Project 4 Report - Family Relationship/Kinship in "I'm My Own Grandpa"
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Introduction:
The projects explores the logical structure of kinship relationships in the song *"I'm My Own Grandpa."* The song continues to narrate an exaggerated and logically consistent sequence of marriages and family connections that ultimately lead to the conclusion that the narrator is his own grandfather. These complex relations can be solved using Prolog to model kinship, marriage, parenthood, childhood, and step-relationships using simple logic rules. The main goal of the project was to represent the facts and kinship implications found in the song and verify those claims using Prolog. I had to mainly focus on maximizing the number of rules while also minimizing the number of facts. I did all of that by creating the program to infer about these relationships using logical deduction.

Background:
I had to listen to the song and read the lyrics, and also understand the relationships described in the song like marriages and parent/child relationships. After I had to implement a model in Prolog that covers these relationships using inference rules. I also understood the diagram of the situation shown on page 7 of the PDF document.

The diagram showed how the "me" or "I", his father ("my father"), the widow ("pretty widow"), and the red-haired daughter ("red_hair_grown_up_daughter_of_widow") became entangled in a web of relationships throught marriage and childbirth.
The sample writeup shown in Page 12 of the pdf showed for the exact set of facts should be used.
- I followed these set of facts/rule to "maximize rules, minimize facts"
    - Two spouse facts/relationships
        - spouse(i, widow)
        - spouse(dad, rehdair)
    - Two female facts/individuals
        - Widow
        - Redhair
    - Four male facts/individuals
        - i, dad, onrun, baby
    - Four children facts
        - child(redhair, widow)
        - child(i, dad(
        - child(onrun, dad)
        - child(baby, i)

Implementation:

The Prolog system was divided into multiple categories like parent rules, marriage rules, grandparent rules, sibling rules, in-law rules, and uncle/aunt rules. I only used the minimal facts stated in the assignment PDF and all of the additional relationships were derived through the given rules.

Similar to what I said before and using the content given in the PDF
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    - child(redhair, widow)
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    - child(onrun, dad(
    - child(baby, i)

The Rules define the parent, mother, father, step-parent, grandparent, sibling, in-law, and uncle relationships. These general rules work for any set of facts, including:
- Parent and Biological Parent Rules
  - parent(P, C) is defined from the child fact
- Marriage Rules
  - married(X, Y) is symmetric, which allows inference in both directions
- Step-Parent Rules: Married to biological parent but not their parents themselves
- Grandparent Rules: Derived recursively from parent relationships
- Sibling Rules: Individuals are siblings if they share a parent.
- Sibling-In-Law Rules: Married to a sibling or sibling of their spouses
- Uncle Rules: Brother os a parent of spouse of an aunt or sibling-in-law

These above roles allow the program to deduce all kinship connections

Testing:

Expected Output as shown in Slide 6 of the Project PDF:

Project-4: Sample output

```
?- runIt.
Is redhair the daughter of i?: Yes
Is redhair the mother of i?: Yes
Is dad the son in law of i?: Yes
Is baby the brother of dad?: No
Is baby the uncle of i?: Yes
Is baby the brother of redhair?: Yes
Is onrun the grandchild of i?: Yes
Is widow the mother of redhair?: Yes
Is widow the grandmother of i?: Yes
Is i the grandchild of widow?: Yes
Is i the grandfather of i: Yes
true.
```

Test Cases that I ran for my program in SWIProlog Console:


```
?- consult('/Users/rishitmaiti/Desktop/CSE259Prolog/project4.pl').
true.

?- runIt.
Is redhair the daughter of i?: Yes
Is redhair the mother of i?: Yes
Is dad the son in law of i?: Yes
Is baby the brother of dad?: No
Is baby the uncle of i?: Yes
Is baby the brother of redhair?: Yes
Is onrun the grandchild of i?: Yes
Is widow the mother of redhair?: Yes
Is widow the grandmother of i?: Yes
Is i the grandchild of widow?: Yes
Is i the grandfather of i?: Yes
true.

?- daughter(redhair, i).
true ;
false.

?- mother(redhair, i).
true .

?- son_in_law(dad, i).
true .

?- brother(baby, dad).
false.

?- uncle(baby, i).
true .

?- grandchild(onrun, i).
true .

?- mother(widow, redhair).
true .

?- grandmother(widow, i).
true .

?- grandchild(i, widow).
true .

?- grandfather(i, i).
true .

?-
```

Conclusion:

Overall, this project helped me understand how Prolog's rule-based logic can help model and analyze compex kinship relationships. Even in a deliberately confusing scenario presented in the song _"I'm My Own Grandpa,"_ if we can minimize facts and maximize rules, we can create an effective kinship system that can cover all potential and required relationships. The rules that I implemented exactly match the output shown in the assignment instructions.