# Sython文法规格以及解释器说明文档

## 小组成员

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## 介绍

Sython取名来源于Simple Python，即为简单的Python语言，它是一门无类型、面向对象的脚本语言，在基本语法层面上，较为类似C语言。同时，它是解释型语言，即Sython解释器将源代码转换为语法树，然后再由解释器分析语法树并执行。

本小组从C语言的基本文法入手，通过自己对Python语言语法规则的理解以及一些其他资料的学习，以C文法为基础，设计了Sython文法，既支持面向对象的抽象编程也支持面向过程的函数编程。通过对lex&yacc的学习，本小组为Sython设计制作了词法语法分析器，并部分完成了Sython的解释器。

## 设计初衷

目前，Python的使用热度逐步上升，其特点是“优雅”、“明确”、“简单”，其最终的代码不但看起来简单美观，并且功能同样十分强大。初学者学Python，相比于学习C\C++等语言简单了很多。然而，正是由于其简单性，我们在学习Python的时候，很多时候都是倾听点水，浅尝辄止。同时，Python语言也有一些让人又爱又恨的特性，例如不需要花括号，只需要缩进，不需要分号，只需要换行。这样确实使得代码看起来简洁、美观，但是有时候一个小空格造成的小bug确困扰人很久。

本小组为加深对Python语言的了解以及深入学习程序语言的设计，从C语言出发，按照我们的设计，将其扩充为一种类似Python语言的脚本语言，Sython。相比于c语言,Sython更简单易学，上手快，同时也具有可扩展性和可嵌入型。我们在Sython中引入了类，从而Sython既支持面向对象的抽象编程也支持面向过程的函数编程。相比与Python，Sython当然比不了，但是我们按照自己意图定制了一门语言，并拥有大部分Python的特性，这已经达到了我们的意图。

我们为Sython设计了解释器，在一步步的实现中，也加深了自己对于编译原理的理解以及脚本语言的运行方式。

## Sython文法介绍

### 功能

目前，Sython支持的功能如下：

1. 变量

   支持局部变量、全局变量定义、支持变量引用、变量赋值

2. 基本数据类型（不需要声明）

   int、double、字符串、bool型

3. 运算

   数值：+、-、*、/、%、+=、-=、 *=、/=

   逻辑：<、>、!=、||、&&、|、&

   方法调用：.

索引：[]

4. 控制结构

   支持if-else选择语句

   支持while循环

   支持for循环

   支持break退出循环

   支持continue跳出本次循环，开始下一轮循环

   支持return返回

5. 函数

   使用function实现函数定义

6. 类

   包括类定义和类实例

   支持类继承

   支持类成员

7. 注释

   使用#作为注释开始符号，换行自动结束

8. 异常处理

   支持try、catch语句

9. 包导入

   支持import关键字导入其他包

## 关键字

- function
- if
- else
- elsif
- while
- for
- return
- break
- continue
- null
- true
- false
- new
- closure
- try
- catch
- global
- finally
- throw
- final
- class
- extend
- static

# 文法终结符定义

终结符

| string | 终结符 | string | 终结符 |
| --- | --- | --- | --- |
| "(" | LP | "<" | LT |
| ")" | RP | "<=" | LE |
| "[" | LB | "+=" | ADD_ASSIGN_T |
| "]" | RB | "-=" | SUB_ASSIGN_T |
| "{" | LC | "*=" | MUL_ASSIGN_T |
| "}" | RC | "/=" | DIV_ASSIGN_T |
| ";" | SEMICOLON | "%=" | MOD_ASSIGN_T |
| "," | COMMA | "!" | EXCLAMATION |
| "&&" | LOGICAL_AND | "~" | '~' |
| "\|\|" | LOGICAL_OR | "+" | ADD |
| "=" | ASSIGN_T | "++" | INCREMENT |
| "==" | EQ | "--" | DECREMENT |
| "!=" | NE | "-" | SUB |
| ">=" | GE | "*" | MUL |
| "/" | DIV | "%" | MOD |
| "." | DOT | ">" | GT |

# ENBF产生式

在本文法中，除""号之内包含的符号为终结符外， IDENTIFIER 、 INT_LITERAL 、 DOUBLE 、STRING 、TRUE 、FALSE 、 NULL也是终结符。为与yacc内的BNF尽量保持一致，非终极符没有使用大写符号。

| 非终结符 | 产生式 |
| --- | --- |
| program | ::= {translation_unit} |
| translation_unit | :: = {definition_or_statement} definition_or_statement |
| definition_or_statement | :: =function_definition\| statement\| def_class\| def_calss |
| def_class | :: ="class" IDENTIFIER class_extend "{" field_def methods_def "}" |
| class_extend | :: = {"extend" IDENTIFIER} |
| field_def | :: = ["static"] instant_filed |
| instant_filed | :: = expression ";" |
| methods_def | :: = method_or_gs |
| method_or_gs | :: ={method_def \| getter_def \| setter_def} |
| method_def | :: = ["static"] IDENTIFIER "(" [parameter_list] ")" block |
| getter_def | :: = ["static"] IDENTIFIER block |
| setter_def | :: = ["static"] "IDENTIFIER" "=" "(" block ")" block |
| function_definition | :: = "function" IDENTIFIER "(" [parameter_list] ")" block |
| parameter_list | :: = [parameter_list ","] IDENTIFIER |
| argument_list | :: = [argument_list ","] assignment_expression |
| expression | :: = [expression ","] assignment_expression |
| assignment_expression | ::={["FINAL"] postfix_expression "=" \| "+=" \| "-=" \| "*=" \| "/=" \| "%="} logical_or_expression |
| logical_or_expression | ::= {lgical_and_expression "\|\|" } logical_and_expression |
| logical_and_expression | ::={equality_expression "&&" } equality_expression |
| equality_expression | ::={relation_expression "==" \| "!=" }relation_expression |
| relation_expression | ::={additive_expression ">" \| ">=" \| "<="} additive_expression |

| 非终结符 | 产生式 |
| --- | --- |
| additive_expression | ::= {multicative_expression "+" \| "-" } multiplicative_expression |
| multiplicative_expression | ::={unary_expression "*" \| "/" \| "%"} unary_expression |
| unary_expression | ::={"-" \| "!" }postfix_expression |
| postfix_expression | :: = {postfix_expression ("[" expression "]" \| ( "." IDENTIFIER) \| ( "(" [argument_list] ")") \|( "." "new" "(" [argument_list] ")" \| "++" \| "--"} primary_expression |
| primary_expression | ::= "[" expression "]" \| IDENTIFIER \| INT_LITERAL \| DOUBLE \| STRING \| TRUE \| FALSE \| NULL \| array_literal \| closure_defination |
| array_literal | ::= "{" expression_list ["," ] "}" |
| closure_defination | ::= "closure" [IDENTIFIER] "(" [parameter_list] ")" block |
| expression_list | ::= assignment_expression { "," assignment_expression} |
| statement | expression ";" \| global_statement \| if_statement \| while_statement \| for_statement \| foreach_statement \| return_statement \| break_statement \| continue_statement \| try_statement \| throw_statement |
| global_statement | ::= "global" identifier_list |
| identifier_list | ::= IDENTIFIER{ "," IDENTIFIER} |
| if_statement | :: ="if" "(" expression ")" block [elsif_list] ["else" block] |
| elsif_list | ::= {elsif_list} elsif |
| elsif | ::= "elsif" "(" expression ")" block |
| while_statement | ::= "while" "(" expression ")" block |
| for_statement | ::= "for" "(" [expression] ";" [expression] ";" [expression] ")" block |
| foreach_statement | ::= "foreach" "(" IDENTIFIER ":" expression ")" block |
| return_statement | ::= "return " [expression] ";" |
| break_statement | :: = "break" ";" |
| continue_statement | :: = "continue" ";" |
| try_statement | ::= "try" block ["catch" "(" IDENTIFIER ")" block] ["finally" block] |
| throw_statement | ::= "throw" expression ";" |
| block | ::= "{" [statement_list] "}" |

# 示范代码

## 代码说明

如需要测试自己的代码文法正确性，请使用语法分析器（见后说明）进行检测，有输出的可执行代码见运行说明一节

- 代码1和代码2是符合Sython文法的实例代码，语法分析器可以正确识别语法。
- 代码7/8/9是目前完成的解释器可以执行的代码，使用Ubuntu解释器或者Windows下的解释器均会有输出

代码1

```
class EM{
  q=5;
  create_point(x, y) {

   return this;
  }
  static test_static_method(){
  }
}

print("hhh");
```

预期结果，输出全部代码并输出no error!

```
(base) ricard@ubuntu:~/文档/研一/程序设计原理/最终大作业/interpreter/语法分析_src$ ./Sython 1.txt
class EM{
        q=5;
        create_point(x, y) {

         return this;
        }
        static test_static_method(){
        }
}

print("hhh");

>>>>>>>>>>no error!<<<<<<<<<<<<<
```

代码2

```
#################################################################
#test fuction defination
import nunmpy;
global a,b,c;
function show(){
  for(i=0;i<3;i=i+1){
    print(i);
  }
}
function show2(){
  for(i=0;i<4;i=i+1){
    print(i);
  }
}
#test funtion call
show();
show2();
import animal;
```

```
#test class defination
class Dog{
   name;
   #static str="wolf";
   #test method def
   new(name1){
      name=name1;
   }
   call(){
      print(str);
   }
   eat(food){

   }


}
#test class method call
dog1 = Dog.new("dog1");
dog1.eat("meat");
#test calculation
a=(2+5)*2/2-1;
a++;
a--;
b={1,2,3};
c={a,b};
p = create_point(10, 20);
#test try catch
try {
   a=1/0;
} catch (ex) {
   desc_exception(ex);
}

if(a==6){
   print("== successful");
}else{
   print("== error");
}
if(a<=6){
   print("<= successful");
}else{
   print("<= error");
}
if(a>=6){
   print(">= successful");
}else{
   print(">= error");
}
# test elsif
if(a>=6){
   print(">= successful");
}elsif(a==4){
   print("a == 4");
}elsif(a==3){
   print("a == 3");
}
else{
```

```
    print(">= error");
}
#test for while loop
for(i=0;i<10;i++){
    while(i<5){
        print(i);
    }
    if(i == 1){
        continue;
    }
    elsif(i == 9){
        break;
    }

}
```

语法分析器输出如下（输出过长，只截取了一部分，）：

```
}
dog1 = Dog.new("dog1");
dog1.eat("meat");
a=(2+5)*2/2-1;
a++;
a--;
b={1,2,3};
c={a,b};
p = create_point(10, 20);
try {
    a=1/0;
} catch (ex) {
    desc_exception(ex);
}

if(a==6){
        print("== successful");
}else{
        print("== error");
}
if(a<=6){
        print("<= successful");
}else{
        print("<= error");
}
if(a>=6){
        print(">= successful");
}else{
        print(">= error");
}
if(a>=6){
        print(">= successful");
}elsif(a==4){
        print("a == 4");
}elsif(a==3){
        print("a == 3");
}
else{
        print(">= error");
}
for(i=0;i<10;i++){
        while(i<5){
                print(i);
        }
        if(i == 1){
                continue;
        }
        elsif(i == 9){
                break;
        }

}

>>>>>>>>>>no error!<<<<<<<<<<<<
```

代码3

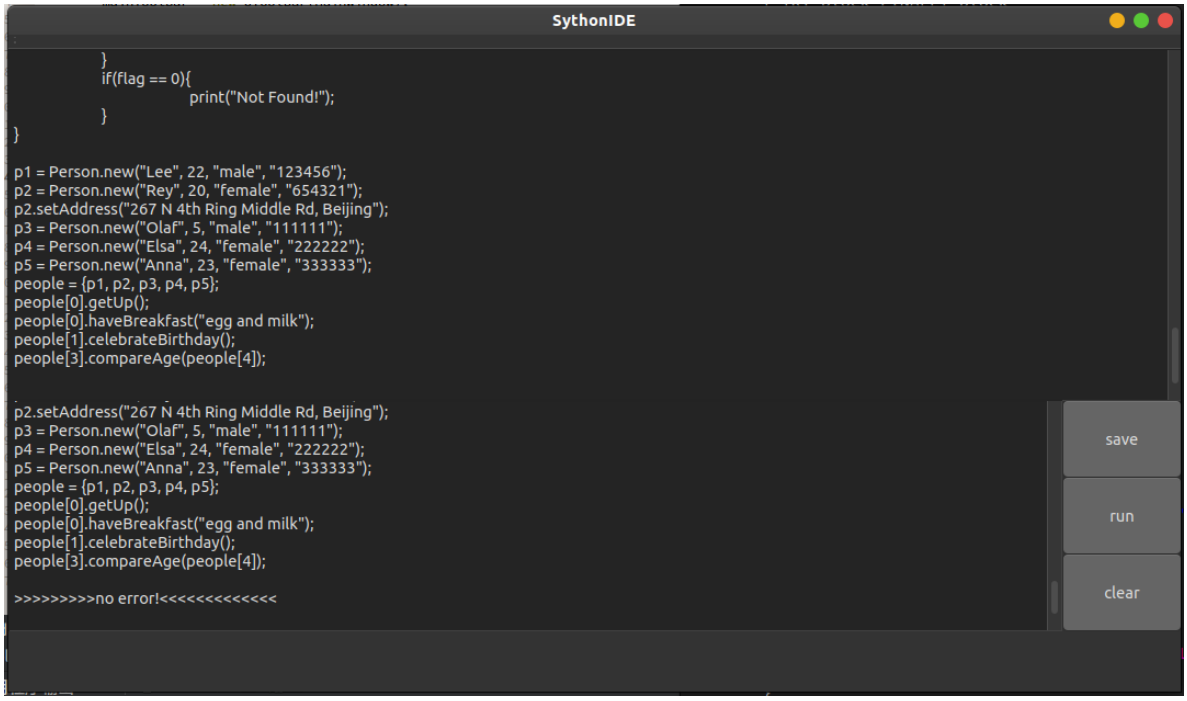
```
class Person{
  name, age, sex, ID, address;
  new( _name, _age, _sex, _ID){
```

```
        name = _name;
        age = _age;
        sex = _sex;
        ID = _ID;
    }
    setAddress(_address){
        address = _address;
    }
    getUp(){
        print(name);
        print(": get up.\n");
    }
    haveBreakfast(food){
        print(name);
        print(": have breakfast of ");
        print(food);
        print(".\n");
    }
    takeRest(){
        print(name);
        print(": take a rest.\n");
    }
    celebrateBirthday(){
        age += 1;
        print(name);
        print(": celebrate a birthday.\n");
        return age;
    }
    compareAge(p){
        if(this.age==p.age){
            print("The same age.");
        }
        elsif(this.age>p.age){
            print(this.name);
            print(" is older than ");
            print(p.name);
        }
        else{
            print(this.name);
            print(" is younger than ");
            print(p.name);
        }
    }
}

function getLength(arr){
    size = 0;
    foreach(num:arr){
        size = size +1;
    }
    return size;
}
function getSum(arr){
    res = 0;
    foreach(num:arr){
        res += num;
    }
    return res;
```

```
}

function getMean(arr){
  return getSum(arr) / getLength(arr);
}

function findPerson(name, arr){
  i = 0;
  flag = 0;
  for( ;i < getLength(arr); i++){
    if(arr[i].name == name){
      flag = 1;
      return arr[i];
    }
  }
  if(flag == 0){
    print("Not Found!");
  }
}

p1 = Person.new("Lee", 22, "male", "123456");
p2 = Person.new("Rey", 20, "female", "654321");
p2.setAddress("267 N 4th Ring Middle Rd, Beijing");
p3 = Person.new("Olaf", 5, "male", "111111");
p4 = Person.new("Elsa", 24, "female", "222222");
p5 = Person.new("Anna", 23, "female", "333333");
people = {p1, p2, p3, p4, p5};
people[0].getUp();
people[0].haveBreakfast("egg and milk");
people[1].celebrateBirthday();
people[3].compareAge(people[4]);
```

运行结果均为先输入源代码，如果没有语法错误，将会输出`>>>>>>>>>no error!<<<<<<<<<<<<`

我们设计了UI，展示效果为：

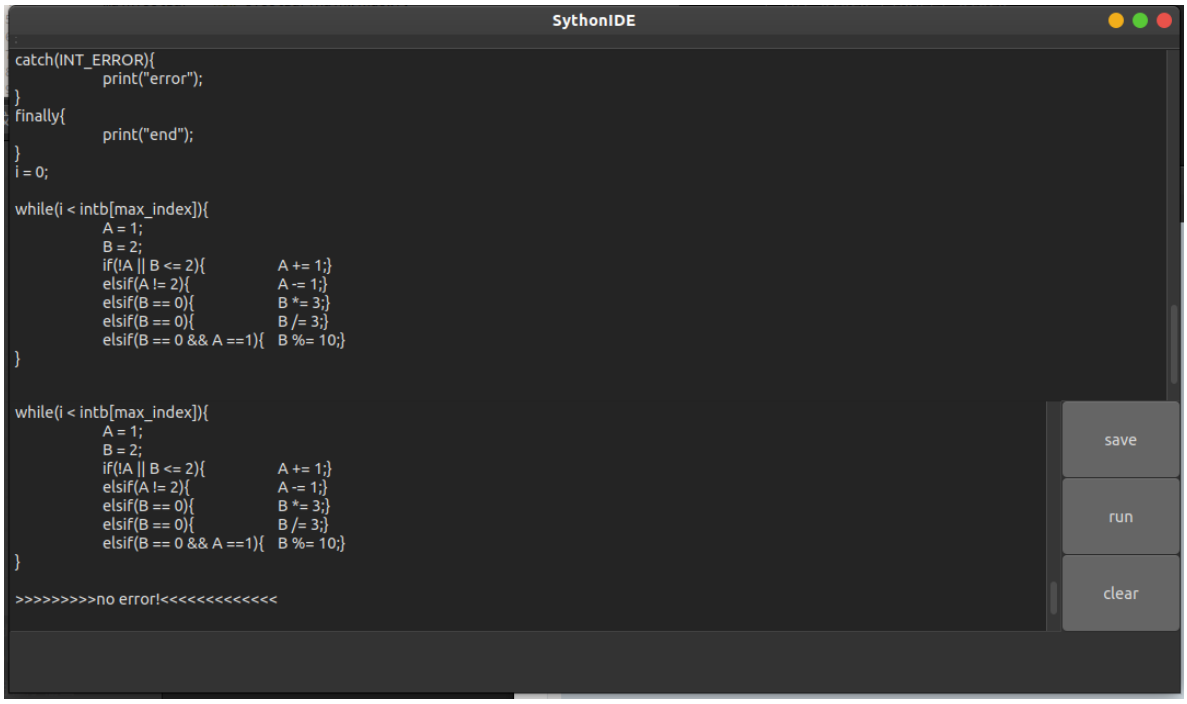



代码4

```
max_index = 9;
class a{
  attr_a;
  new(_attr_a){
    attr_a = _attr_a;
  }

  aprint(){
    print("aaaa");
  }
}

class b extend a{
  attr_b,attr_2;
  new(_attr_b, _attr_2){
    attr_b = _attr_b;
  }

  bprint(){
    print("bbbb");
  }
}

class tEst_I{
  de1f;
  new(_de1f){
    de1f = _de1f;
  }
}

class TeSt_INde extend tEst_I{
  attr_a,attr_2;
  new(_attr_a, _attr_2){
    attr_a = _attr_b;
  }
  a(){
    print("aaaa");
  }
}

print("hhh");
intb = {0,1,2,3,4,5,6,7,8,9};
try{
  for( i = 0; i < intb[max_index]; i++){
    if(i %2 == 0){
      print(intb[i]);
    }
    else{
      print("mod!=0");}
  }
}
catch(INT_ERROR){
  print("error");
}
finally{
  print("end");
}
i = 0;
```

```
while(i < intb[max_index]){
   A = 1;
   B = 2;
   if(!A || B <= 2){   A += 1;}
   elsif(A != 2){  A -= 1;}
   elsif(B == 0){  B *= 3;}
   elsif(B == 0){  B /= 3;}
   elsif(B == 0 && A ==1){ B %= 10;}
}
```

同上，语法正确



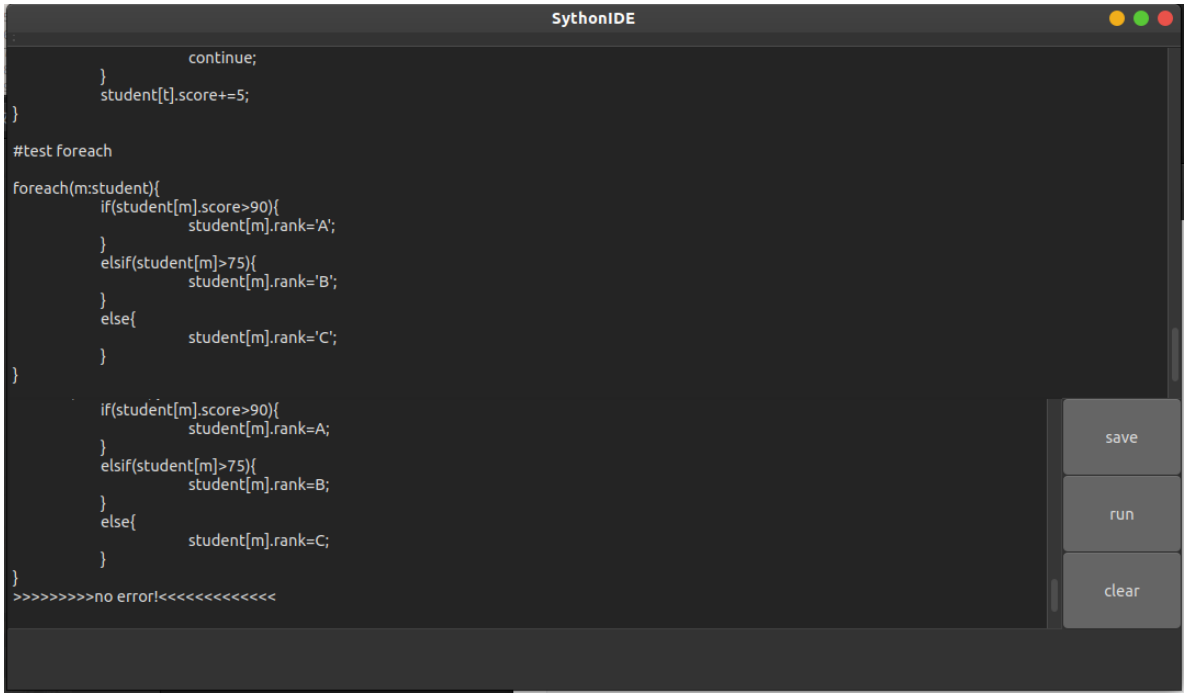

代码5

```
#test function defination
function isPrime(num){
   tmp=num-1;
   for(i=2;i<tmp;i=i+1){
      if(num%i==0){
         print("no");
         return false;
      }
   }
   print("yes");
   return true;
}

#test function call
for(j=1;j<100;j=j+1){
   if(isPrime(j)){
      print(j+"is Prime");
   }
}

#test class def
```

```
class Person{
  name,age,address;
}
class Student extend Person{
  sid,
  classroom = "101",
  score,
  rank;

  new(name1,sid1,score1){
    name=name1;
    sid=sid1;
    score=score1;
  }


  show_score(){
    print(name+"'s score is"+score);
  }


}
#test return
function max(num1,num2){
  if(num1>num2){
    return num1;
  }
  else{
    return num2;
  }

}

#test class call

stu1=Student.new("1","Kiki",99);
stu2=Student.new("2","Chuchu",74);
stu3=Student.new("3","Lily",93);
stu4=Student.new("4","Dode",66);

student[5]={stu1,stu2,stu3,stu4};

maxScore=stu1.score;
topId=1;

#test for
for(k=1;k<4;k++){
  if(student[k]>max){
    maxScore=student[k];
    topId=k;
  }
}
print(topId+"get the max score:"+maxScore);

#test while
t=0;
while(t<4){
```

```
    if(student[t].score>=98){
        continue;
    }
    student[t].score+=5;
}

#test foreach

foreach(m:student){
    if(student[m].score>90){
        student[m].rank='A';
    }
    elsif(student[m]>75){
        student[m].rank='B';
    }
    else{
        student[m].rank='C';
    }
}
```

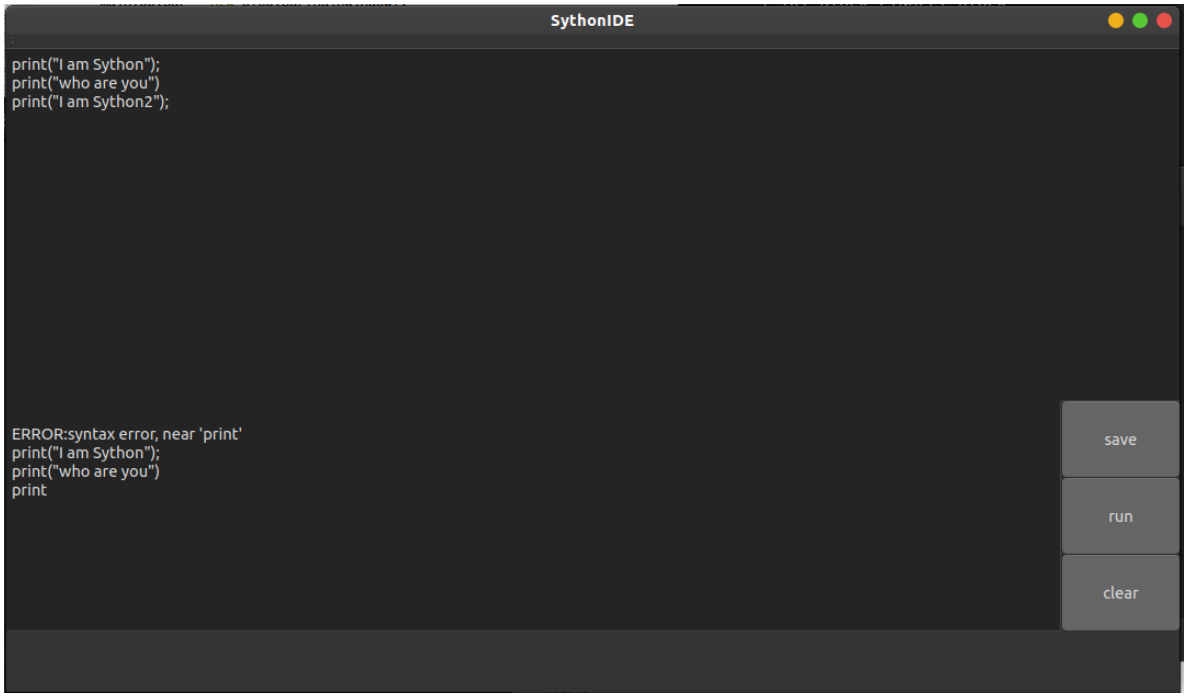
运行效果如图




代码6

```
print("I am Sython");
print("who are you")
print("I am Sython2");
```

运行结果如下，缺少一个";"，将会提示语法错误



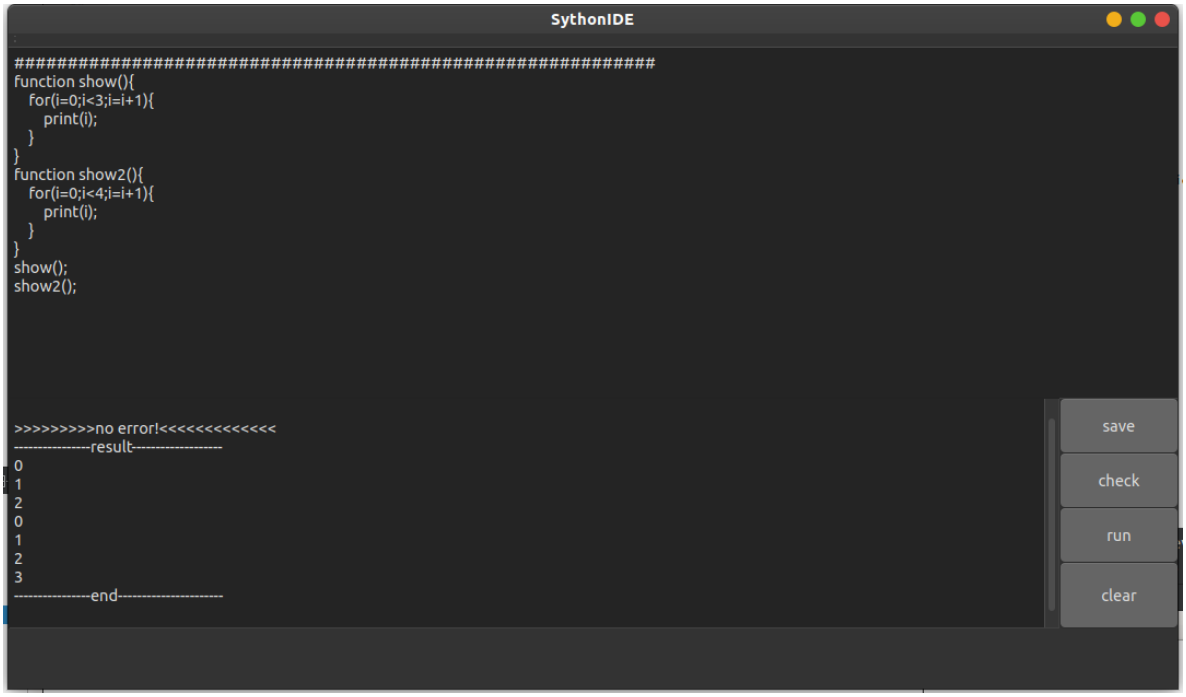

---

以下部分的代码可在最终完成的解释器上运行

代码7

```
############################################################
function show(){
  for(i=0;i<3;i=i+1){
    print(i);
  }
}
function show2(){
  for(i=0;i<4;i=i+1){
    print(i);
  }
}
show();
show2();
```

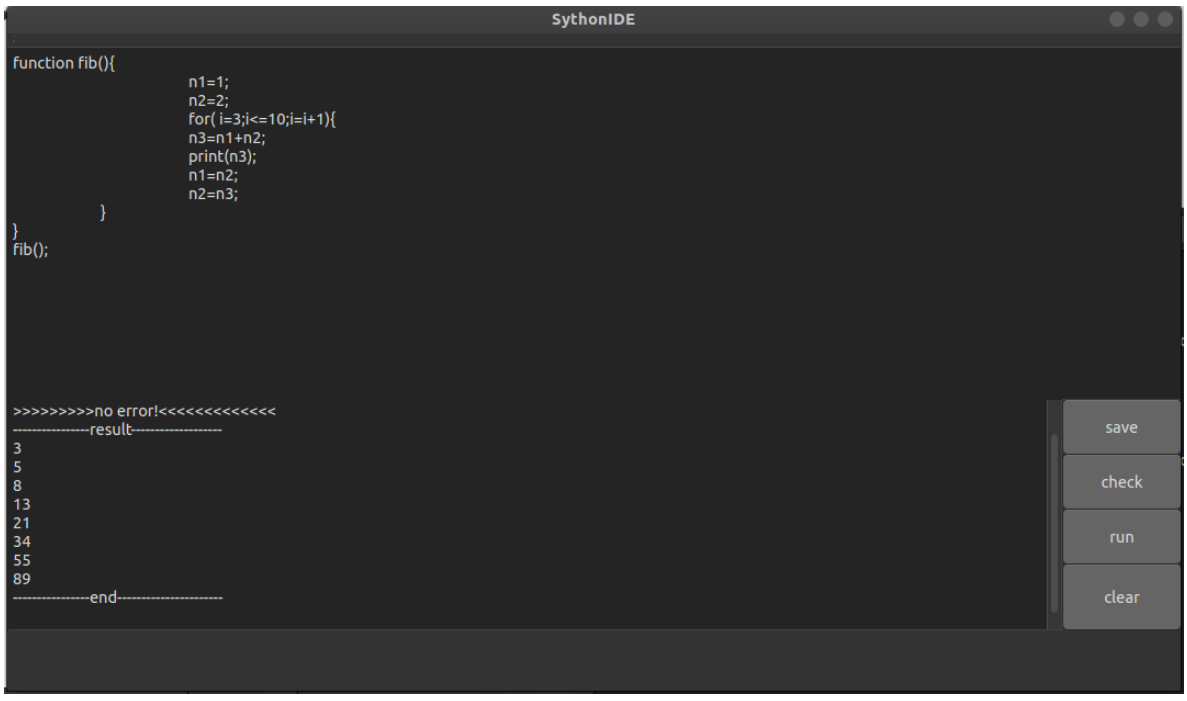
运行结果为，




代码8

```
function fib(){
    n1=1;
    n2=2;
    for( i=3;i<=10;i=i+1){
      n3=n1+n2;
      print(n3);
      n1=n2;
      n2=n3;
   }
}
fib();
```

运行结果：




# 文档说明

# 目录结构

在interpreter文件夹下有三个文件夹

--interpreter

----src　包含Ubuntu环境下可执行文件以及源码

----语法分析_src　包含Ubuntu环境下语法分析部分可执行文件以及源码；可执行文件名为`Sython`

----win_src 包含Win环境下可执行文件以及源码

----可执行文件　将四个可执行文件拿出来了，Ubuntu、Windows下运行对应程序即可，运行方式见下

# 运行方式

## Ubuntu

进入终端，cd到`Sython`文件所在目录，运行。`.\Sython code.txt`

## Windows

打开可执行文件`SythonWin.exe`，程序提示输入代码路径，输入路径即可

## IDE运行方式（仅限Ubuntu）

进入UI目录，输入`.\SythonIDE`,即可打开界面

在输入框输入代码，点击`save`,提示保存成功，然后点击`check`可以检查语法，点击`run`可以运行，点击`clear`可以清楚输入和输出内容。

## 其他

各个src下均有makefile，make即可编译，make win即可编译win下可执行文件（）