الوحدة	BAI501
عنوان التقييم	الذكاء الصنعي
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تاريخ الاستلام	على مودل

يجب استضافة المشروع على Google Colab لأن تصحيح الوظيفة سيكون online من الرابط الذي سترسله لي

ضع أسماء و Ids المشاركين في أول خلية من كولاب بشكل واضح و خط كبير

أضف بيانات أخرى كي يكون لكل سؤال ناتج OUTPUT غير التي في هذا الملف

يجب عدم تحميل أي بيانات من أي ملف csv كي أستطيع التنفيذ فورا من رابط كولاب

Title: *Building a Comprehensive Family Relations Expert System using PyDatalog*

🎯 **Objective**

Use **PyDatalog** to build a knowledge-based expert system capable of **modeling, inferring, and querying complex multi-generational family relationships**, including blended, extended, and in-law relationships.

🧰 **Setup Instructions**

1. Install PyDatalog:
2. pip install pyDatalog
3. Start a new file: family_expert_system.ipynb on Google COLAB notebook.
4. Use comments to separate sections for each relationship category.

✅ **Tasks & Questions by Relationship Type**

🧑‍🤝‍🧑 **1. Individuals and Basic Relationships**

Q1.1

USE THIS data:

Name	Gender	Father	Mother	Spouse(s)	Notes
John	Male			Mary	1st marriage
Mary	Female			John, Peter	Multiple marriages → Peter is stepfather to John's children
Peter	Male			Mary	Stepfather to David, Emma, Diana
David	Male	John	Mary	Sophia, Clara	Multiple marriages
Emma	Female	John	Mary	Paul, Alex	Multiple marriages

Diana	Female	John	Mary		Sibling to David & Emma
Sophia	Female			David	Mother of Paul, Olivia, Michael, Tom
Clara	Female			David	Stepmother to David's children with Sophia
Paul	Male	David	Sophia	Emma	Husband of Emma, father of Nora, Liam, Emily, James
Olivia	Female	David	Sophia	Michael	Mother of Kevin, Linda, Lucas, Tom's wife later
Michael	Male	David	Sophia	Olivia	Father of Kevin, Linda, Lucas

Tom	Male	David	Sophia	Olivia	Half-step tie: later married Olivia, father of Ivy & Daniel
Kevin	Male	Michael	Olivia	Linda	Father of Isla, Noah, Alice
Linda	Female	Michael	Olivia	Kevin, Lucas	Multiple marriages
Lucas	Male	Michael	Olivia	Linda	Father of Zoe, Grace, Henry, Layla, Ryan
Nora	Female	Paul	Emma	Liam	Mother of George, Ella
Liam	Male	Paul	Emma	Nora	Father of George, Ella
Emily	Female	Paul	Emma	James	Mother of Sarah, Adam
James	Male	Paul	Emma	Emily	Father of Sarah, Adam
Isla	Female	Kevin	Linda		Adopted by Anna
Noah	Male	Kevin	Linda		–

Alice	Female	Kevin	Linda		–
Zoe	Female	Lucas	Linda		Adopted by Daniel
Grace	Female	Lucas	Linda		–
Henry	Male	Lucas	Linda		–
Layla	Female	Lucas	Linda		–
Ryan	Male	Lucas	Linda		–
George	Male	Liam	Nora		–
Ella	Female	Liam	Nora		–
Sarah	Female	James	Emily		–
Adam	Male	James	Emily		–
Ivy	Female	Tom	Olivia		–
Daniel	Male	Tom	Olivia		Adoptive father of Zoe
Anna	Female	Mark	Ella		Adoptive mother of Isla
Mark	Male	Mark	Diana		Descendant of Diana

Q1.2 Define the base rule:
parent(X, Y) <= father(X, Y) | mother(X, Y)

👨‍👩‍👧 2. Core Family Roles

Q2.1 Define rules for:

- child(X, Y) → X is a child of Y
- son(X, Y) and daughter(X, Y)
- is_male(X) and is_female(X)

Q2.2 Query:

- List all sons and daughters of any individual.
- Who are the children of John?

👬 3. Sibling Logic

Q3.1 Define rules:

- sibling(X, Y) → X and Y share at least one parent and are not the same
- full_sibling(X, Y) → X and Y share both parents
- half_sibling(X, Y) → X and Y share only one parent

- brother(X, Y) / sister(X, Y)

Q3.2 Query:

- All siblings of Alice
- All half-siblings of Michael
- List all sibling pairs

👴 4. Ancestry and Descendants

Q4.1 Define:

- grandparent(X, Y), grandfather, grandmother
- great_grandparent(X, Y)
- ancestor(X, Y) (recursive)
- descendant(X, Y) (reverse of ancestor)

Q4.2 Query:

- All ancestors of Liam
- Who are the great-grandparents of Sophia?
- List all descendants of Emma

🧬 5. Extended Family (Aunt/Uncle/Cousins)

Q5.1 Define rules for:

- uncle(X, Y) and aunt(X, Y)
- first_cousin(X, Y) → children of siblings
- second_cousin(X, Y) → children of first cousins
- cousin(X, Y) → general cousin relationship
- cousin_degree(X, Y, D) → distance in generations

Q5.2 Query:

- Who are the cousins of Noah?
- Find all uncles and aunts of Emily
- List second cousins of James

💍 6. Spouse and In-law Logic

Q6.1 Add facts: spouse(X, Y) (make symmetric)

Q6.2 Define:

- mother_in_law, father_in_law, brother_in_law, sister_in_law
- son_in_law, daughter_in_law
- sibling_in_law(X, Y)
- niece_in_law, nephew_in_law

Q6.3 Query:

- Who is the mother-in-law of Amir?
- List all siblings-in-law of Fatima

👨‍👩‍👧 7. Step Relationships ADD RULES

Q7.1 Add rules:

❓ step_parent(X, Y)

- **A step-parent is someone who becomes a parent figure by marriage, not by blood.**
- **Example: If Oliver's father marries Anna, Anna is Oliver's stepmother. She is a *spouse of the biological parent*, but not the biological parent herself.**

❓ step_child(X, Y)

- **A step-child is simply the reverse relationship of step-parent.**
- **If Anna is Oliver's stepmother, then Oliver is Anna's step-child.**

step_sibling(X, Y)

- **Step-siblings are children who don't share both biological parents but become "siblings" through marriage of their parents.**
- **Example: If Oliver's father marries Anna, and Anna already has a daughter Emma, then Oliver and Emma are step-siblings.**

step_grandparent(X, Y)

- **A step-grandparent is someone who becomes a grandparent figure through marriage.**
- **Example: If Sophia's mother marries Peter, and Peter's father is Robert, then Robert is Sophia's step-grandfather. He is not related by blood but is part of the family through marriage.**

Q7.2 Add facts and query:

- All step-siblings of Oliver
- Who is the stepfather of Sophia?

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8. Blended and Complex Relationships

Q8.1 Add rules:

adoptive_parent(X, Y)

- **An adoptive parent is someone who legally becomes a parent to a child, even if they are not the biological parent.**
- **Example: If Oliver is adopted by Anna, then Anna is his adoptive mother. The relationship is based on legal guardianship, not blood.**

biological_parent(X, Y)

- **A biological parent is the person who is genetically related to the child.**
- **Example: If John and Mary gave birth to Oliver, then John and Mary are Oliver's biological parents.**

multiple_marriages(X)

- **This refers to a person who has been married to more than one spouse (at different times, or even simultaneously depending on culture/law).**
- **Example: If Mary first marries John, and later marries Peter, then Mary has had multiple marriages. This often creates step-relations and half-sibling relations in families.**

half_uncle(X, Y)

- **A half-uncle is the half-brother of your parent.**
- **That means he shares only one biological parent with your mother or father.**
- **Example: If your mother Mary and her brother David have the same father but different mothers, then David is your half-uncle.**

step_cousin(X, Y)

- **A step-cousin is someone who becomes your cousin through step-relations, not through blood.**
- **Example: If your step-uncle (a man who married your aunt, but is not blood-related) has a child, that child is your step-cousin.**
- **Or, if your step-sibling has an uncle/aunt through their other parent, their children could also be considered step-cousins.**

Q8.2 Query:

- Who are the adoptive parents of Daniel?
- List children of parents with multiple spouses
- Who are the step-cousins of Grace?

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9. Knowledge Reasoning & Edge Cases

Q9.1 Test inference:

- Who are all relatives of Adam within 2 generations?
- Identify unrelated individuals in the system

- Write a query to find if X is in a direct line of descent from Y
  Q9.2 Write a query:
- Is X the aunt or uncle of Y?
- Is X a cousin of Y within N generations?

📜 **Deliverables**

1. **Google COLAB Notebook**: family_expert_system.ipynb
2. **Report (PDF)**:
   - All relationships defined and explained
   - Example queries and their outputs

📊 **Evaluation Rubric**

Section	Points
Facts + Basic Relationships	15
Extended + In-law Logic	15
Queries and Output Verification	15
Step / Half / Blended Families	15
Advanced Cousin & Ancestry Logic	15
Code Structure & Comments	15
Report & Documentation	20