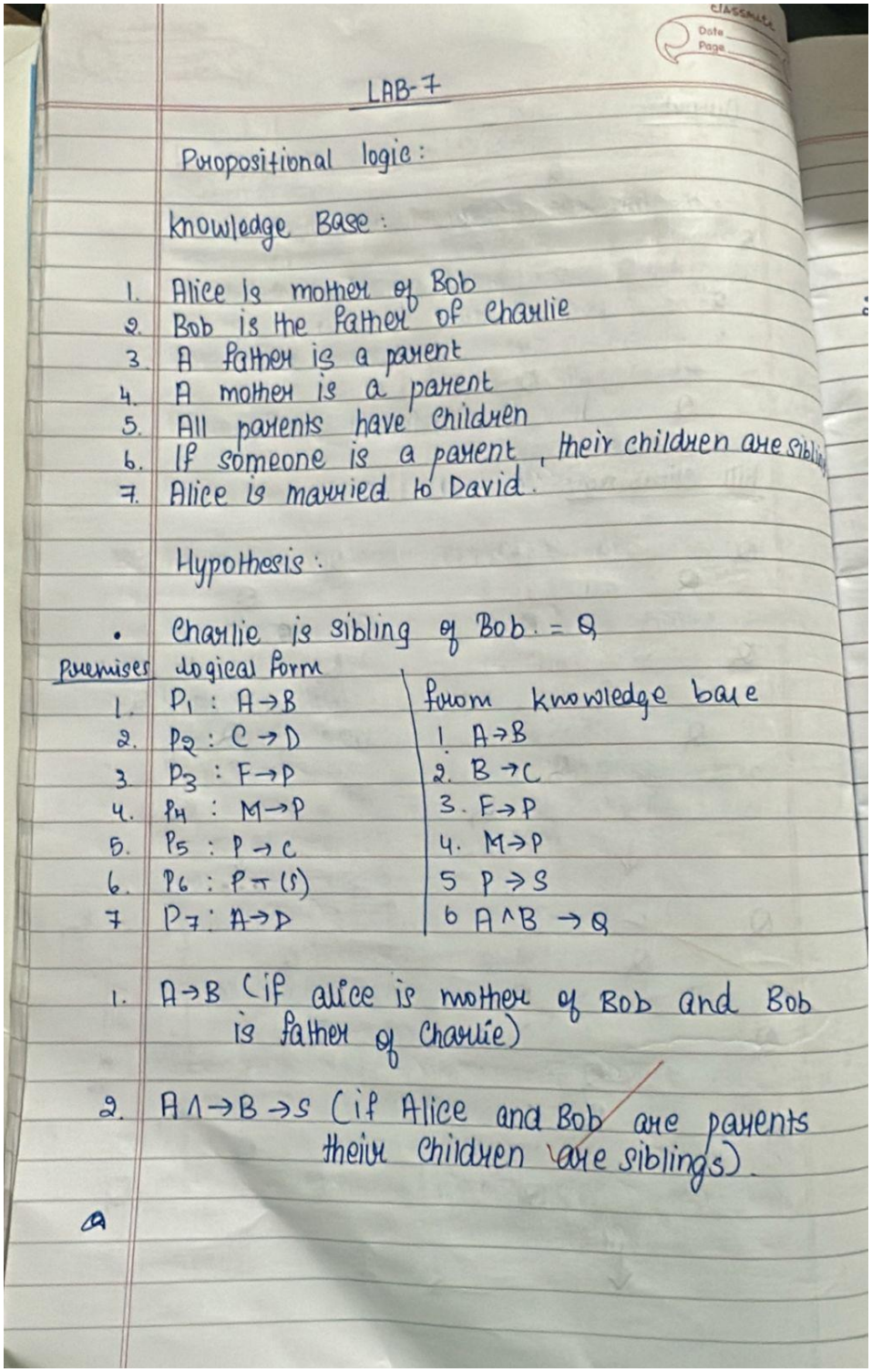
LAB-7 - Entailment Using Literals

Observation book:



LAB-7

Propositional logic:

Knowledge Base:

1. Alice is mother of Bob
2. Bob is the father of Charlie
3. A father is a parent
4. A mother is a parent
5. All parents have children
6. If someone is a parent, their children are sibling
7. Alice is married to David.

Hypothesis:

- Charlie is sibling of Bob. = Q

Premises	logical form	from knowledge base
1.	$P_1 : A \to B$	1. $A \to B$
2.	$P_2 : C \to D$	2. $B \to C$
3.	$P_3 : F \to P$	3. $F \to P$
4.	$P_4 : M \to P$	4. $M \to P$
5.	$P_5 : P \to C$	5 $P \to S$
6.	$P_6 : P \to (S)$	6 $A \wedge B \to Q$
7	$P_7 : A \to D$	

1. $A \to B$ (if alice is mother of Bob and Bob is father of Charlie)

2. $A \wedge \to B \to S$ (if Alice and Bob are parents their children are siblings).

Entailment

1. if A (Alice is mother of Bob) is true
   → B must be true (since A → B)

2. if B is true
   → C must be true (F → P)
   → N must be true (M → P)

3. If Both Alice and Bob are parents (M & F) are true)
   → S must be true

4. Since S is true
   → Q is true

Conclusion:
The hypothesis "Charlie is a sibling of Bob" is True. Therefore the hypothesis is entailed by the knowledge base.

Code:

```
import re


# Helper function to parse user input into logical predicates
def parse_input(input_sentence, knowledge_base):
    # Convert the sentence to lowercase for consistency
    input_sentence = input_sentence.lower()

    # Match patterns for predicates and facts (e.g., 'X is the mother of Y' or 'X is married to Y')

    # Fact or Rule: "X is the mother of Y"
    mother_match = re.match(r"(\w+) is the mother of (\w+)", input_sentence)

    # Fact or Rule: "X is the father of Y"
    father_match = re.match(r"(\w+) is the father of (\w+)", input_sentence)

    # General rule: "All X have children"
    parent_match = re.match(r"all (\w+) have children", input_sentence)

    # Rule for parent-child relation and siblings
    parent_rule_match = re.match(r"if someone is a parent, their children are siblings", input_sentence)

    # General fact: "X is married to Y"
    married_match = re.match(r"(\w+) is married to (\w+)", input_sentence)
```

```
    # Parsing rules and facts
    if mother_match:
        mother, child = mother_match.groups()
        # Add the mother-child relationship to knowledge base
        knowledge_base["Mother"].append((mother.capitalize(),
child.capitalize()))

    elif father_match:
        father, child = father_match.groups()
        # Add the father-child relationship to knowledge base
        knowledge_base["Father"].append((father.capitalize(), child.capitalize()))

    elif parent_match:
        parent = parent_match.group(1)
        # Rule: All X are parents with children
        knowledge_base["ParentRule"].append((parent.capitalize(),
"HasChildren"))

    elif parent_rule_match:
        # General rule: If someone is a parent, their children are siblings
        knowledge_base["ParentSiblingRule"].append(("Parent", "Siblings"))

    elif married_match:
        spouse1, spouse2 = married_match.groups()
        # Add the married relationship to knowledge base
        knowledge_base["Married"].append((spouse1.capitalize(),
spouse2.capitalize()))
```

```
# Function to check if two children are siblings
def are_siblings(child1, child2, knowledge_base):
    # Check if both children share the same parent
    parents = set()
    for mother, child in knowledge_base["Mother"]:
        if child == child1:
            parents.add(mother)
        if child == child2:
            parents.add(mother)

    for father, child in knowledge_base["Father"]:
        if child == child1:
            parents.add(father)
        if child == child2:
            parents.add(father)

    return len(parents) > 1  # If both children share a parent, they are siblings

# Function to check the hypothesis "Charlie is a sibling of Bob"
def check_hypothesis(hypothesis, knowledge_base):
    # Parse the hypothesis
    hyp_match = re.match(r"(\w+) is a sibling of (\w+)", hypothesis.lower())
    if hyp_match:
        child1, child2 = hyp_match.groups()
        # Check if the children are siblings
```

```
        if are_siblings(child1.capitalize(), child2.capitalize(), knowledge_base):
            return True
    return False

# Main function for user input and entailment reasoning
def main():
    # Create an empty knowledge base
    knowledge_base = {
        "Mother": [],
        "Father": [],
        "ParentRule": [],
        "ParentSiblingRule": [],
        "Married": []
    }

    print("Enter knowledge base rules. Type 'done' when finished.")

    # Allow the user to input knowledge base facts, rules, or actions
    while True:
        user_input = input("Enter fact/rule/action: ").strip()
        if user_input.lower() == "done":
            break
        parse_input(user_input, knowledge_base)

    # Print the current knowledge base
    print("\nCurrent Knowledge Base:")
```

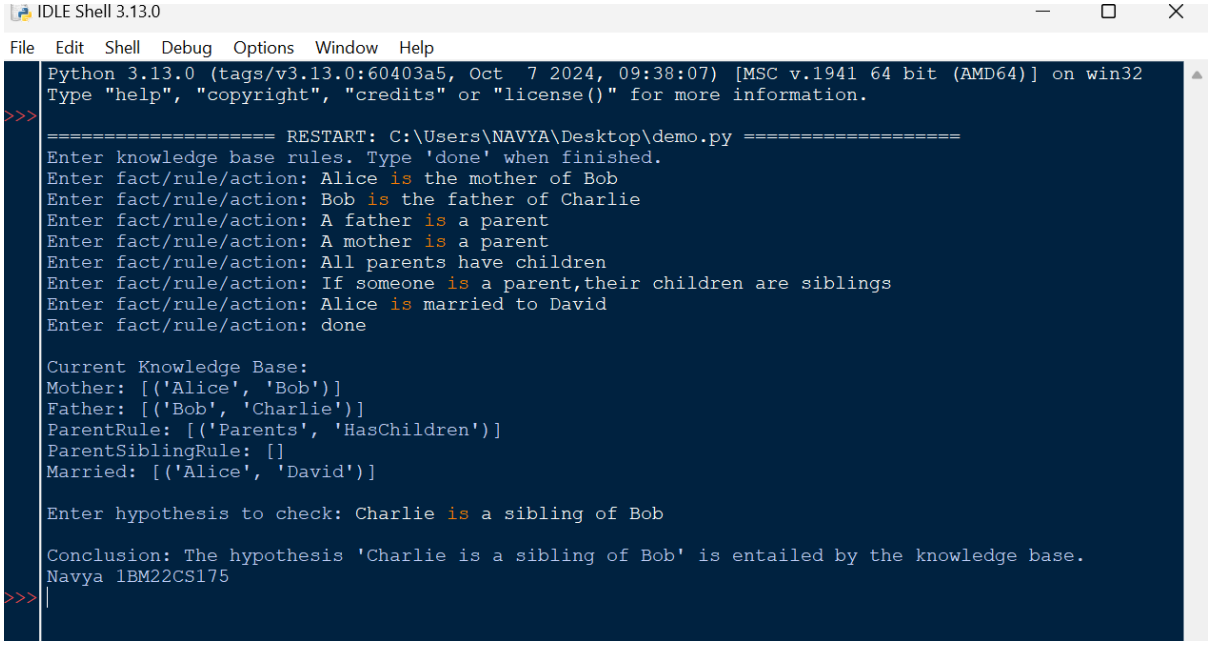
```
    for category, items in knowledge_base.items():
        print(f"{category}: {items}")

    # Ask for the hypothesis (the statement to check)
    hypothesis = input("\nEnter hypothesis to check: ").strip()

    # Check if the hypothesis is entailed
    if check_hypothesis(hypothesis, knowledge_base):
        print(f"\nConclusion: The hypothesis '{hypothesis}' is entailed by the knowledge base.")
    else:
        print(f"\nConclusion: The hypothesis '{hypothesis}' is NOT entailed by the knowledge base.")

# Run the program
main()
print("Navya 1BM22CS175")
```

Output:


IDLE Shell 3.13.0
File Edit Shell Debug Options Window Help
Python 3.13.0 (tags/v3.13.0:60403a5, Oct 7 2024, 09:38:07) [MSC v.1941 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
========== RESTART: C:\Users\NAVYA\Desktop\demo.py ==========
Enter knowledge base rules. Type 'done' when finished.
Enter fact/rule/action: Alice is the mother of Bob
Enter fact/rule/action: Bob is the father of Charlie
Enter fact/rule/action: A father is a parent
Enter fact/rule/action: A mother is a parent
Enter fact/rule/action: All parents have children
Enter fact/rule/action: If someone is a parent,their children are siblings
Enter fact/rule/action: Alice is married to David
Enter fact/rule/action: done
Current Knowledge Base:
Mother: [('Alice', 'Bob')]
Father: [('Bob', 'Charlie')]
ParentRule: [('Parents', 'HasChildren')]
ParentSiblingRule: []
Married: [('Alice', 'David')]
Enter hypothesis to check: Charlie is a sibling of Bob
Conclusion: The hypothesis 'Charlie is a sibling of Bob' is entailed by the knowledge base.
Navya 1BM22CS175
>>>