LR(0) ITEMS FOR THE GIVEN SET OF GRAMMAR

A MINI PROJECT REPORT

18CSC304J – COMPILER DESIGN

Submitted by

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BONAFIDE CERTIFICATE

Certified that Mini project report titled **"LR(0) FOR THE GIVEN SET OF GRAMMAR"**is the bona fide work of **KAYYALA PRASANNANJANEYULU (RA2011026010358) and NAKKA VIVEK(RA2011026010379)** who carried out the minor project under my supervision. Certified further, that to the best of my knowledge, the work reported herein does not form any other project report or dissertation on the basis of which a degree or award was conferred on anearlier occasion on this or any other candidate.

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TABLE CONTENTS

1.AIM:

To implement LR(0) Items for the given set of Grammar.

2.ABSTRACT:-

LR(0) items are an essential concept in constructing LR(0) parsers for programming languages. The goal of this project is to generate a complete set of LR(0) items for a given context-free grammar. The LR(0) items describe the state of the parser while it's parsing the input stream. The project begins by constructing the initial LR(0) item for the start symbol of the grammar, and then iteratively generating more LR(0) items until all possible states are explored. The resulting set of LR(0) items can be used to construct the parsing table for an LR(0) parser, which can then be used to parse any valid input string according to the given grammar. The project demonstrates the importance of LR(0) items in parsing and provides a practical example of their construction.

3.INTRODUCTION*:* -

The LR(0) parsing algorithm is a fundamental technique for constructing parsers for programming languages. It requires a complete set of LR(0) items, which describe the parser's state while it's parsing the input stream. The generation of these LR(0) items for a given grammar is not a trivial task and requires a systematic approach. In this project, we aim to generate the LR(0) items for a context-free grammar by implementing an algorithm that constructs the set of LR(0) items for the grammar. The LR(0) items provide crucial information for constructing the parsing table for an LR(0) parser, which can then be used to parse any input string according to the given grammar.

In this project, we will begin by defining the concept of LR(0) items and their significance in constructing parsers for programming languages. We will then present a step-by-step algorithm for constructing the complete set of LR(0) items for a given grammar. We will demonstrate this algorithm on a sample context-free grammar and show how it generates the complete set of LR(0) items. Finally, we will discuss the importance of LR(0) items in parsing and their applications in various fields, such as compilers, interpreters, and other areas of computer science. By the end of this project, the reader should have a clear understanding of the LR(0) parsing algorithm and the role of LR(0) items in constructing parsers for programming languages.

4.ADVANTAGES OF LR(0) ITEMS: -

The LR(0) parsing algorithm is a widely used parsing technique for constructing parsers for programming languages due to its efficiency and ease of implementation. The advantages of LR(0) items in this context are as follows:

1. **Deterministic Parsing**: The LR(0) parsing algorithm is deterministic, meaning that it can parse any valid input string without backtracking or lookahead. This is possible because the LR(0) items provide complete information about the parser's state during the parsing process. This makes the parsing process efficient and faster than other parsing algorithms that use backtracking.

2. **Table-Driven Parsing**: The LR(0) parsing algorithm uses a table-driven parsing technique, where the parsing table is constructed using the complete set of LR(0) items. The parsing table provides a mapping between the current state of the parser and the next action to be taken, which can be shift, reduce, or accept. This makes the parsing process faster, as the parser only needs to consult the parsing table to decide its next move.

3. **Error Handling**: The LR(0) parsing algorithm can detect and recover from syntax errors during the parsing process. When the

parser encounters a syntax error, it can use the information in the parsing table to determine the correct error recovery action. This helps in providing better error messages to the user, improving the overall user experience.

4. **Scalability**: The LR(0) parsing algorithm is scalable and can handle large context-free grammars efficiently. The LR(0) items provide a compact representation of the parser's state, making it easier to store and manipulate large sets of LR(0) items. This is particularly important in building parsers for complex programming languages that have large grammars.

In summary, LR(0) items provide a comprehensive and efficient approach for constructing parsers for programming languages. They enable deterministic parsing, table-driven parsing, error handling, and scalability, making the LR(0) parsing algorithm one of the most widely used parsing techniques in computer science.

5. WORKING OF LR(0) ITEMS: -

The LR(0) parsing algorithm uses LR(0) items to construct a parsing table that can be used to parse any valid input string according to the given context-free grammar. The working of LR(0) items can be broken down into the following steps:

1. Initialization: The algorithm begins by initializing a set of LR(0) items for the start symbol of the grammar. An LR(0) item is a production rule of the grammar, along with a dot ('.') symbol placed at some position in the right-hand side of the rule.

2. Closure Operation: The algorithm then applies the closure operation to the set of LR(0) items. The closure operation adds all possible LR(0) items that can be reached from the current set of LR(0) items by applying a production rule that has the dot symbol immediately before a non-terminal symbol. This process is repeated until no more LR(0) items can be added.

3. Goto Operation: The algorithm then applies the goto operation to the set of LR(0) items. The goto operation applies a transition from one set of LR(0) items to another set of LR(0) items based on the appearance of the dot symbol in the right-hand side of a production rule. This process generates a new set of

LR(0) items that can be reached from the current set of LR(0) items by applying a specific terminal or non-terminal symbol.

4. Parsing Table: The algorithm constructs a parsing table that maps each LR(0) item set to the action to be taken by the parser. The parsing table has entries for each terminal and non-terminal symbol of the grammar. The entries can be shift, reduce, or accept, depending on the current state of the parser.

5. Parsing: The parser uses the parsing table to parse any input string according to the given grammar. The parser reads the input stream from left to right and decides its next move based on the current state of the parser and the input symbol. If the entry in the parsing table is a shift, the parser shifts the input symbol and updates its state. If the entry in the parsing table is a reduce, the parser reduces the stack of symbols according to the production rule, updates its state, and continues parsing. If the entry in the parsing table is an accept, the parser accepts the input string as valid according to the given grammar.

In summary, LR(0) items provide a systematic approach for constructing a parsing table that can be used by an LR(0) parser to parse any valid input string according to the given context-free grammar. The parser uses the information in the parsing table to decide its next move during the parsing process

6.EXAMPLE OF LR(0) :

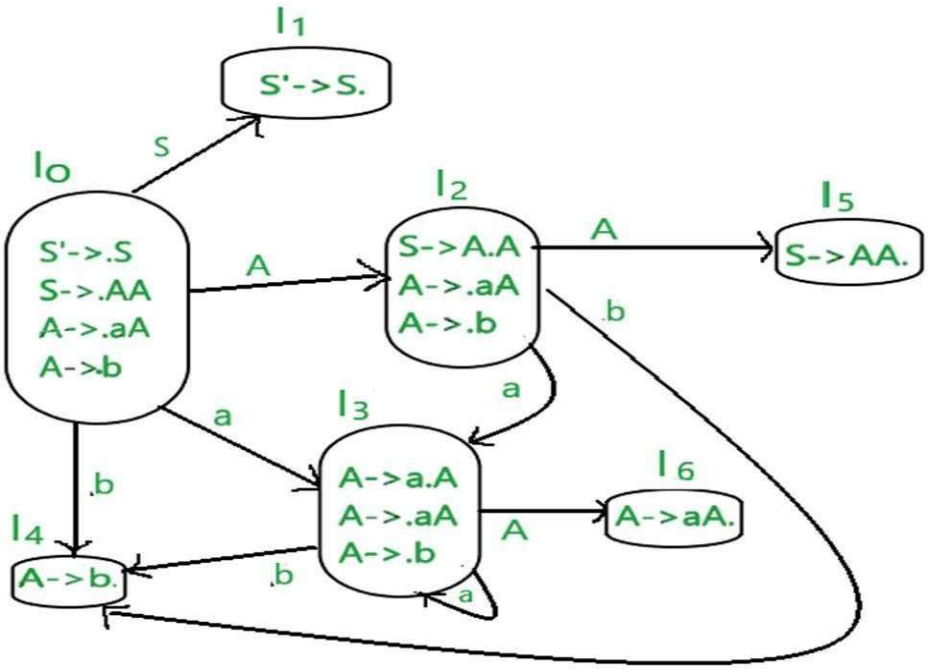
Construct an LR parsing table for the given context-free grammar –

S–>AA

A–>aA|b

Find LR(0) collection of items

Below is the figure showing the LR(0) collection of items. We will understand everything one by one.



7.REQUIREMENTS TO RUN THE SCRIPT:

- C++ language
- Online GDB

8.APPLICATIONS: -

LR(0) items have several applications in computer science and programming language theory, including:

1. Parser Generation: LR(0) items are used to construct LR(0) parsers, which are a type of bottom-up parser that can parse any context-free grammar. LR(0) parsers are efficient and can be automatically generated from LR(0) item sets.

2. Syntax Analysis: LR(0) items are used in syntax analysis of programming languages, which is the process of determining whether a program is syntactically correct according to a given grammar. LR(0) items can be used to construct a parse tree for a given program.

3. Compiler Design: LR(0) items are used in the design of compilers for programming languages. The parser generated using LR(0) items is a key component of a compiler, and the LR(0) item set can be used to determine the grammar of a programming language.

4. Language Processing: LR(0) items can be used in natural language processing, which is the process of analyzing and understanding human language. LR(0) items can be used to construct a grammar for a natural language, which can then be used to parse and understand sentences.

5. Code Analysis: LR(0) items can be used in code analysis tools, such as static analyzers, which are used to analyze source code for errors, security vulnerabilities, and other issues. LR(0) items can be used to identify and analyze syntax errors in source code.

9.IMPLEMENTATION:

```
#include<iostream>
#include<conio.h>
#include<string.h>

using namespace std;

char prod[20][20],listofvar[26]="ABCDEFGHIJKLMNOPQR";
int novar=1,i=0,j=0,k=0,n=0,m=0,arr[30];
int noitem=0;

struct Grammar
{
        char lhs;
        char rhs[8];
}g[20],item[20],clos[20][10];

int isvariable(char variable)
{
```

```
        for(int i=0;i<novar;i++)
                if(g[i].lhs==variable)
                        return i+1;
        return 0;
}
void findclosure(int z, char a)
{
        int n=0,i=0,j=0,k=0,l=0;
        for(i=0;i<arr[z];i++)
        {
                for(j=0;j<strlen(clos[z][i].rhs);j++)
                {
                        if(clos[z][i].rhs[j]=='.' && clos[z][i].rhs[j+1]==a)
                        {
                                clos[noitem][n].lhs=clos[z][i].lhs;
                                strcpy(clos[noitem][n].rhs,clos[z][i].rhs);
                                char temp=clos[noitem][n].rhs[j];

        clos[noitem][n].rhs[j]=clos[noitem][n].rhs[j+1];
                                clos[noitem][n].rhs[j+1]=temp;
```

```
                        n=n+1;
                    }
                }
            }
            for(i=0;i<n;i++)
            {
                for(j=0;j<strlen(clos[noitem][i].rhs);j++)
                {
                    if(clos[noitem][i].rhs[j]=='.' &&
isvariable(clos[noitem][i].rhs[j+1])>0)
                    {
                        for(k=0;k<novar;k++)
                        {

            if(clos[noitem][i].rhs[j+1]==clos[0][k].lhs)
                                {
                                    for(l=0;l<n;l++)

            if(clos[noitem][l].lhs==clos[0][k].lhs &&
strcmp(clos[noitem][l].rhs,clos[0][k].rhs)==0)
                                                break;
```

```
                        if(l==n)
                        {
clos[noitem][n].lhs=clos[0][k].lhs;

strcpy(clos[noitem][n].rhs,clos[0][k].rhs);
                            n=n+1;
                        }
                    }
                }
            }
        }
}
arr[noitem]=n;
int flag=0;
for(i=0;i<noitem;i++)
{
    if(arr[i]==n)
    {
        for(j=0;j<arr[i];j++)
```

```
                {
                        int c=0;
                        for(k=0;k<arr[i];k++)
                                if(clos[noitem][k].lhs==clos[i][k].lhs
&& strcmp(clos[noitem][k].rhs,clos[i][k].rhs)==0)
                                        c=c+1;
                        if(c==arr[i])
                        {
                                flag=1;
                                goto exit;
                        }
                }
        }
    }
    exit:;
    if(flag==0)
        arr[noitem++]=n;
}

int main()
```

```
{
    cout<<"ENTER THE PRODUCTIONS OF THE
GRAMMAR(0 TO END) :\n";
    do
    {
        cin>>prod[i++];
    }while(strcmp(prod[i-1],"0")!=0);
    for(n=0;n<i-1;n++)
    {
        m=0;
        j=novar;
        g[novar++].lhs=prod[n][0];
        for(k=3;k<strlen(prod[n]);k++)
        {
            if(prod[n][k] != '|')
            g[j].rhs[m++]=prod[n][k];
            if(prod[n][k]=='|')
            {
                g[j].rhs[m]='\0';
                m=0;
```

```
                    j=novar;
                    g[novar++].lhs=prod[n][0];
                }
        }
}
for(i=0;i<26;i++)
        if(!isvariable(listofvar[i]))
                break;
g[0].lhs=listofvar[i];
char temp[2]={g[1].lhs,'\0'};
strcat(g[0].rhs,temp);
cout<<"\n\n augumented grammar \n";
for(i=0;i<novar;i++)
        cout<<endl<<g[i].lhs<<"->"<<g[i].rhs<<" ";

for(i=0;i<novar;i++)
{
        clos[noitem][i].lhs=g[i].lhs;
        strcpy(clos[noitem][i].rhs,g[i].rhs);
        if(strcmp(clos[noitem][i].rhs,"ε")==0)
```

```
                strcpy(clos[noitem][i].rhs,".");
            else
            {
                for(int j=strlen(clos[noitem][i].rhs)+1;j>=0;j--)
                    clos[noitem][i].rhs[j]=clos[noitem][i].rhs[j-
1];
                clos[noitem][i].rhs[0]='.';
            }
        }
        arr[noitem++]=novar;
        for(int z=0;z<noitem;z++)
        {
            char list[10];
            int l=0;
            for(j=0;j<arr[z];j++)
            {
                for(k=0;k<strlen(clos[z][j].rhs)-1;k++)
                {
                    if(clos[z][j].rhs[k]=='.')
                    {
```

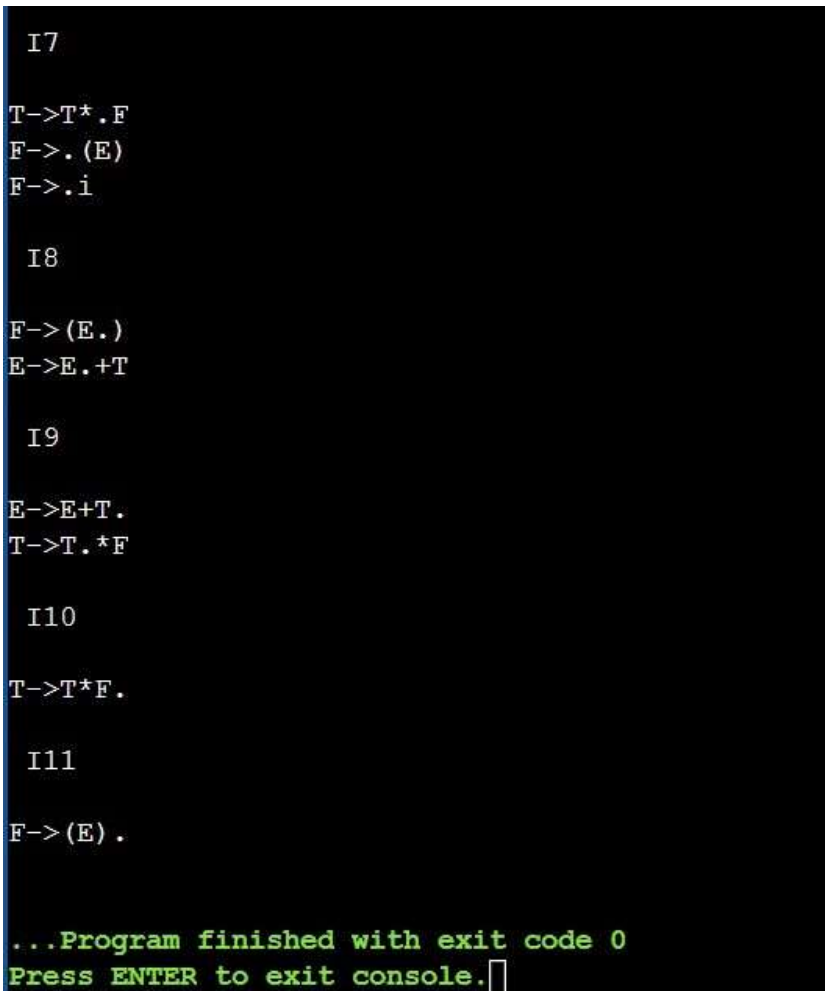
```
                    for(m=0;m<l;m++)
                        if(list[m]==clos[z][j].rhs[k+1])
                            break;
                    if(m==l)
                        list[l++]=clos[z][j].rhs[k+1];
                }
            }
        }
        for(int x=0;x<l;x++)
            findclosure(z,list[x]);
}
cout<<"\n THE SET OF ITEMS ARE \n\n";
for(int z=0; z<noitem; z++)
{
        cout<<"\n I"<<z<<"\n\n";
        for(j=0;j<arr[z];j++)
            cout<<clos[z][j].lhs<<"->"<<clos[z][j].rhs<<"\n";

}
```

}

10.OUTPUT:

```
 augumented grammar

A->E
E->E+T
E->T
T->T*F
T->F
F->(E)
F->i
 THE SET OF ITEMS ARE


 I0

A->.E
E->.E+T
E->.T
T->.T*F
T->.F
F->.(E)
F->.i

 I1

A->E.
E->E.+T
```

```
 I2

E->T.
T->T.*F

 I3

T->F.

 I4

F->(.E)
E->.E+T
E->.T
T->.T*F
T->.F
F->.(E)
F->.i

 I5

F->i.

 I6

E->E+.T
T->.T*F
T->.F
F->.(E)
F->.i

 I7

T->T*.F
F->.(E)
F->.i
```



11.RESULT:

LR(0) Items for the given set of Grammar is successfully implemented and executed.

11.CONCLUSION :

LR(0) parsing has been a vital component in our compiler project. It helped us build a parsing table and analyze the structure of the input code effectively. By using LR(0) parsing, we successfully constructed a parse tree or an abstract syntax tree that represented the input program accurately.

Despite its limitations in handling conflicts, LR(0) parsing served as a solid foundation for our compiler. It enabled us to recognize valid grammar rules and make appropriate parsing decisions. We also explored additional techniques to resolve conflicts when encountered.

Overall, LR(0) parsing has been instrumental in our project, improving the compiler's ability to process a wide range of context-free grammars. Its successful implementation has contributed to the overall functionality and efficiency of our compiler system.

13.REFERENCES

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- Fischer, C. N., & LeBlanc Jr, R. J. (1991). Crafting a Compiler with C. Benjamin/Cummings Publishing. ISBN: 978-0805332014.
- Dragon Book (Compilers: Principles, Techniques, and Tools) - The book by Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman is a widely referenced resource for compiler construction. It provides comprehensive coverage of parsing techniques, including LR(0). Please provide the relevant chapter and section numbers when citing.
- Compiler Design and Construction - This online resource by Prof. Nigel Horspool from the University of Victoria covers various aspects of compiler design, including LR(0) parsing. It can be accessed at: http://webhome.cs.uvic.ca/~nigelh/Publications/Book/compilers-contents.html