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编译原理实验

语法分析器的简单实现

1. **实验目的**

通过构建一个简单的语法分析程序，进一步熟悉语法分析的过程以及加深对First和Follow的认识。

1. **实验描述**

本次实验使用Java语言编写，简单实现了对C语言程序的语法分析。程序的输入是C语言程序代码program.c文件以及已经定义好的文法CFG.txt文件。程序的输出是控制台和output.txt文件，内容是语法分析的过程。本实验中用到的词法分析部分是实验一的词法分析器。

1. **实验方法**

本次实验选用的方法是PPT中给出的第一种方法中的a方法，根据文法编程构建LL(1)预测分析表来进行语法分析。

1. **实验设想**

无。

1. **相关的自动机描述**

大部分同词法分析。

1. **数据结构的定义**

**Lex类**：词法分析程序

**Token类**：Token序列中的元素

**Production类**：产生式类，包括两个属性，一个是left（String类型），表示产生式的左部；另一个是right（List<String>类型），表示产生式的右部。

**FirstFollow类**：表示First或Follow的类，包括两个属性，一个是left（String类型），另一个是right（List<String>类型）。

**Syntax类**：语法分析程序核心

终结符和非终结符分别用List<String>类型来表示。

产生式用List<Production>类型来表示。

符号的First和Follow分别用List<FirstFollow>类型来表示。

预测分析表用Production[][]类型表示，还需要借助终结符和非终结符的List<String>作为表头。

语法分析过程中的栈用Java自带的Stack<String>来表示。

Token序列（简化版）用List<String>类型来表示。

1. **核心算法描述**

程序的核心算法主要有四个：

1. getFirst()：获得符号的First集合，算法在龙书的P140.
2. getFollow()：获得符号的Follow集合，算法在龙书的P140-141.
3. getParsingTable()：构建预测分析表，算法在龙书的P142-143，算法4.31
4. syntaxParsing()：表驱动的预测语法分析，算法在龙书的P144，算法4.34
5. **测试用例**

**C语言程序源代码：（program.c）**

int main(float a) {

while (a <= 5) {

if (a == 6) {

a = 8;

} else {

int b = 5;

b = a + 5;

}

}

return 0;

}

**文法：（CFG.txt）**

<Program> -> <Function>

<Function> -> [void] <FuncName> [(] <Para> [)] [{] <Statement> [}]

<Function> -> <DataType> <FuncName> [(] <Para> [)] [{] <Statement> <Return> [}]

<FuncName> -> [ID]

<Para> -> [ε]

<Para> -> <DataType> [ID]

<Statement> -> <S> <Statement>

<Statement> -> [ε]

<S> -> <DataType> [ID] <M>

<M> -> [;]

<M> -> [=] [NUM] [;]

<S> -> [ID] [=] <Keyword> <N>

<N> -> [;]

<N> -> <OP> <Keyword> [;]

<S> -> [if] [(] <C> [)] <B> <D>

<D> -> [else] <B>

<D> -> [ε]

<B> -> [{] <Statement> [}]

<C> -> <Keyword> <CompareOP> <Keyword>

<S> -> [while] [(] <C> [)] <B>

<DataType> -> [int]

<DataType> -> [float]

<DataType> -> [double]

<OP> -> [+]

<OP> -> [-]

<OP> -> [\*]

<OP> -> [/]

<OP> -> [%]

<CompareOP> -> [==]

<CompareOP> -> [!=]

<CompareOP> -> [>=]

<CompareOP> -> [<=]

<CompareOP> -> [>]

<CompareOP> -> [<]

<Keyword> -> [ID]

<Keyword> -> [NUM]

<Return> -> [return] <Keyword> [;]

下面是一些可选择的输出：（Syntax类中的public方法）：

**outputTerminals()：**

void ( ) { } ID ε ; = NUM if else while int float double + - \* / % == != >= <= > < return $

**outputNonTerminals()：**

Program Function FuncName Para Statement DataType Return S M Keyword N OP C B D CompareOP

**outputProductions()：**

Program -> Function

Function -> void FuncName ( Para ) { Statement }

Function -> DataType FuncName ( Para ) { Statement Return }

FuncName -> ID

Para -> ε

Para -> DataType ID

Statement -> S Statement

Statement -> ε

S -> DataType ID M

M -> ;

M -> = NUM ;

S -> ID = Keyword N

N -> ;

N -> OP Keyword ;

S -> if ( C ) B D

D -> else B

D -> ε

B -> { Statement }

C -> Keyword CompareOP Keyword

S -> while ( C ) B

DataType -> int

DataType -> float

DataType -> double

OP -> +

OP -> -

OP -> \*

OP -> /

OP -> %

CompareOP -> ==

CompareOP -> !=

CompareOP -> >=

CompareOP -> <=

CompareOP -> >

CompareOP -> <

Keyword -> ID

Keyword -> NUM

Return -> return Keyword ;

**outputFirstFollows()：**

First( void ) → void

First( ( ) → (

First( ) ) → )

First( { ) → {

First( } ) → }

First( ID ) → ID

First( ε ) → ε

First( ; ) → ;

First( = ) → =

First( NUM ) → NUM

First( if ) → if

First( else ) → else

First( while ) → while

First( int ) → int

First( float ) → float

First( double ) → double

First( + ) → +

First( - ) → -

First( \* ) → \*

First( / ) → /

First( % ) → %

First( == ) → ==

First( != ) → !=

First( >= ) → >=

First( <= ) → <=

First( > ) → >

First( < ) → <

First( return ) → return

First( $ ) → $

First( Program ) → void int float double

First( Function ) → void int float double

First( FuncName ) → ID

First( Para ) → ε int float double

First( Statement ) → ε int float double ID if while

First( DataType ) → int float double

First( Return ) → return

First( S ) → int float double ID if while

First( M ) → ; =

First( Keyword ) → ID NUM

First( N ) → ; + - \* / %

First( OP ) → + - \* / %

First( C ) → ID NUM

First( B ) → {

First( D ) → ε else

First( CompareOP ) → == != >= <= > <

Follow( void ) → ID

Follow( ( ) → int float double ID NUM

Follow( ) ) → {

Follow( { ) → int float double ID if while

Follow( } ) → $ else int float double ID if while } return

Follow( ID ) → ; = ( ) + - \* / % == != >= <= > <

Follow( ε ) → ) } return int float double ID if while

Follow( ; ) → } int float double ID if while return

Follow( = ) → ID NUM

Follow( NUM ) → ; + - \* / % == != >= <= > < )

Follow( if ) → (

Follow( else ) → {

Follow( while ) → (

Follow( int ) → ID

Follow( float ) → ID

Follow( double ) → ID

Follow( + ) → ID NUM

Follow( - ) → ID NUM

Follow( \* ) → ID NUM

Follow( / ) → ID NUM

Follow( % ) → ID NUM

Follow( == ) → ID NUM

Follow( != ) → ID NUM

Follow( >= ) → ID NUM

Follow( <= ) → ID NUM

Follow( > ) → ID NUM

Follow( < ) → ID NUM

Follow( return ) → ID NUM

Follow( $ ) →

Follow( Program ) → $

Follow( Function ) → $

Follow( FuncName ) → (

Follow( Para ) → )

Follow( Statement ) → } return

Follow( DataType ) → ID

Follow( Return ) → }

Follow( S ) → int float double ID if while } return

Follow( M ) → int float double ID if while } return

Follow( Keyword ) → ; + - \* / % == != >= <= > < )

Follow( N ) → int float double ID if while } return

Follow( OP ) → ID NUM

Follow( C ) → )

Follow( B ) → else int float double ID if while } return

Follow( D ) → int float double ID if while } return

Follow( CompareOP ) → ID NUM

**outputPPT()：**

<Program> [void] Program -> Function

<Program> [(] \_

<Program> [)] \_

<Program> [{] \_

<Program> [}] \_

<Program> [ID] \_

<Program> [ε] \_

<Program> [;] \_

<Program> [=] \_

<Program> [NUM] \_

<Program> [if] \_

<Program> [else] \_

<Program> [while] \_

<Program> [int] Program -> Function

<Program> [float] Program -> Function

<Program> [double] Program -> Function

<Program> [+] \_

<Program> [-] \_

<Program> [\*] \_

<Program> [/] \_

<Program> [%] \_

<Program> [==] \_

<Program> [!=] \_

<Program> [>=] \_

<Program> [<=] \_

<Program> [>] \_

<Program> [<] \_

<Program> [return] \_

<Program> [$] \_

<Function> [void] Function -> void FuncName ( Para ) { Statement }

<Function> [(] \_

<Function> [)] \_

<Function> [{] \_

<Function> [}] \_

<Function> [ID] \_

<Function> [ε] \_

<Function> [;] \_

<Function> [=] \_

<Function> [NUM] \_

<Function> [if] \_

<Function> [else] \_

<Function> [while] \_

<Function> [int] Function -> DataType FuncName ( Para ) { Statement Return }

<Function> [float] Function -> DataType FuncName ( Para ) { Statement Return }

<Function> [double] Function -> DataType FuncName ( Para ) { Statement Return }

<Function> [+] \_

<Function> [-] \_

<Function> [\*] \_

<Function> [/] \_

<Function> [%] \_

<Function> [==] \_

<Function> [!=] \_

<Function> [>=] \_

<Function> [<=] \_

<Function> [>] \_

<Function> [<] \_

<Function> [return] \_

<Function> [$] \_

<FuncName> [void] \_

<FuncName> [(] \_

<FuncName> [)] \_

<FuncName> [{] \_

<FuncName> [}] \_

<FuncName> [ID] FuncName -> ID

<FuncName> [ε] \_

<FuncName> [;] \_

<FuncName> [=] \_

<FuncName> [NUM] \_

<FuncName> [if] \_

<FuncName> [else] \_

<FuncName> [while] \_

<FuncName> [int] \_

<FuncName> [float] \_

<FuncName> [double] \_

<FuncName> [+] \_

<FuncName> [-] \_

<FuncName> [\*] \_

<FuncName> [/] \_

<FuncName> [%] \_

<FuncName> [==] \_

<FuncName> [!=] \_

<FuncName> [>=] \_

<FuncName> [<=] \_

<FuncName> [>] \_

<FuncName> [<] \_

<FuncName> [return] \_

<FuncName> [$] \_

<Para> [void] \_

<Para> [(] \_

<Para> [)] Para -> ε

<Para> [{] \_

<Para> [}] \_

<Para> [ID] \_

<Para> [ε] Para -> ε

<Para> [;] \_

<Para> [=] \_

<Para> [NUM] \_

<Para> [if] \_

<Para> [else] \_

<Para> [while] \_

<Para> [int] Para -> DataType ID

<Para> [float] Para -> DataType ID

<Para> [double] Para -> DataType ID

<Para> [+] \_

<Para> [-] \_

<Para> [\*] \_

<Para> [/] \_

<Para> [%] \_

<Para> [==] \_

<Para> [!=] \_

<Para> [>=] \_

<Para> [<=] \_

<Para> [>] \_

<Para> [<] \_

<Para> [return] \_

<Para> [$] \_

<Statement> [void] \_

<Statement> [(] \_

<Statement> [)] \_

<Statement> [{] \_

<Statement> [}] Statement -> ε

<Statement> [ID] Statement -> S Statement

<Statement> [ε] Statement -> ε

<Statement> [;] \_

<Statement> [=] \_

<Statement> [NUM] \_

<Statement> [if] Statement -> S Statement

<Statement> [else] \_

<Statement> [while] Statement -> S Statement

<Statement> [int] Statement -> S Statement

<Statement> [float] Statement -> S Statement

<Statement> [double] Statement -> S Statement

<Statement> [+] \_

<Statement> [-] \_

<Statement> [\*] \_

<Statement> [/] \_

<Statement> [%] \_

<Statement> [==] \_

<Statement> [!=] \_

<Statement> [>=] \_

<Statement> [<=] \_

<Statement> [>] \_

<Statement> [<] \_

<Statement> [return] Statement -> ε

<Statement> [$] \_

<DataType> [void] \_

<DataType> [(] \_

<DataType> [)] \_

<DataType> [{] \_

<DataType> [}] \_

<DataType> [ID] \_

<DataType> [ε] \_

<DataType> [;] \_

<DataType> [=] \_

<DataType> [NUM] \_

<DataType> [if] \_

<DataType> [else] \_

<DataType> [while] \_

<DataType> [int] DataType -> int

<DataType> [float] DataType -> float

<DataType> [double] DataType -> double

<DataType> [+] \_

<DataType> [-] \_

<DataType> [\*] \_

<DataType> [/] \_

<DataType> [%] \_

<DataType> [==] \_

<DataType> [!=] \_

<DataType> [>=] \_

<DataType> [<=] \_

<DataType> [>] \_

<DataType> [<] \_

<DataType> [return] \_

<DataType> [$] \_

<Return> [void] \_

<Return> [(] \_

<Return> [)] \_

<Return> [{] \_

<Return> [}] \_

<Return> [ID] \_

<Return> [ε] \_

<Return> [;] \_

<Return> [=] \_

<Return> [NUM] \_

<Return> [if] \_

<Return> [else] \_

<Return> [while] \_

<Return> [int] \_

<Return> [float] \_

<Return> [double] \_

<Return> [+] \_

<Return> [-] \_

<Return> [\*] \_

<Return> [/] \_

<Return> [%] \_

<Return> [==] \_

<Return> [!=] \_

<Return> [>=] \_

<Return> [<=] \_

<Return> [>] \_

<Return> [<] \_

<Return> [return] Return -> return Keyword ;

<Return> [$] \_

<S> [void] \_

<S> [(] \_

<S> [)] \_

<S> [{] \_

<S> [}] \_

<S> [ID] S -> ID = Keyword N

<S> [ε] \_

<S> [;] \_

<S> [=] \_

<S> [NUM] \_

<S> [if] S -> if ( C ) B D

<S> [else] \_

<S> [while] S -> while ( C ) B

<S> [int] S -> DataType ID M

<S> [float] S -> DataType ID M

<S> [double] S -> DataType ID M

<S> [+] \_

<S> [-] \_

<S> [\*] \_

<S> [/] \_

<S> [%] \_

<S> [==] \_

<S> [!=] \_

<S> [>=] \_

<S> [<=] \_

<S> [>] \_

<S> [<] \_

<S> [return] \_

<S> [$] \_

<M> [void] \_

<M> [(] \_

<M> [)] \_

<M> [{] \_

<M> [}] \_

<M> [ID] \_

<M> [ε] \_

<M> [;] M -> ;

<M> [=] M -> = NUM ;

<M> [NUM] \_

<M> [if] \_

<M> [else] \_

<M> [while] \_

<M> [int] \_

<M> [float] \_

<M> [double] \_

<M> [+] \_

<M> [-] \_

<M> [\*] \_

<M> [/] \_

<M> [%] \_

<M> [==] \_

<M> [!=] \_

<M> [>=] \_

<M> [<=] \_

<M> [>] \_

<M> [<] \_

<M> [return] \_

<M> [$] \_

<Keyword> [void] \_

<Keyword> [(] \_

<Keyword> [)] \_

<Keyword> [{] \_

<Keyword> [}] \_

<Keyword> [ID] Keyword -> ID

<Keyword> [ε] \_

<Keyword> [;] \_

<Keyword> [=] \_

<Keyword> [NUM] Keyword -> NUM

<Keyword> [if] \_

<Keyword> [else] \_

<Keyword> [while] \_

<Keyword> [int] \_

<Keyword> [float] \_

<Keyword> [double] \_

<Keyword> [+] \_

<Keyword> [-] \_

<Keyword> [\*] \_

<Keyword> [/] \_

<Keyword> [%] \_

<Keyword> [==] \_

<Keyword> [!=] \_

<Keyword> [>=] \_

<Keyword> [<=] \_

<Keyword> [>] \_

<Keyword> [<] \_

<Keyword> [return] \_

<Keyword> [$] \_

<N> [void] \_

<N> [(] \_

<N> [)] \_

<N> [{] \_

<N> [}] \_

<N> [ID] \_

<N> [ε] \_

<N> [;] N -> ;

<N> [=] \_

<N> [NUM] \_

<N> [if] \_

<N> [else] \_

<N> [while] \_

<N> [int] \_

<N> [float] \_

<N> [double] \_

<N> [+] N -> OP Keyword ;

<N> [-] N -> OP Keyword ;

<N> [\*] N -> OP Keyword ;

<N> [/] N -> OP Keyword ;

<N> [%] N -> OP Keyword ;

<N> [==] \_

<N> [!=] \_

<N> [>=] \_

<N> [<=] \_

<N> [>] \_

<N> [<] \_

<N> [return] \_

<N> [$] \_

<OP> [void] \_

<OP> [(] \_

<OP> [)] \_

<OP> [{] \_

<OP> [}] \_

<OP> [ID] \_

<OP> [ε] \_

<OP> [;] \_

<OP> [=] \_

<OP> [NUM] \_

<OP> [if] \_

<OP> [else] \_

<OP> [while] \_

<OP> [int] \_

<OP> [float] \_

<OP> [double] \_

<OP> [+] OP -> +

<OP> [-] OP -> -

<OP> [\*] OP -> \*

<OP> [/] OP -> /

<OP> [%] OP -> %

<OP> [==] \_

<OP> [!=] \_

<OP> [>=] \_

<OP> [<=] \_

<OP> [>] \_

<OP> [<] \_

<OP> [return] \_

<OP> [$] \_

<C> [void] \_

<C> [(] \_

<C> [)] \_

<C> [{] \_

<C> [}] \_

<C> [ID] C -> Keyword CompareOP Keyword

<C> [ε] \_

<C> [;] \_

<C> [=] \_

<C> [NUM] C -> Keyword CompareOP Keyword

<C> [if] \_

<C> [else] \_

<C> [while] \_

<C> [int] \_

<C> [float] \_

<C> [double] \_

<C> [+] \_

<C> [-] \_

<C> [\*] \_

<C> [/] \_

<C> [%] \_

<C> [==] \_

<C> [!=] \_

<C> [>=] \_

<C> [<=] \_

<C> [>] \_

<C> [<] \_

<C> [return] \_

<C> [$] \_

<B> [void] \_

<B> [(] \_

<B> [)] \_

<B> [{] B -> { Statement }

<B> [}] \_

<B> [ID] \_

<B> [ε] \_

<B> [;] \_

<B> [=] \_

<B> [NUM] \_

<B> [if] \_

<B> [else] \_

<B> [while] \_

<B> [int] \_

<B> [float] \_

<B> [double] \_

<B> [+] \_

<B> [-] \_

<B> [\*] \_

<B> [/] \_

<B> [%] \_

<B> [==] \_

<B> [!=] \_

<B> [>=] \_

<B> [<=] \_

<B> [>] \_

<B> [<] \_

<B> [return] \_

<B> [$] \_

<D> [void] \_

<D> [(] \_

<D> [)] \_

<D> [{] \_

<D> [}] D -> ε

<D> [ID] D -> ε

<D> [ε] D -> ε

<D> [;] \_

<D> [=] \_

<D> [NUM] \_

<D> [if] D -> ε

<D> [else] D -> else B

<D> [while] D -> ε

<D> [int] D -> ε

<D> [float] D -> ε

<D> [double] D -> ε

<D> [+] \_

<D> [-] \_

<D> [\*] \_

<D> [/] \_

<D> [%] \_

<D> [==] \_

<D> [!=] \_

<D> [>=] \_

<D> [<=] \_

<D> [>] \_

<D> [<] \_

<D> [return] D -> ε

<D> [$] \_

<CompareOP> [void] \_

<CompareOP> [(] \_

<CompareOP> [)] \_

<CompareOP> [{] \_

<CompareOP> [}] \_

<CompareOP> [ID] \_

<CompareOP> [ε] \_

<CompareOP> [;] \_

<CompareOP> [=] \_

<CompareOP> [NUM] \_

<CompareOP> [if] \_

<CompareOP> [else] \_

<CompareOP> [while] \_

<CompareOP> [int] \_

<CompareOP> [float] \_

<CompareOP> [double] \_

<CompareOP> [+] \_

<CompareOP> [-] \_

<CompareOP> [\*] \_

<CompareOP> [/] \_

<CompareOP> [%] \_

<CompareOP> [==] CompareOP -> ==

<CompareOP> [!=] CompareOP -> !=

<CompareOP> [>=] CompareOP -> >=

<CompareOP> [<=] CompareOP -> <=

<CompareOP> [>] CompareOP -> >

<CompareOP> [<] CompareOP -> <

<CompareOP> [return] \_

<CompareOP> [$] \_

**语法分析的过程输出output.txt：**

Match:

Stack: $ Function

Input: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Program -> Function

Match:

Stack: $ } Return Statement { ) Para ( FuncName DataType

Input: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Function -> DataType FuncName ( Para ) { Statement Return }

Match:

Stack: $ } Return Statement { ) Para ( FuncName int

Input: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: DataType -> int

Match: int

Stack: $ } Return Statement { ) Para ( FuncName

Input: ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 int

Match: int

Stack: $ } Return Statement { ) Para ( ID

Input: ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: FuncName -> ID

Match: int ID

Stack: $ } Return Statement { ) Para (

Input: ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 ID

Match: int ID (

Stack: $ } Return Statement { ) Para

Input: float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 (

Match: int ID (

Stack: $ } Return Statement { ) ID DataType

Input: float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Para -> DataType ID

Match: int ID (

Stack: $ } Return Statement { ) ID float

Input: float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: DataType -> float

Match: int ID ( float

Stack: $ } Return Statement { ) ID

Input: ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 float

Match: int ID ( float ID

Stack: $ } Return Statement { )

Input: ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 ID

Match: int ID ( float ID )

Stack: $ } Return Statement {

Input: { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 )

Match: int ID ( float ID ) {

Stack: $ } Return Statement

Input: while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 {

Match: int ID ( float ID ) {

Stack: $ } Return Statement S

Input: while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Statement -> S Statement

Match: int ID ( float ID ) {

Stack: $ } Return Statement B ) C ( while

Input: while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: S -> while ( C ) B

Match: int ID ( float ID ) { while

Stack: $ } Return Statement B ) C (

Input: ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 while

Match: int ID ( float ID ) { while (

Stack: $ } Return Statement B ) C

Input: ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 (

Match: int ID ( float ID ) { while (

Stack: $ } Return Statement B ) Keyword CompareOP Keyword

Input: ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: C -> Keyword CompareOP Keyword

Match: int ID ( float ID ) { while (

Stack: $ } Return Statement B ) Keyword CompareOP ID

Input: ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Keyword -> ID

Match: int ID ( float ID ) { while ( ID

Stack: $ } Return Statement B ) Keyword CompareOP

Input: <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 ID

Match: int ID ( float ID ) { while ( ID

Stack: $ } Return Statement B ) Keyword <=

Input: <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: CompareOP -> <=

Match: int ID ( float ID ) { while ( ID <=

Stack: $ } Return Statement B ) Keyword

Input: NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 <=

Match: int ID ( float ID ) { while ( ID <=

Stack: $ } Return Statement B ) NUM

Input: NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Keyword -> NUM

Match: int ID ( float ID ) { while ( ID <= NUM

Stack: $ } Return Statement B )

Input: ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 NUM

Match: int ID ( float ID ) { while ( ID <= NUM )

Stack: $ } Return Statement B

Input: { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 )

Match: int ID ( float ID ) { while ( ID <= NUM )

Stack: $ } Return Statement } Statement {

Input: { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: B -> { Statement }

Match: int ID ( float ID ) { while ( ID <= NUM ) {

Stack: $ } Return Statement } Statement

Input: if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 {

Match: int ID ( float ID ) { while ( ID <= NUM ) {

Stack: $ } Return Statement } Statement S

Input: if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Statement -> S Statement

Match: int ID ( float ID ) { while ( ID <= NUM ) {

Stack: $ } Return Statement } Statement D B ) C ( if

Input: if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: S -> if ( C ) B D

Match: int ID ( float ID ) { while ( ID <= NUM ) { if

Stack: $ } Return Statement } Statement D B ) C (

Input: ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 if

Match: int ID ( float ID ) { while ( ID <= NUM ) { if (

Stack: $ } Return Statement } Statement D B ) C

Input: ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 (

Match: int ID ( float ID ) { while ( ID <= NUM ) { if (

Stack: $ } Return Statement } Statement D B ) Keyword CompareOP Keyword

Input: ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: C -> Keyword CompareOP Keyword

Match: int ID ( float ID ) { while ( ID <= NUM ) { if (

Stack: $ } Return Statement } Statement D B ) Keyword CompareOP ID

Input: ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Keyword -> ID

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID

Stack: $ } Return Statement } Statement D B ) Keyword CompareOP

Input: == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 ID

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID

Stack: $ } Return Statement } Statement D B ) Keyword ==

Input: == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: CompareOP -> ==

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID ==

Stack: $ } Return Statement } Statement D B ) Keyword

Input: NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 ==

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID ==

Stack: $ } Return Statement } Statement D B ) NUM

Input: NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Keyword -> NUM

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM

Stack: $ } Return Statement } Statement D B )

Input: ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 NUM

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM )

Stack: $ } Return Statement } Statement D B

Input: { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 )

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM )

Stack: $ } Return Statement } Statement D } Statement {

Input: { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: B -> { Statement }

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) {

Stack: $ } Return Statement } Statement D } Statement

Input: ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 {

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) {

Stack: $ } Return Statement } Statement D } Statement S

Input: ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Statement -> S Statement

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) {

Stack: $ } Return Statement } Statement D } Statement N Keyword = ID

Input: ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: S -> ID = Keyword N

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID

Stack: $ } Return Statement } Statement D } Statement N Keyword =

Input: = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 ID

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID =

Stack: $ } Return Statement } Statement D } Statement N Keyword

Input: NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 =

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID =

Stack: $ } Return Statement } Statement D } Statement N NUM

Input: NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Keyword -> NUM

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM

Stack: $ } Return Statement } Statement D } Statement N

Input: ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 NUM

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM

Stack: $ } Return Statement } Statement D } Statement ;

Input: ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: N -> ;

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ;

Stack: $ } Return Statement } Statement D } Statement

Input: } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 ;

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ;

Stack: $ } Return Statement } Statement D }

Input: } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Statement -> ε

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; }

Stack: $ } Return Statement } Statement D

Input: else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 }

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; }

Stack: $ } Return Statement } Statement B else

Input: else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: D -> else B

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else

Stack: $ } Return Statement } Statement B

Input: { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 else

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else

Stack: $ } Return Statement } Statement } Statement {

Input: { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: B -> { Statement }

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else {

Stack: $ } Return Statement } Statement } Statement

Input: int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 {

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else {

Stack: $ } Return Statement } Statement } Statement S

Input: int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Statement -> S Statement

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else {

Stack: $ } Return Statement } Statement } Statement M ID DataType

Input: int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: S -> DataType ID M

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else {

Stack: $ } Return Statement } Statement } Statement M ID int

Input: int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: DataType -> int

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int

Stack: $ } Return Statement } Statement } Statement M ID

Input: ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 int

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID

Stack: $ } Return Statement } Statement } Statement M

Input: = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 ID

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID

Stack: $ } Return Statement } Statement } Statement ; NUM =

Input: = NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 输出: M -> = NUM ;

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID =

Stack: $ } Return Statement } Statement } Statement ; NUM

Input: NUM ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 =

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM

Stack: $ } Return Statement } Statement } Statement ;

Input: ; ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 NUM

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ;

Stack: $ } Return Statement } Statement } Statement

Input: ID = ID + NUM ; } } return NUM ; } $

Action: 匹配 ;

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ;

Stack: $ } Return Statement } Statement } Statement S

Input: ID = ID + NUM ; } } return NUM ; } $

Action: 输出: Statement -> S Statement

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ;

Stack: $ } Return Statement } Statement } Statement N Keyword = ID

Input: ID = ID + NUM ; } } return NUM ; } $

Action: 输出: S -> ID = Keyword N

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID

Stack: $ } Return Statement } Statement } Statement N Keyword =

Input: = ID + NUM ; } } return NUM ; } $

Action: 匹配 ID

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID =

Stack: $ } Return Statement } Statement } Statement N Keyword

Input: ID + NUM ; } } return NUM ; } $

Action: 匹配 =

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID =

Stack: $ } Return Statement } Statement } Statement N ID

Input: ID + NUM ; } } return NUM ; } $

Action: 输出: Keyword -> ID

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID

Stack: $ } Return Statement } Statement } Statement N

Input: + NUM ; } } return NUM ; } $

Action: 匹配 ID

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID

Stack: $ } Return Statement } Statement } Statement ; Keyword OP

Input: + NUM ; } } return NUM ; } $

Action: 输出: N -> OP Keyword ;

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID

Stack: $ } Return Statement } Statement } Statement ; Keyword +

Input: + NUM ; } } return NUM ; } $

Action: 输出: OP -> +

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID +

Stack: $ } Return Statement } Statement } Statement ; Keyword

Input: NUM ; } } return NUM ; } $

Action: 匹配 +

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID +

Stack: $ } Return Statement } Statement } Statement ; NUM

Input: NUM ; } } return NUM ; } $

Action: 输出: Keyword -> NUM

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM

Stack: $ } Return Statement } Statement } Statement ;

Input: ; } } return NUM ; } $

Action: 匹配 NUM

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ;

Stack: $ } Return Statement } Statement } Statement

Input: } } return NUM ; } $

Action: 匹配 ;

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ;

Stack: $ } Return Statement } Statement }

Input: } } return NUM ; } $

Action: 输出: Statement -> ε

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; }

Stack: $ } Return Statement } Statement

Input: } return NUM ; } $

Action: 匹配 }

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; }

Stack: $ } Return Statement }

Input: } return NUM ; } $

Action: 输出: Statement -> ε

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } }

Stack: $ } Return Statement

Input: return NUM ; } $

Action: 匹配 }

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } }

Stack: $ } Return

Input: return NUM ; } $

Action: 输出: Statement -> ε

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } }

Stack: $ } ; Keyword return

Input: return NUM ; } $

Action: 输出: Return -> return Keyword ;

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return

Stack: $ } ; Keyword

Input: NUM ; } $

Action: 匹配 return

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return

Stack: $ } ; NUM

Input: NUM ; } $

Action: 输出: Keyword -> NUM

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM

Stack: $ } ;

Input: ; } $

Action: 匹配 NUM

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ;

Stack: $ }

Input: } $

Action: 匹配 ;

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; }

Stack: $

Input: $

Action: 匹配 }

Match: int ID ( float ID ) { while ( ID <= NUM ) { if ( ID == NUM ) { ID = NUM ; } else { int ID = NUM ; ID = ID + NUM ; } } return NUM ; } $

Stack:

Input:

Action: 匹配 $

1. **问题和解决方案**

这次实验的问题主要是验证几个核心算法的正确性，在我的程序中，核心算法写的比较乱，自己也很容易绕晕，所以在验证上有一定的困难。但最后还是耐心下来和龙书给出的算法校对，最后应该没有什么问题。

1. **实验感受和评价**

个人感觉这次实验比之前的词法分析要难，难在该用何种数据结构或者类去表示语法分析中的一些对象以及核心算法也具有一定的挑战性，特别是从自然语言描述转化到程序语言这个过程。个人认为这次完成的语法分析器只是一个简单版本，文法的定义也比较少，只能算是一个小程序。