Lists

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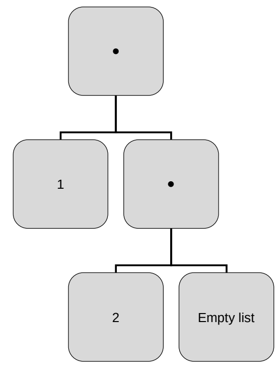
Lists

We can represent lists as binary trees where list elements are left children

‘.’(1, ‘.’(2, empty list))

Is the list [1,2]

(how to represent the empty list?)

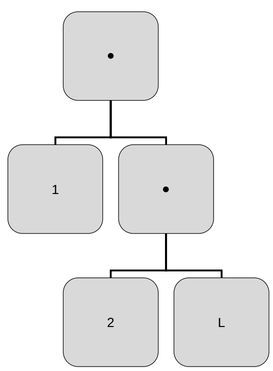


Lists

We can represent lists as binary trees where sub-lists are right children

‘.’(1, ‘.’(2, L))

Is the list [1,2| L]



Lists

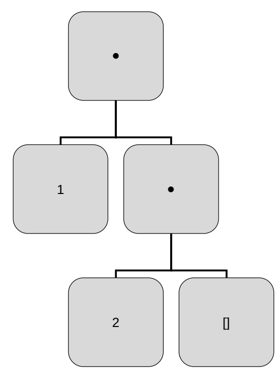
The empty list is the atom []

‘.’(1, ‘.’(2, []))

Is the list [1,2| []] which is the list [1,2]

:- [1,2|[]] = [1,2].

:- display([1,2|[]]).



Write the following procedures

- car(?List, ?Head)
  - Succeeds if Head is the first element of List (the head)
- cdr(?List, ?Tail)
  - Succeeds if Tail is the sub-list of List without its first element (the tail)
- cons(?List, ?Head, ?Tail)
  - Succeeds if Head is the first element of List (the head) and Tail is the sub-list of List without its first element (the tail)

Implement a Stack

- push(?Element, +OldSctack, -NewStack)
- pop(+OldStack, -NewStack, -Element)
- top(+Stack, -Element)
- empty(+Stack)

List Manipulation

- member(?Term, ?List)
  - Succeeds if Term unifies with a member of the list List.
- delete(?Element, ?List1, ?List2)
  - Succeeds if List2 is List1 less an occurrence of Element in List1.
- append(?List1, ?List2, ?List3)
  - Succeeds if List3 is the result of appending List2 to List1.
- reverse(+List, ?Reversed)
  - Succeeds if Reversed is the reversed list List.
- length(?List, ?N)
  - Succeeds if the length of list List is N.

Recursion

```
% my_length1.pl
my_length([], 0).
my_length([Head|Tail], Count) :-
   my_length (Tail, Sum),
   Count is Sum + 1.
```


Accumulator

```
% my_length2.pl
my_length(L, Total):- my_length(L, 0, Total).
sub_my_length([], Total, Total).
sub_my_length([Head|Tail], Sum, Total) :-
   Count is Sum + 1,
   sub_my_length (Tail, Count, Total).
```


Tail recursion

```
% my_length2.pl
my_length(L, Total):- my_length(L, 0, Total).
sub_my_length([], Total, Total).
sub_my_length([Head|Tail], Sum, Total) :-
   Count is Sum + 1,
   sub_my_length (Tail, Count, Total).
```


Naïve reverse

```
reverse_naive([], []).
reverse_naive([Head|Tail1], Reversed) :-
   reverse_naive(Tail1, Tail2),
   append(Tail2, [Head], Reversed).
```


Reverse with Accumulator and Tail Recursion

```
:- reverse_acc(List, [], Tsil).

reverse_acc([], Reversed, Reversed).
reverse_acc([Head|Tail], Rest, Reversed) :-
   reverse_acc(Tail, [Head|Rest], Reversed).
```

Generalizing Accumulators: Difference Structures

Probably one of the most ingenious programming techniques ever invented (by Sten-Åke Tärnlund, 1975) yet neglected by mainstream computer science.

A way of using variables as 'holes' in data structures that are filled in by unification as the computation proceeds.

Variables and Unification

:- test([a, b, c, X], X, Y) = test(Z, d, Z)

Z = [a, b, c, X]
X = d
Y = Z = [a, b, c, d]

Variables and Unification

:- test([a, b | L1], L1, L2)= test(L3, [c, d], L3)

L3 = [a, b| L1]
L1 = [c, d]
L2 = L3 = [a, b, c, d]

Difference Lists

We represent the list [1, 2, 3] by the difference:

[1, 2, 3|L1] – L1

This is conceptual, this is only a structure and no difference is computed

Appending Difference Lists

we want to append list
L1 – LL1 = [a, b, c | LL1] – LL1
With
L2 – LLL2 = [d, e, f | LL2] – LL2
And get
L3 – LL3 = [a, b, c | [d, e, f | LL3]] – LL3

L1

LL1 = L2

L3

Appending Difference Lists

```
/* diff.pl */
diff_append(L1 – L2, L2 – LL3, L1 – LL3).
```

Member of Difference Lists

```
/* diff.pl */
member(_, L1 – L1) :- !, fail.
member(X, [X|_] – _).
member(X, [_|L1] – L2):-
  member(X, L1 – L2).

% need occur check, why?
```


Credits

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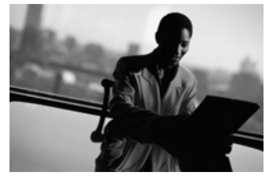

Logic Programming and Constraints