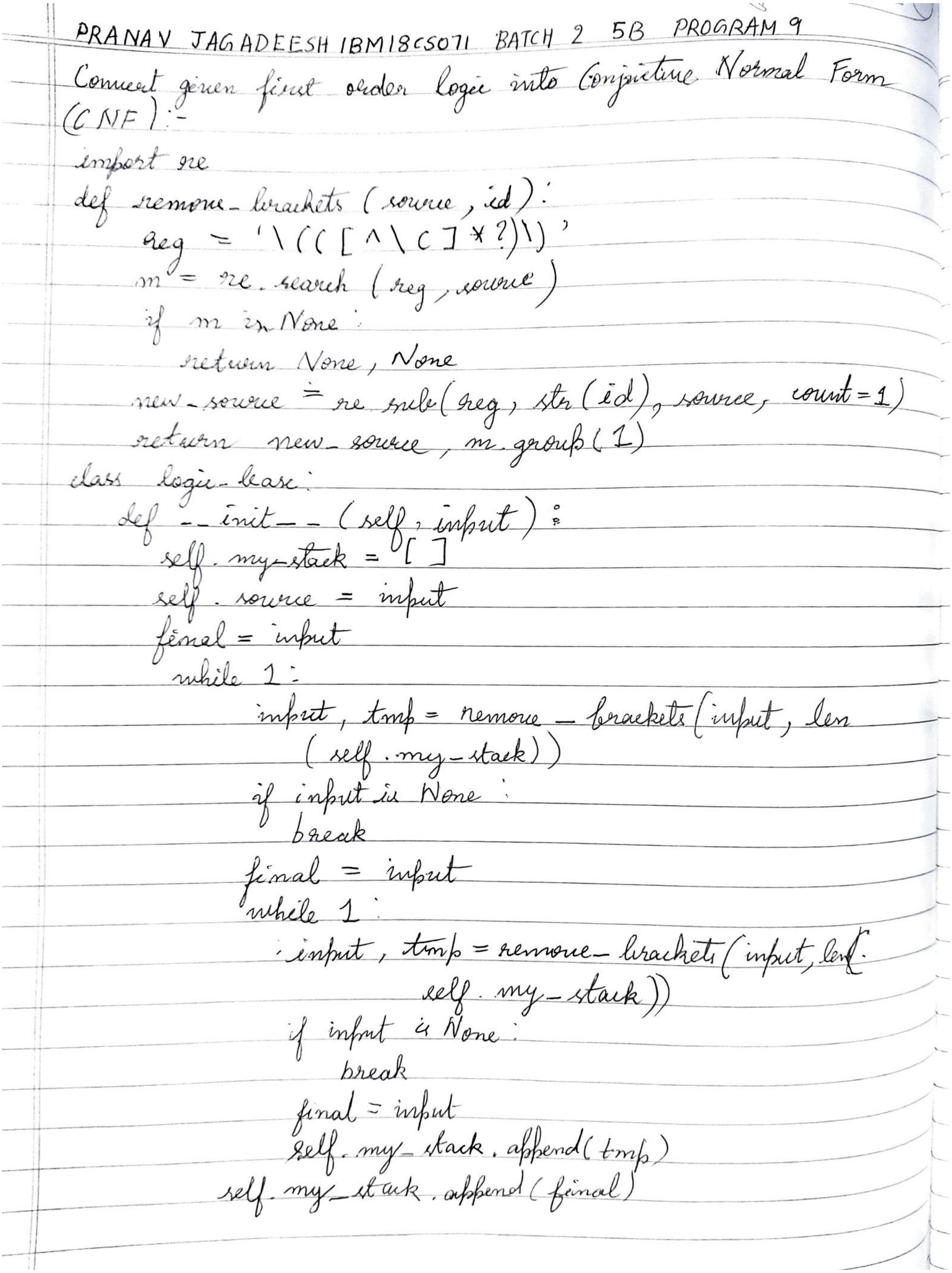
Program 9: Convert given first order logic statement into Conjunctive Normal Form(CNF).
Write_up:



PRANAV JAGADEESH 1BM18CS071 BATCH 2 5B PROGRAM 9

Convert given first order logic into Conjunctive Normal Form (CNF):-

```
import re
def remove_brackets (source, id):
    reg = '\(([^\(]*?)\)'
    m = re.search (reg, source)
    if m is None:
        return None, None
    new_source = re.sub(reg, str(id), source, count=1)
    return new_source, m.group(1)
class logic_base:
    def __init__(self, input):
        self.my_stack = [ ]
        self.source = input
        final = input
        while 1:
            input, tmp = remove_brackets(input, len
                (self.my_stack))
            if input is None:
                break
            final = input
            while 1:
                input, tmp = remove_brackets(input, len(
                        self.my_stack))
                if input is None:
                    break
                final = input
                self.my_stack.append(tmp)
            self.my_stack.append(final)
def get_result (self) :
    root = self.my_stack [-1]
    m = rematch('\s*([0-9]+)\s*$', root)
    if m is not None :
        root = self.my_stack [int(m.group(1))]
    reg = '(\d+)'
    while 1:
        m = re.search (reg , root)
        if m is None :
            break
        new = '(' + self.my_stack [int (m.group(1))] + ')'
        root = re.sub(reg, new, root, count=1)
    return root)
def merge_items (self, logic) :
    reg0 = '(\d+)'
    reg1 = 'neg\s+(\d+)'
    flag = False
    for i in range(len(self.my_stack)) :
        target = self.my_stack [i]
        if logic not in target :
            continue
        m = re.search (reg1, target)
        if m is not None :
            continue
        m = re.search (reg0, target)
        if m is None :
            continue
        for j in re.findall( reg 0, target):
            child = self.my_stack [int(j)]
            if logic not in child :
                continue
            new_reg = "(^|\s)"+j+"(\s|$)"
```

```
self. my- stack [i] = re. sub (new_reg, ''+child+'',
        self. my-stack[i], count = 1)
self. my- stack [i] = self. my_ stack[i]. strip()
    flag = True
  if flag :
        self. merge-items (logic)
 class ordering ( logic_base ) :
     def run ( self ) :
         flag = False
         for i in range ( len( self. my_stack ) ) :
            new_source = self. add_brackets ( self. my-stack[i])
            if self. my_ stack[i] != new_source :
                self . my_-stack[i] = new_source
                flag = True
         return flag
def add-brackets( self, source ) :
   reg = "\s+( and | or | imp | iff ) \s+"
   if len( re. findall ( reg - source )) < 2 ;
      return source
   reg_and = "(neg \s+) ? \s+ \s + and \s+ (neg)s+) ? \s+"
   m. = re .search( reg_and , source)
   if m is not None ;
       return re. sub(reg_and, "(" + m-group (0) + ")",
       source , count = 1)
   reg-or = "(neg \s+ ) ? \s + \s + or \s+ (neg \s+ ) ? \s+"
   m. = re search ( reg-or, source)
   if m is not None :
      return re. sub ( reg-or, "(" + m. group(0) + ")",
            source , count = 1)
   reg_imp = "(neg \s+ ) ? \s + \s + or \s+ (neg \s+ ) ? \s+"
   m = re . search ( reg-imp , source )
   if m is not None :
    return re.sub(reg-imp, "("+ m.group (0) + ")",
        source, count = 1)
    reg-iff = "(neg\s+)?\s+\s+iff\s+(neg\s+)?\s+"
    m = re.search (reg-iff, source)
    if m is not None:
        return re.sub (reg-iff, "("+ m.group (0) + ")",
        source, count = 1)
class replace_iff (logic_base):
    def run (self):
        final = len (self.my_stack) - 1
        flag = self.replace_all_iff()
        self.my_stack.append (self.my_stack[final])
        return flag
    def replace_all_iff (self):
        flag = False
        for i in range (len (self.my_stack)):
            ans = self.replace_iff_inner (self.my_stack[i], l
                    len.(self.my_stack))
            if ans is None:
                continue
            self.my_stack[i] = ans[0]
            self.my_stack.append (ans[1])
            self.my_stack.append (ans[2])
            flag = True
        return flag
    def replace_iff_inner (self, source, id):
        reg = '^(.*?)\s+iff\s+(.*?)$'
        m = re.search (reg, source)
        if m is None:
            return None
        a, b = m.group (1), m.group (2)
        return (str(id) + 'and' + str (id+1), a + 'imp'
    +b, b+'imp'+a)
class replace-imp (logic-base):
    def run(self):
        flag = False
        for i in range(len(self.my-stack)):
            ans = self.replace-imp-inner(self.my-stack[i])
            if ans is None:
                continue
            self.my-stack[i] = ans
            flag = True
        return flag
    def replace-imp-inner(self, source):
        reg = '^(.*?)\s+imp\s+(.*?)$'
        m = re.search(reg, source)
        if m is None:
            return None
        a, b = m.group(1), m.group(2)
        if 'neg' in a:
            return a.replace('neg', '') + 'or' + b
        return 'neg' + a + 'or' + b
class de-morgan (logic-base):
    def run(self):
        reg = 'neg\s+(\d+)'
        flag = False
        final = len(self.mystack) - 1
            for i in range(len(self.my-stack)):
                target = self.my-stack[i]
                m = re.search(reg, target)
                if m is None:
                    continue
                flag = True
                child = self.My-stack[int(m.group(1))]
        self.my_stack[i] = re.sub(reg, str(len(self.my_stack)),
                        target, count = 1)
        self.my_stack.append(self.doing_de_morgan(child))
          break
      self.my_stack.append(self.my_stack[final])
      return flag
  def doing_de_morgan(self, source):
      items = re.split('\s+', source)
      new_items = []
      for item in items:
          if item == 'or':
              new_items.append('and')
          elif item == 'and':
              new_items ==('neg'):
          elif item == 'neg':
              new_items.append('neg')
          elif len(item.strip()) > 0:
              new_items.append('neg')
              new_items.append(item)
      for i in range(len(new_items)-1):
          if new_items[i] == 'neg':
              if new_items[i+1] == 'neg':
                  new_items[i] = ''
                  new_items(i+1] = ''
      return ' '.join([i for i in new_items if len(i)>0])
class distributive(logic_base):
    def run(self):
        flag = False
        reg = '(\d+)'
        final = len(self.my_stack) - 1
        for i in range(len(self.my_stack)):
            target = self.my_stack[i]
```

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if 'or' not in self.my-stack[i] :
    continue
m= re.search(reg, target)
 if m is None:
    continue
 for j in re.findall(reg, target):
   child =self.my-stack[int(j)]
   if 'and' not in child :
       continue
   new-reg = "(^|\s)" + j+ "(\s|$)"
  items =re.split('\s+and \s+', child)
 tmp-list = [str(j) for j in range(len(self.
   my-stack), len(self.my-stack)+len(items))]
 for item in items:
   self.my-stack.append(re.sub(new-reg, ' '
          + item + ' ', target).strip())
  self.my-stack[i] = ' and '.join(tmp-list)
   flag = True
  if flag:
     break
 self.my_stack.append(self.my-stack[final])
  return flag
class simplification(logic_base) :
  def run(self):
     old = self.get-result()
     for i in range(len(self.my-stack)):
       #self.my-stack[i]= self.reducing..
       final=self.my-stack[-1]
       self.my-stack[-1] = self-reducing-and(final)
       return len(old) != len(self.get-result())
```

```
def reducing_and (self, target):
    if 'and' not in target:
        return target
    items = set (re.split ('\s+and\s+', target))
    for item in list (items):
        if ('neg'+ item) in items:
            return ''
        if re.match ('\d+$';item) is None:
            continue
        value = self.my_stack [int (item)]
        if self.my_stack.count (value) > 1 :
            value = ''
            self.my_stack[int(item)]] = ''
            if value == '':
                items.remove (item)
        return 'and'.join (list (items))
  def reducing or (self, target):
    if 'or' not in target :
        return target
    items = set (re.split ('\s+or|s+', target))
    for item in list (items):
        if ('neg' + item) in iteams:
            return ''
        return 'or'.join (list (items))
def merging (source):
    old = source.get_result ()
    source.Merge_items ('or')
    source.merge_items ('and')
    return old != source.get_result ()
```

```
def run (input ):
    all-strings =[]
    # all_strings. append ( input )
    zero = ordering( input )
    while zero. run () :
      zero = ordering (zero . get-result ())
    merging (zero)
    one = replace - iff (zero - get-result ())
    one . run()
    all-strings . append (one . get_result())
    merging (one)
    two = replace - imp (one . get - result ())
    two. run ()
    all_strings. append. (two . get_result())
    merging (two)
    three, four = None, None
    old = two - get-result ()
    three = de_morgan(old)
    while three. run ():
       pass
    all_strings. append ( three. get_result ())
    merging(three)
    three - help = simplication ( three. get_result())
    three_help . run()
    four = distributive (three -help . get-result())
     while four. run():
        pass
     merging (four)
     five = simplification ( four. get_result())
       five. run ()
         all_strings - append ( five . get_result())
         return all_strings
```

```
inputs = input(). split('\n')
 for input in inputs
   for item in run (input):
       print (item)
    # output. write ('\n')
```

Output:

```
--(A iff C) or B
((A imp C) and(C imp A)) or B
((neg A or C) and(neg C or A)) or B
((neg A or C) and(neg C or A)) or B
((neg C or A or B) and(neg A or B or C)
```

Program:

```
import re



def remove_brackets(source, id):
    reg = '\(([^\(]*?)\)'
    m = re.search(reg, source)
    if m is None:
        return None, None
    new_source = re.sub(reg, str(id), source, count=1)
    return new_source, m.group(1)



class logic_base:
    def __init__(self, input):
        self.my_stack = []
        self.source = input
        final = input
        while 1:
            input, tmp = remove_brackets(input, len(self.my_stack))
            if input is None:
                break
            final = input
            self.my_stack.append(tmp)
        self.my_stack.append(final)

    def get_result(self):
        root = self.my_stack[-1]
        m = re.match('\s*([0-9]+)\s*$', root)
    if m is not None:
        root = self.my_stack[int(m.group(1))]
    reg = '(\d+)'
    while 1:
        m = re.search(reg, root)
        if m is None:
            break
        new = '(' + self.my_stack[int(m.group(1))] + ')'
        root = re.sub(reg, new, root, count=1)
    return root

def merge_items(self, logic):
    reg0 = '(\d+)'
    reg1 = 'neg\s+(\d+)'
    flag = False
    for i in range(len(self.my_stack)):
        target = self.my_stack[i]
        if logic not in target:
            continue
        m = re.search(reg1, target)
        if m is not None:
            continue
        m = re.search(reg0, target)
        if m is None:
            continue
        for j in re.findall(reg0, target):
            child = self.my_stack[int(j)]
            if logic not in child:
                continue
            new_reg = "(^|\s)" + j + "(\s|$)"
            self.my_stack[i] = re.sub(new_reg, ' ' + child + ' ', self.my_stack[i], count=1)
            self.my_stack[i] = self.my_stack[i].strip()
            flag = True
        if flag:
            self.merge_items(logic)



class ordering(logic_base):
    def run(self):
        flag = False
        for i in range(len(self.my_stack)):
            new_source = self.add_brackets(self.my_stack[i])
            if self.my_stack[i] != new_source:
                self.my_stack[i] = new_source
                flag = True
        return flag


    def add_brackets(self, source):
        reg = "\s+(and|or|imp|iff)\s+"
        if len(re.findall(reg, source)) < 2:
            return source
        reg_and = "(neg\s+)?\S+\s+and\s+(neg\s+)?\S+"
        m = re.search(reg_and, source)
        if m is not None:
            return re.sub(reg_and, "(" + m.group(0) + ")", source, count=1)
        reg_or = "(neg\s+)?\S+\s+or\s+(neg\s+)?\S+"
        m = re.search(reg_or, source)
        if m is not None:
            return re.sub(reg_or, "(" + m.group(0) + ")", source, count=1)
        reg_imp = "(neg\s+)?\S+\s+imp\s+(neg\s+)?\S+"
        m = re.search(reg_imp, source)
        if m is not None:
            return re.sub(reg_imp, "(" + m.group(0) + ")", source, count=1)
        reg_iff = "(neg\s+)?\S+\s+iff\s+(neg\s+)?\S+"
        m = re.search(reg_iff, source)
        if m is not None:
            return re.sub(reg_iff, "(" + m.group(0) + ")", source, count=1)



class replace_iff(logic_base):
    def run(self):
        final = len(self.my_stack) - 1
        flag = self.replace_all_iff()
        self.my_stack.append(self.my_stack[final])
        return flag

    def replace_all_iff(self):
        flag = False
        for i in range(len(self.my_stack)):
            ans = self.replace_iff_inner(self.my_stack[i], len(self.my_stack))
            if ans is None:
                continue
            self.my_stack[i] = ans[0]
            self.my_stack.append(ans[1])
            self.my_stack.append(ans[2])
            flag = True
        return flag
    def replace_iff_inner(self, source, id):
        reg = '^(.*?)\s+iff\s+(.*?)$'
        m = re.search(reg, source)
        if m is None:
            return None
        a, b = m.group(1), m.group(2)
        return (str(id) + ' and ' + str(id + 1), a + ' imp ' + b, b + ' imp ' + a)


class replace_imp(logic_base):
    def run(self):
        flag = False
        for i in range(len(self.my_stack)):
            ans = self.replace_imp_inner(self.my_stack[i])
            if ans is None:
                continue
            self.my_stack[i] = ans
            flag = True
        return flag

    def replace_imp_inner(self, source):
        reg = '^(.*?)\s+imp\s+(.*?)$'
        m = re.search(reg, source)
        if m is None:
            return None
        a, b = m.group(1), m.group(2)
        if 'neg ' in a:
            return a.replace('neg ', '') + ' or ' + b
        return 'neg ' + a + ' or ' + b



class de_morgan(logic_base):
    def run(self):
        reg = 'neg\s+(\d+)'
        flag = False
        final = len(self.my_stack) - 1
        for i in range(len(self.my_stack)):
            target = self.my_stack[i]
            m = re.search(reg, target)
            if m is None:
                continue
            flag = True
            child = self.my_stack[int(m.group(1))]
            self.my_stack[i] = re.sub(reg, str(len(self.my_stack)), target, count=1)
            self.my_stack.append(self.doing_de_morgan(child))
            break
        self.my_stack.append(self.my_stack[final])
        return flag

    def doing_de_morgan(self, source):
        items = re.split('\s+', source)
        new_items = []
        for item in items:
            if item == 'or':
                new_items.append('and')
            elif item == 'and':
                new_items.append('or')
            elif item == 'neg':
                new_items.append('neg')
            elif len(item.strip()) > 0:
                new_items.append('neg')
                new_items.append(item)
        for i in range(len(new_items) - 1):
            if new_items[i] == 'neg':
                if new_items[i + 1] == 'neg':
                    new_items[i] = ''
                    new_items[i + 1] = ''
        return ' '.join([i for i in new_items if len(i) > 0])


class distributive(logic_base):
    def run(self):
        flag = False
        reg = '(\d+)'
        final = len(self.my_stack) - 1
        for i in range(len(self.my_stack)):
            target = self.my_stack[i]
            if 'or' not in self.my_stack[i]:
                continue
            m = re.search(reg, target)
            if m is None:
                continue
            for j in re.findall(reg, target):
                child = self.my_stack[int(j)]
                if 'and' not in child:
                    continue
                new_reg = "(^|\s)" + j + "(\s|$)"
                items = re.split('\s+and\s+', child)
                tmp_list = [str(j) for j in range(len(self.my_stack), len(self.my_stack) + len(items))]
                for item in items:
                    self.my_stack.append(re.sub(new_reg, ' ' + item + ' ', target).strip())
                self.my_stack[i] = ' and '.join(tmp_list)
                flag = True
            if flag:
                break
        self.my_stack.append(self.my_stack[final])
        return flag


class simplification(logic_base):
    def run(self):
        old = self.get_result()
        for i in range(len(self.my_stack)):
            self.my_stack[i] = self.reducing_or(self.my_stack[i])
        # self.my_stack[i] = self.reducing_and(self.my_stack[i])
        final = self.my_stack[-1]
        self.my_stack[-1] = self.reducing_and(final)
        return len(old) != len(self.get_result())

    def reducing_and(self, target):
        if 'and' not in target:
            return target
        items = set(re.split('\s+and\s+', target))
        for item in list(items):
            if ('neg ' + item) in items:
                return ''
            if re.match('\d+$', item) is None:
                continue
            value = self.my_stack[int(item)]
            if self.my_stack.count(value) > 1:
                value = ''
                self.my_stack[int(item)] = ''
            if value == '':
                items.remove(item)
        return ' and '.join(list(items))

    def reducing_or(self, target):
        if 'or' not in target:
            return target
        items = set(re.split('\s+or\s+', target))
        for item in list(items):
            if ('neg ' + item) in items:
                return ''
        return ' or '.join(list(items))



def merging(source):
    old = source.get_result()
    source.merge_items('or')
    source.merge_items('and')
    return old != source.get_result()
```

```
def run(input):
    all_strings = []
    # all_strings.append(input)
    zero = ordering(input)
    while zero.run():
        zero = ordering(zero.get_result())
    merging(zero)

    one = replace_iff(zero.get_result())
    one.run()
    all_strings.append(one.get_result())
    merging(one)

    two = replace_imp(one.get_result())
    two.run()
    all_strings.append(two.get_result())
    merging(two)

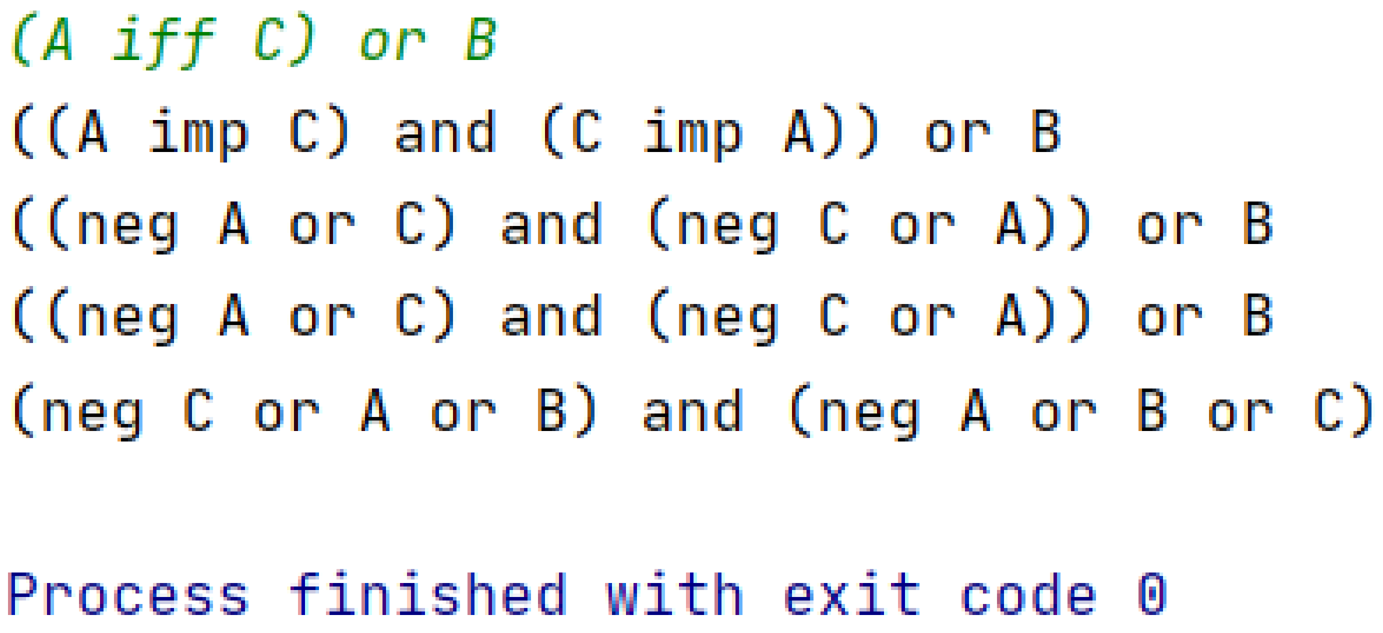
    three, four = None, None
    old = two.get_result()
    three = de_morgan(old)
    while three.run():
        pass
    all_strings.append(three.get_result())
    merging(three)
    three_helf = simplification(three.get_result())
    three_helf.run()

    four = distributive(three_helf.get_result())
    while four.run():
        pass
    merging(four)
    five = simplification(four.get_result())
    five.run()
    all_strings.append(five.get_result())
    return all_strings



inputs = input().split('\n')
for input in inputs:
    for item in run(input):
        print(item)
    # output.write('\n')
```

Output:



```
(A iff C) or B
((A imp C) and (C imp A)) or B
((neg A or C) and (neg C or A)) or B
((neg A or C) and (neg C or A)) or B
(neg C or A or B) and (neg A or B or C)

Process finished with exit code 0
```