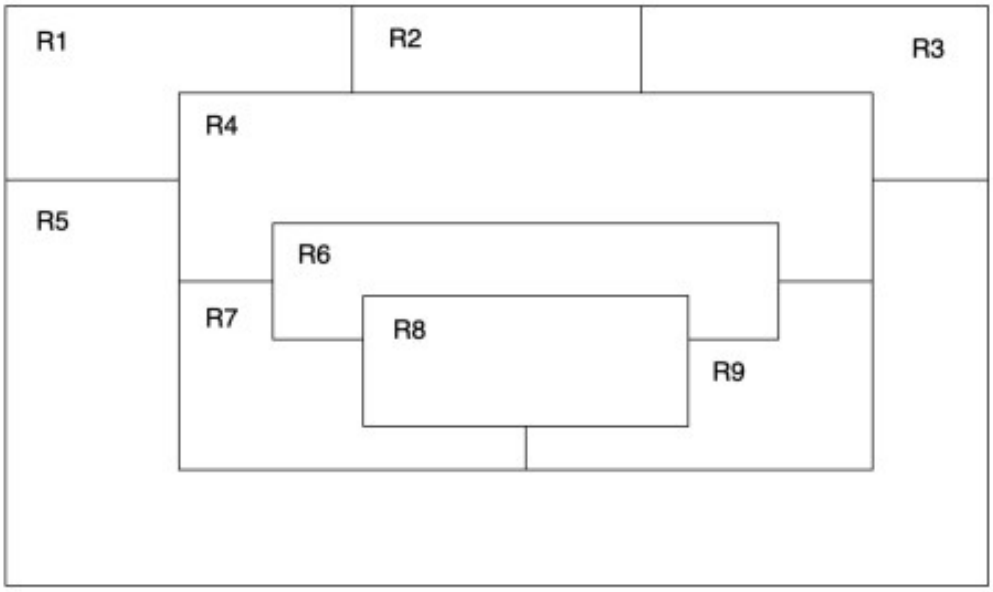
First Prolog Programming Assignment Solution

This prolog assignment was my first introduction to writing prolog. I wrote a program to solve the map coloring problem, wrote queries and functions to return information on the Pokemon knowledge base, and performed Head/Tail list processing to manipulate lists.

Task 1: Map Coloring

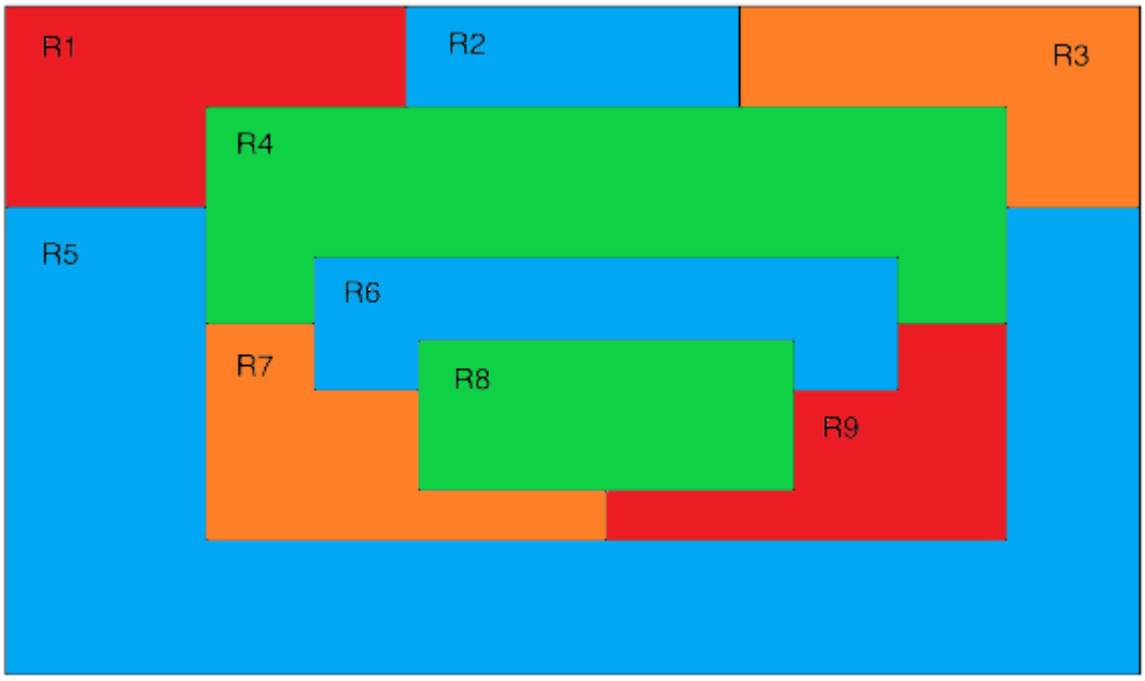


Source

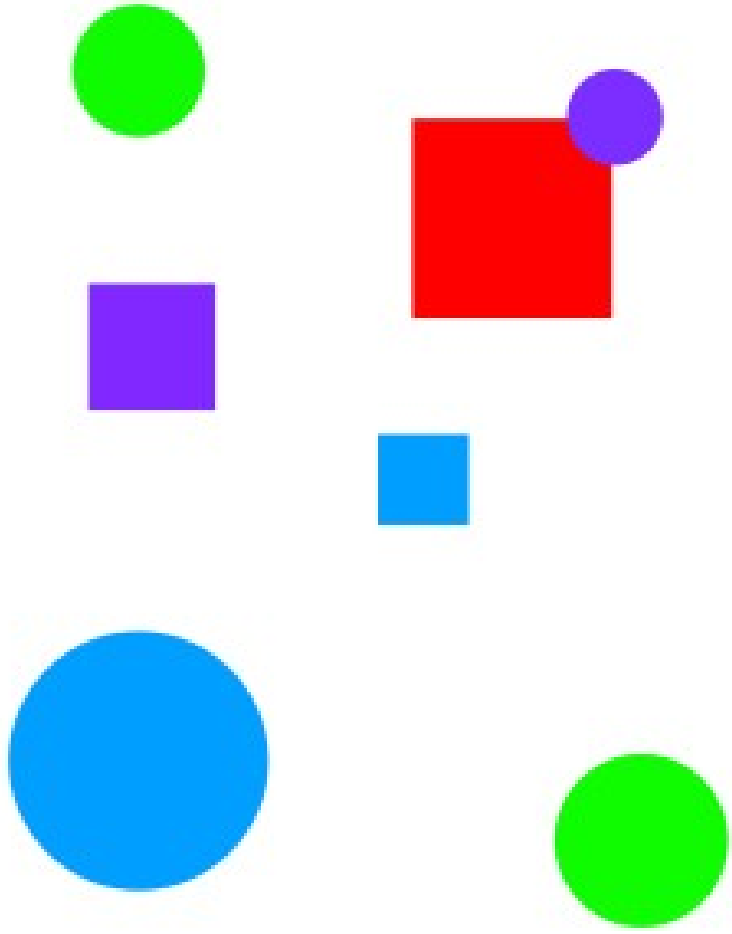
```
% different(X, Y) :: X is not equal to Y

different(red,blue).
different(red,green).
different(red,orange).
different(green,blue).
different(green,orange).
different(green, red).
different(blue, green).
different(blue, orange).
different(blue, red).
different(orange, blue).
different(orange, green).
different(orange, red).

coloring(R1, R2, R3, R4, R5, R6, R7, R8, R9) :-
    different(R1, R2),
    different(R1, R4),
    different(R1, R5),
    different(R2, R4),
    different(R2, R3),
    different(R3, R4),
    different(R3, R5),
    different(R4, R7),
    different(R4, R6),
    different(R4, R9),
    different(R5, R7),
    different(R5, R4),
    different(R5, R9),
    different(R6, R7),
    different(R6, R8),
    different(R6, R9),
    different(R7, R8),
    different(R7, R9),
    different(R8, R9).
```

Result

```
?- coloring(R1,R2,R3,R4,R5,R6,R7,R8,R9).
R1 = R9, R9 = red,
R2 = R5, R5 = R6, R6 = blue,
R3 = R7, R7 = orange,
R4 = R8, R8 = green ,
```



Task 2: The Floating Shapes World



KB

```
% ------------------------------------------------------------------------
% ------------------------------------------------------------------------
% --- File: shapes_world_1.pro
% --- Line: Loosely represented 2-D shapes world (simple take on SHRDLU)
% ------------------------------------------------------------------------
% ------------------------------------------------------------------------
% --- Facts ...
% ------------------------------------------------------------------------

% ------------------------------------------------------------------------
% --- square(N,side(L),color(C)) :: N is the name of a square with side L
% --- and color C

    square(sera,side(7),color(purple)).
    square(sara,side(5),color(blue)).
    square(sarah,side(11),color(red)).

% ------------------------------------------------------------------------
% --- circle(N,radius(R),color(C)) :: N is the name of a circle with
% --- radius R and color C

    circle(carla,radius(4),color(green)).
    circle(cora,radius(7),color(blue)).
    circle(connie,radius(3),color(purple)).
    circle(claire,radius(5),color(green)).

% ------------------------------------------------------------------------
% Rules ...
% ------------------------------------------------------------------------
% ------------------------------------------------------------------------
% --- circles :: list the names of all of the circles

    circles :- circle(Name,_,_), write(Name),nl,fail.
    circles.

% ------------------------------------------------------------------------
% --- squares :: list the names of all of the squares

    squares :- square(Name,_,_), write(Name),nl,fail.
    squares.

% ------------------------------------------------------------------------
% --- squares :: list the names of all of the shapes

    shapes :- circles,squares.

% ------------------------------------------------------------------------
% --- blue(Name) :: Name is a blue shape

    blue(Name) :- square(Name,_,color(blue)).
    blue(Name) :- circle(Name,_,color(blue)).

% ------------------------------------------------------------------------
% --- large(Name) :: Name is a large shape

    large(Name) :- area(Name,A), A >= 100.

% ------------------------------------------------------------------------
% --- small(Name) :: Name is a small shape

    small(Name) :- area(Name,A), A < 100.

% ------------------------------------------------------------------------
% --- area(Name,A) :: A is the area of the shape with name Name

    area(Name,A) :- circle(Name,radius(R),_), A is 3.14 * R * R.
    area(Name,A) :- square(Name,side(S),_), A is S * S.
```

Shapes Demo

```
?- listing(squares).
squares :-
    square(Name, _, _),
    write(Name),
    nl,
    fail.
squares.

true.

?- squares.
sera
sara
sarah
true.

?- listing(circles).
circles :-
    circle(Name, _, _),
    write(Name),
    nl,
    fail.
circles.

true.

?- circles.
carla
cora
connie
claire
true.

?- listing(shapes).
shapes :-
    circles,
    squares.

true.

?- shapes.
carla
cora
connie
claire
sera
sara
sarah
true.

?- blue(Shape).
Shape = sara ;
Shape = cora.

?- large(Name),write(Name),nl,fail.
cora
sarah
false.

?- small(Name),write(Name),nl,fail.
carla
connie
claire
sera
sara
false.

?- area(cora,A).
A = 153.86 ;
false.

?- area(carla,A).
A = 50.24 ;
false.
```

Task 3: Pokemon KB Interaction and Programming

Part 1 - Queries:

```
?- cen(pikachu).
true.

?- cen(raichu).
false.

?- cen(Name).
Name = pikachu ;
Name = bulbasaur ;
Name = caterpie ;
Name = charmander ;
Name = vulpix ;
Name = poliwag ;
Name = squirtle ;
Name = staryu.

?- cen(Name),write(Name),nl,fail.
pikachu
bulbasaur
caterpie
charmander
vulpix
poliwag
squirtle
staryu
false.

?- evolves(squirtle,wartortle).
true.

?- evolves(wartortle,squirtle).
false.

?- evolves(squirtle,blastoise).
false.

?- evolves(X,Y),evolves(Y,Z).
X = bulbasaur,
Y = ivysaur,
Z = venusaur ;
X = caterpie,
Y = metapod,
Z = butterfree ;
X = charmander,
Y = charmeleon,
Z = charizard ;
X = poliwag,
Y = poliwhirl,
Z = poliwrath ;
X = squirtle,
Y = wartortle,
Z = blastoise ;
false.

?- evolves(X,Y),evolves(Y,Z),write(X),write(-->),write(Z),nl,fail.
bulbasaur-->venusaur
caterpie-->butterfree
charmander-->charizard
poliwag-->poliwrath
squirtle-->blastoise
false.
```

```
?- pokemon(name(Name),_,_,_),write(Name),nl,fail.
pikachu
raichu
bulbasaur
ivysaur
venusaur
caterpie
metapod
butterfree
charmander
charmeleon
charizard
vulpix
ninetails
poliwag
poliwhirl
poliwrath
squirtle
wartortle
blastoise
staryu
starmie
false.

?- pokemon(name(Name),fire,_,_),write(Name),nl,fail.
charmander
charmeleon
charizard
vulpix
ninetails
false.

?- pokemon(name(N),T,_,_),write(nks(name(N),(kind(T)))),nl,fail.
nks(name(pikachu),kind(electric))
nks(name(raichu),kind(electric))
nks(name(bulbasaur),kind(grass))
nks(name(ivysaur),kind(grass))
nks(name(venusaur),kind(grass))
nks(name(caterpie),kind(grass))
nks(name(metapod),kind(grass))
nks(name(butterfree),kind(grass))
nks(name(charmander),kind(fire))
nks(name(charmeleon),kind(fire))
nks(name(charizard),kind(fire))
nks(name(vulpix),kind(fire))
nks(name(ninetails),kind(fire))
nks(name(poliwag),kind(water))
nks(name(poliwhirl),kind(water))
nks(name(poliwrath),kind(water))
nks(name(squirtle),kind(water))
nks(name(wartortle),kind(water))
nks(name(blastoise),kind(water))
nks(name(staryu),kind(water))
nks(name(starmie),kind(water))
false.

?- pokemon(name(N),_,_,attack(waterfall,_)).
N = wartortle ;
false.

?- pokemon(name(N),_,_,attack(poison-powder,_)).
N = venusaur ;
false.

?- pokemon(name(N),water,_,attack(A,_)),write(A),nl,fail.
water-gun
amnesia
dashing-punch
bubble
waterfall
hydro-pump
slap
star-freeze
false.

?- pokemon(name(poliwhirl),_,hp(HP),_).
HP = 80.

?- pokemon(name(butterfree),_,hp(HP),_).
HP = 130.
```

```
?- pokemon(name(N),_,hp(HP),_),HP>85,write(N),nl,fail.
raichu
venusaur
butterfree
charizard
ninetails
poliwrath
blastoise
false.

?- pokemon(name(N),_,_,attack(_,D)),D>60,write(N),nl,fail.
raichu
venusaur
butterfree
charizard
ninetails
false.

?- cen(Name),pokemon(name(Name),_,hp(HP),_),write(Name: HP),nl,fail.
pikachu:60
bulbasaur:40
caterpie:50
charmander:50
vulpix:60
poliwag:60
squirtle:40
staryu:40
false.
```

Part 2 – Extended pokemon knowledge base:

```
% ------------------------------------------------------------------------------
display_names :- pokemon(name(N),_,_,_),write(N),nl,fail.
display_names.

display_attacks :- pokemon(_,_,_,attack(N,_)),write(N),nl,fail.
display_attacks.

powerful(Name) :-
    pokemon(name(Name),_,_,attack(_,D)),D>55.

tough(Name) :-
    pokemon(name(Name),_,hp(HP),_),HP>100.

type(Name,Type) :-
    pokemon(name(Name),T,_,_),Type=T.

dump_kind(Type) :-
    pokemon(name(Name),T,HP,Attack),Type=T,write(pokemon(name(Name),Type,HP,Attack)),nl,fail.

display_cen :-
    cen(Name),write(Name),nl,fail.

family(Name) :-
    evolves(Name,Y),write(Name),write(' '),write( Y),evolves(Y,Z),write(' '),write(Z),nl,fail.

families :- cen(Name),family(Name).
    families.

dump_pokemon(Name) :-
    pokemon(name(Name),T,HP,Attack),
    write(pokemon(name(Name),T,HP,Attack)),nl.

lineage(Name) :-
    dump_pokemon(Name),
    evolves(Name,Y),
    dump_pokemon(Y),
    evolves(Y,Z),
    dump_pokemon(Z).
```

Part 2 – Demo:

```
?- display_names.
pikachu
raichu
bulbasaur
ivysaur
venusaur
caterpie
metapod
butterfree
charmander
charmeleon
charizard
vulpix
ninetails
poliwag
poliwhirl
poliwrath
squirtle
wartortle
blastoise
staryu
starmie
true.

?- display_attacks.
gnaw
thunder-shock
leech-seed
vine-whip
poison-powder
gnaw
stun-spore
whirlwind
scratch
slash
royal-blaze
confuse-ray
fire-blast
water-gun
amnesia
dashing-punch
bubble
waterfall
hydro-pump
slap
star-freeze
true.

?- powerful(pikachu).
false.

?- powerful(blastoise).
true ;
false.
```

```
?- powerful(X),write(X),nl,fail.
raichu
venusaur
butterfree
charizard
ninetails
wartortle
blastoise
false.

?- tough(raichu).
false.

?- tough(venusaur).
true.

?- tough(Name),write(Name),nl,fail.
venusaur
butterfree
charizard
poliwrath
blastoise
false.

?- type(caterpie,grass).
true.

?- type(pikachu,water).
false.

?- type(N,electric).
N = pikachu ;
N = raichu ;
false.

?- type(N,water),write(N),nl,fail.
poliwag
poliwhirl
poliwrath
squirtle
wartortle
blastoise
staryu
starmie
false.

?- dump_kind(water).
pokemon(name(poliwag),water,hp(60),attack(water-gun,30))
pokemon(name(poliwhirl),water,hp(80),attack(amnesia,30))
pokemon(name(poliwrath),water,hp(140),attack(dashing-punch,50))
pokemon(name(squirtle),water,hp(40),attack(bubble,10))
pokemon(name(wartortle),water,hp(80),attack(waterfall,60))
pokemon(name(blastoise),water,hp(140),attack(hydro-pump,60))
pokemon(name(staryu),water,hp(40),attack(slap,20))
pokemon(name(starmie),water,hp(60),attack(star-freeze,20))
false.

?- dump_kind(fire).
pokemon(name(charmander),fire,hp(50),attack(scratch,10))
pokemon(name(charmeleon),fire,hp(80),attack(slash,50))
pokemon(name(charizard),fire,hp(170),attack(royal-blaze,100))
pokemon(name(vulpix),fire,hp(60),attack(confuse-ray,20))
pokemon(name(ninetails),fire,hp(100),attack(fire-blast,120))
false.
```

```
?- display_cen.
pikachu
bulbasaur
caterpie
charmander
vulpix
poliwag
squirtle
staryu
false.

?- family(pikachu).
pikachu raichu
false.

?- family(squirtle).
squirtle wartortle blastoise
false.

?- families.
pikachu raichubulbasaur ivysaur venusaur
caterpie metapod butterfree
charmander charmeleon charizard
vulpix ninetailspoliwag poliwhirl poliwrath
squirtle wartortle blastoise
staryu starmie
true.

?- lineage(caterpie).
pokemon(name(caterpie),grass,hp(50),attack(gnaw,20))
pokemon(name(metapod),grass,hp(70),attack(stun-spore,20))
pokemon(name(butterfree),grass,hp(130),attack(whirlwind,80))
true.

?- lineage(metapod).
pokemon(name(metapod),grass,hp(70),attack(stun-spore,20))
pokemon(name(butterfree),grass,hp(130),attack(whirlwind,80))
false.

?- lineage(butterfree).
pokemon(name(butterfree),grass,hp(130),attack(whirlwind,80))
false.
```

Task 4: Lisp Processing in Prolog

Part 1 – Head/Tail Referencing Exercises:

```
?- [H|T] = [red, yellow, blue, green].
H = red,
T = [yellow, blue, green].

?- [H, T] = [red, yellow, blue, green].
false.

?- [F|_] = [red, yellow, blue, green].
F = red.

?- [_|[S|_]] = [red, yellow, blue, green].
S = yellow.

?- [F|[S|R]] = [red, yellow, blue, green].
F = red,
S = yellow,
R = [blue, green].

?- List = [this|[and, that]].
List = [this, and, that].

?- List = [this, and, that].
List = [this, and, that].

?- [a,[b, c]] = [a, b, c].
false.

?- [a|[b, c]] = [a, b, c].
true.

?- [cell(Row,Column)|Rest] = [cell(1,1), cell(3,2), cell(1,3)].
Row = Column, Column = 1,
Rest = [cell(3, 2), cell(1, 3)].

?- [X|Y] = [one(un, uno), two(dos, deux), three(trois, tres)].
X = one(un, uno),
Y = [two(dos, deux), three(trois, tres)].

?-
```

Part 2 – List processing function definitions:

```
first([H|_],H).

rest([_|T],T).

last([H|[]],H).
last([_|T],Result):- last(T,Result).

nth(0,[H|_],H).
nth(N,[_|T],E) :- K is N - 1, nth(K,T,E).

writelist([]).
writelist([H|T]) :- write(H),nl,writelist(T).

sum([],0).
sum([Head|Tail],Sum) :-
    sum(Tail,SumOfTail),
    Sum is Head + SumOfTail.

add_first(X,L,[X|L]).

add_last(X,[],[X]).
add_last(X,[H|T],[H|TX]) :- add_last(X,T,TX).

iota(0,[]).
iota(N,IotaN) :-
    K is N - 1,
    iota(K,IotaK),
    add_last(N,IotaK,IotaN).

pick(L,Item) :-
    length(L,Length),
    random(0,Length,RN),
    nth(RN,L,Item).

make_set([],[]).
make_set([H|T],TS) :-
    member(H,T),
    make_set(T,TS).
make_set([H|T],[H|TS]) :-
    make_set(T,TS).
```

```
product([],1).
product([Head|Tail],Product) :-
    product(Tail,ProductOfTail),
    Product is Head * ProductOfTail.

factorial(Num) :-
    iota(Num,Iota),
    product(Iota,Product),
    write(Product),nl,fail.

make_list(0,_,[]).
make_list(Num, Data, Result) :-
    Number is Num - 1,
    make_list(Number, Data, Results),
    add_last(Data,Results,Result).

but_first([_],[]).
but_first([_|T],T).

but_last([_],[]).
but_last([H|T], Result) :-
    reverse(T, [_|TX]),
    reverse(TX, R),
    add_first(H, R, Result).

is_palendrome([]).
is_palendrome([_]).
is_palendrome(List) :-
    first(List,F),
    last(List,L),
    F = L,
    but_first(List, X),
    but_last(X,Y),
    is_palendrome(Y).

noun_phrase(Result) :-
    pick([happy,angry,bewildered,fuming,ecstatic,bored], Adj),
    pick([batman, screwdriver, car, elephant, balloon, worm], Noun),
    add_last(Adj, [the], R),
    add_last(Noun, R, Result).

sentence(Sen) :-
    noun_phrase(P1),
    noun_phrase(P2),
    pick([chose, forgot, lost, enjoyed, wanted, ordered, applauded], Past),
    add_last(Past,P1, R),
    append(R,P2,Sen).
```

Part 3 – Example List Processors Demo:

```
?- first([apple],First).
First = apple.

?- first([c,d,e,f,g,a,b],P).
P = c.

?- rest([apple],Rest).
Rest = [].

?- rest([c,d,e,f,g,a,b],Rest).
Rest = [d, e, f, g, a, b].

?- last([peach],Last).
Last = peach ;
false.

?- last([c,d,e,f,g,a,b],P).
P = b ;
false.

?- nth(0,[zero,one,two,three,four],Element).
Element = zero ,

?- nth(3,[four,three,two,one,zero],Element).
Element = one ,

?- writelist([red,yellow,blue,green,purple,orange]).
red
yellow
blue
green
purple
orange
true.

?- sum([],Sum).
Sum = 0.

?- sum([2,3,5,7,11],SumOfPrimes).
SumOfPrimes = 28.

?- add_first(thing,[],Result).
Result = [thing].

?- add_first(racket,[prolog,haskell,rust],Languages).
Languages = [racket, prolog, haskell, rust].

?- add_last(thing,[],Result).
Result = [thing] ,

?- add_last(rust,[racket,prolog,haskell],Languages).
Languages = [racket, prolog, haskell, rust] ,

?- iota(5,Iota5).
Iota5 = [1, 2, 3, 4, 5] ,

?- iota(9,Iota9).
Iota9 = [1, 2, 3, 4, 5, 6, 7, 8, 9] ,

?- pick([cherry,peach,apple,blueberry],Pie).
Pie = peach ,

?- pick([cherry,peach,apple,blueberry],Pie).
Pie = blueberry ,

?- pick([cherry,peach,apple,blueberry],Pie).
Pie = peach ,

?- pick([cherry,peach,apple,blueberry],Pie).
Pie = apple ,

?- pick([cherry,peach,apple,blueberry],Pie).
Pie = blueberry ,

?- pick([cherry,peach,apple,blueberry],Pie).
Pie = apple ,

?- pick([cherry,peach,apple,blueberry],Pie).
Pie = apple ,

?- pick([cherry,peach,apple,blueberry],Pie).
Pie = apple ,

?- make_set([1,1,2,1,2,3,1,2,3,4],Set).
Set = [1, 2, 3, 4] ,

?- make_set([bit,bot,bet,bot,bot,bit],B).
B = [bet, bot, bit] ,

?-
```

Part 4 – List Processing Exercises Demo:

```
?- product([],P).
P = 1.

?- product([1,3,5,7,9],Product).
Product = 945.

?- iota(9,Iota),product(Iota,Product).
Iota = [1, 2, 3, 4, 5, 6, 7, 8, 9],
Product = 362880 ,

?- make_list(7,seven,Seven).
Seven = [seven, seven, seven, seven, seven, seven, seven] ,

?- make_list(8,2,List).
List = [2, 2, 2, 2, 2, 2, 2, 2] ,

?- but_first([a,b,c],X).
X = [b, c].

?- but_last([a,b,c,d,e],X).
X = [a, b, c, d].
```

```
?- is_palindrome([x]).
true .

?- is_palindrome([a,b,c]).
false.

?- is_palindrome([a,b,b,a]).
true .

?- is_palindrome([1,2,3,4,5,4,2,3,1]).
false.

?- is_palindrome([c,o,f,f,e,e,e,e,f,f,o,c]).
true .

?- noun_phrase(NP).
NP = [the, bored, worm] .

?- noun_phrase(NP).
NP = [the, angry, batman] .

?- noun_phrase(NP).
NP = [the, ecstatic, balloon] .

?- noun_phrase(NP).
NP = [the, bewildered, worm] .

?- noun_phrase(NP).
NP = [the, angry, worm] .

?- sentence(S).
S = [the, bored, worm, ordered, the, ecstatic, elephant] .

?- sentence(S).
S = [the, ecstatic, worm, chose, the, fuming, car] .

?- sentence(S).
S = [the, fuming, car, applauded, the, angry, batman] .

?- sentence(S).
S = [the, ecstatic, balloon, ordered, the, fuming, worm] .

?- sentence(S).
S = [the, bored, screwdriver, chose, the, angry, car] .

?- sentence(S).
S = [the, fuming, screwdriver, enjoyed, the, angry, screwdriver] .

?- sentence(S).
S = [the, bewildered, car, lost, the, angry, car] .

?- sentence(S).
S = [the, angry, car, chose, the, angry, elephant] .

?- sentence(S).
S = [the, bewildered, batman, forgot, the, fuming, screwdriver] .

?- sentence(S).
S = [the, fuming, worm, applauded, the, fuming, elephant] .

?- sentence(S).
S = [the, fuming, elephant, applauded, the, fuming, batman] .

?- sentence(S).
S = [the, angry, screwdriver, lost, the, fuming, elephant] .

?- sentence(S).
S = [the, fuming, screwdriver, chose, the, bewildered, car] .

?- sentence(S).
S = [the, bewildered, screwdriver, applauded, the, bewildered, balloon] .

?- sentence(S).
S = [the, ecstatic, elephant, forgot, the, ecstatic, worm] .

?- sentence(S).
S = [the, angry, worm, forgot, the, happy, screwdriver] .
```