Name: Amarsingh Kashyap
Roll No: 101

Practical No. 3

Theory

FIRST Set :

FIRST(X) for a grammar symbol X is the set of terminals that begin the strings derivable from X.

Rules to compute FIRST set:

1. If x is a terminal, then FIRST(x) = { 'x' }
2. If x-> Є, is a production rule, then add Є to FIRST(x).
3. If X->Y1 Y2 Y3….Yn is a production,
   1. FIRST(X) = FIRST(Y1)
   2. If FIRST(Y1) contains Є then FIRST(X) = { FIRST(Y1) – Є } U { FIRST(Y2) }
   3. If FIRST (Yi) contains Є for all i = 1 to n, then add Є to FIRST(X).

FOLLOW Set :

Follow(X) to be the set of terminals that can appear immediately to the right of Non-Terminal X in some sentential form.

Rules to compute FOLLOW set:

1. FOLLOW(S) = { $ } // where S is the starting Non-Terminal
2. If A -> pBq is a production, where p, B and q are any grammar symbols,

   then everything in FIRST(q) except Є is in FOLLOW(B).
3. If A->pB is a production, then everything in FOLLOW(A) is in FOLLOW(B).
4. If A->pBq is a production and FIRST(q) contains Є,

   then FOLLOW(B) contains { FIRST(q) – Є } U FOLLOW(A)

LL(1) Parsing:

The 1st L represents that the scanning of the Input will be done from Left to Right manner and the second L shows that in this parsing technique we are going to use Left most Derivation Tree. And finally, the 1 represents the number of look-ahead, which means how many symbols are you going to see when you want to make a decision.

Algorithm to construct LL(1) Parsing Table:

Step 1: First check for left recursion in the grammar, if there is left recursion in the grammar remove that and go to step 2.

Step 2: Calculate First() and Follow() for all non-terminals.

1. First(): If there is a variable, and from that variable, if we try to drive all the strings then the beginning Terminal Symbol is called the First.
2. Follow(): What is the Terminal Symbol which follows a variable in the process of derivation.

Step 3: For each production A –> α. (A tends to alpha)

1. Find First(α) and for each terminal in First(α), make entry A –> α in the table.
2. If First(α) contains ε (epsilon) as terminal than, find the Follow(A) and for each terminal in Follow(A), make entry A –> α in the table.
3. If the First(α) contains ε and Follow(A) contains $ as terminal, then make entry A –> α in the table for the $.

To construct the parsing table, we have two functions:

AIM :

(A) Write a program to find FIRST for any grammar. All the following rules of FIRST must be implemented.

Following inputs can be used:

Implementation: FIRST rules

Output: FIRST information for each non-terminal

(B) Construct the LL(1) parsing table using the FIRST values computed above and consider Follow information as input from the user.

Batch B4: **# = Epsilon**

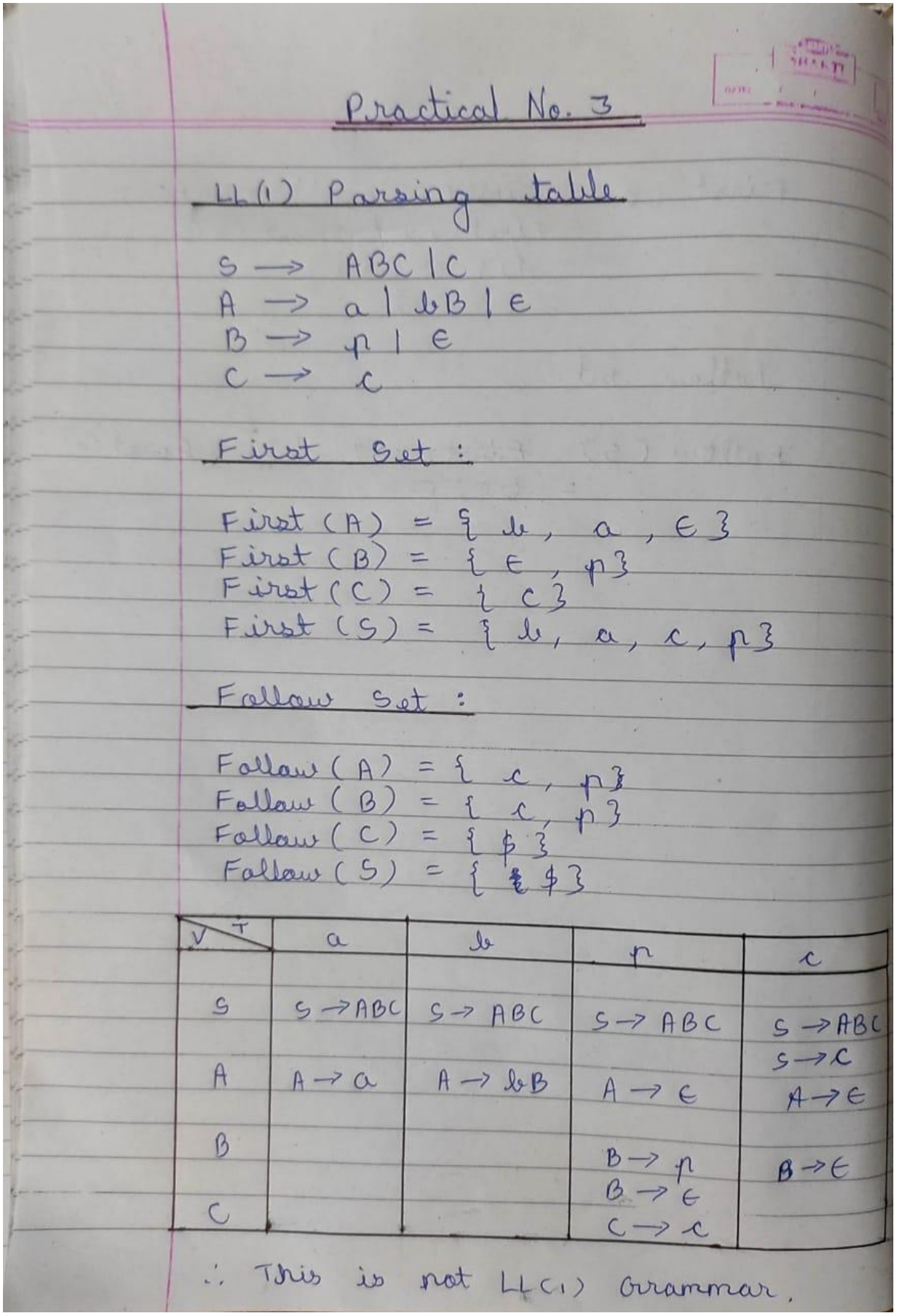
S -> ABC | C

A -> a | bB | #

B -> p | #

C -> c

HAND WRITTEN EXAMPLE :



Practical No. 3

LL(1) Parsing table

$S \rightarrow ABC \mid C$
$A \rightarrow a \mid bB \mid \epsilon$
$B \rightarrow p \mid \epsilon$
$C \rightarrow c$

First Set :

First (A) = { b, a, ∈ }
First (B) = { ∈, p }
First (C) = { c }
First (S) = { b, a, c, p }

Follow Set :

Follow (A) = { c, p }
Follow (B) = { c, p }
Follow (C) = { $ }
Follow (S) = { $ }

V \ T	a	b	p	c
S	S → ABC	S → ABC	S → ABC	S → ABC S → C
A	A → a	A → bB	A → ∈	A → ∈
B			B → p B → ∈	B → ∈
C			C → c	

∴ This is not LL(1) Grammar.

CODE :

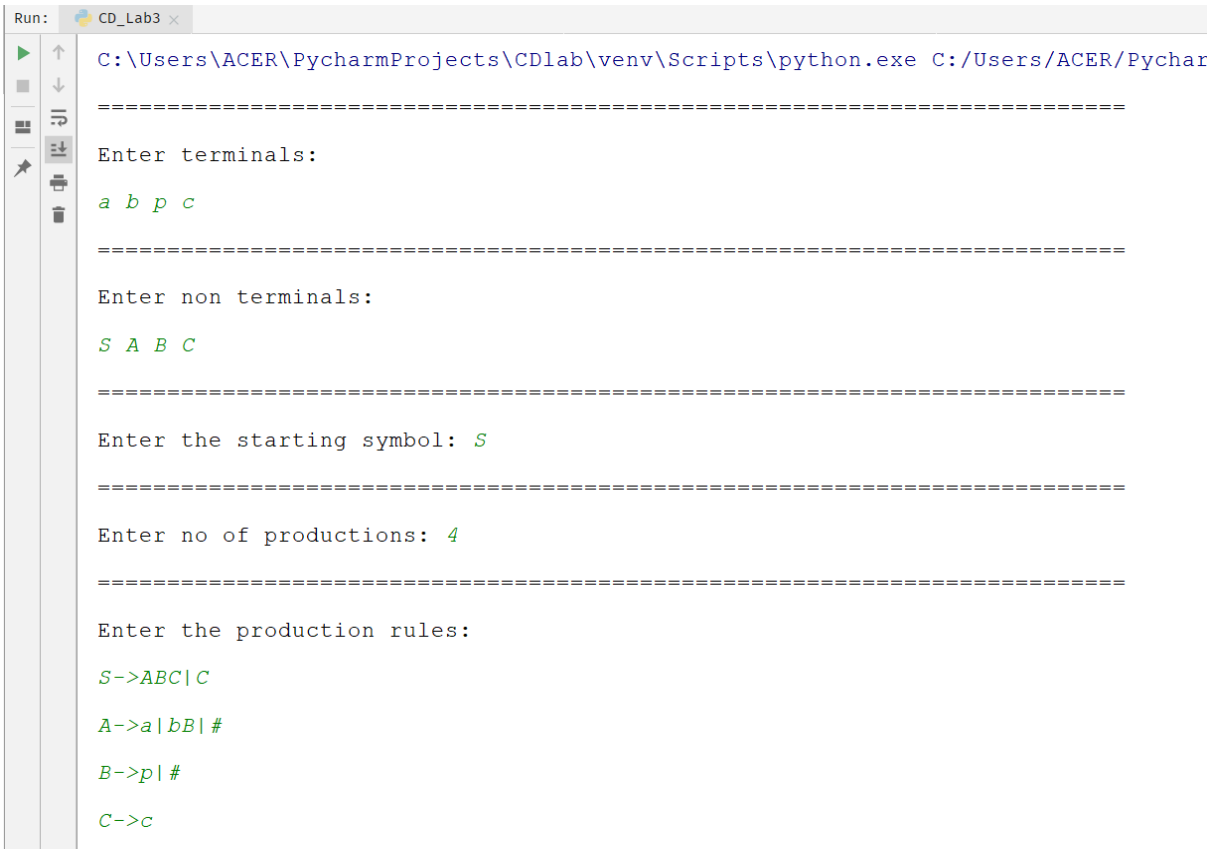
```
firstD = {}
followD = {}
eps = "Є"

def CaluclateFirst(start):
    first = set()

    for v in rules[start]:
        for each in v:
            if eps in first:
                first.remove(eps)

            if each in ter:
                first.add(each)

            elif each == eps:
                first.add(eps)

            elif each in non_ter:
                first =
first.union(CaluclateFirst(each))

            if eps not in first:
                break


    firstD[start] = first
    return first


def CalculateFollow(start):
    follow = set()
    if start == start_symbol:
        follow.add("$")
    for k, r in rules.items():
        #print(start,'\t', r)
        for each in r:
            if start in each:
                index = each.index(start)
                if index != len(each)-1:
                    for i in range(index+1, len(each)):
                        if eps in follow:
```

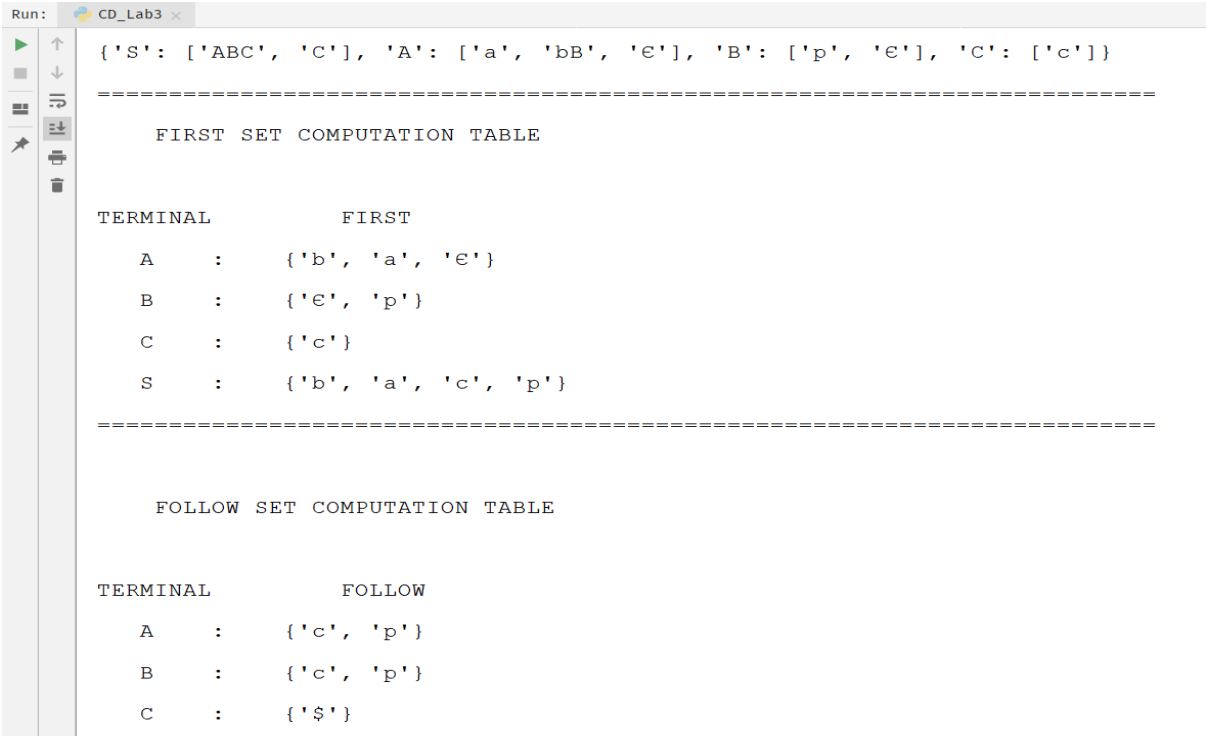
```
                                follow.remove(eps)
                                followD[start] = follow
                            if each[i] in ter:
                                follow =
follow.union(each[i])
                                followD[start] = follow
                            else:
                                follow =
follow.union(firstD[each[i]])
                                followD[start] = follow
                            if eps not in follow:
                                break
                    else:
                        if k not in followD:
                            follow =
follow.union(CalculateFollow(k))
                            followD[start] = follow
                        else:
                            follow =
follow.union(followD[k])
                            followD[start] = follow
                    if eps in follow or len(follow) == 0:
                        if eps in follow:
                            follow.remove(eps)
                        follow =
follow.union(CalculateFollow(k))
                        followD[start] = follow
        followD[start] = follow
        return follow


#input terminal symbols
print("==========================================
============================")
print("Enter terminals:")
ter = list(map(str, input().split()))
print("==========================================
============================")
#input non terminal symbols
print("Enter non terminals:")
non_ter = list(map(str, input().split()))
print("==========================================
============================")
#input start symbol
start_symbol = input("Enter the starting symbol: ")
```

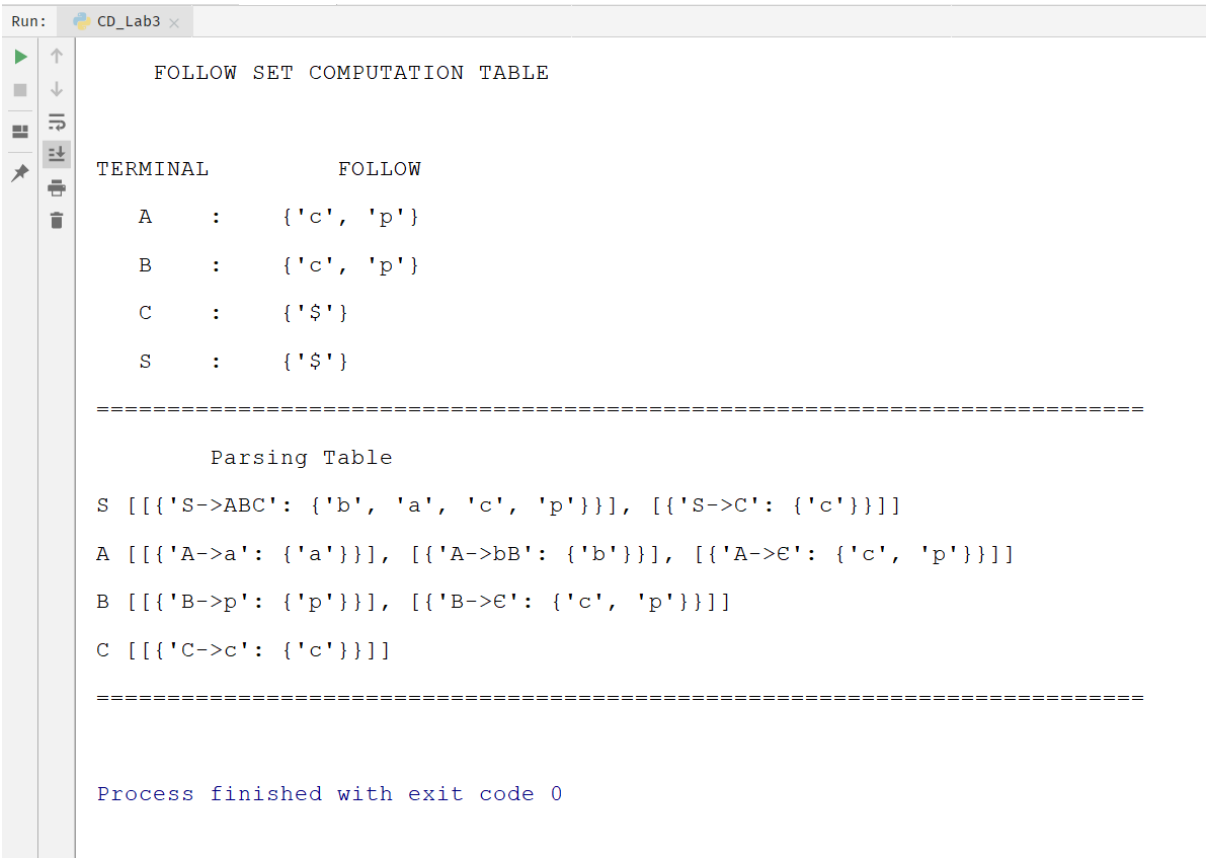
```
print("=============================================
============================")
#input all production rules
no_of_productions = int(input("Enter no of productions:
"))
productions = []
print("=============================================
============================")
print("Enter the production rules:")
for _ in range(no_of_productions):
    productions.append(input().replace("#", eps))

rules = {}
for p in productions:
    r = p.split("->")
    rules[r[0]] = r[1].split('|')
print(rules)


CaluclateFirst(start_symbol)


for start in non_ter:
    CaluclateFirst(start)
print("=============================================
============================")
print("\tFIRST SET COMPUTATION TABLE\n")
print("TERMINAL\t\t FIRST")
for F in sorted(firstD):
    print("  ",F,"\t:\t",firstD[F])


for start in non_ter:
    CalculateFollow(start)
print("=============================================
============================")
print("\n\tFOLLOW SET COMPUTATION TABLE\n")
print("TERMINAL\t\t FOLLOW")
for F in sorted(followD):
    print("  ",F,"\t:\t",followD[F])


def parsingTable(rules):
    for symbol, prod in rules.items():
        for each in prod:
```

```
                t = set()
                for e in each:
                    if e in non_ter:
                        if eps in t:
                            t.remove(eps)
                        t = t.union(firstD[e])
                        if eps not in t:
                            break
                    else:
                        t = t.union(e)
                        break
                if eps in t:
                    t.remove(eps)
                    t = t.union(followD[symbol])
                table[symbol].append([{symbol+'->'+each:
t}])

table = dict()
for each in non_ter:
    table[each] = []

parsingTable(rules)
print("================================================
==========================")
print("\t\tParsing Table")
for row in table:
    print(row, table[row])
print("================================================
==========================")
```

OUTPUT :


Run:
CD_Lab3
C:\Users\ACER\PycharmProjects\CDlab\venv\Scripts\python.exe C:/Users/ACER/Pychar
==========
Enter terminals:
a b p c
==========
Enter non terminals:
S A B C
==========
Enter the starting symbol: S
==========
Enter no of productions: 4
==========
Enter the production rules:
S->ABC|C
A->a|bB|#
B->p|#
C->c


Run:
CD_Lab3
{'S': ['ABC', 'C'], 'A': ['a', 'bB', 'Є'], 'B': ['p', 'Є'], 'C': ['c']}
==========
FIRST SET COMPUTATION TABLE
TERMINAL FIRST
A : {'b', 'a', 'Є'}
B : {'Є', 'p'}
C : {'c'}
S : {'b', 'a', 'c', 'p'}
==========
FOLLOW SET COMPUTATION TABLE
TERMINAL FOLLOW
A : {'c', 'p'}
B : {'c', 'p'}
C : {'$'}


Run:
CD_Lab3
FOLLOW SET COMPUTATION TABLE
TERMINAL FOLLOW
A : {'c', 'p'}
B : {'c', 'p'}
C : {'$'}
S : {'$'}
Parsing Table
S [[{'S->ABC': {'b', 'a', 'c', 'p'}}], [{'S->C': {'c'}}]]
A [[{'A->a': {'a'}}], [{'A->bB': {'b'}}], [{'A->Є': {'c', 'p'}}]]
B [[{'B->p': {'p'}}], [{'B->Є': {'c', 'p'}}]]
C [[{'C->c': {'c'}}]]
Process finished with exit code 0