Week 9
Forward Chaining

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1BM22CS237

```
# Define the knowledge base with facts and rules
knowledge_base = [
    # Rule: Selling weapons to a hostile nation makes one a criminal
    {
        "type": "rule",
        "if": [
            {"type": "sells", "seller": "?X", "item": "?Z", "buyer":
"?Y"},
            {"type": "hostile_nation", "nation": "?Y"},
            {"type": "citizen", "person": "?X", "country": "america"}
        ],
        "then": {"type": "criminal", "person": "?X"}
    },
    # Facts
    {"type": "hostile_nation", "nation": "CountryA"},
    {"type": "sells", "seller": "Robert", "item": "missiles", "buyer":
"CountryA"},
    {"type": "citizen", "person": "Robert", "country": "america"}
]

# Forward chaining function
def forward_reasoning(kb, query):
    inferred = []  # Track inferred facts
    while True:
        new_inferences = []
        for rule in [r for r in kb if r["type"] == "rule"]:
            conditions = rule["if"]
            conclusion = rule["then"]
            substitutions = {}
            if match_conditions(conditions, kb, substitutions):
                inferred_fact = substitute(conclusion, substitutions)
                if inferred_fact not in kb and inferred_fact not in
new_inferences:
                    new_inferences.append(inferred_fact)
        if not new_inferences:
            break
        kb.extend(new_inferences)
        inferred.extend(new_inferences)
    return query in kb

# Helper to match conditions
def match_conditions(conditions, kb, substitutions):
    for condition in conditions:
        if not any(match_fact(condition, fact, substitutions) for fact in
kb):
            return False
    return True

# Helper to match a single fact
def match_fact(condition, fact, substitutions):
    if condition["type"] != fact["type"]:
        return False
    for key, value in condition.items():
        if key == "type":
            continue
        if isinstance(value, str) and value.startswith("?"):  # Variable
            variable = value
            if variable in substitutions:
                if substitutions[variable] != fact[key]:
                    return False
            else:
                substitutions[variable] = fact[key]
        elif fact[key] != value:  # Constant
            return False
    return True

# Substitute variables with their values
def substitute(conclusion, substitutions):
    result = conclusion.copy()
    for key, value in conclusion.items():
        if isinstance(value, str) and value.startswith("?"):
            result[key] = substitutions[value]
    return result

# Query: Is Robert a criminal?
```

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query = {"type": "criminal", "person": "Robert"}

# Run the reasoning algorithm
if forward_reasoning(knowledge_base, query):
    print("Robert is a criminal.")
else:
    print("Could not prove that Robert is a criminal.")
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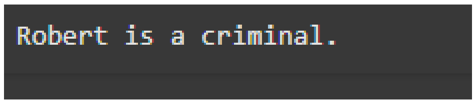
OUTPUT:



```
Robert is a criminal.
```