Title: Implementation of unification and resolution problems.

Ex. No : 07 **Reg.No. : RA2011003011334**

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Aim:

Implementation of unification and resolution problems.

Algorithm:

Unification

Step. 1: If Ψ1 or Ψ2 is a variable or constant, then:

a) If Ψ1 or Ψ2 are identical, then return NIL.

b) Else if Ψ1is a variable,

a. then if Ψ1 occurs in Ψ2, then return FAILURE

b. Else return { (Ψ2/ Ψ1)}.

c) Else if Ψ2 is a variable,

a. If Ψ2 occurs in Ψ1 then return FAILURE,

b. Else return {(Ψ1/ Ψ2)}.

d) Else return FAILURE.

Step.2: If the initial Predicate symbol in Ψ1 and Ψ2 are not same, then return FAILURE.

Step. 3: IF Ψ1 and Ψ2 have a different number of arguments, then return FAILURE.

Step. 4: Set Substitution set(SUBST) to NIL.

Step. 5: For i=1 to the number of elements in Ψ1.

a) Call Unify function with the ith element of Ψ1 and ith element of Ψ2, and put the result into S.

b) If S = failure then returns Failure

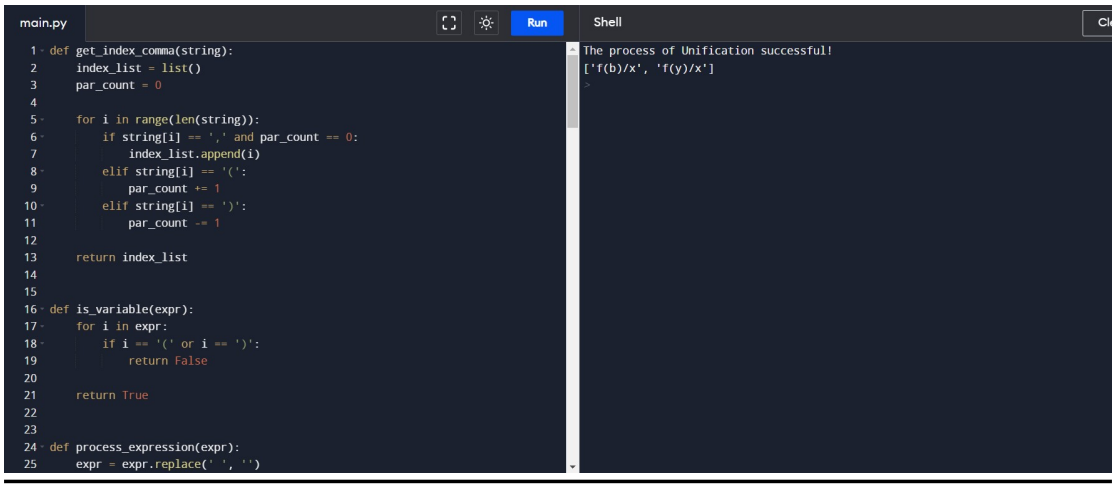
c) If S ≠ NIL then do,

a. Apply S to the remainder of both L1 and L2.

b. SUBST= APPEND(S, SUBST).

Step.6: Return SUBST.

Output:



Resolution:

```
import copy
import time


class Parameter:
    variable_count = 1

    def __init__(self, name=None):
        if name:
            self.type = "Constant"
            self.name = name
        else:
            self.type = "Variable"
            self.name = "v" + str(Parameter.variable_count)
            Parameter.variable_count += 1

    def isConstant(self):
        return self.type == "Constant"

    def unify(self, type_, name):
        self.type = type_
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        self.name = name

    def __eq__(self, other):
        return self.name == other.name

    def __str__(self):
        return self.name


class Predicate:
    def __init__(self, name, params):
        self.name = name
        self.params = params

    def __eq__(self, other):
        return self.name == other.name and all(a == b for a, b in zip(self.params,
other.params))

    def __str__(self):
        return self.name + "(" + ",".join(str(x) for x in self.params) + ")"

    def getNegatedPredicate(self):
        return Predicate(negatePredicate(self.name), self.params)


class Sentence:
    sentence_count = 0

    def __init__(self, string):
        self.sentence_index = Sentence.sentence_count
        Sentence.sentence_count += 1
        self.predicates = []
        self.variable_map = {}
        local = {}
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    for predicate in string.split("|"):
        name = predicate[:predicate.find("(")]
        params = []

        for param in predicate[predicate.find("(") + 1: predicate.find(")")].split(","):
            if param[0].islower():
                if param not in local:  # Variable
                    local[param] = Parameter()
                    self.variable_map[local[param].name] = local[param]
                new_param = local[param]
            else:
                new_param = Parameter(param)
                self.variable_map[param] = new_param

            params.append(new_param)

        self.predicates.append(Predicate(name, params))

def getPredicates(self):
    return [predicate.name for predicate in self.predicates]

def findPredicates(self, name):
    return [predicate for predicate in self.predicates if predicate.name == name]

def removePredicate(self, predicate):
    self.predicates.remove(predicate)
    for key, val in self.variable_map.items():
        if not val:
            self.variable_map.pop(key)

def containsVariable(self):
    return any(not param.isConstant() for param in self.variable_map.values())
```

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    def __eq__(self, other):
        if len(self.predicates) == 1 and self.predicates[0] == other:
            return True
        return False

    def __str__(self):
        return "".join([str(predicate) for predicate in self.predicates])


class KB:
    def __init__(self, inputSentences):
        self.inputSentences = [x.replace(" ", "") for x in inputSentences]
        self.sentences = []
        self.sentence_map = {}

    def prepareKB(self):
        self.convertSentencesToCNF()
        for sentence_string in self.inputSentences:
            sentence = Sentence(sentence_string)
            for predicate in sentence.getPredicates():
                self.sentence_map[predicate] = self.sentence_map.get(
                    predicate, []) + [sentence]

    def convertSentencesToCNF(self):
        for sentenceIdx in range(len(self.inputSentences)):
            # Do negation of the Premise and add them as literal
            if "=>" in self.inputSentences[sentenceIdx]:
                self.inputSentences[sentenceIdx] = negateAntecedent(
                    self.inputSentences[sentenceIdx])

    def askQueries(self, queryList):
        results = []

        for query in queryList:
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            negatedQuery = Sentence(negatePredicate(query.replace(" ", "")))
            negatedPredicate = negatedQuery.predicates[0]
            prev_sentence_map = copy.deepcopy(self.sentence_map)
            self.sentence_map[negatedPredicate.name] = self.sentence_map.get(
                negatedPredicate.name, []) + [negatedQuery]
            self.timeLimit = time.time() + 40

            try:
                result = self.resolve([negatedPredicate], [
                                      False]*(len(self.inputSentences) + 1))
            except:
                result = False

            self.sentence_map = prev_sentence_map

            if result:
                results.append("TRUE")
            else:
                results.append("FALSE")

        return results

    def resolve(self, queryStack, visited, depth=0):
        if time.time() > self.timeLimit:
            raise Exception
        if queryStack:
            query = queryStack.pop(-1)
            negatedQuery = query.getNegatedPredicate()
            queryPredicateName = negatedQuery.name
            if queryPredicateName not in self.sentence_map:
                return False
            else:
                queryPredicate = negatedQuery
                for kb_sentence in self.sentence_map[queryPredicateName]:
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            if not visited[kb_sentence.sentence_index]:
                for kbPredicate in kb_sentence.findPredicates(queryPredicateName):

                    canUnify, substitution = performUnification(
                        copy.deepcopy(queryPredicate), copy.deepcopy(kbPredicate))

                    if canUnify:
                        newSentence = copy.deepcopy(kb_sentence)
                        newSentence.removePredicate(kbPredicate)
                        newQueryStack = copy.deepcopy(queryStack)

                        if substitution:
                            for old, new in substitution.items():
                                if old in newSentence.variable_map:
                                    parameter = newSentence.variable_map[old]
                                    newSentence.variable_map.pop(old)
                                    parameter.unify(
                                        "Variable" if new[0].islower() else "Constant", new)
                                    newSentence.variable_map[new] = parameter

                            for predicate in newQueryStack:
                                for index, param in enumerate(predicate.params):
                                    if param.name in substitution:
                                        new = substitution[param.name]
                                        predicate.params[index].unify(
                                            "Variable" if new[0].islower() else "Constant", new)

                        for predicate in newSentence.predicates:
                            newQueryStack.append(predicate)

                        new_visited = copy.deepcopy(visited)
                        if kb_sentence.containsVariable() and
len(kb_sentence.predicates) > 1:
                            new_visited[kb_sentence.sentence_index] = True
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                        if self.resolve(newQueryStack, new_visited, depth + 1):
                            return True
                return False
        return True


def performUnification(queryPredicate, kbPredicate):
    substitution = {}
    if queryPredicate == kbPredicate:
        return True, {}
    else:
        for query, kb in zip(queryPredicate.params, kbPredicate.params):
            if query == kb:
                continue
            if kb.isConstant():
                if not query.isConstant():
                    if query.name not in substitution:
                        substitution[query.name] = kb.name
                    elif substitution[query.name] != kb.name:
                        return False, {}
                    query.unify("Constant", kb.name)
                else:
                    return False, {}
            else:
                if not query.isConstant():
                    if kb.name not in substitution:
                        substitution[kb.name] = query.name
                    elif substitution[kb.name] != query.name:
                        return False, {}
                    kb.unify("Variable", query.name)
                else:
                    if kb.name not in substitution:
                        substitution[kb.name] = query.name
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```
                elif substitution[kb.name] != query.name:
                    return False, {}
    return True, substitution


def negatePredicate(predicate):
    return predicate[1:] if predicate[0] == "~" else "~" + predicate


def negateAntecedent(sentence):
    antecedent = sentence[:sentence.find("=>")]
    premise = []

    for predicate in antecedent.split("&"):
        premise.append(negatePredicate(predicate))

    premise.append(sentence[sentence.find("=>") + 2:])
    return "|".join(premise)


def getInput(filename):
    with open(filename, "r") as file:
        noOfQueries = int(file.readline().strip())
        inputQueries = [file.readline().strip() for _ in range(noOfQueries)]
        noOfSentences = int(file.readline().strip())
        inputSentences = [file.readline().strip()
                          for _ in range(noOfSentences)]
        return inputQueries, inputSentences


def printOutput(filename, results):
    print(results)
    with open(filename, "w") as file:
        for line in results:
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            file.write(line)
            file.write("\n")
    file.close()


if __name__ == '__main__':
    inputQueries_, inputSentences_ = getInput('C:/shushrut/studies/SRM
University/SEM 6/AI/7-Unification Resolutiion/Resolution/Input/input_1.txt')
    knowledgeBase = KB(inputSentences_)
    knowledgeBase.prepareKB()
    results_ = knowledgeBase.askQueries(inputQueries_)
    printOutput("output.txt", results_)
```
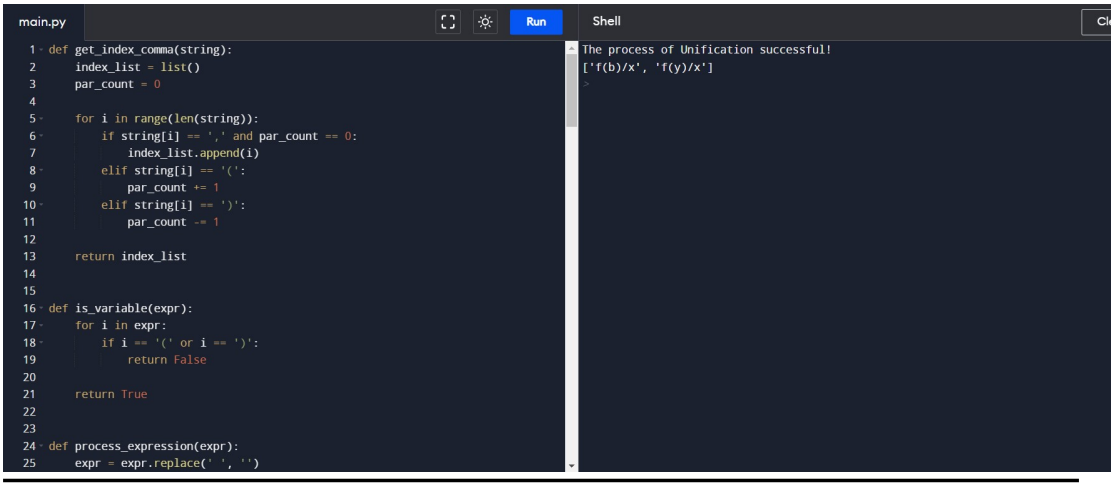

Output:



Result:

Successfully Implemented of unification and resolution problems.