3), e(3,2)], 1, 2).`

Part 3: Operations on graphs

Ex3.3: reaching

```
% reaching(+Graph, +Node, -List)

% all the nodes that can be reached in 1 step from Node
% possibly use findall, looking for e(Node,_) combined
% with member(?Elem,?List)
```

- Implement it
- `reaching([e(1,2),e(1,3),e(2,3)],1,L). -> L/[2,3]`
- `reaching([e(1,2),e(1,2),e(2,3)],1,L). -> L/[2,2]).`

Part 3: Operations on graphs

Ex3.4: nodes

```
% nodes (+Graph, -Nodes)
% craate a list of all nodes (no duplicates) in the
    graph (inverse of fromList)
```

- Implement it
- `nodes([e(1,2),e(2,3),e(3,4)],L). -> L/[1,2,3,4]`
- `nodes([e(1,2),e(1,3)],L). -> L/[1,2,3].`

Ex3.5: anypath (advanced!!)

```
% anypath(+Graph, +Node1, +Node2, -ListPath)

% a path from Node1 to Node2
% if there are many path, they are showed 1-by-1
```

- `anypath([e(1,2),e(1,3),e(2,3)],1,3,L).`
  - `L/[e(1,2),e(2,3)]`
  - `L/[e(1,3)]`
- Implement it!
- Suggestions:
  - a path from N1 to N2 exists if there is a e(N1,N2)
  - a path from N1 to N2 is OK if N3 can be reached from N1, and then there is a path from N2 to N3, recursively

Part 3: Operations on graphs

Ex3.6: allreaching

```
% allreaching(+Graph, +Node, -List)

% all the nodes that can be reached from Node
% Suppose the graph is NOT circular!
% Use findall and anyPath!
```

- Implement it using the above suggestions
- `allreaching([e(1,2),e(2,3),e(3,5)],1,[2,3,5]).`

Ex3.7: grid-like nets (Optional)

- During last lesson we see how to generate a grid-like network. Adapt that code to create a graph for the predicates implemented so far.
- Try to generate all paths from a node to another, limiting the maximum number of hops

Part 4: Generating Connect3 (“forza 3”)

Ex4.1: next

- Implement predicate next/4 as follows
  - `next(@Table,@Player,-Result,-NewTable)`
  - Table is a representation of a TTT table where players x or o are playing
  - Player (either x or o) is the player to move
  - Result is either win(x), win(o), nothing, or even
  - NewTable is the table after a valid move
  - Should find a representation for the Table
  - Calling the predicate should give all results

Ex4.2: game

- Implement `game(@Table,@Player,-Result,-TableList)`
- TableList is the sequence of tables until Result win(x), win(o) or even

Part 4: Generating Connect3 ("forza 3")

Hints

- Choosing the right representation for a table is key
  - with a good representation it is easier to select the next move, and to check if somebody won
  - if needed, prepare to separate representation from visualisation
- Possibilities
  - `[[_,_,_],[x,o,x],[o,x,o]]`: nice but advanced
  - `[[n,n,n],[x,o,x],[o,x,o]]`: compact, but need work
  - `[cell(0,1,x),cell(1,1,o),cell(2,1,x),...]`: easier
  - ... do you have a different proposal?