

Answers to Exercises A

1. a. ?- class(monday,_,_,1.1,_).
b. ?- course(1.3,_,mjs).
c. ?- class(____,2.2,_).
d. ?- class(____,145,1.1,_).
e. ?- class(____,1.6,laboratory).
f. ?- lecturer(drb,david,_).
g. ?- class(____,343,_,laboratory).
h. ?- lecturer(I,jeff,kramer), course(____,I).
i. ?- class(D,____,1.1,_).
j. ?- class(monday,11,_,C,_).
k. ?- course(C,_,clh).
l. ?- class(D,T,_,2.3,_).
m. ?- class(____,145,C,_).
n. ?- class(____,_,C,laboratory).
o. ?- lecturer(I,marek,sergot), course(____,N,I).
p. ?- class(monday,____,C,lecture), class(monday,____,C,tutorial).
q. ?- class(____,R,C,_), R \== 343.
r. ?- lecturer(I,chris,_), course(C,_,I),class(thursday,____,C,_).
s. ?- course(C,_,L1), course(C,_,L2), L1 \== L2.
t. ?- lecturer(L1,F,_), lecturer(L2,F,_), L1 \== L2.
u. ?- course(C1,_,I), course(C2,_,I), C1 \== C2, lecturer(I,_,S).
- 2 a. teacher(X) :-
 lecturer(X,____).
b. teaches(X) :-
 course(____,X).
c. polymath(X) :-
 course(C1,_,X),
 course(C2,_,X),
 C1 \== C2.
d. overworked(X) :-
 polymath(X).
 overworked(X) :-
 class(____,9,_,C,_),
 course(C,_,X).
e. clashes(X,Y) :-
 class(D,T,_,X,_),
 class(D,T,_,Y,_),
 X \== Y.
f. miraculous(X) :-
 course(C1,_,X),
 course(C2,_,X),
 clashes(C1,C2).

Answers to Exercises B

1. a. `?- member(a, [a, b, c]).`
b. `?- member(X, [a, b, c]).`
c. `?- member(a, L).`

2. a. `?- append([a, b, c], [d, e, f], L).`
b. `?- append(L1, L2, [r, s, t, u, v]).`

3. a. `first(H, [H|T]).`
b. `last(H, [H]).`
`last(X, [H1, H2|T]) :-`
`last(X, [H2|T]).`
c. `palindrome([X]).`
`palindrome([X, X]).`
`palindrome([X|L]) :-`
`append(L1, [X], L),`
`palindrome(L1).`
d. `add(X, Y, Y) :-`
`member(X, Y).`
`add(X, Y, [X|Y]) :-`
`\+ member(X, Y).`

Answers to Exercise C

- ```
del(X, [], []).
del(X, [X|Z], Z1) :-
 del(X, Z, Z1).
del(X, [Y|Z], [Y|Z1]) :-
 X \== Y,
 del(X, Z, Z1).
```
- ```
del_f(X, [], []).
del_f(X, [X|Z], Z).
del_f(X, [Y|Z], [Y|Z1]) :-
    X \== Y,
    del_f(X, Z, Z1).
```
- ```
del_l(X, Z, Z):-
 \+ member(X, Z).
del_l(X, [X|Z], Z) :-
 \+ member(X, Z).
del_l(X, [Y|Z], [Y|Z1]) :-
 member(X, Z),
 del_l(X, Z, Z1).
```
- ```
rep(X, [], Y, []).
rep(X, [X|Z], Y, [Y|Z1]) :-
    rep(X, Z, Y, Z1).
rep(X, [U|Z], Y, [U|Z1]) :-
    X \== U,
    rep(X, Z, Y, Z1).
```
- ```
rep_f(X, [], Y, []).
rep_f(X, [X|Z], Y, [Y|Z]).
rep_f(X, [U|Z], Y, [U|Z1]) :-
 X \== U,
 rep_f(X, Z, Y, Z1).
```
- ```
rep_l(X, Z, Y, Z):-
    \+ member(X, Z).
rep_l(X, [X|Z], Y, [Y|Z]) :-
    \+ member(X, Z).
rep_l(X, [U|Z], Y, [U|Z1]) :-
    member(X, Z),
    rep_l(X, Z, Y, Z1).
```
- ```
quicksort([], []).
quicksort([X|Y], Z) :-
 partition(X, Y, Y1, Y2),
 quicksort(Y1, Z1),
 quicksort(Y2, Z2),
 append(Z1, [X|Z2], Z).

partition(X, [], [], []).
partition(X, [H|T], [H|L1], L2) :-
 H =< X,
 partition(X, T, L1, L2).
partition(X, [H|T], L1, [H|L2]) :-
 H > X,
 partition(X, T, L1, L2).
```
- The query `?- max(2, 1, 1)` would succeed erroneously.

An improved definition is:

```
max(X, Y, Z) :-
 Y < X, !,
 Z = X.
max(X, Y, Y).
```

or the more elegant, if slightly less efficient:

```
max(X, Y, X) :-
 Y < X, !.
max(X, Y, Y) :-
 Y >= X.
```

## Answers to Exercises D

1. `even(0).`  
`even(X) :-`  
    `X > 1,`  
    `X1 is X-2,`  
    `even(X1).`

`subset([], L).`  
`subset([H|T], L) :-`  
    `member(H, L),`  
    `subset(T, L).`
2. `evens([]).`  
`evens([H|T]) :-`  
    `even(H),`  
    `evens(T).`

`prague(P11,P21,P31,P41,P12,P22,P32,P42,P13,P23,P33,P43,P14,P24,P34,P44) :-`  
    `subset([P11,P21,P31,P41,P12,P22,P32,P42,P13,P23,P33,P43,P14,P24,P34,P44], [0,1]),`  
    `R1 is P11 + P12 + P13 + P14,`  
    `R2 is P21 + P22 + P23 + P24,`  
    `R3 is P31 + P32 + P33 + P34,`  
    `R4 is P41 + P42 + P43 + P44,`  
    `C1 is P11 + P21 + P31 + P41,`  
    `C2 is P12 + P22 + P32 + P42,`  
    `C3 is P13 + P23 + P33 + P43,`  
    `C4 is P14 + P24 + P34 + P44,`  
    `D1 is P11 + P22 + P33 + P44,`  
    `D2 is P14 + P23 + P32 + P41,`  
    `10 is R1 + R2 + R3 + R4,`  
    `evens([R1, R2, R3, R4, C1, C2, C3, C4, D1, D2]).`
3. `brno(P11,P21,P31,P41,P12,P22,P32,P42,P13,P23,P33,P43,P14,P24,P34,P44) :-`  
    `subset([P11,P21,P31,P41,P12,P22,P32,P42,P13,P23,P33,P43,P14,P24,P34,P44], [0,1,2,3,4,5,6,7,8,9,10]),`  
    `R1 is P11 + P12 + P13 + P14,`  
    `R2 is P21 + P22 + P23 + P24,`  
    `R3 is P31 + P32 + P33 + P34,`  
    `R4 is P41 + P42 + P43 + P44,`  
    `C1 is P11 + P21 + P31 + P41,`  
    `C2 is P12 + P22 + P32 + P42,`  
    `C3 is P13 + P23 + P33 + P43,`  
    `C4 is P14 + P24 + P34 + P44,`  
    `D1 is P11 + P22 + P33 + P44,`  
    `D2 is P14 + P23 + P32 + P41,`  
    `10 is R1 + R2 + R3 + R4,`  
    `evens([R1, R2, R3, R4, C1, C2, C3, C4, D1, D2]).`