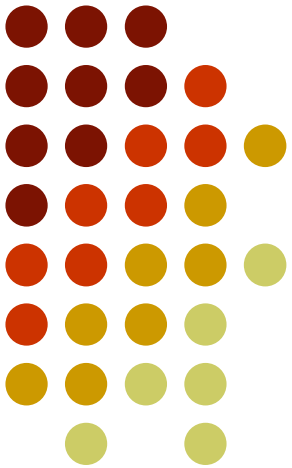
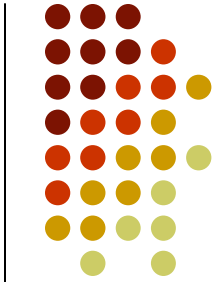
Introduction to Prolog
Lists, Recursions, Cuts

CS181: Programming Languages



Topics:



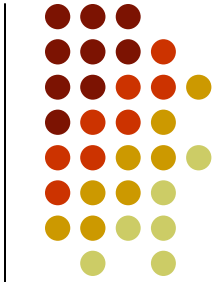
- Lists
- Recursion
- Cuts

Lists

- Variable length ordered sequences of elements
- Very common data structures in non-numeric programming

- A list is either an empty list **[ ]**
- or it has two components:
  the head and the tail **.(a,[ ])**

Lists



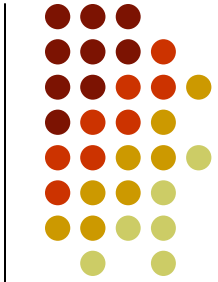
- There are two ways to represent lists

```
.(a,.(b,.(c,[])))
[a,b,c]
```

- Lists can contain other lists and variables

```
[ ]
[the, men, [like, to, fish]]
[a,V1,b,[X,Y]]
```

Lists

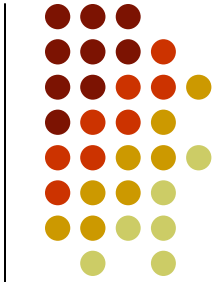


- The list with head X and tail Y is written

[X|Y]

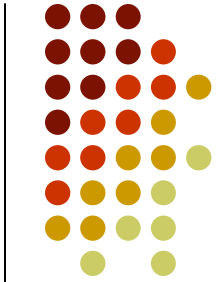
List	Head	Tail
[a, b, c]	a	[b,c]
[ ]	(None)	(None)
[[a,b], c]	[a,b]	[c]
[a,[b], c]	a	[[b], c]
[a, [b,c]]	a	[[b,c]]

List Matching



List 1	List 2	Instantiations
[X,Y,Z,]	[john, likes, fish]	X = john Y = likes Z = fish
[X|Y]	[cat]	X = cat Y = []
[X|Y]	[[cat], dog]	X = [cat] Y = [dog]

List Matching

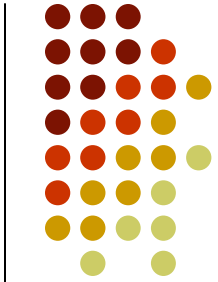


- Example:

```
p([1, 2, 3]).
p([john, likes, [football, baseball]]).

?- p[X|Y].
X=1       Y=[2,3]
X=john    Y=[likes, [football, baseball]]
```

Lists and Recursion

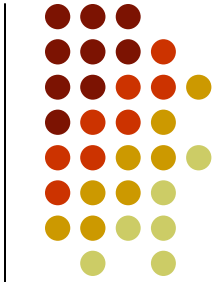


- More examples:

```
member(X, [X|L]).
member(X, [Y|L]) :- member(X,L).

last(X, [X]).
last(X, [Y|L]) :- last(X, L).
```

Recursion

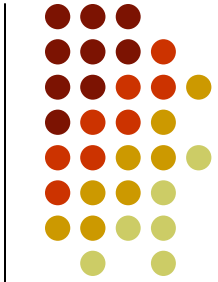


- Always define the boundary condition and the recursive step.
- Careful with the recursive step! The first rule will work, but the second one will loop forever:

```
ancestor(X,Y):- parent(X,Y).
ancestor(X,Y):- ancestor(X,Y), parent(Y, Z).

ancestor(X,Y):- parent(X,Y).
ancestor(X,Y):- parent(X,Z), ancestor(Z,Y).
```

Recursion



- Also you must be careful to avoid circular definitions:

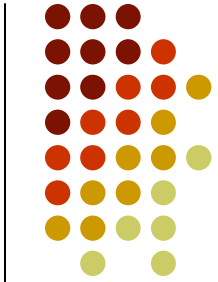
```
parent(X,Y) :- child(Y,X).
child(A,B) :- parent(B,A).
```

Recursions

- Another example of a recursion (however, note that Prolog is not an efficient way to do numerical computations):

```
factorial(0, 1).
factorial(N, F) :- N>0,
                   N1 is N-1,
                   factorial(N1, F1),
                   F is N * F1.
```

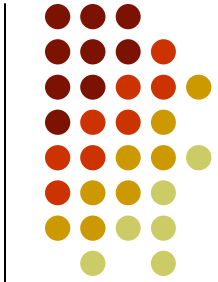
Cuts



- ! is a special PROLOG facility called *the cut*.
- Cuts may be inserted anywhere within a clause to prevent backtracking to previous subgoals, for example:

```
p(X) :- b(X), c(X), !, d(X), e(X).
```

Cuts



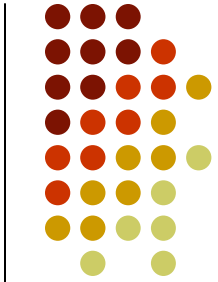
- Suppose that this clause has been invoked with a goal matching p(X) and the subgoals b(X) and c(X) have been satisfied. On encountering the cut:

1) The cut will succeed and PROLOG will try to satisfy subgoals d(X) and e(X).

2) If d(X) and e(X) succeed then p(X) succeeds.

3) If d(X) and e(X) do not succeed and backtracking returns to the cut, then the backtracking process will immediately terminate and p(X) fails.

Cuts

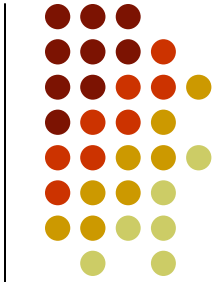


- Example:

```
max(A,B,B) :- A < B.
max(A,B,A).

?- max(3,4,M).
M = 4     ;
M = 3
```

Cuts

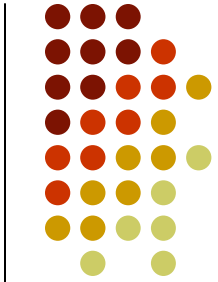


- Confirming the choice of a rule:

```
max(A,B,B) :- A < B, !.
max(A,B,A).

?- max(3,4,M).
M = 4
```

Cuts

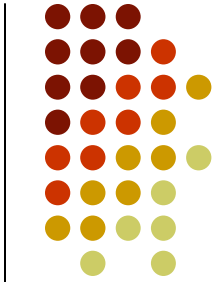


- Avoiding useless searches:

```
member(X,[X|L]) :- !.
member(X,[Y|Z]) :- member([X,Z]).

?-  X is 5,
    member(X, [5, 9, 24, 17, 5, 2]),
    X < 4.
```

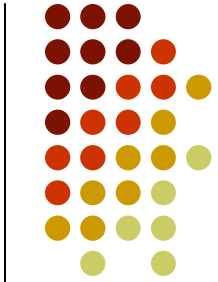
Cuts



- Cuts are commonly used in conjunction with the generate-and-test programming paradigm

```
find_just_one_solution(X) :-
        candidate_solution(X),
        test_solution(X),
        !.
```

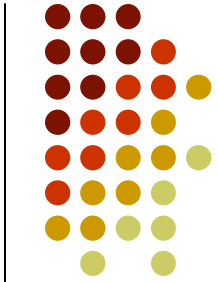
Cuts



- cut – fail combination, to express negation:

```
nonsibling(X, Y) :- sibling(X, Y), !, fail.
nonsibling(X, Y).
```

References



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- Aaby, A. *Prolog Tutorial*. Walla Walla College. 1997. On line. http://cs.wwc.edu/~cs_dept/KU/PR/Prolog.html