VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

ARTIFICIAL INTELLIGENCE

LAB REPORT

Submittedby

SHIVANSHU PANDE(1BM19CS151)

Under the Guidance of

Dr. Manjunath
Associate Professor, BMSCE

in partial fulfilment for the award of the degree of

BACHELOR OF ENGINEERING

In

COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING

(Autonomous Institution under VTU)

BENGALURU-560019

Oct-2021 to Jan-2022

B. M. S. College of Engineering,

Bull Temple Road, Bangalore 560019

(Affiliated To Visvesvaraya Technological University, Belgaum)

Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Advance Data Structures Lab for Cycle 2 (CIE 2) carried out by**, SHIVANSHU PANDE(1BM19CS151)** who are Bonafede students of **B. M. S. College of Engineering.** It is in partial fulfilment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visveswaraiah Technological University, Belgaum during the year 2021-2022. The Lab report has been approved as it satisfies the academic requirements in respect of **ARTIFICIAL INTELLIGENCE (20CS5PCAIP)** work prescribed for the said degree.

Signature of the Guide   Signature of the HOD

Dr.Manjunath   Dr. Umadevi V

Associate Professor   Associate Prof.& Head,Dept.of CSE

BMSCE,Bengalur   BMSCE, Bengaluru

Index

1. Create a knowledgebase using prepositional logic and show that the given query entails the knowledge base or not.

```
combinations=[(True,True, True),(True,True,False),(True,False,True),(True,False,
False),(False,True, True),(False,True, False),(False, False,True),(False,False, False)]
variable={'p':0,'q':1, 'r':2}
kb="
q="
priority={'~':3,'v':1,'^':2}


def input_rules():
    global kb, q
    kb = (input("Knowledge base : "))
    q = input("Query : ")


def entailment():
    global kb, q
    print("*10+"Truth Table Reference"+"*10)
    print('kb    α')
    print('-'*10)
    for comb in combinations:
        s = evaluatePostfix(toPostfix(kb), comb)
        f = evaluatePostfix(toPostfix(q), comb)
        print(s,  f)
        if s is True and f is False:
            return False
    return True


def isOperand(c):
    return c.isalpha() and c!='v'


def isLeftParanthesis(c):
    return c == '('


def isRightParanthesis(c):
    return c == ')'
```

```python
def isEmpty(stack):
    return len(stack) == 0


def peek(stack):
    return stack[-1]


def hasLessOrEqualPriority(c1, c2):
    try:
        return priority[c1]<=priority[c2]
    except KeyError:
        return False


def toPostfix(infix):
    stack = []
    postfix = ''
    for c in infix:
        if isOperand(c):
            postfix += c
        else:
            if isLeftParanthesis(c):
                stack.append(c)
            elif isRightParanthesis(c):
                operator = stack.pop()
                while not isLeftParanthesis(operator):
                    postfix += operator
                    operator = stack.pop()
            else:
                while (not isEmpty(stack)) and hasLessOrEqualPriority(c, peek(stack)):
                    postfix += stack.pop()
                stack.append(c)
    while (not isEmpty(stack)):
        postfix += stack.pop()

    return postfix


def evaluatePostfix(exp, comb):
    stack = []
    for i in exp:
        if isOperand(i):
```

```python
            stack.append(comb[variable[i]])
        elif i == '~':
            val1 = stack.pop()
            stack.append(not val1)
        else:
            val1 = stack.pop()
            val2 = stack.pop()
            stack.append(_eval(i,val2,val1))
    return stack.pop()


def _eval(i, val1, val2):
    if i == '^':
        return val2 and val1
    return val2 or val1


input_rules()
ans = entailment()
if ans:
    print("The Knowledge Base entails query")
    print(" KB |= α ")
else:
    print("The Knowledge Base does not entail query")
print("\n")
```

OUTPUT SCREEN[ALL OUTPUT ARE ALDREADY ON GITHUB]

```
C:\SHIVANSHUWORK\Scripts\python.exe C:/Users/Dell/PycharmProjects/pythonProject/knowledgebase.py
Enter the rule: (~Qv~PvR)^(~Q^P)^Q
Enter the query: R
Evaluating: ( not False or  not False or False) and ( not False and False) and False
Knowledge Base: False      Query: False
Evaluating: ( not False or  not False or True) and ( not False and False) and False
Knowledge Base: False      Query: True
Evaluating: ( not True or  not False or False) and ( not True and False) and True
Knowledge Base: False      Query: False
Evaluating: ( not True or  not False or True) and ( not True and False) and True
Knowledge Base: False      Query: True
Evaluating: ( not False or  not True or False) and ( not False and True) and False
Knowledge Base: False      Query: False
Evaluating: ( not False or  not True or True) and ( not False and True) and False
Knowledge Base: False      Query: True
Evaluating: ( not True or  not True or False) and ( not True and True) and True
Knowledge Base: False      Query: False
Evaluating: ( not True or  not True or True) and ( not True and True) and True
Knowledge Base: False      Query: True
Knowledge Base entails the query
Enter the rule: |
```

2. Create a knowledgebase using prepositional logic and prove the given query using resolution.

```python
# Global variable kb (knowledge base)
kb = []

# Reset kb to an empty list
def Clear():
   global kb
   kb = []

# Insert sentence to the kb
def AddSentence(sentence):
   global kb
   # If the sentence is a clause, insert directly.
   if isClause(sentence):
      kb.append(sentence)
   # If not, convert to CNF, and then insert clauses one by one.
   else:
      sentenceCNF = convertCNF(sentence)
      if not sentenceCNF:
         print("Illegal input")
         return
      # Insert clauses one by one when there are multiple clauses
      if isAndList(sentenceCNF):
         for s in sentenceCNF[1:]:
            kb.append(s)
      else:
         kb.append(sentenceCNF)

# 'Query' the kb whether a sentence is True or not
def Query(sentence):
   global kb
   # Negate the sentence, and convert it to CNF accordingly.
   if isClause(sentence):
      neg = negation(sentence)
   else:
      sentenceCNF = convertCNF(sentence)
      if not sentenceCNF:
         print("Illegal input")
         return
      neg = convertCNF(negation(sentenceCNF))
```

```python
    # Insert individual clauses that we need to ask to ask_list.
    ask_list = []
    if isAndList(neg):
       for n in neg[1:]:
          nCNF = makeCNF(n)
          if type(nCNF).__name__ == 'list':
             ask_list.insert(0, nCNF)
          else:
             ask_list.insert(0, nCNF)
    else:
       ask_list = [neg]
# Create a new list combining the asked sentence and kb.
    # Resolution will happen between the items in the list.
    clauses = ask_list + kb[:]

    # Recursivly conduct resoltion between items in the clauses list
    # until it produces an empty list or there's no more pregress.
    while True:
       new_clauses = []
       for c1 in clauses:
          for c2 in clauses:
             if c1 is not c2:
                resolved = resolve(c1, c2)
                if resolved == False:
                   continue
                if resolved == []:
                   return True
                new_clauses.append(resolved)

       if len(new_clauses) == 0:
          return False
       new_in_clauses = True
       for n in new_clauses:
          if n not in clauses:
             new_in_clauses = False
             clauses.append(n)
       if new_in_clauses:
          return False
    return False
# Conduct resolution on two CNF clauses.
def resolve(arg_one, arg_two):
    resolved = False
```

```
s1 = make_sentence(arg_one)
s2 = make_sentence(arg_two)

resolve_s1 = None
resolve_s2 = None

# Two for loops that iterate through the two clauses.
for i in s1:
    if isNotList(i):
        a1 = i[1]
        a1_not = True
    else:
        a1 = i
        a1_not = False

    for j in s2:
        if isNotList(j):
            a2 = j[1]
            a2_not = True
        else:
            a2 = j
            a2_not = False

        # cancel out two literals such as 'a' $ ['not', 'a']
        if a1 == a2:
            if a1_not != a2_not:
                # Return False if resolution already happend
                # but contradiction still exists.
                if resolved:
                    return False
                else:
                    resolved = True
                    resolve_s1 = i
                    resolve_s2 = j
                    break
            # Return False if not resolution happened
if not resolved:
    return False
# Remove the literals that are canceled
s1.remove(resolve_s1)
s2.remove(resolve_s2)
```

```python
   # # Remove duplicates
   result = clear_duplicate(s1 + s2)

   # Format the result.
    if len(result) == 1:
      return result[0]
   elif len(result) > 1:
      result.insert(0, 'or')

   return result

# Prepare sentences for resolution.
def make_sentence(arg):
   if isLiteral(arg) or isNotList(arg):
      return [arg]
   if isOrList(arg):
      return clear_duplicate(arg[1:])
   return

# Clear out duplicates in a sentence.
def clear_duplicate(arg):
   result = []
   for i in range(0, len(arg)):
      if arg[i] not in arg[i+1:]:
         result.append(arg[i])
   return result

# Check whether a sentence is a legal CNF clause.
def isClause(sentence):
   if isLiteral(sentence):
      return True
   if isNotList(sentence):
      if isLiteral(sentence[1]):
         return True
      else:
         return False
   if isOrList(sentence):
      for i in range(1, len(sentence)):
         if len(sentence[i]) > 2:
            return False
         elif not isClause(sentence[i]):
            return False
```

```python
      return True
   return False

# Check if a sentence is a legal CNF.
def isCNF(sentence):
   if isClause(sentence):
      return True
   elif isAndList(sentence):
      for s in sentence[1:]:
         if not isClause(s):
            return False
      return True
   return False

# Negate a sentence.
def negation(sentence):
   if isLiteral(sentence):
      return ['not', sentence]
   if isNotList(sentence):
      return sentence[1]

   # DeMorgan:
   if isAndList(sentence):
      result = ['or']
      for i in sentence[1:]:
         if isNotList(sentence):
            result.append(i[1])
         else:
            result.append(['not', sentence])
      return result
   if isOrList(sentence):
      result = ['and']
      for i in sentence[:]:
         if isNotList(sentence):
            result.append(i[1])
         else:
            result.append(['not', i])
      return result
   return None

# Convert a sentence into CNF.
def convertCNF(sentence):
```

```
    while not isCNF(sentence):
        if sentence is None:
            return None
        sentence = makeCNF(sentence)
    return sentence


def makeCNF(sentence):
    if isLiteral(sentence):
        return sentence

    if (type(sentence).__name__ == 'list'):
        operand = sentence[0]
        if isNotList(sentence):
            if isLiteral(sentence[1]):
                return sentence
            cnf = makeCNF(sentence[1])
            if cnf[0] == 'not':
                return makeCNF(cnf[1])
            if cnf[0] == 'or':
                result = ['and']
                for i in range(1, len(cnf)):
                    result.append(makeCNF(['not', cnf[i]]))
                return result
            if cnf[0] == 'and':
                result = ['or']
                for i in range(1, len(cnf)):
                    result.append(makeCNF(['not', cnf[i]]))
                return result
            return "False: not"

        # Implication Elimination:
        if operand == 'implies' and len(sentence) == 3:
            return makeCNF(['or', ['not', makeCNF(sentence[1])], makeCNF(sentence[2])])
            # Biconditional Elimination:
        if operand == 'biconditional' and len(sentence) == 3:
            s1 = makeCNF(['implies', sentence[1], sentence[2]])
            s2 = makeCNF(['implies', sentence[2], sentence[1]])
            return makeCNF(['and', s1, s2])

        if isAndList(sentence):
            result = ['and']
```

```python
    for i in range(1, len(sentence)):
      cnf = makeCNF(sentence[i])
      # Distributivity:
      if isAndList(cnf):
        for i in range(1, len(cnf)):
          result.append(makeCNF(cnf[i]))
        continue
      result.append(makeCNF(cnf))
    return result

  if isOrList(sentence):
    result1 = ['or']
    for i in range(1, len(sentence)):
      cnf = makeCNF(sentence[i])
      # Distributivity:
      if isOrList(cnf):
        for i in range(1, len(cnf)):
          result1.append(makeCNF(cnf[i]))
        continue
      result1.append(makeCNF(cnf))
      # Associativity:
    while True:
      result2 = ['and']
      and_clause = None
      for r in result1:
        if isAndList(r):
          and_clause = r
          break

      # Finish when there's no more 'and' lists
      # inside of 'or' lists
      if not and_clause:
        return result1

      result1.remove(and_clause)

      for i in range(1, len(and_clause)):
        temp = ['or', and_clause[i]]
        for o in result1[1:]:
          temp.append(makeCNF(o))
        result2.append(makeCNF(temp))
      result1 = makeCNF(result2)
```

```
        return None
    return None


# Below are 4 functions that check the type of a variable
def isLiteral(item):
    if type(item).__name__ == 'str':
        return True
    return False



def isNotList(item):
    if type(item).__name__ == 'list':
        if len(item) == 2:
            if item[0] == 'not':
                return True
    return False



def isAndList(item):
    if type(item).__name__ == 'list':
        if len(item) > 2:
            if item[0] == 'and':
                return True
    return False



def isOrList(item):
    if type(item).__name__ == 'list':
        if len(item) > 2:
            if item[0] == 'or':
                return True
    return False

AddSentence(['and', 'p', 'q'])
AddSentence(['or', 'r', 's'])
print(Query(['and',['or','p','r'], ['or', 'q', 's']]))
```

OUTPUT SCREEN

Test Case 1:

```
C:\SHIVANSHUWORK\Scripts\python.exe C:/Users/Dell/PycharmProjects/pythonProject/main.py
Enter the kb:
~Qv~PvR ~Q^P Q
Enter the query:
R

Step    |Clause |Derivation
----------------------------
 1. | ~Qv~PvR  | Given.
 2. | ~Q^P  | Given.
 3. | Q | Given.
 4. | ~R    | Negated conclusion.

Process finished with exit code 0
|
```

NEGATED CONCLUSION→NULL SET→PROVED.

3. Implement unification in first order logic.

```python
import re

def getAttributes(expression):
    expression = expression.split("(")[1:]
    expression = "(".join(expression)
    expression = expression[:-1]
    expression = re.split("(?<!\(.),(?!.\))", expression)
    return expression


def getInitialPredicate(expression):
    return expression.split("(")[0]

def isConstant(char):
    return char.isupper() and len(char) == 1

def isVariable(char):
    return char.islower() and len(char) == 1

def replaceAttributes(exp, old, new):
    attributes = getAttributes(exp)
    for index, val in enumerate(attributes):
        if val == old:
            attributes[index] = new
    predicate = getInitialPredicate(exp)
    return predicate + "(" + ",".join(attributes) + ")"

def apply(exp, substitutions):
    for substitution in substitutions:
        new, old = substitution
        exp = replaceAttributes(exp, old, new)
    return exp

def checkOccurs(var, exp):
    if exp.find(var) == -1:
        return False
    return True


def getFirstPart(expression):
```

```python
   attributes = getAttributes(expression)
   return attributes[0]


def getRemainingPart(expression):
   predicate = getInitialPredicate(expression)
   attributes = getAttributes(expression)
   newExpression = predicate + "(" + ",".join(attributes[1:]) + ")"
   return newExpression

def unify(exp1, exp2):
   if exp1 == exp2:
      return []

   if isConstant(exp1) and isConstant(exp2):
      if exp1 != exp2:
         return False

   if isConstant(exp1):
      return [(exp1, exp2)]

   if isConstant(exp2):
      return [(exp2, exp1)]

   if isVariable(exp1):
      if checkOccurs(exp1, exp2):
         return False
      else:
         return [(exp2, exp1)]

   if isVariable(exp2):
      if checkOccurs(exp2, exp1):
         return False
      else:
         return [(exp1, exp2)]

   if getInitialPredicate(exp1) != getInitialPredicate(exp2):
      print("Predicates do not match. Cannot be unified")
      return False

   attributeCount1 = len(getAttributes(exp1))
   attributeCount2 = len(getAttributes(exp2))
```

```
    if attributeCount1 != attributeCount2:
        return False

    head1 = getFirstPart(exp1)
    head2 = getFirstPart(exp2)
    initialSubstitution = unify(head1, head2)
    if not initialSubstitution:
        return False
    if attributeCount1 == 1:
        return initialSubstitution

    tail1 = getRemainingPart(exp1)
    tail2 = getRemainingPart(exp2)

    if initialSubstitution != []:
        tail1 = apply(tail1, initialSubstitution)
        tail2 = apply(tail2, initialSubstitution)

    remainingSubstitution = unify(tail1, tail2)
    if not remainingSubstitution:
        return False

    initialSubstitution.extend(remainingSubstitution)
    return initialSubstitution

print("\n\nTest Case 1:\n")
exp1 = "knows(A,x)"
exp2 = "knows(y,Y)"
substitutions = unify(exp1, exp2)
print("Substitutions:")
print(substitutions)

print("\n\nTest Case 2:\n")
exp1 = "knows(A,x)"
exp2 = "knows(y,mother(y))"
substitutions = unify(exp1, exp2)
print("Substitutions:")
print(substitutions)
```

OUTPUT SCREEN

```
Enter the first expression
P(x,y)
Enter the second expression
P(z,m)
The substitutions are:
['z / x', 'm / y']

Process finished with exit code 0
```

4. Convert given first order logic statement into Conjunctive Normal Form (CNF).

```python
def getAttributes(string):
    expr = '\(([^)]+)\)'
    matches = re.findall(expr, string)
    return [m for m in str(matches) if m.isalpha()]

def getPredicates(string):
    expr = '[a-z~]+\(([A-Za-z,]+\)'
    return re.findall(expr, string)

def DeMorgan(sentence):
    string = ''.join(list(sentence).copy())
    string = string.replace('~~','')
    flag = '[' in string
    string = string.replace('~[','')
    string = string.strip(']')
    for predicate in getPredicates(string):
        string = string.replace(predicate, f'~{predicate}')
    s = list(string)
    for i, c in enumerate(string):
        if c == '|':
            s[i] = '&'
        elif c == '&':
            s[i] = '|'
    string = ''.join(s)
    string = string.replace('~~','')
    return f'[{string}]' if flag else string

def Skolemization(sentence):
    SKOLEM_CONSTANTS = [f'{chr(c)}' for c in range(ord('A'), ord('Z')+1)]
    statement = ''.join(list(sentence).copy())
    matches = re.findall('[∀∃].', statement)
    for match in matches[::-1]:
        statement = statement.replace(match, '')
        statements = re.findall('\[\[[^]]+\]]', statement)
        for s in statements:
            statement = statement.replace(s, s[1:-1])
        for predicate in getPredicates(statement):
            attributes = getAttributes(predicate)
            if ''.join(attributes).islower():
```

```
            statement = statement.replace(match[1],SKOLEM_CONSTANTS.pop(0))
        else:
            aU = [a for a in attributes if not a.islower()][0]
            statement = statement.replace(aU,
f'{SKOLEM_CONSTANTS.pop(0)}({match[1]})')
    return statement


import re

def fol_to_cnf(fol):

    statement = fol.replace("<=>", "_")
    while '_' in statement:
        i = statement.index('_')
        new_statement = '[' + statement[:i] + '=>' + statement[i+1:] + ']&['+ statement[i+1:] +
'=>' + statement[:i] + ']'
        statement = new_statement
    statement = statement.replace("=>", "-")
    expr = '\[([^]]+)\]'
    statements = re.findall(expr, statement)
    for i, s in enumerate(statements):
        if '[' in s and ']' not in s:
            statements[i] += ']'
    for s in statements:
        statement = statement.replace(s, fol_to_cnf(s))
    while '-' in statement:
        i = statement.index('-')
        br = statement.index('[') if '[' in statement else 0
        new_statement = '~' + statement[br:i] + '|' + statement[i+1:]
        statement = statement[:br] + new_statement if br > 0 else new_statement
    while '~∀' in statement:
        i = statement.index('~∀')
        statement = list(statement)
        statement[i], statement[i+1], statement[i+2] = '∃', statement[i+2], '~'
        statement = ''.join(statement)
    while '~∃' in statement:
        i = statement.index('~∃')
        s = list(statement)
        s[i], s[i+1], s[i+2] = '∀', s[i+2], '~'
        statement = ''.join(s)
    statement = statement.replace('~[∀','[~∀')
```

```
    statement = statement.replace('~[∃','[~∃')
    expr = '(~[∀|∃].)'
    statements = re.findall(expr, statement)
    for s in statements:
        statement = statement.replace(s, fol_to_cnf(s))
    expr = '~\[[^]]+\]'
    statements = re.findall(expr, statement)
    for s in statements:
        statement = statement.replace(s, DeMorgan(s))
    return statement


print("\n Test Case: 1")

print(Skolemization(fol_to_cnf("animal(y)<=>loves(x,y)")))

print("\n Test Case: 2")

print(Skolemization(fol_to_cnf("∀x[∀y[animal(y)=>loves(x,y)]]=>[∃z[loves(z,x)]]")))

print("\n Test Case: 3")

print(Skolemization(fol_to_cnf("[american(x)&weapon(y)&sells(x,y,z)&hostile(z)]=>crim
inal(x)")))

print("\n \n ")
```

OUTPUT SCREEN

```
C:\SHIVANSHUWORK\Scripts\python.exe C:/Users/Dell/PycharmProjects/pythonProject/foltcnf.py
Enter FOL:
animal(y)<=>loves(x,y)
The CNF form of the given FOL is:
[~animal(y)Vloves(x,y)]^[~loves(x,y)Vanimal(y)]

Process finished with exit code 0
```

5. Create a knowledgebase consisting of first order logic statements and prove the given query using forward reasoning.

```python
import re

def isVariable(x):
    return len(x) == 1 and x.islower() and x.isalpha()

def getAttributes(string):
    expr = '\(([^)]+)\)'
    matches = re.findall(expr, string)
    return matches

def getPredicates(string):
    expr = '([a-z~]+)\(([^&|]+)\)'
    return re.findall(expr, string)

class Fact:
    def init (self, expression):
        self.expression = expression
        predicate, params = self.splitExpression(expression)
        self.predicate = predicate
        self.params = params
        self.result = any(self.getConstants())

    def splitExpression(self, expression):
        predicate = getPredicates(expression)[0]
        params = getAttributes(expression)[0].strip('()').split(',')
        return [predicate, params]

    def getResult(self):
        return self.result

    def getConstants(self):
        return [None if isVariable(c) else c for c in self.params]

    def getVariables(self):
        return [v if isVariable(v) else None for v in self.params]

    def substitute(self, constants):
        c = constants.copy()
```

```
      f = f"{self.predicate}({','.join([constants.pop(0) if isVariable(p) else p for p in
self.params])})"
      return Fact(f)

class Implication:
   def_init_(self, expression):
      self.expression = expression
      l = expression.split('=>')
      self.lhs = [Fact(f) for f in l[0].split('&')]
      self.rhs = Fact(l[1])

   def evaluate(self, facts):
      constants = {}
      new_lhs = []
      for fact in facts:
         for val in self.lhs:
            if val.predicate == fact.predicate:
               for i, v in enumerate(val.getVariables()):
                  if v:
                     constants[v] = fact.getConstants()[i]
               new_lhs.append(fact)
      predicate, attributes = getPredicates(self.rhs.expression)[0],
str(getAttributes(self.rhs.expression)[0])
      for key in constants:
         if constants[key]:
            attributes = attributes.replace(key, constants[key])
      expr = f'{predicate}{attributes}'
      return Fact(expr) if len(new_lhs) and all([f.getResult() for f in new_lhs]) else None

class KB:
   def__init__(self):
      self.facts = set()
      self.implications = set()

   def tell(self, e):
      if '=>' in e:
         self.implications.add(Implication(e))
      else:
         self.facts.add(Fact(e))
      for i in self.implications:
         res = i.evaluate(self.facts)
```

```python
        if res:
            self.facts.add(res)

    def query(self, e):
        facts = set([f.expression for f in self.facts])
        i = 1
        print(f'Querying {e}:')
        for f in facts:
            if Fact(f).predicate == Fact(e).predicate:
                print(f'\t{i}. {f}')
                i += 1

    def display(self):
        print("All facts: ")
        for i, f in enumerate(set([f.expression for f in self.facts])):
            print(f'\t{i+1}. {f}')

print("\n \n Test Case 1:")

kb = KB()
kb.tell('missile(x)=>weapon(x)')
kb.tell('missile(M1)')
kb.tell('enemy(x,America)=>hostile(x)')
kb.tell('american(West)')
kb.tell('enemy(Nono,America)')
kb.tell('owns(Nono,M1)')
kb.tell('missile(x)&owns(Nono,x)=>sells(West,x,Nono)')
kb.tell('american(x)&weapon(y)&sells(x,y,z)&hostile(z)=>criminal(x)')
kb.query('criminal(x)')
kb.display()


print("\n \n Test Case 2:")

kb_ = KB()
kb_.tell('king(x)&greedy(x)=>evil(x)')
kb_.tell('king(John)')
kb_.tell('greedy(John)')
kb_.tell('king(Richard)')
kb_.query('evil(x)')
```

```
Enter KB: (enter e to exit)
missile(x)=>weapon(x)
missile(M1)
enemy(x,America)=>hostile(x)
american(West)
enemy(Nono,America)
owns(Nono,M1)
missile(x)&owns(Nono,x)=>sells(West,x,Nono)
american(x)&weapon(y)&sells(x,y,z)&hostile(z)=>criminal(x)
e
Enter Query:
criminal(x)
Querying criminal(x):
All facts:
    1. kb.tell('owns(Nono,M1)')
    2. kb.tell('enemy(Nono,America)')
    3. kb.tell('missile(M1)')
    4. kb.tell('american(West)')
    5. sells(West,x,Nono)
    6. kb.query('criminal(x)')
    7. hostile(x)

Process finished with exit code 0
```