LAB-7: Entailment Using Literals

Observation book:

classmate
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Propositional Logic:

Knowledge Base:

1. Alice is the 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 siblings.
7. Alice is married to David.

Hypothesis:

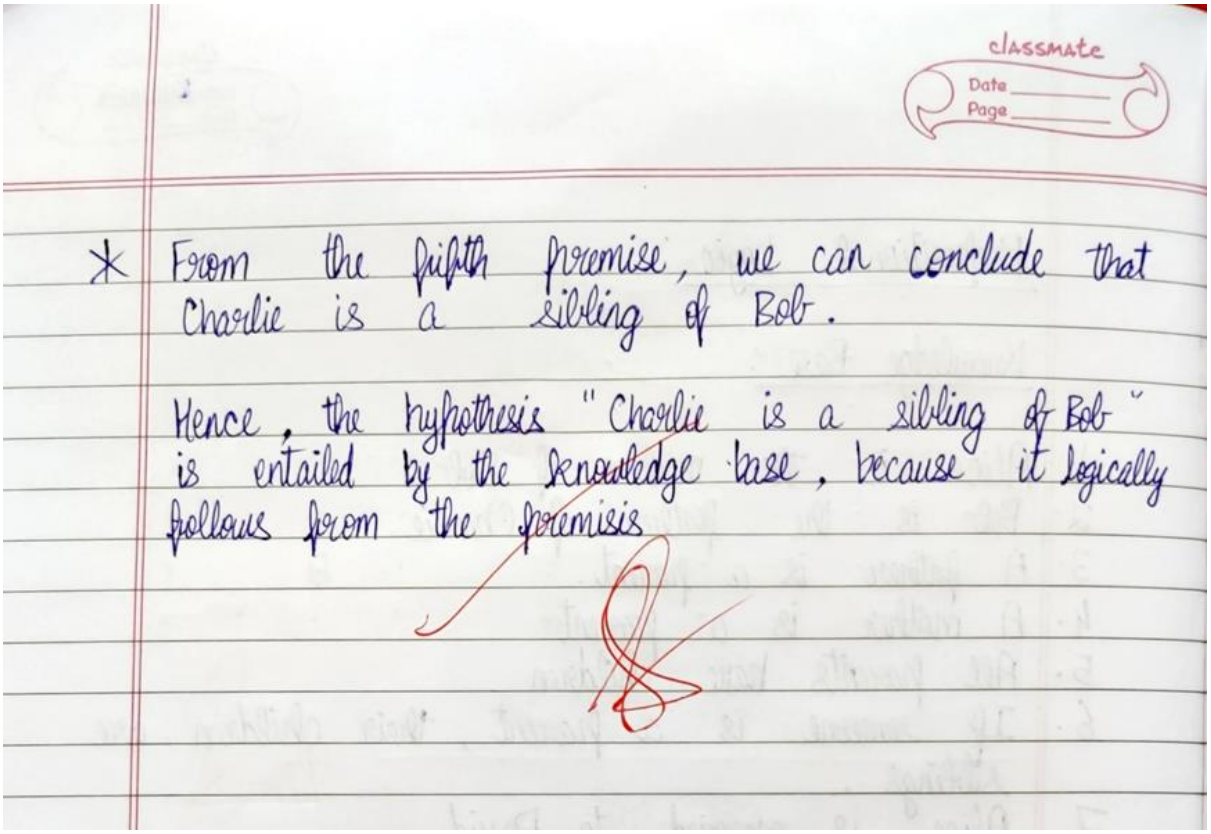
Charlie is a sibling

Premise from Knowledge Base:

* Bob is the father of Charlie (A)
* A father is a parent (B)
* Alice is the mother of Bob (C)
* A mother is a parent (D)
* If someone is a parent, their children are siblings (E)

Entailment Process:

* From the first entailment, we can conclude that Bob is Charlie's parent
* From the third entailment, we can conclude that Alice is Bob's parent.
* From the above, we can conclude that Alice is a parent of Charlie. (By Transitivity)



* From the fifth premise, we can conclude that Charlie is a sibling of Bob.

Hence, the hypothesis "Charlie is a sibling of Bob" is entailed by the knowledge base, because it logically follows from the premisis

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()
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        # 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)
```

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        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": [],
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    "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("Nikhilesh 1BM22CS181")

Output :

```
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.
```