Bansilal Ramnath Agarwal Charitable Trust's
VISHWAKARMA INSTITUTE OF TECHNOLOGY – PUNE

ARTIFICIAL INTELLIGENCE

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Assignment 6:

Implementation of an Expert system using PROLOG: Animal Zoo example.

System Description:

The Animal Zoo Expert System utilizes a knowledge base containing facts about various animals, organized by taxonomic classification and their distinguishing characteristics. The system implements several interaction methods to demonstrate different approaches to knowledge retrieval and inference. The knowledge base uses a structured fact format that encapsulates essential properties of each animal in a way that's both human-readable and efficiently queryable. The system includes 15 different animals across 5 taxonomic classes, with various features, diets, habitats, and sizes defined for each.

The system demonstrates multiple inference approaches including direct identification for retrieving comprehensive information about a specific animal by name, attribute-based queries for finding animals that match specific characteristics, and interactive diagnosis using a decision tree approach with yes/no questions to narrow down possibilities. Users can interact with the system in three main modes: identification by name to query complete information about a known animal, characteristic-based search where users provide multiple attributes and the system finds matching animals, and an interactive guessing game where the system asks targeted questions to determine which animal the user is thinking of.

- **Code:**

```
% Animal Zoo Expert System
% This system identifies animals based on their characteristics

% Knowledge Base: Animal Facts
% Format: animal(Name, Class, Features, Diet, Habitat, Size).

animal(lion, mammal, [fur, mane, tail, four_legs], carnivore, savanna, large).
animal(tiger, mammal, [fur, stripes, tail, four_legs], carnivore, jungle, large).
animal(giraffe, mammal, [fur, long_neck, tail, four_legs, spots], herbivore, savanna, large).
animal(elephant, mammal, [thick_skin, trunk, tusks, big_ears, four_legs], herbivore, savanna, large).
animal(zebra, mammal, [fur, stripes, tail, four_legs, hooves], herbivore, savanna, medium).
animal(penguin, bird, [feathers, wings, beak, two_legs], carnivore, polar, small).
animal(eagle, bird, [feathers, wings, beak, talons, two_legs], carnivore, mountains, medium).
animal(parrot, bird, [feathers, wings, beak, colorful, two_legs], herbivore, jungle, small).
animal(snake, reptile, [scales, no_legs, forked_tongue], carnivore, various, medium).
animal(crocodile, reptile, [scales, four_legs, tail, sharp_teeth], carnivore, water, large).
animal(turtle, reptile, [shell, scales, four_legs, slow], herbivore, various, small).
animal(frog, amphibian, [smooth_skin, four_legs, jumps], carnivore, water, small).
animal(salamander, amphibian, [smooth_skin, four_legs, tail], carnivore, water, small).
animal(shark, fish, [fins, gills, sharp_teeth], carnivore, ocean, large).
animal(goldfish, fish, [fins, gills, scales], herbivore, freshwater, tiny).

% Rules for identification

% Identify an animal by name
identify(Animal) :-
    animal(Animal, Class, Features, Diet, Habitat, Size),
    write('Animal: '), write(Animal), nl,
    write('Class: '), write(Class), nl,
    write('Features: '), write(Features), nl,
    write('Diet: '), write(Diet), nl,
```

```
    write('Habitat: '), write(Habitat), nl,
    write('Size: '), write(Size), nl.

% Find animals by class
find_by_class(Class, Animal) :-
    animal(Animal, Class, _, _, _, _).

% Find animals by feature
find_by_feature(Feature, Animal) :-
    animal(Animal, _, Features, _, _, _),
    member(Feature, Features).

% Find animals by diet
find_by_diet(Diet, Animal) :-
    animal(Animal, _, _, Diet, _, _).

% Find animals by habitat
find_by_habitat(Habitat, Animal) :-
    animal(Animal, _, _, _, Habitat, _).

% Find animals by size
find_by_size(Size, Animal) :-
    animal(Animal, _, _, _, _, Size).

% Expert system to identify animal based on user inputs
identify_animal :-
    write('Welcome to the Animal Zoo Expert System!'), nl,
    write('I will help you identify an animal based on characteristics.'), nl,
    write('What class is the animal? (mammal, bird, reptile, amphibian, fish):
'),
    read(Class),
    write('What is the diet? (carnivore, herbivore): '),
    read(Diet),
    write('What is its size? (tiny, small, medium, large): '),
    read(Size),
    write('What habitat does it live in? (savanna, jungle, polar, mountains,
various, water, ocean, freshwater): '),
    read(Habitat),
    write('Enter a distinctive feature (fur, feathers, scales, shell, wings,
etc.): '),
    read(Feature),

    % Find matching animals
    findall(Animal, (
        animal(Animal, Class, Features, Diet, Habitat, Size),
```

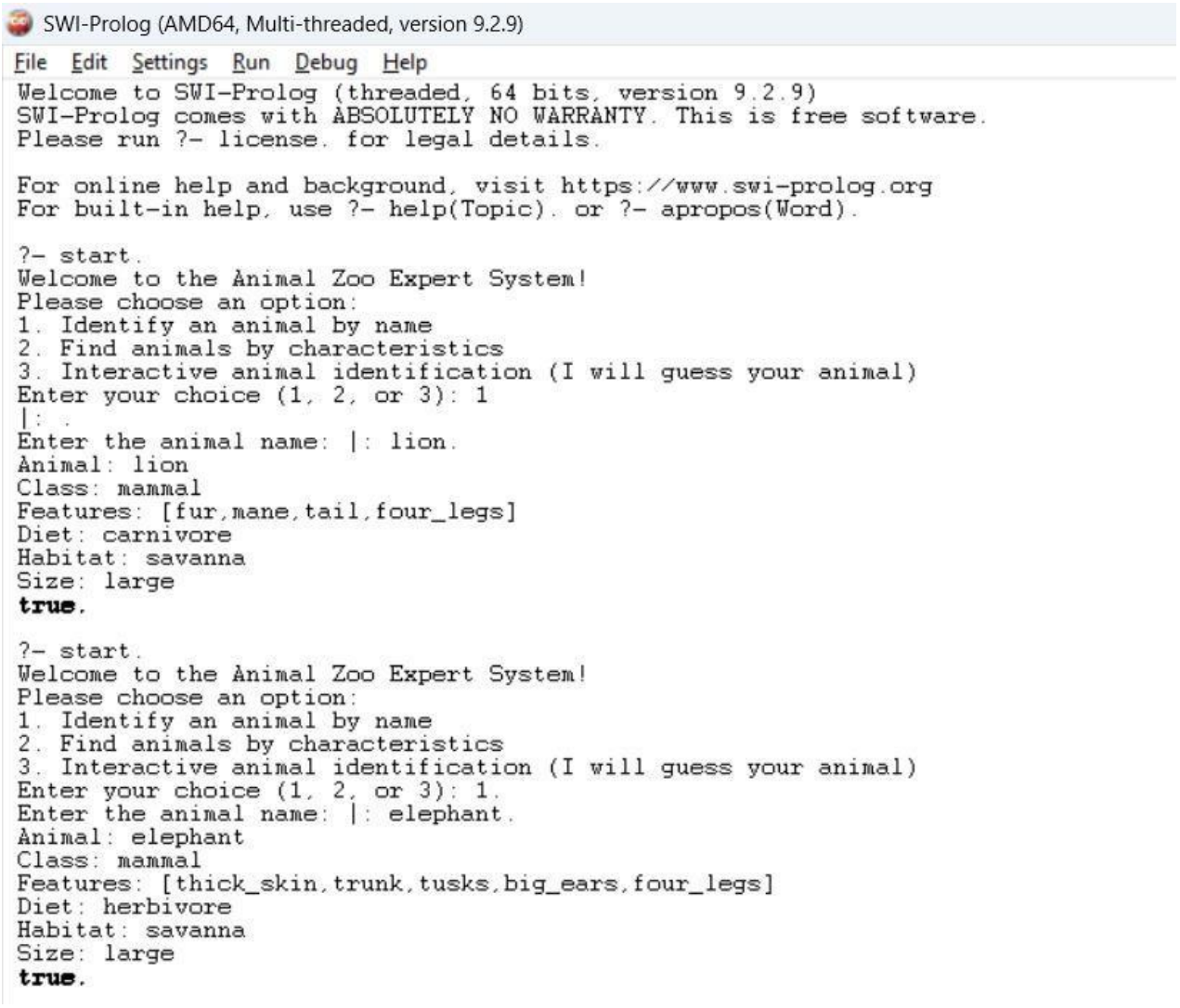
```
        member(Feature, Features)
    ), Animals),

    % Display results
    (   Animals = []
    ->  write('No animals match all these characteristics in our database.')
    ;   write('Possible animals: '), write(Animals)
    ).

% Alternative approach: interactive questioning
animal_quiz :-
    write('Think of an animal in our zoo, and I will try to guess it!'), nl,
    write('Please answer the following questions with yes or no.'), nl,

    % Start with high-level classification
    ask_question('Is it a mammal?'),
    (   is_yes
    ->  mammal_branch
    ;   ask_question('Is it a bird?'),
        (   is_yes
        ->  bird_branch
        ;   ask_question('Is it a reptile?'),
            (   is_yes
            ->  reptile_branch
            ;   ask_question('Is it a fish?'),
                (   is_yes
                ->  fish_branch
                ;   amphibian_branch
                )
            )
        )
    ).

% Branch for mammals
mammal_branch :-
    ask_question('Is it large?'),
    (   is_yes
    ->  ask_question('Does it have a trunk?'),
        (   is_yes
        ->  write('I think it is an elephant!')
        ;   ask_question('Does it have a long neck?'),
            (   is_yes
            ->  write('I think it is a giraffe!')
            ;   ask_question('Does it have a mane?'),
                (   is_yes
```

```
                ->  write('I think it is a lion!')
                ;   write('I think it is a tiger!')
                )
            )
        )
    ;   ask_question('Does it have stripes?'),
        (   is_yes
        ->  write('I think it is a zebra!')
        ;   write('I do not have enough information about this mammal.')
        )
    ).

% Branch for birds
bird_branch :-
    ask_question('Does it swim?'),
    (   is_yes
    ->  write('I think it is a penguin!')
    ;   ask_question('Is it colorful?'),
        (   is_yes
        ->  write('I think it is a parrot!')
        ;   write('I think it is an eagle!')
        )
    ).

% Branch for reptiles
reptile_branch :-
    ask_question('Does it have a shell?'),
    (   is_yes
    ->  write('I think it is a turtle!')
    ;   ask_question('Does it have legs?'),
        (   is_yes
        ->  write('I think it is a crocodile!')
        ;   write('I think it is a snake!')
        )
    ).

% Branch for fish
fish_branch :-
    ask_question('Is it large?'),
    (   is_yes
    ->  write('I think it is a shark!')
    ;   write('I think it is a goldfish!')
    ).

% Branch for amphibians
```

```
amphibian_branch :-
    ask_question('Does it have a tail?'),
    (   is_yes
    ->  write('I think it is a salamander!')
    ;   write('I think it is a frog!')
    ).

% Helper predicates for user input
ask_question(Question) :-
    write(Question), write(' (yes/no): '),
    read(Answer),
    asserta(user_answer(Answer)).

is_yes :-
    user_answer(yes),
    retract(user_answer(_)).

% Main menu
start :-
    write('Welcome to the Animal Zoo Expert System!'), nl,
    write('Please choose an option:'), nl,
    write('1. Identify an animal by name'), nl,
    write('2. Find animals by characteristics'), nl,
    write('3. Interactive animal identification (I will guess your animal)'), nl,
    write('Enter your choice (1, 2, or 3): '),
    read(Choice),
    process_choice(Choice).

process_choice(1) :-
    write('Enter the animal name: '),
    read(Animal),
    identify(Animal).

process_choice(2) :-
    identify_animal.

process_choice(3) :-
    animal_quiz.

% Example queries:
% ?- start.
% ?- identify(lion).
% ?- find_by_class(mammal, X).
% ?- find_by_feature(trunk, X).
```

Screenshots/Output:

1) **Query:** start.



```
?- start.
Welcome to the Animal Zoo Expert System!
Please choose an option:
1. Identify an animal by name
2. Find animals by characteristics
3. Interactive animal identification (I will guess your animal)
Enter your choice (1, 2, or 3): 1.
Enter the animal name: |: snake.
Animal: snake
Class: reptile
Features: [scales,no_legs,forked_tongue]
Diet: carnivore
Habitat: various
Size: medium
true.

?- start.
Welcome to the Animal Zoo Expert System!
Please choose an option:
1. Identify an animal by name
2. Find animals by characteristics
3. Interactive animal identification (I will guess your animal)
Enter your choice (1, 2, or 3): 1.
Enter the animal name: |: shark.
Animal: shark
Class: fish
Features: [fins,gills,sharp_teeth]
Diet: carnivore
Habitat: ocean
Size: large
true.
```

```
?- start.
Welcome to the Animal Zoo Expert System!
Please choose an option:
1. Identify an animal by name
2. Find animals by characteristics
3. Interactive animal identification (I will guess your animal)
Enter your choice (1, 2, or 3): 2.
Welcome to the Animal Zoo Expert System!
I will help you identify an animal based on characteristics.
What class is the animal? (mammal, bird, reptile, amphibian, fish): |: amphibian.
What is the diet? (carnivore, herbivore): |: herbivore.
What is its size? (tiny, small, medium, large): |: small.
What habitat does it live in? (savanna, jungle, polar, mountains, various, watesavanna.
Enter a distinctive feature (fur, feathers, scales, shell, wings, etc.): |: scales.
No animals match all these characteristics in our database.
true.

?- start.
Welcome to the Animal Zoo Expert System!
Please choose an option:
1. Identify an animal by name
2. Find animals by characteristics
3. Interactive animal identification (I will guess your animal)
Enter your choice (1, 2, or 3): 3.
Think of an animal in our zoo, and I will try to guess it!
Please answer the following questions with yes or no.
Is it a mammal? (yes/no): |: yes.
Is it large? (yes/no): |: yes.
Does it have a trunk? (yes/no): |: yes.
I think it is an elephant!
true.
```

2) **Query:** identify(lion).

```
?- identify(goldfish).
Animal: goldfish
Class: fish
Features: [fins,gills,scales]
Diet: herbivore
Habitat: freshwater
Size: tiny
true.

?- identify(salamander).
Animal: salamander
Class: amphibian
Features: [smooth_skin,four_legs,tail]
Diet: carnivore
Habitat: water
Size: small
true.

?- identify(penguin).
Animal: penguin
Class: bird
Features: [feathers,wings,beak,two_legs]
Diet: carnivore
Habitat: polar
Size: small
true.
```

3) **Query:** find_by_class(mammal, X).

```
?- find_by_class(bird, X).
X = penguin ;
X = eagle ;
X = parrot.

?- find_by_class(mammal, X).
X = lion ;
X = tiger ;
X = giraffe ;
X = elephant ;
X = zebra.
```

4) **Query:** find_by_feature(trunk, X).

```
?- find_by_feature(trunk, X).
X = elephant ;
false.

?- find_by_feature(scales, X).
X = snake ;
X = crocodile ;
X = turtle ;
X = goldfish.

?- find_by_feature(beak, X).
X = penguin ;
X = eagle ;
X = parrot ;
false.
```

5) **Query:** find_by_habitat(water, X).

```
?- find_by_habitat(water, X).
X = crocodile ;
X = frog ;
X = salamander.

?- find_by_habitat(freshwater, X).
X = goldfish.

?- find_by_habitat(jungle, X).
X = tiger ;
X = parrot.

?- find_by_habitat(savanna, X).
X = lion ;
X = giraffe ;
X = elephant ;
X = zebra.

?- find_by_habitat(mountains, X).
X = eagle.
```