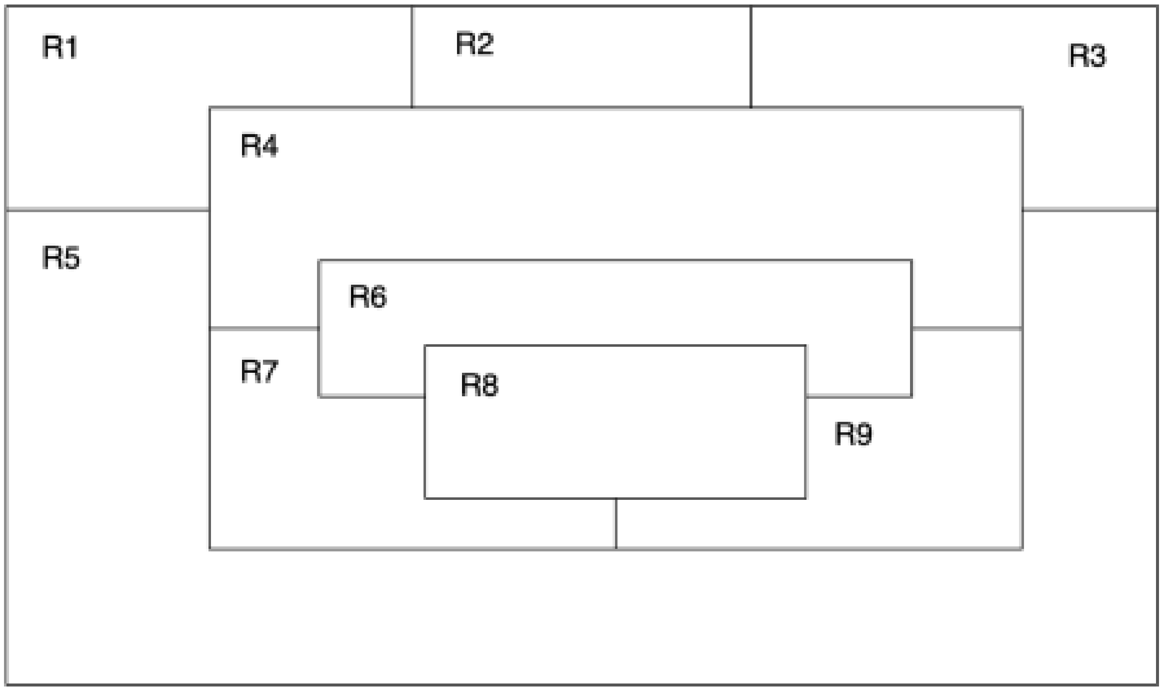
First Prolog Programming Assignment

Learning Abstract:

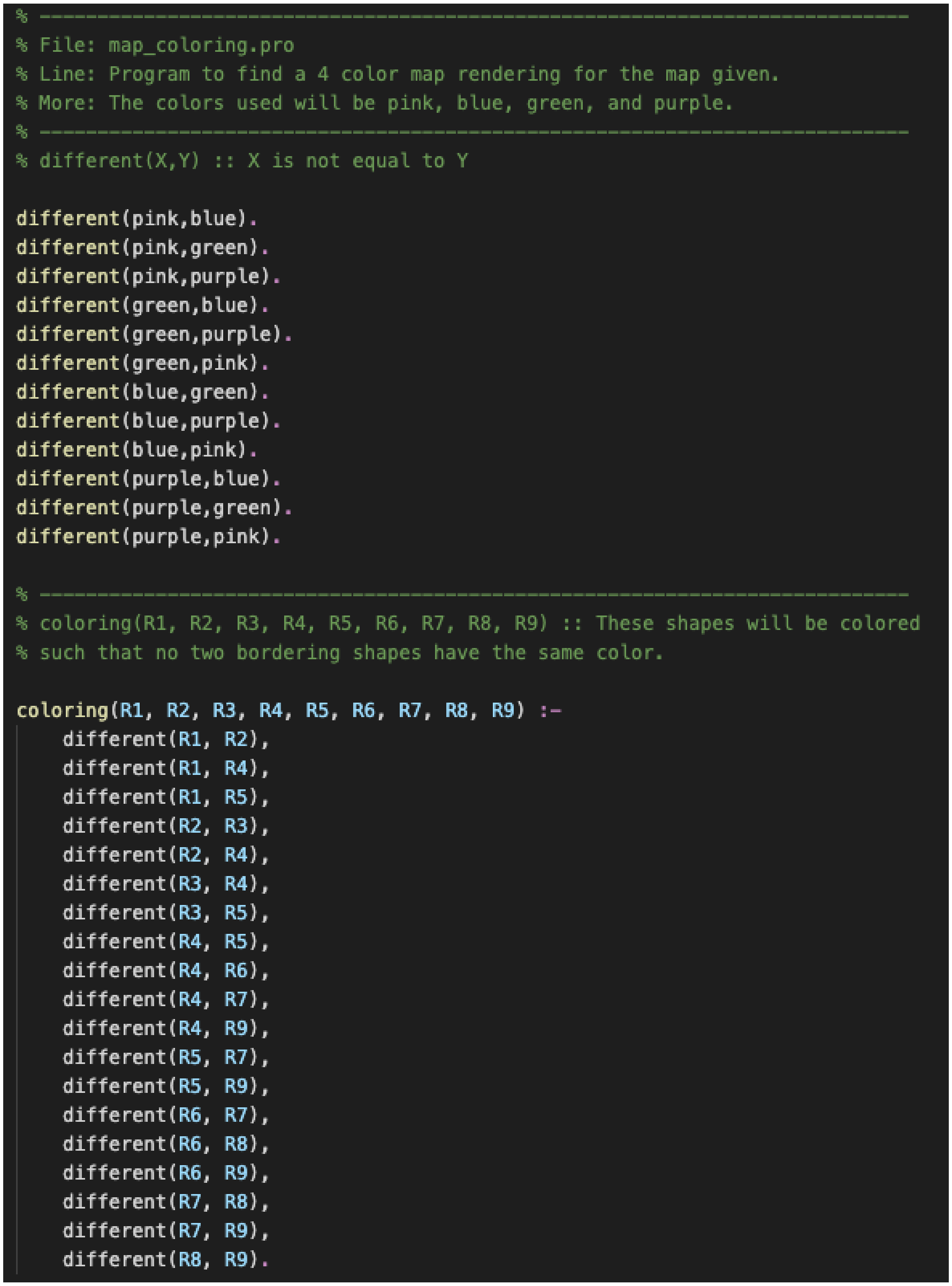
In this assignment I learned all about the syntax and functionality of the language Prolog, as well as creating some knowledge bases that I then interacted with. Tasks 1 and 2 dealt with visual knowledge bases involving a map and different shapes. Task 3 was all about a Pokemon KB that contained information such as the hp and attack names of certain pokemon. Lastly in Task 4, I learned about how to construct and manipulate lists within Prolog.

Task 1 - Map Coloring

Empty Map:

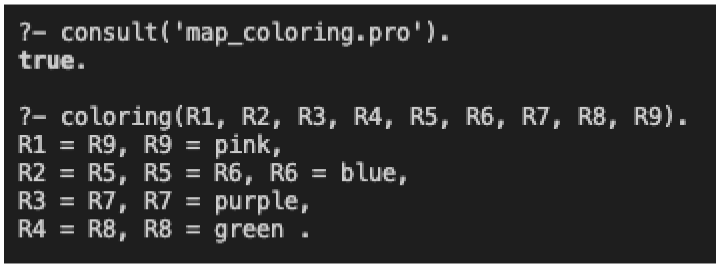


Code:



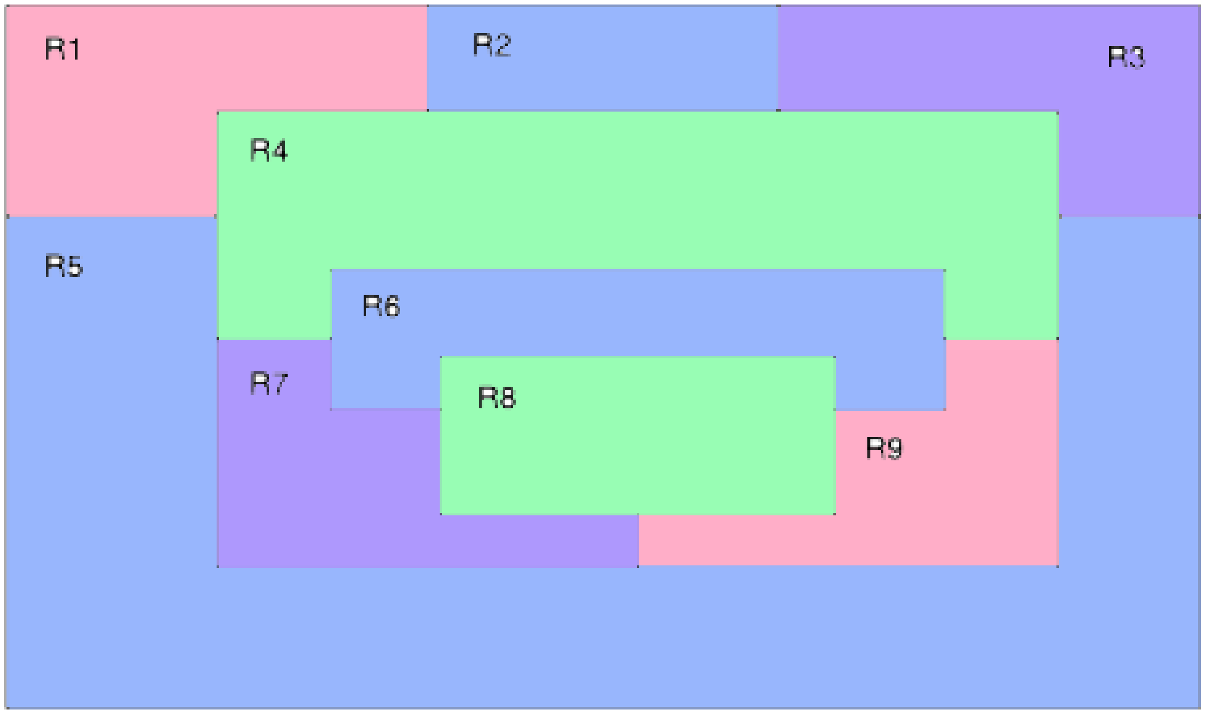
```
% ---------------------------------------------------------------------------
% File: map_coloring.pro
% Line: Program to find a 4 color map rendering for the map given.
% More: The colors used will be pink, blue, green, and purple.
% ---------------------------------------------------------------------------
% different(X,Y) :: X is not equal to Y

different(pink,blue).
different(pink,green).
different(pink,purple).
different(green,blue).
different(green,purple).
different(green,pink).
different(blue,green).
different(blue,purple).
different(blue,pink).
different(purple,blue).
different(purple,green).
different(purple,pink).

% ---------------------------------------------------------------------------
% coloring(R1, R2, R3, R4, R5, R6, R7, R8, R9) :: These shapes will be colored
% such that no two bordering shapes have the same color.

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

Demo:



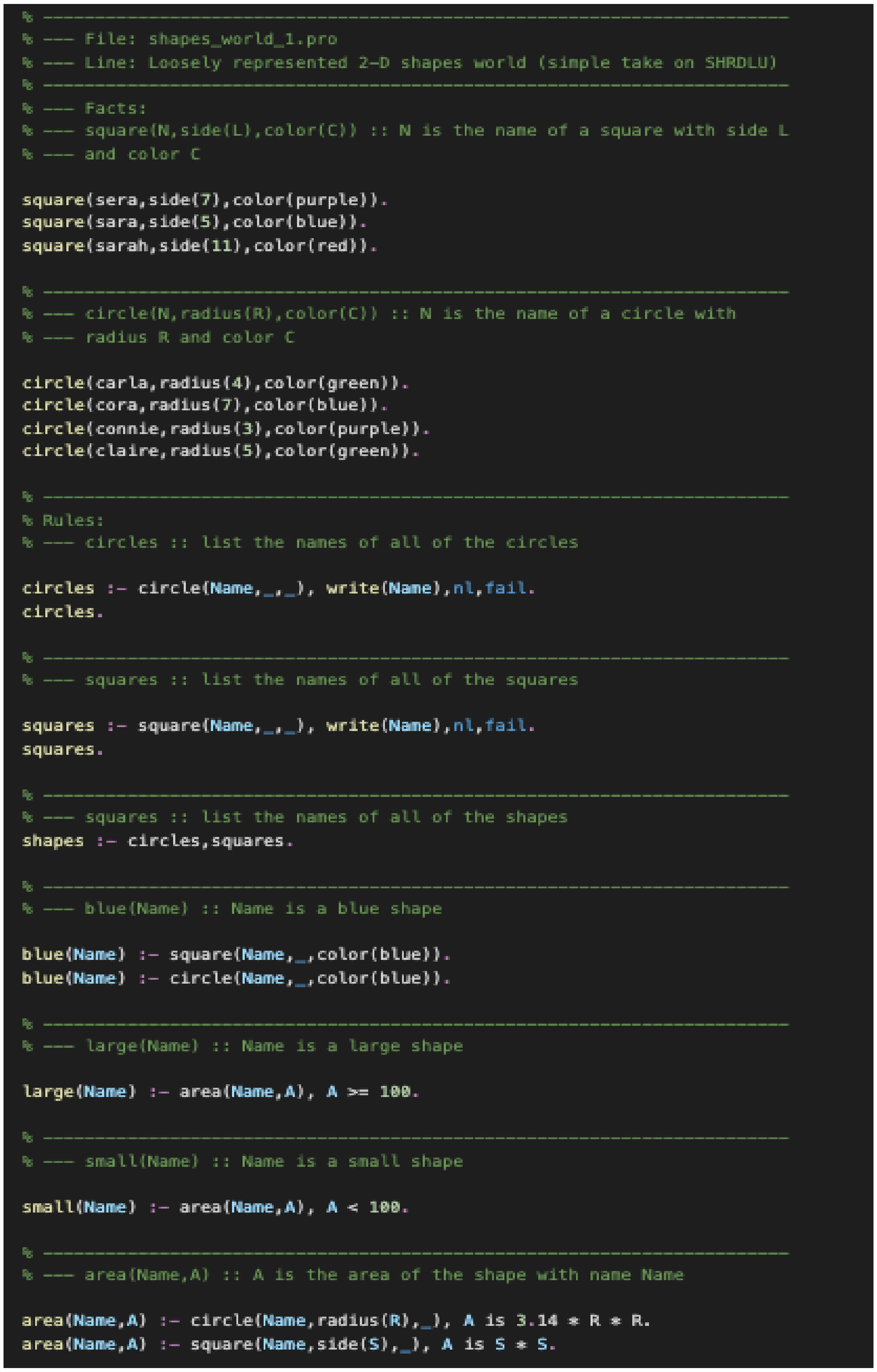
```
?- consult('map_coloring.pro').
true.

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

Colored Map:



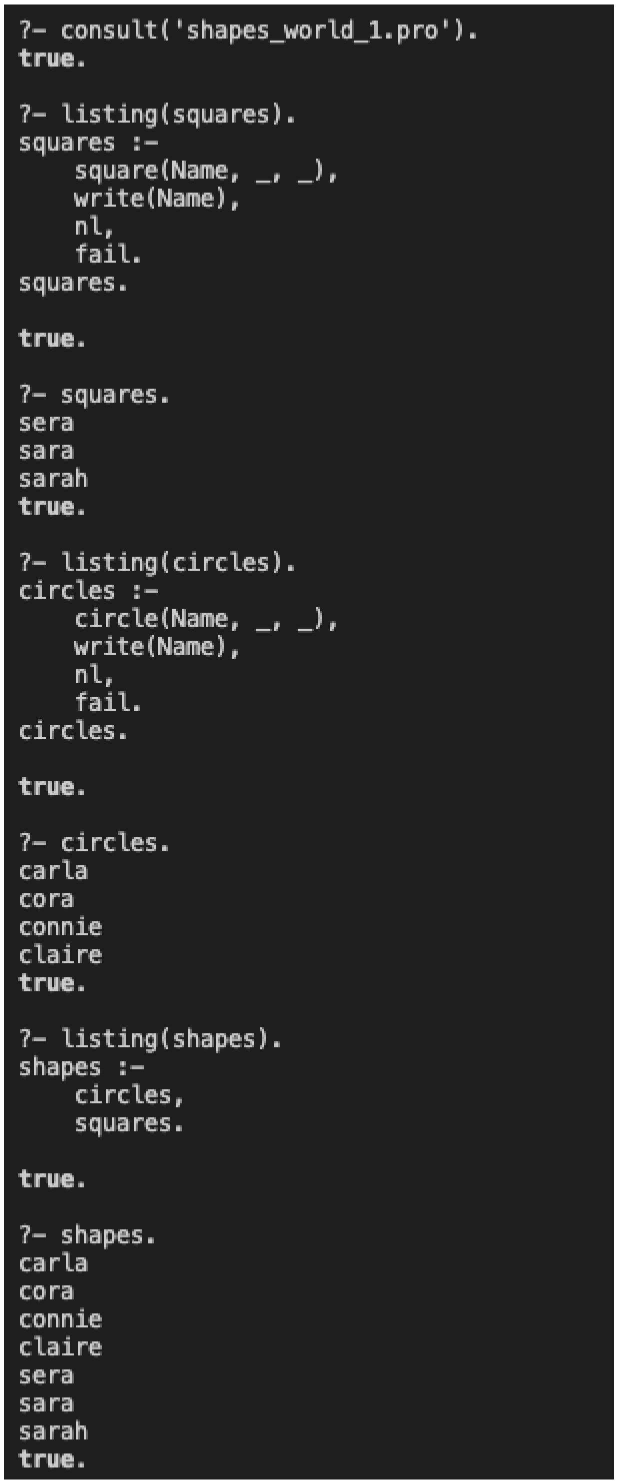
Task 2 - The Floating Shapes World

Code:

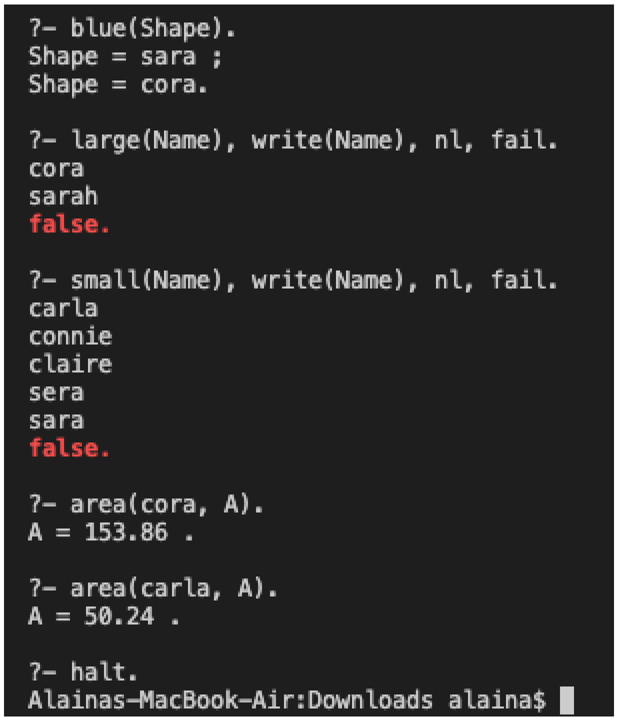


```
% ----------------------------------------------------------------------
% --- File: shapes_world_1.pro
% --- Line: Loosely represented 2-D shapes world (simple take on SHRDLU)
% ----------------------------------------------------------------------
% --- Facts:
% --- square(N,side(L),color(C)) :: 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.
```

Demo:



```
?- consult('shapes_world_1.pro').
true.

?- 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.
```

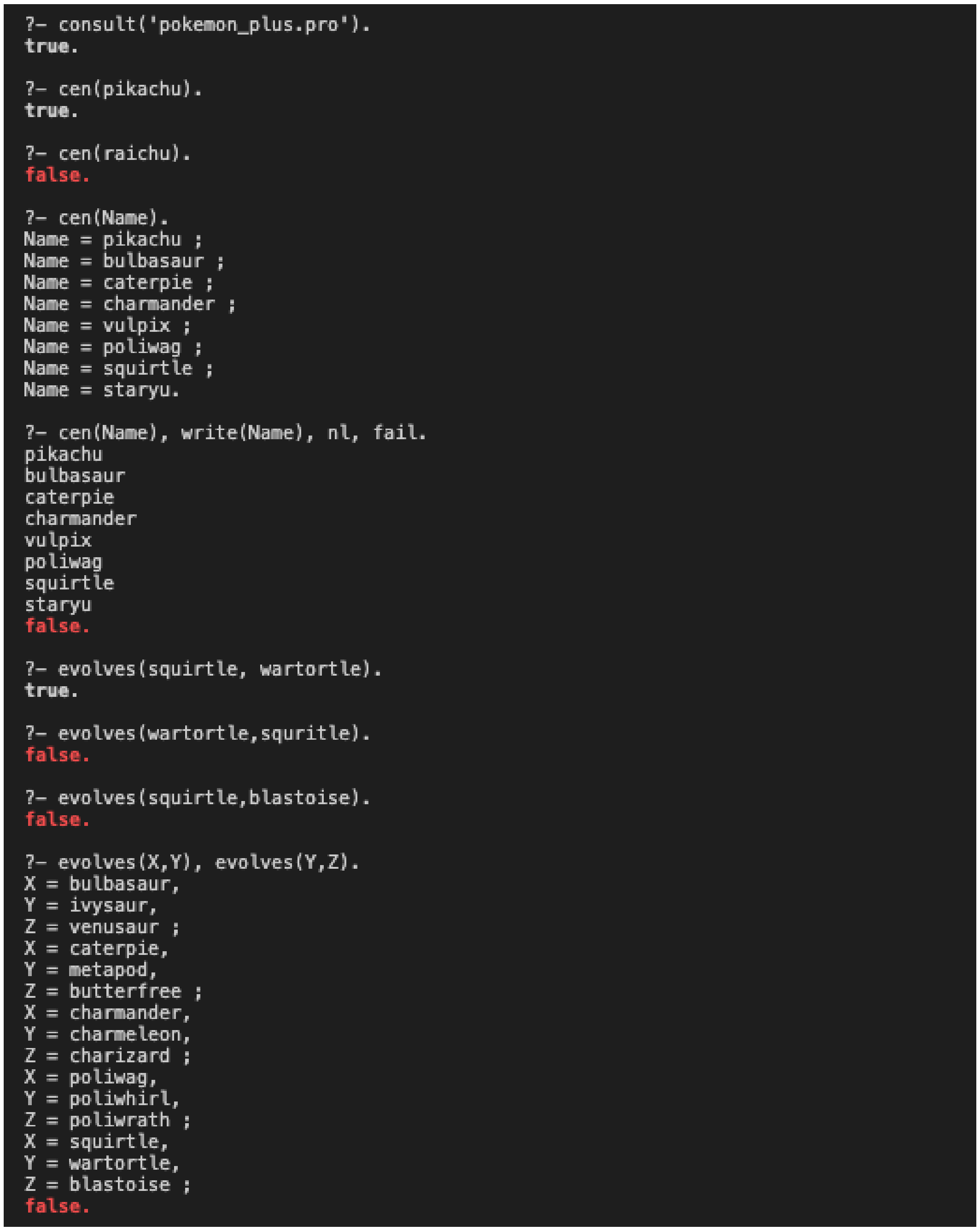


```
?- blue(Shape).
Shape = sara ;
Shape = cora.

?- 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 .

?- area(carla, A).
A = 50.24 .

?- halt.
Alainas-MacBook-Air:Downloads alaina$ 
```

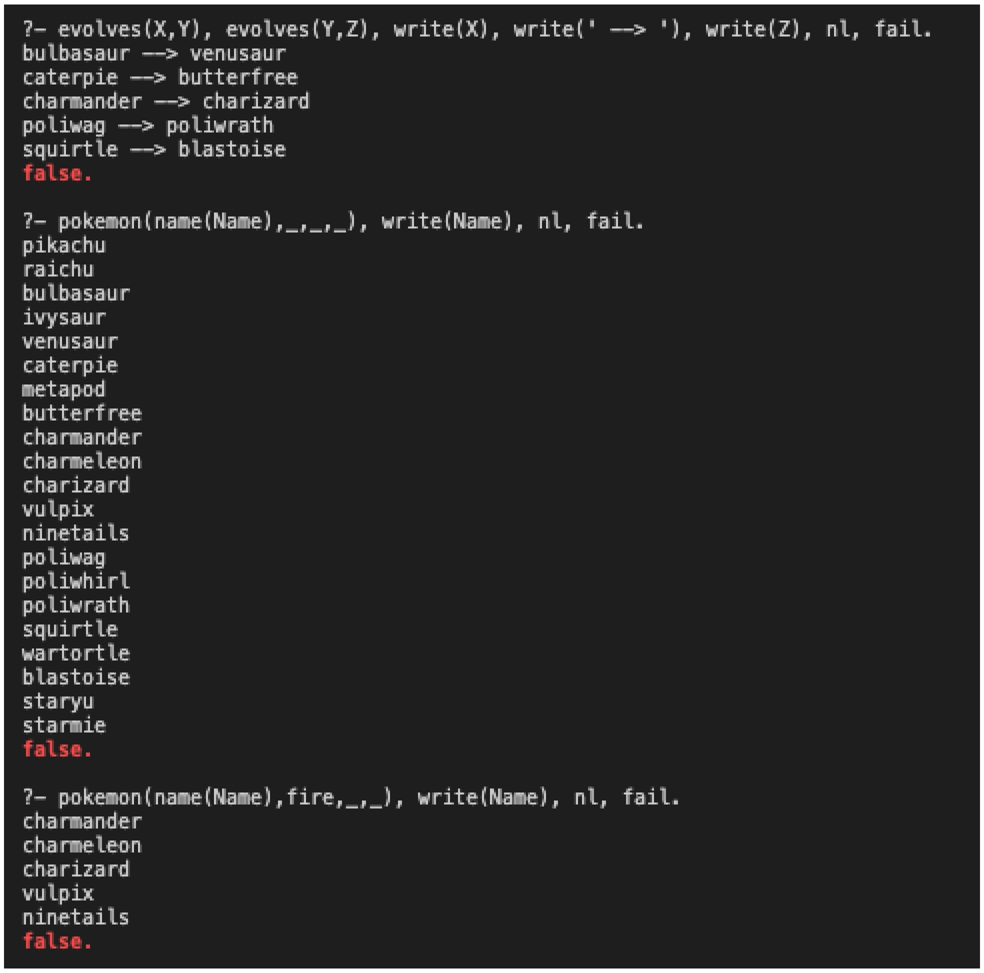
Task 3 - Pokemon KB Interaction and Programming

Part 1: Queries

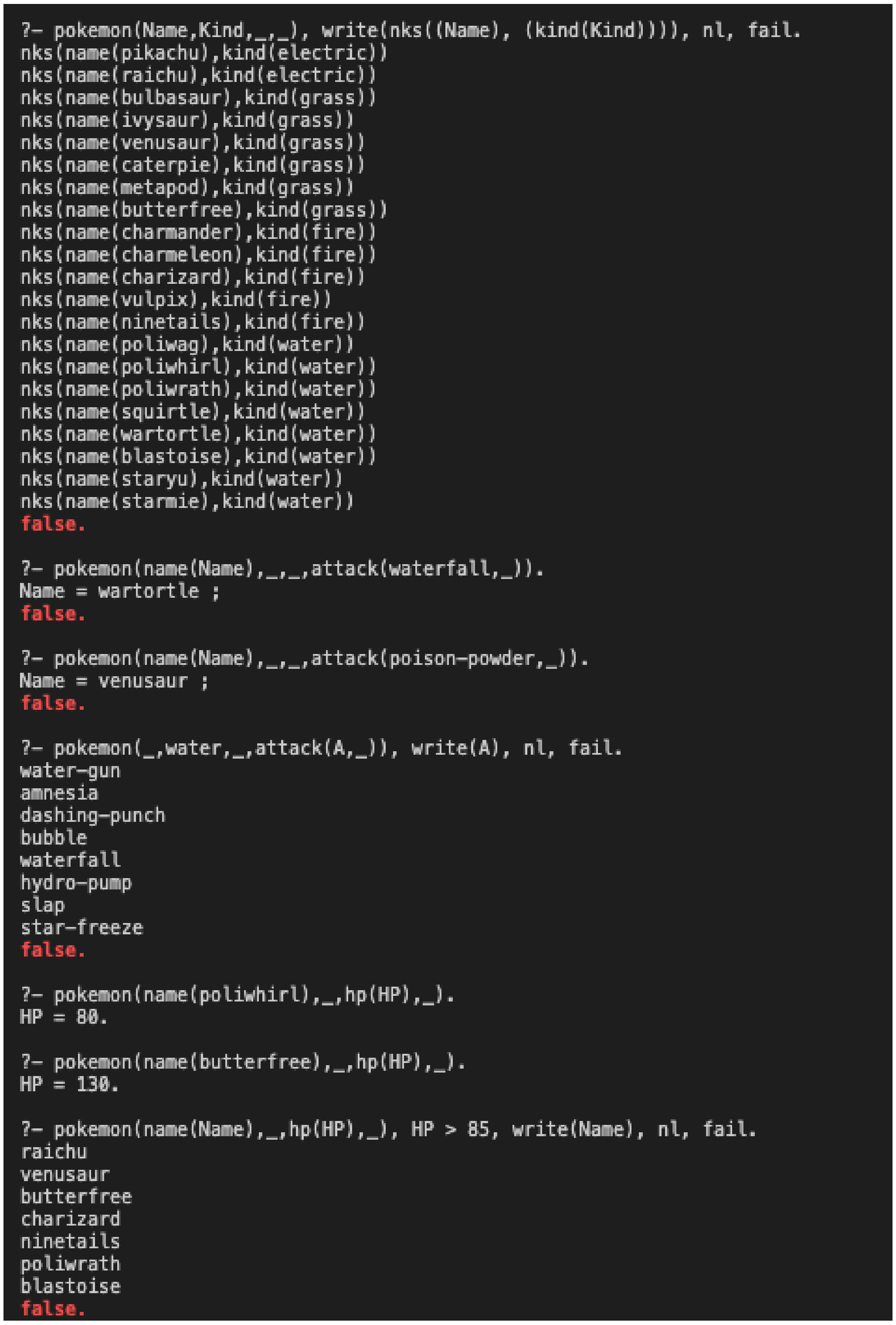
Demo:



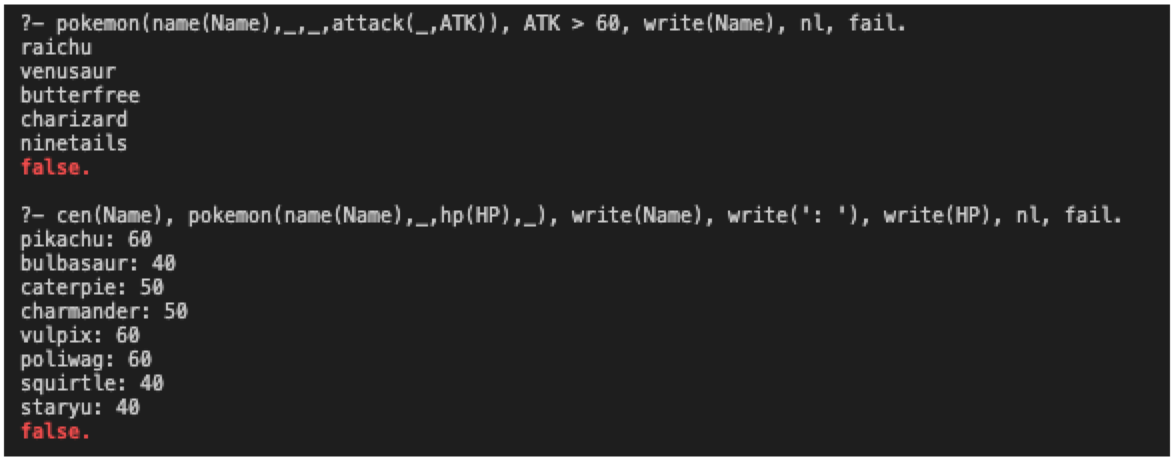
```
?- consult('pokemon_plus.pro').
true.

?- 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,squritle).
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.
```



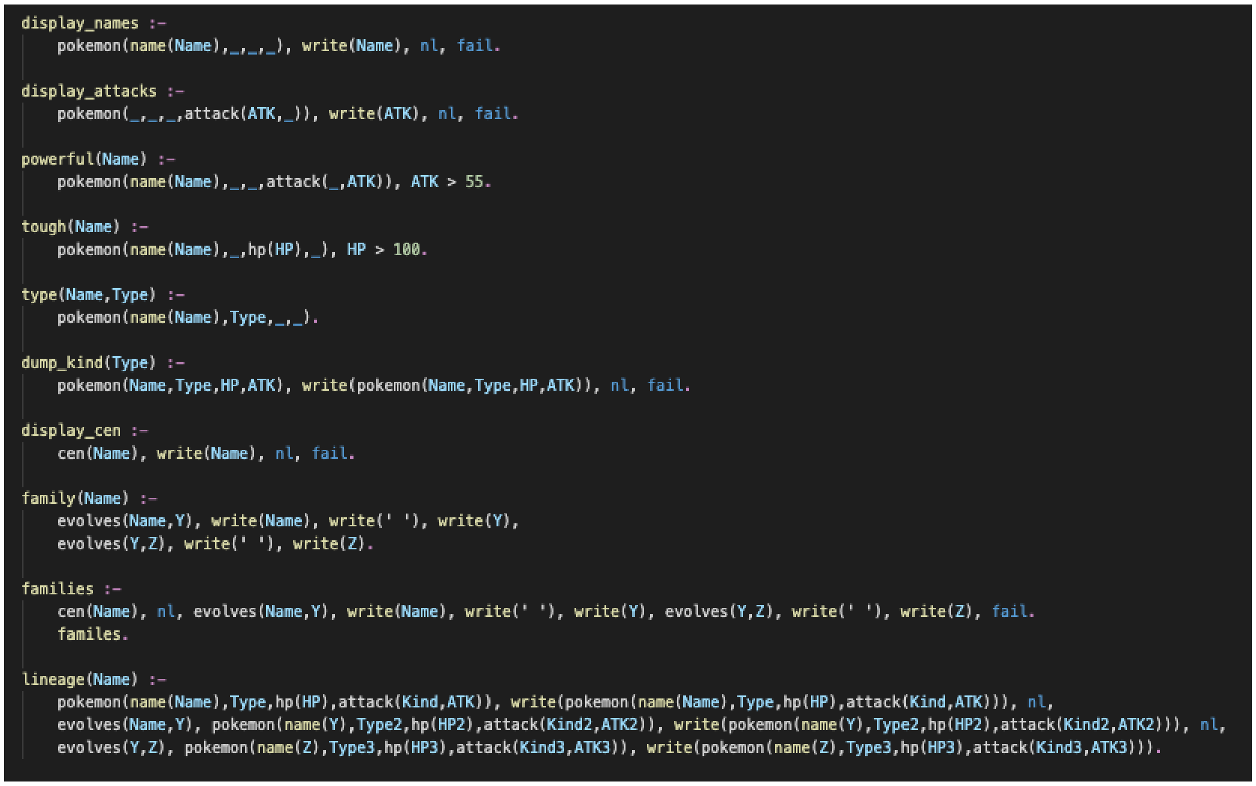
```
?- pokemon(Name,Kind,_,_), write(nks((Name), (kind(Kind)))), nl, fail.
nks(name(pikachu),kind(electric))
nks(name(raichu),kind(electric))
nks(name(bulbasaur),kind(grass))
nks(name(ivysaur),kind(grass))
nks(name(venusaur),kind(grass))
nks(name(caterpie),kind(grass))
nks(name(metapod),kind(grass))
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(Name),_,_,attack(waterfall,_)).
Name = wartortle ;
false.

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

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



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

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

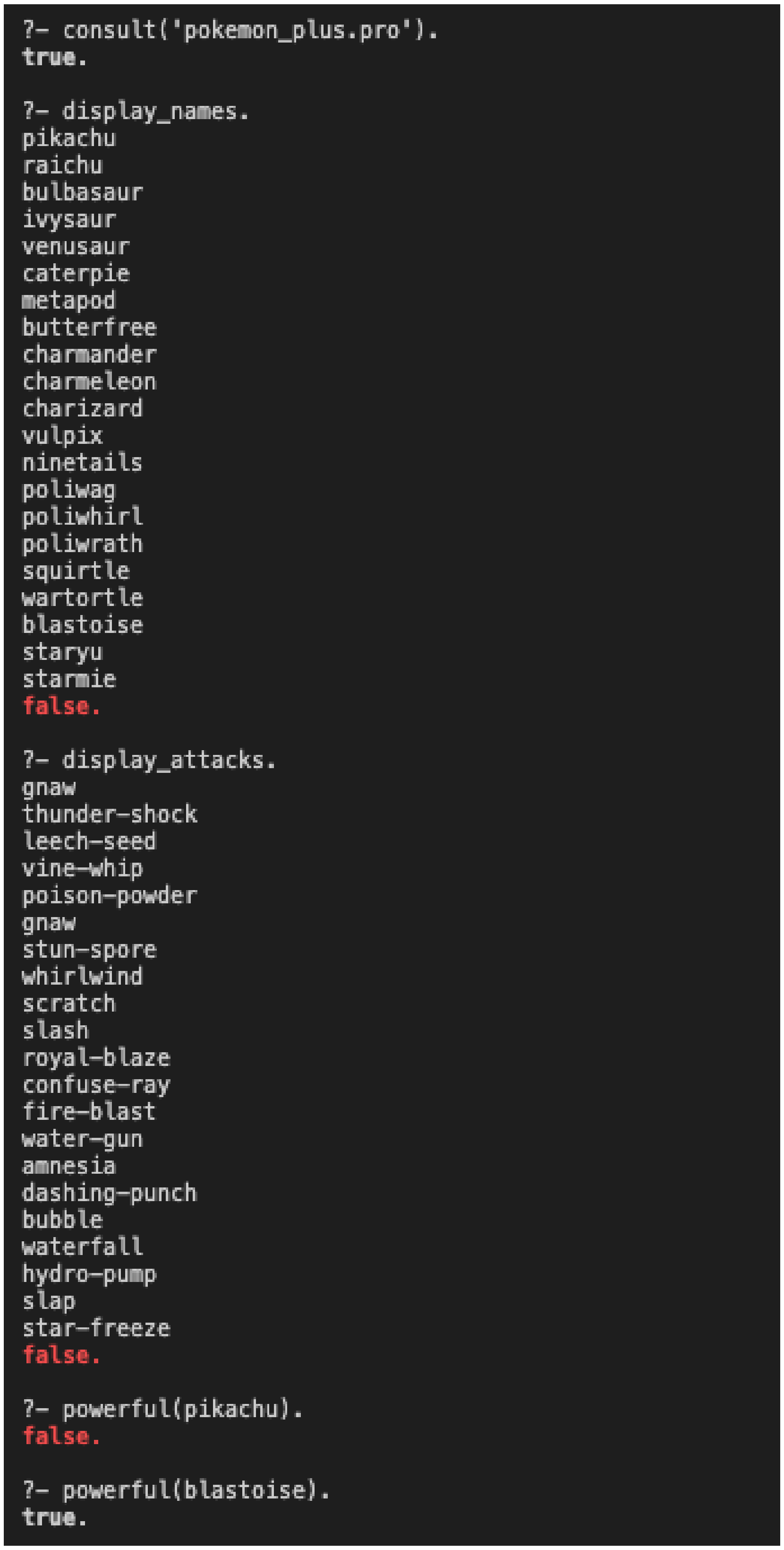
Part 2: Programs

Code:

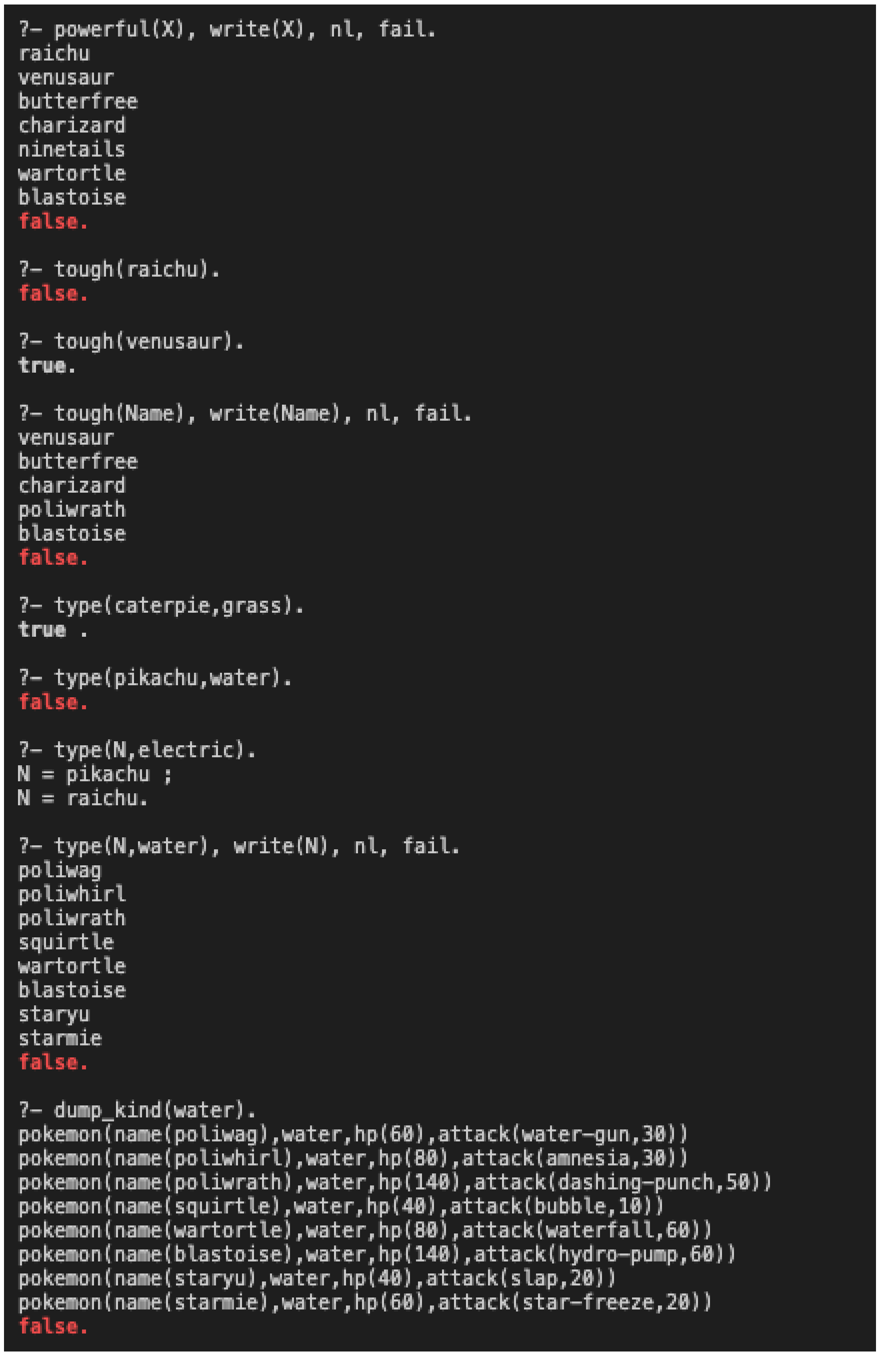


```
display_names :-
    pokemon(name(Name),_,_,_), write(Name), nl, fail.

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

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

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

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

dump_kind(Type) :-
    pokemon(Name,Type,HP,ATK), write(pokemon(Name,Type,HP,ATK)), 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).

families :-
    cen(Name), nl, evolves(Name,Y), write(Name), write(' '), write(Y), evolves(Y,Z), write(' '), write(Z), fail.
    familes.

lineage(Name) :-
    pokemon(name(Name),Type,hp(HP),attack(Kind,ATK)), write(pokemon(name(Name),Type,hp(HP),attack(Kind,ATK))), nl,
    evolves(Name,Y), pokemon(name(Y),Type2,hp(HP2),attack(Kind2,ATK2)), write(pokemon(name(Y),Type2,hp(HP2),attack(Kind2,ATK2))), nl,
    evolves(Y,Z), pokemon(name(Z),Type3,hp(HP3),attack(Kind3,ATK3)), write(pokemon(name(Z),Type3,hp(HP3),attack(Kind3,ATK3))).
```

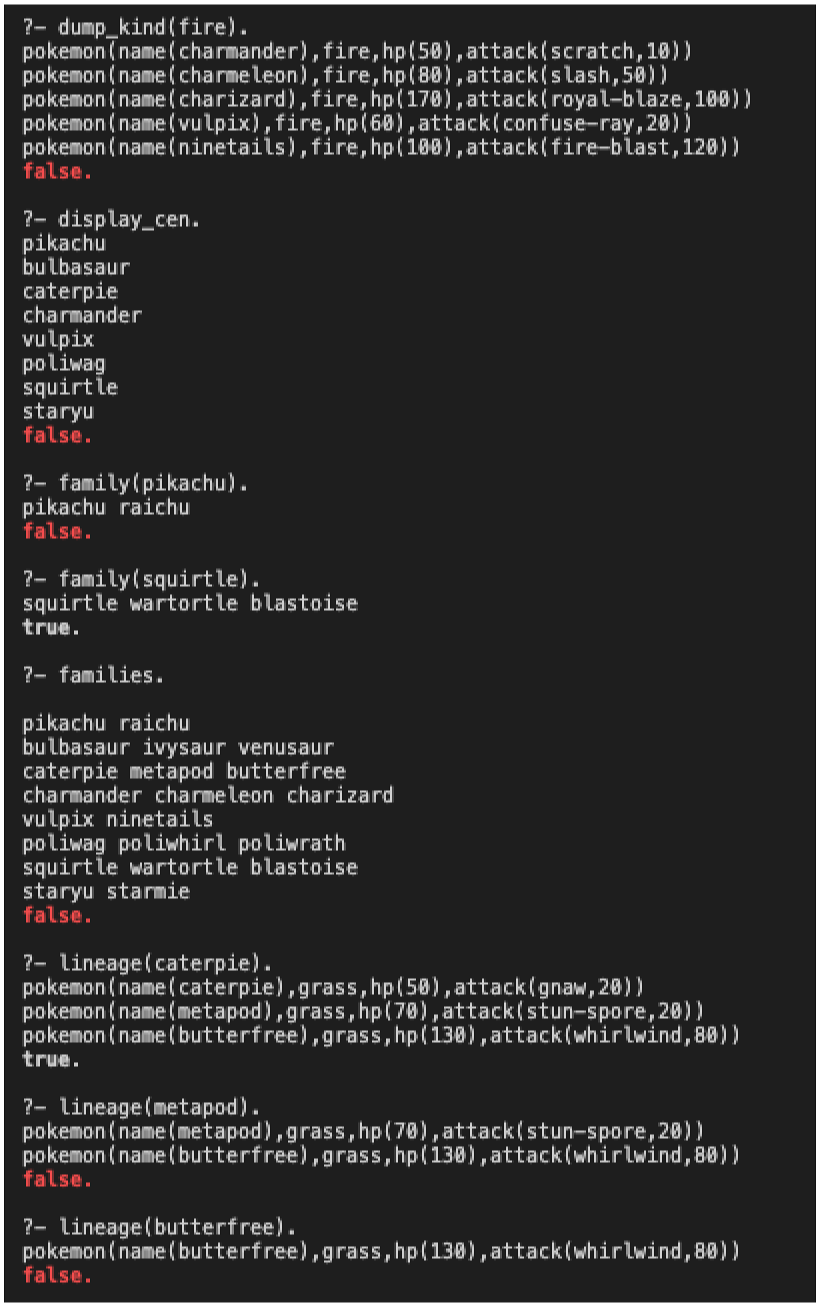
Demo:



```
?- consult('pokemon_plus.pro').
true.

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

?- 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
false.

?- powerful(pikachu).
false.

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



```
?- 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.

?- 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
true.

?- families.

pikachu raichu
bulbasaur ivysaur venusaur
caterpie metapod butterfree
charmander charmeleon charizard
vulpix ninetails
poliwag poliwhirl poliwrath
squirtle wartortle blastoise
staryu starmie
false.

?- 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

Head/Tail Referencing Exercises

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

I think the output will be `H = red and T = (yellow, blue, green).`

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

I think this will fail.

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

I think the output will be `F = red.`

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

I think the output will be `S = yellow.`

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

I think the output will be `F = red, S = yellow, and R = (blue, green).`

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

I think the output will be `List = (this, and, that).`

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

I think the output will be `List = (this, and, that).`

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

I think this will fail because they do not equal each other.

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

I think this will be true.

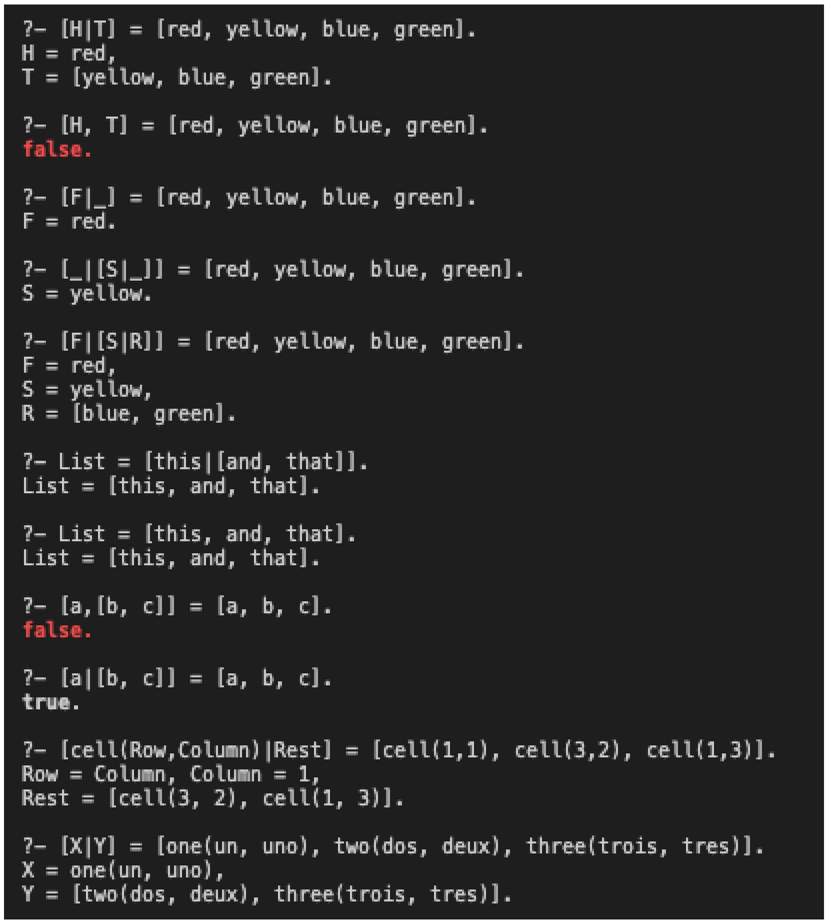
```
?- [cell(Row,Column)|Rest] = [cell(1,1), cell(3,2), cell(1,3)].
```

I think the output will be `cell(Row,Column) = cell(1,1), and Rest = (cell(3,2), cell(1,3)).`

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

I think the output will be `X = one(un, uno), and Y = (two(dos, deux), three(trois, tres)).`

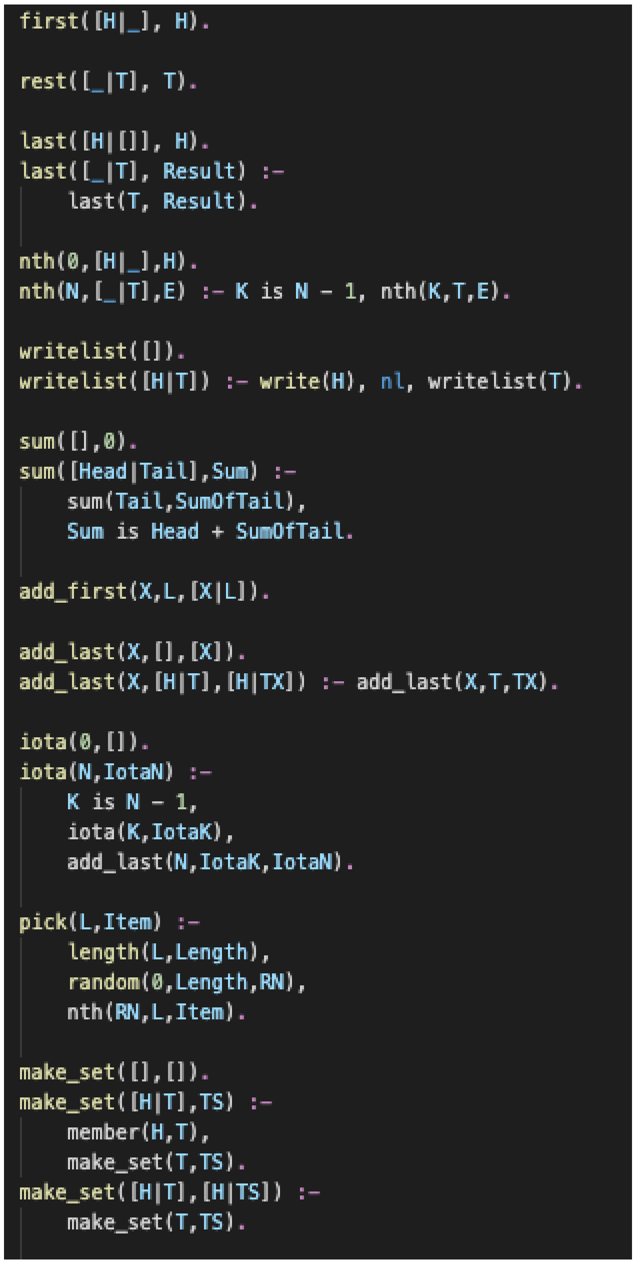
Demo:



```
?- [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)].
```

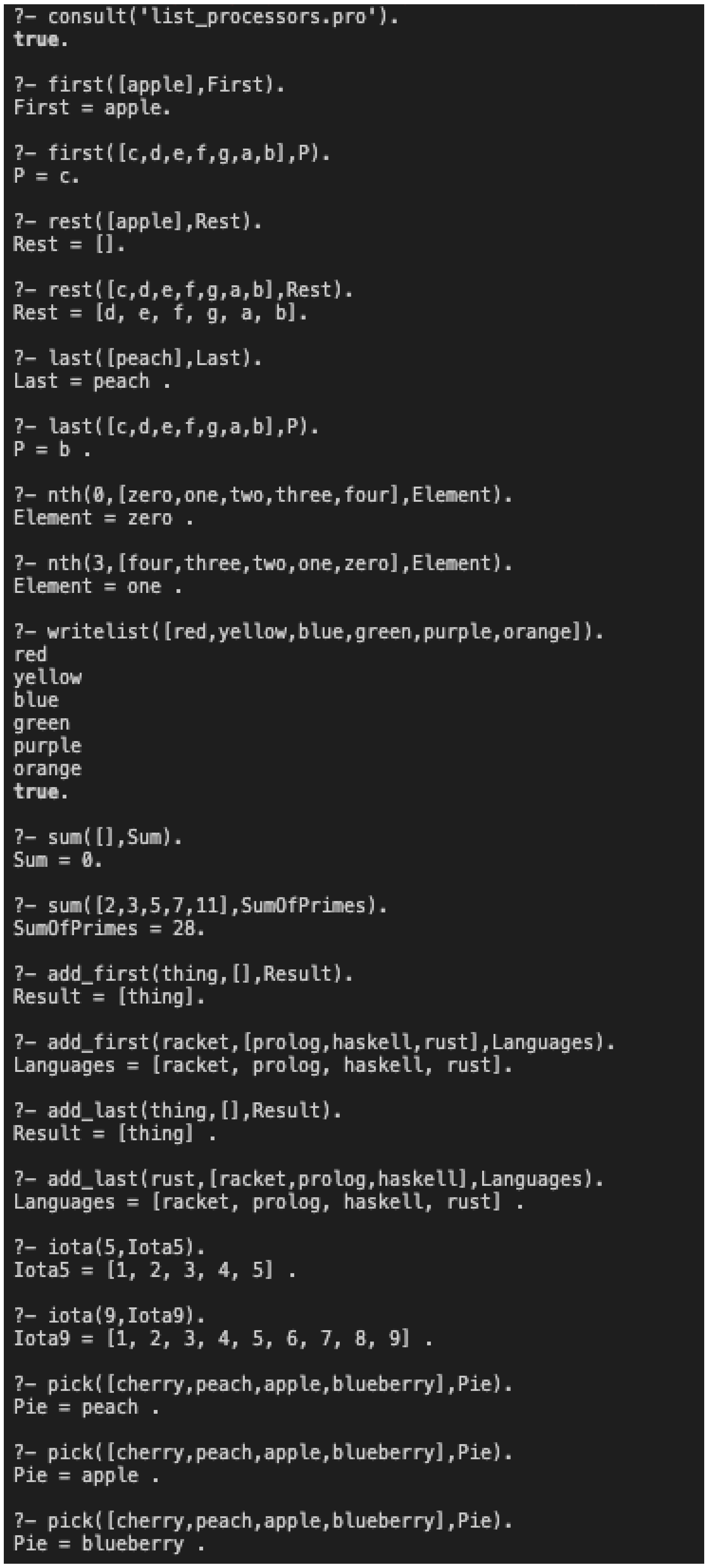
Example List Processors

Code:

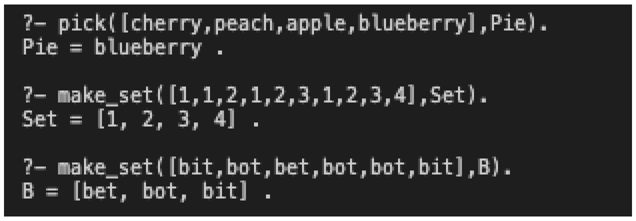


```prolog
first([H|_], H).

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).
```

Demo:



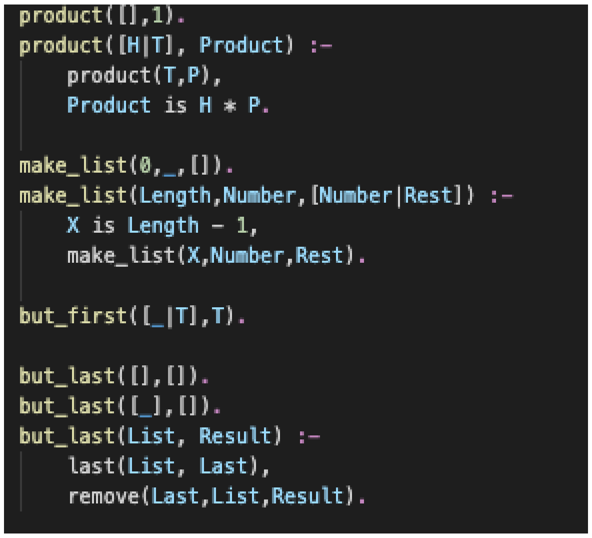
```
?- consult('list_processors.pro').
true.

?- 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 .

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

?- 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 = apple .

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



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

?- 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] .
```

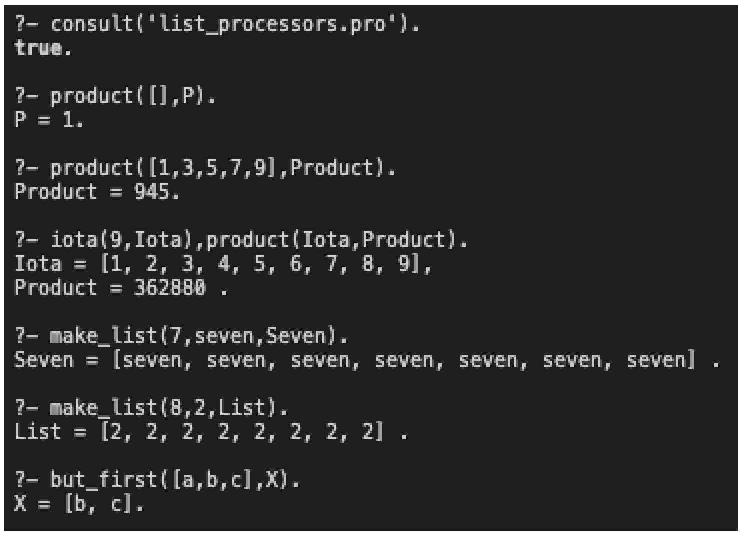
List Processing Exercises

Code:



```
product([],1).
product([H|T], Product) :-
    product(T,P),
    Product is H * P.

make_list(0,_,[]).
make_list(Length,Number,[Number|Rest]) :-
    X is Length - 1,
    make_list(X,Number,Rest).

but_first([_|T],T).

but_last([],[]).
but_last([_],[]).
but_last(List, Result) :-
    last(List, Last),
    remove(Last,List,Result).
```

Demo:



```
?- consult('list_processors.pro').
true.

?- 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].
```