# More Prolog Mini Exercises
# Derivation Trees; Difference Lists; Controlling Search — Answer Key

These questions use the Prolog rules in the lecture notes (both the basics and the ones on controlling search).

1. Draw the derivation tree for the following goals:

   ```
   ?- reverse([1],R).
   ```

   Please see the separate scan of the hand-drawn tree. Also try running the goal with the Prolog trace facility.

2. Consider `mymember` and also the `member_cut` rule defined in the notes on controlling search. What are all the answers that Prolog returns for the following goals?

   ```
   ?- mymember(1,[A,B,C]).
   A = 1 ;
   B = 1 ;
   C = 1 ;
   false.

   ?- member_cut(1,[A,B,C]).
   A = 1.
   ```

3. What are all the answers that Prolog returns for the following goals?

   ```
   ?- mymember(X,[1,2]), mymember(X,[0,2,2]).
   X = 2 ;
   X = 2 ;
   false.

   (Note that you get the same answer twice!)


   ?- member_cut(X,[1,2]), mymember(X,[0,2,2]).
   false.


   ?- mymember(X,[1,2]), member_cut(X,[0,2,2]).
   X = 2 ;
   false.


   ?- member_cut(X,[1,2]), member_cut(X,[0,2,2]).
   false.
   ```

4. What are all the answers that Prolog returns for the following goals?

   ```
   ?- not(mymember(1,[1,2,3])).
   false.
   ```

```
?- not(mymember(5,[1,2,3])).
true.


?- not(mymember(X,[1,2,3])).
false.


?- mymember(X,[1,2,3]), not(mymember(X,[1,2,4])).
X = 3 ;
false.



?- not(mymember(X,[1,2,4])), mymember(X,[1,2,3]).
false.
```

5. Consider the standard version of `append`:

   ```
   append([],Ys,Ys).
   append([X|Xs],Ys,[X|Zs]) :- append(Xs,Ys,Zs).
   ```

   If you know that the first argument is ground (that is, fully instantiated, containing no variables), there is a more efficient version that you can write by including a cut.

   (a) Define such a version.

   ```
   append([],Ys,Ys) :- !.
   append([X|Xs],Ys,[X|Zs]) :- append(Xs,Ys,Zs).
   ```

   (b) Give an example of a query that has exactly the same behavior for both the standard version and the version with a cut.

   ```
   append([1,2],[3,4,5],X).
   ```

   (c) Give an example of a query that behaves differently for for the standard version and the version with a cut.

   ```
   append(A,B,[1,2,3]).
   ```

   (d) What restrictions do we need on the inputs for the two versions to behave exactly the same? (Is it that the first argument is ground?)

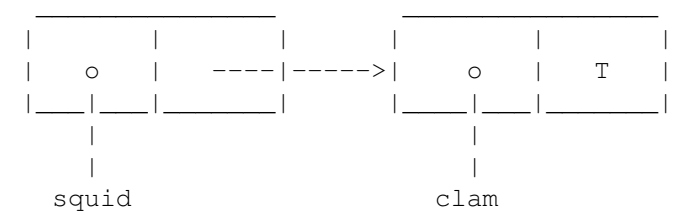
   No, it's a little more general: just that the first argument not be a variable or a list with a variable as the tail of the list.

6. Which of the following lists represent valid difference lists? For valid difference lists, what list do they represent?

   ```
   [1,2|T]\T          -- valid, represented [1,2]
   [1,2,3]\[]         -- valid, represents [1,2,3]
   [1,2,3]\[1,2]      -- not valid
   [1,2,3|T]\[3|T]    -- valid, represents [1,2]
   [1,2,3]\[1,2,3]    -- valid, represents []
   ```

7. Write the list `[squid,clam]` as a difference list (in the most general possible way). Also draw a box-and-arrow diagram of the first part of the difference list.

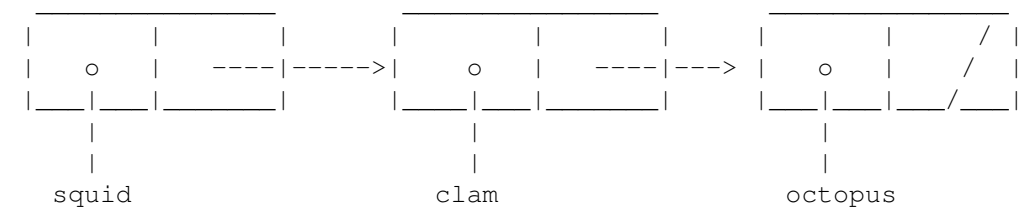
```
[squid,clam|T]\T
```




Notice that this remains a valid difference list representation of `[squid,clam]` no matter what we unify with `T`. For example, if we unify `T` with `[octopus]`, we get this difference list:

```
[squid,clam,octopus]\[octopus]
```

which still represents `[squid,clam]`. Here's the box-and-arrow representation of what happens to `[squid,clam|T]`:




8. Using the clpr library, write a rule `mymin` such that if you call `mymin(A,B,C)`, `C` will be the minimum of `A` and `B`.

```
mymin(X,Y,X) :- {X<=Y}.
mymin(X,Y,Y) :- {X>Y}.
```

9. Write a rule `solve` using the clpr library that solves the simultaneous equations $2x + 3y = 8$ and $x + y = 3$.

```
solve(X,Y) :- {2*X + 3*Y=8, X+Y=3}.
```

10. Again using the clpr library, write a rule `sum` such that for `sum(Xs,S)`, `S` is the sum of the numbers in the list `Xs`. You can assume the list consists only of numbers. For example `sum([],S)` should succeed with `S=0.0`, `sum([3,4],S)` should succeed with `S=7.0`, and `sum([A,A],10)` should succeed with `A=5.0`.

```
sum([],0).
sum([X|Xs],S) :- sum(Xs,S1), {X+S1=S}.
```