

# 1. 语法分析测试

完整测试，对于所有情况能否正确的建立语法树，测试代码如下：

```
program test10;

const
  haha = true;
  PI=3.14 ;
  fir = 1;
  sec = 10;
  LARGE = 10000202020202;

type
  arr1 = array[1..10] of integer;
  arr2 = array[-1..10] of integer;
  arr3 = array[-10..-1] of integer;
  arr4 = array[-fir..sec] of integer;
  arr5 = array[-sec..fir] of integer;
  arr6 = array[-sec..-fir] of integer;
  car = record
    number : string;
    legal : boolean;
    level : integer;
  end;

var
  a, b, c, n:integer;
  arr_var: arr1;
  hhh : integer;
  book: record
    title : integer;
    author : integer;
    content : string;
    pal : boolean;
  end;
  cc : car;
  test_str1 : string;

procedure findMin(x, y:integer; var m:integer);
procedure ptest1;
begin
end;
function ftest1:integer;
```

```
function ftest2(x1, y1:integer):real;
```

```
begin
```

```
end;
```

```
begin
```

```
end;
```

```
begin
```

```
    if x<y then
```

```
        m:=x
```

```
    else
```

```
        m:=y;
```

```
end;
```

```
procedure proc1;
```

```
begin
```

```
end;
```

```
function func1:integer;
```

```
begin
```

```
end;
```

```
begin
```

```
    read(a);
```

```
    readln(n);
```

```
    case n of
```

```
        1: writeln(0);
```

```
        2: writeln(1);
```

```
        3: begin
```

```
            a := 980*10+100;
```

```
            b := 2;
```

```
        end;
```

```
    end;
```

```
    arr_var[10]:=10;
```

```
    while true do
```

```
        begin
```

```
            a:=1;
```

```
            b:=1;
```

```
            c:=2;
```

```
        end;
```

```
    proc1;
```

```
    func1;
```

```
book.title := 1;
book.content := '123';

a:=book.title;
test_str1 := book.content;

begin
    a:=a*2+-3-4;
    b:=(-a-b)*(3+4*5);
    c:=2;
end;

    if (a > b) then
        c := a;
    if (a+8*9 = b) then
        c:=a;
    if (a+8*9 <> b) then
        c:=a;

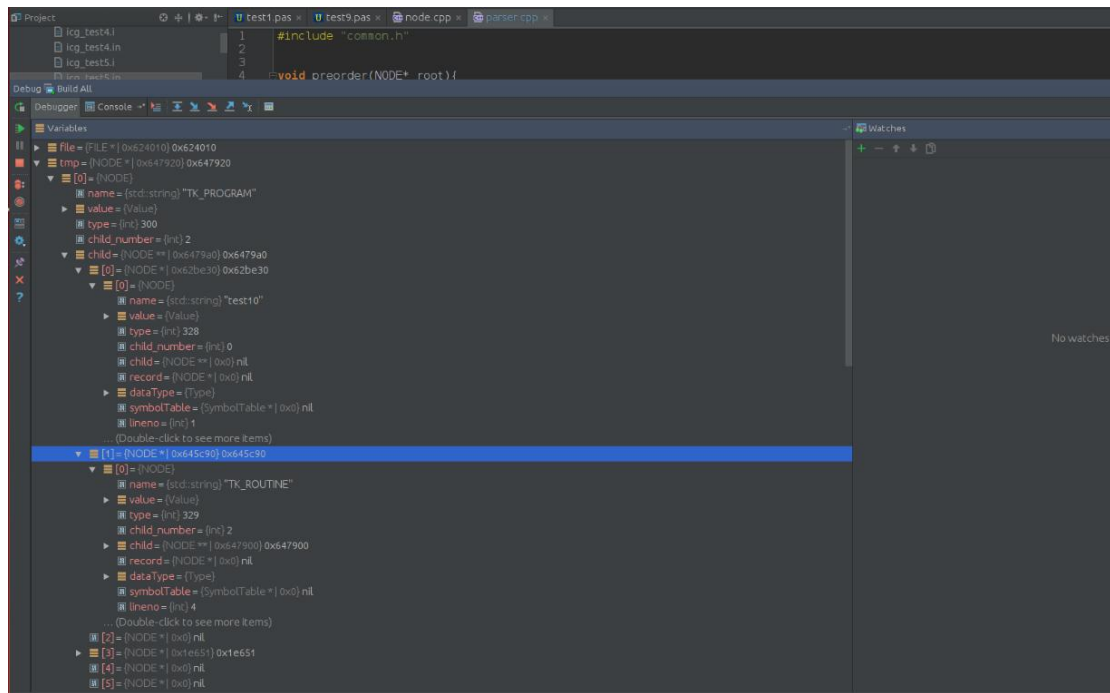
findMin(a,b,c);

    for a:= -1+2 to 100 do begin
        c:= c + 2+8*9;
    end;

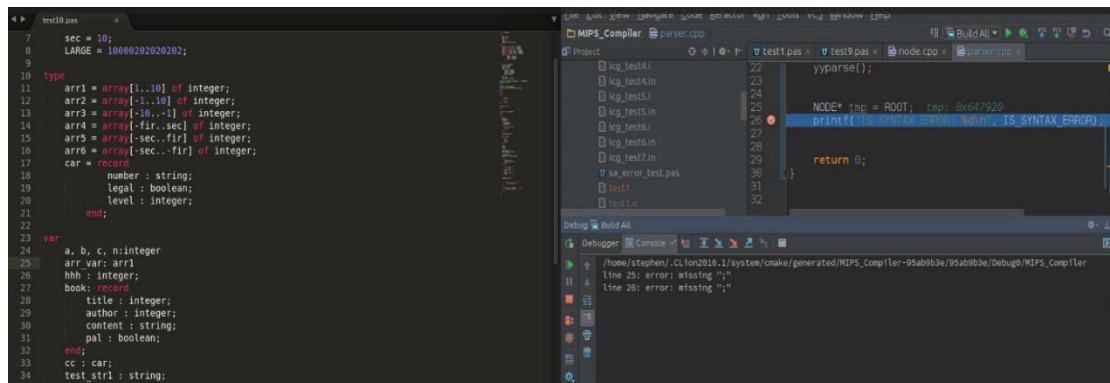
    for b:= a+100*10 downto -1 do begin
        c:= c + 2+8*9;
    end;

end.
```

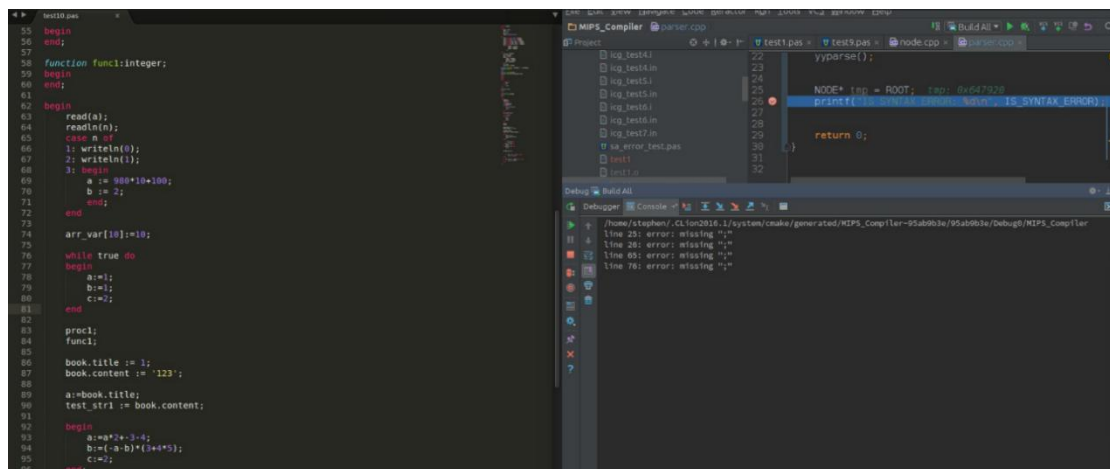
构建的语法树的节点在 IDE 的 DEBUG 模式下可以进行查看，下面是截图，检查所有的节点，语法树是合法的。



然后进行错误处理测试，可以正确检测到没有两个’；’：



继续删除’；’，发现仍然可以检测到：



## 2. 语义分析与符号表测试

在源文件目录的 testcase 文件夹下有一个 sa\_error\_test.pas，如果将该源文件解析出的 AST 送入 semanticAnalysis 函数，可以输出所有可以检查到的错误，下面我们对该文件进行分析：

```
1 program sa_errortest;
2
3 const
4   ica = 1;
5   icb = 10;
6   fcc = 1.0;
7   ccd = 'a';
8   sce = 'hello';
9   {duplicate identifier}
10  fcc = 2.0;
```

首先是一系列常量定义，当发现常量名与之前重复时，报 duplicate identifier 错误。

然后是类型定义：

```
12 type
13   ti = integer;
14   tf = real;
15
16   {duplicate identifier}
17   tf = extended;
18   {undefined type}
19   tu = undefinedType;
20
21   tenum = (a, b, c);
22
23   {invalid enum item identifier}
24   tenum_invalid1 = (ti, d, e);
25   tenum_invalid2 = (ica, f, g);
26   {duplicate enum item}
27   tenum_invalid2 = (e, g, h);
```

与常量定义类似，如果发现类型名与之前的标识符重复，也报 duplicate identifier 错误。当等号右侧不是原生类型时，如果符号表中也找不到该标识符所代表的类型，则报 undefined type 错误。

当定义枚举类型时，要求等号右侧的枚举量标识符不能已被使用（如已被定义为常量或者类型），否则报 invalid enum item identifier 错误

当枚举量标识符已在之前的枚举类型中被定义, 则报 duplicate enum item 错误。

```
29   trange1 = 1..2;  
30   trange2 = ica..icb;  
31   trange3 = -icb..ica;  
32  
33   {range data type mismatch}  
34   trange_invalid1 = 1..2.0;  
35   trange_invalid2 = fcc..icb;  
36   {illegal range}  
37   trange_invalid3 = 2..1;  
38   trange_invalid4 = icb..ica;  
39   {unsupported range data type}  
40   trange_invalid5 = 1.0..2.0;  
41   {undefined const identifier}  
42   trange_invalid6 = undefined1..undefined2;  
43  
44   trecord = record  
45     a: integer;  
46     b: real;  
47     c: string;  
48   end;  
49  
50   {duplicate field name}  
51   trecord_invalid = record  
52     a: integer;  
53     b: real;  
54     c: string;  
55     c: integer;  
56   end;
```

在定义范围类型时, 要求其范围一致且为整数类型, 且左侧小于等于右侧, 不一致时报 range data type mismatch, 左侧大于右侧时报 illegal range, 不为整数类型时报 unsupported range data type, 当找不到该常量标识符时报 undefined const identifier。

定义 record 时, 如果域名有重复, 则报 duplicate field name 错。

变量定义:

```

59 var
60     va, vb, vc, vn: integer;
61     vra: real;
62     vba: boolean;
63     vrange: trange1;
64     vrecord: trecord;
65     varray: array[1..2] of integer;
66     {duplicate identifier}
67     va: real;
68     ica: integer;

```

由于变量定义与类型定义类似，类型定义部分所报的错误变量定义都会报，同时变量部分检查是否定义了重名变量。

```

70 procedure pa;
71 begin
72 end;
73 function fb: integer;
74 begin
75     fb := 1;
76 end;
77
78 {duplicate function definition}
79 function pa: real;
80 begin
81 end;
82
83 {duplicate procedure definition}
84 procedure fb;
85 begin
86 end;

```

函数与过程根据函数名与其类型构成函数签名作为判断是否重名的依据。上图中 pa 虽然一个是过程，一个是类型，但仍判定下面的 pa 与 fb 重名。

```

88 function fparameter(x, y: integer): integer;
89 begin
90     fparameter := 1;
91 end;
92
93 function fparameter_invalid1(x, y: integer): integer;
94 const
95 {duplicate identifier}
96     x = 1;
97 begin
98     fparameter_invalid1 := 1;
99 end;
100
101
102 {duplicate parameter name}
103 function fparameter_invalid2(x, y: integer; x, z: real): integer;
104 begin
105     fparameter_invalid2 := 2;
106 end;
107
108 function fparameter_invalid3(x, y: integer): integer;
109 begin
110 {undefined variable}
111     fparameter := 1;
112 end;

```

在函数中，不能定义与参数重名的变量/常量/类型，否则会报 duplicate identifier 错误。函数参数本身也不能重名，否则报 duplicate parameter name 错误。函数内部支持对同名变量进行赋值，该变量没有显式定义，但其他的未定义变量仍旧会报 undefined variable 错误。



```

115 begin
116     1: va := 1;
117     vra := 1.0;
118     vra := 1;
119
120     {duplicate label}
121     1: vb := 1;
122     {undefined variable}
123     vx := 1;
124
125     {unsupport assignment operator}
126     vrange := 1;
127
128     {type mismatch between assignment operator}
129     vrecord := 1;
130
131     {cannot downcast data type automatically}
132     va := 1.0;

```

当定义了重复的 goto label 时，程序会报 duplicate label 错误。对于不支持赋值操作的变量，会报 unsupport assignment operator 错误，而如果试图将 integer 赋值给 record 则会报 type mismatch between assignment operator 错误。本编译器支持类型的自动提升，但不支持类型的隐式降低，如将 real 赋值给 integer，此时会报 cannot downcast data type automatically 错误。

```

134     varray[1] := 1;
135
136     {va is not an array}
137     va[1] := 1.0;
138     {index must be integer}
139     varray[2.0] := 2;
140     {type mismatch between assignment operator}
141     varray[2] := vrange;
142     {cannot downcast data type automatically}
143     varray[2] := 2.0;
144
145     vrecord.a := 1;
146
147     {va is not a record}
148     va.a := 1;
149     {invalid attribute}
150     vrecord.undefined := 1;

```

当试图对非数组进行数组成员访问时，将会报 xx is not an array 错误。如果下标类型不是 integer，则会报 index must be integer 错误。

试图对非 record 进行 record 域成员访问是，会报 xx is not a record 错误，试图访问一个 record 中不存在的域成员时，会报 invalid attribute 错误。

```
152     pa;  
153  
154     {undefined function or procedure}  
155     ppa;  
156  
157     read(va);  
158  
159     {read needs a lvalue}  
160     read(1);  
161
```

试图调用一个不存在的函数/过程时，会报 undefined function or procedure 错误，如果试图传递一个非左值给需要参数为左值的函数，会报 xx needs a lvalue 错误。

```

163     if va = 1 then
164         write(va)
165     else
166         write(vb);
167
168     repeat
169         va := 1;
170     until va = 1;
171
172     while va = 1 do
173     begin
174         va:=2;
175     end;
176
177     for va := 1 to 2 do
178         vb := vb + 1;
179
180     {the type of condition clause must be boolean}
181     if va then
182         write(va);
183
184     repeat
185         va := 1;
186     until va;
187
188     while va do
189     begin
190         va:=2;
191     end;
192
193     {ica must be a variable}
194     for ica := 1 to 2 do
195         vb := vb + 1;
196     {undefined variable}
197     for undefined := 1 to 2 do
198         vb := vb + 1;
199     {vra must be integer}
200     for vra := 1 to 2 do
201         vb := vb + 1;
202     {for loop require integer type}
203     for va := 1 to vra do
204         vb := vb + 1;

```

if, repeat-until, while 的条件语句要求类型为 boolean，当类型非 boolean 时报 the type of condition clause must be boolean 错误。

当 for 的循环变量不是变量或未定义时，报 xx must be a variable/undefined variable 错误。当其不是 integer 类型时，报 xx must be integer 错误。当其循环边界不是 integer 类型时，报 for loop require integer type 错误。

```

206     case vn of
207     1: writeln(0);
208     2: writeln(1);
209     3: begin
210         va := 980*10+100;
211         vb := 2;
212     end;
213 end;
214
215 {vra must be integer or char}
216 case vra of
217 1: writeln(0);
218 2: writeln(1);
219 3: begin
220     a := 980*10+100;
221     b := 2;
222 end;
223 end;
224 {label type mismatch}
225 case vn of
226 1: writeln(0);
227 2: writeln(1);
228 '3': begin
229     a := 980*10+100;
230     b := 2;
231 end;
232 end;
233
234 goto 1;
235 {use a invalid label}
236 goto 2;
237

```

case 语句要求检查的变量为 integer 与 char，当变量不是上述两种类型时，报 xx must be integer or char 错误。变量类型与下面的分支类型不匹配时，报 label type mismatch 错误。

当试图 goto 一个不存在的 label 时，报 use a invalid label 错误。

```

247 {type mismatch for cmp operator}
248 vba := 1 > '2';
249 {type mismatch for + and -}
250 va := 1 + '2';
251 {type mismatch for or}
252 vba := 1 or '2';
253 {type mismatch for *}
254 va := 1 * '2';
255 {type mismatch for /}
256 va := 1 / '2';
257 {type mismatch for div}
258 va := 1 div '2';
259 {type mismatch for mod}
260 va := 1 mod '2';
261 {type mismatch for and}
262 vba := (va = 1) and 2;
263
264 va := vb;
265 va := fb;
266 va := fparameter(1,2);
267 va := ica;
268 va := (vb + (va + vb));
269 vba := not vba;
270 va := -va;
271
272 {undefined variable or const or function}
273 va := undefined;
274 {undefined function}
275 va := f_undefined(2, 1);
276 {type mismatch for not}
277 va := not va;
278 {type mismatch for -}
279 vba := -vba;

```

上述代码检查 expression 中的各种类型不一致, 包括比较运算, +, -, \*, /, div, mod, 以及逻辑运算。

当赋值符号的右边是标识符时, 会检查 constSymbolTable, varSymbolTable, funcSymbolTable 三个符号表, 都找不到时提示 undefined variable or const or function。如果根据语法确定其是一个函数时, 则提示 undefined function。



最后程序的输出截图如下：

```
andyku0531@ubuntu:~/Desktop/Compiler/Compiler$ ./pcompiler Test/sa_error_test.pas
error in line 10 : duplicate identifier
error in line 17 : duplicate identifier
error in line 19 : undefined type
error in line 24 : invalid enum item identifier
error in line 25 : invalid enum item identifier
error in line 27 : duplicate identifier
error in line 34 : range data type mismatch
error in line 35 : range data type mismatch
error in line 37 : illegal range
error in line 38 : illegal range
error in line 40 : unsupported range data type
error in line 42 : undefined const identifier
error in line 55 : duplicate field name
error in line 67 : duplicate identifier
error in line 68 : duplicate identifier
error in line 79 : duplicate function definition
error in line 84 : duplicate procedure definition
error in line 96 : duplicate identifier
error in line 103 : duplicate parameter name
error in line 111 : undefined variable fparameter
error in line 121 : duplicate label
error in line 123 : undefined variable vx
error in line 126 : vrange unsupport assignment operator
error in line 129 : type mismatch between assignment operator
error in line 132 : cannot downcast data type automatically
error in line 137 : va is not an array
error in line 139 : index must be integer
error in line 141 : type mismatch between assignment operator
error in line 143 : cannot downcast data type automatically
error in line 148 : va is not a record
error in line 150 : invalid attribute undefined
error in line 155 : undefined function or procedure ppa
error in line 160 : read needs a lvalue
error in line 181 : the type of condition clause must be boolean
error in line 186 : the type of condition clause must be boolean
error in line 188 : the type of condition clause must be boolean
error in line 194 : ica must be a variable
error in line 197 : undefined variable undefined
error in line 200 : vra must be integer
error in line 203 : for loop require integer type
error in line 216 : case variable must be integer or char
error in line 217 : label type mismatch
```

```

error in line 218 : label type mismatch
error in line 219 : label type mismatch
error in line 228 : label type mismatch
error in line 248 : type mismatch for cmp operator
error in line 248 : type mismatch between assignment operator
error in line 250 : type mismatch for + and -
error in line 250 : type mismatch between assignment operator
error in line 252 : type mismatch for or
error in line 252 : type mismatch between assignment operator
error in line 254 : type mismatch for *
error in line 254 : type mismatch between assignment operator
error in line 256 : type mismatch for /
error in line 256 : type mismatch between assignment operator
error in line 258 : type mismatch for div and mod
error in line 258 : type mismatch between assignment operator
error in line 260 : type mismatch for div and mod
error in line 260 : type mismatch between assignment operator
error in line 262 : type mismatch for and
error in line 262 : type mismatch between assignment operator
error in line 273 : undefined variable or const or function
error in line 273 : type mismatch between assignment operator
error in line 275 : undefined function
error in line 275 : type mismatch between assignment operator
error in line 277 : type mismatch for not
error in line 277 : type mismatch between assignment operator
error in line 279 : type mismatch for -
error in line 279 : type mismatch between assignment operator
error in line 236 : use a invalid label
Error occurred, compiling stopped.

```

### 3. 代码生成测试

#### 输入与输出

Pascal 源码	三地址码	汇编代码
<pre> program test1; var     n,m:integer; begin     readln(n,m);     writeln(n,m); end. </pre>	<pre> entry main sp = sp - 8 point int t0 t0 = bp - 4 read t0 point int t0 t0 = bp - 8 readln t0 point int t0 t0 = bp - 4 var int t1 t1 = *t0 println t1 </pre>	<p>(由于汇编代码较长，放在文档里会显得很乱，故在测试报告里没有放汇编代码。老师若是想查看汇编代码，可以在工程目录下的 Assemble 文件下自行查看)</p> <p>汇 编 代 码 可 在 Assemble/1.asm 中查看</p>

	<pre> point int t0 t0 = bp - 8 var int t1 t1 = *t0 println t1 sp = sp + 8 </pre>	
--	--	--

运行结果:



## 算术运算符测试

Pascal 源码	三地址码	汇编代码
<pre> program test2; var     a,b,c,d:longint; begin     a:=10;     a:=a+2;     b:=a-3;     c:=a*b;     d:=12345 div c;     writeln(a);     writeln(b);     writeln(c);     writeln(d); end. </pre>	<pre> entry main sp = sp - 16 point int t0 t0 = bp - 4 *t0 = 10 point int t0 t0 = bp - 4 point int t1 t1 = bp - 4 var int t2 t2 = *t1 + 2 *t0 = t2 point int t0 t0 = bp - 8 point int t1 </pre>	<p>汇 编 代 码 可 在 Assemble/2.asm 中查看</p>



	<pre> t1 = bp - 4 var int t2 t2 = *t1 - 3 *t0 = t2 point int t0 t0 = bp - 12 point int t1 t1 = bp - 4 point int t2 t2 = bp - 8 var int t3 t3 = *t1 * *t2 *t0 = t3 point int t0 t0 = bp - 16 point int t1 t1 = bp - 12 var int t2 t2 = 12345 DIV *t1 *t0 = t2 point int t0 t0 = bp - 4 var int t1 t1 = *t0 println t1 point int t0 t0 = bp - 8 var int t1 t1 = *t0 println t1 point int t0 t0 = bp - 12 var int t1 t1 = *t0 println t1 point int t0 t0 = bp - 16 var int t1 t1 = *t0 println t1 sp = sp + 16 </pre>	
--	--	--

运行结果:

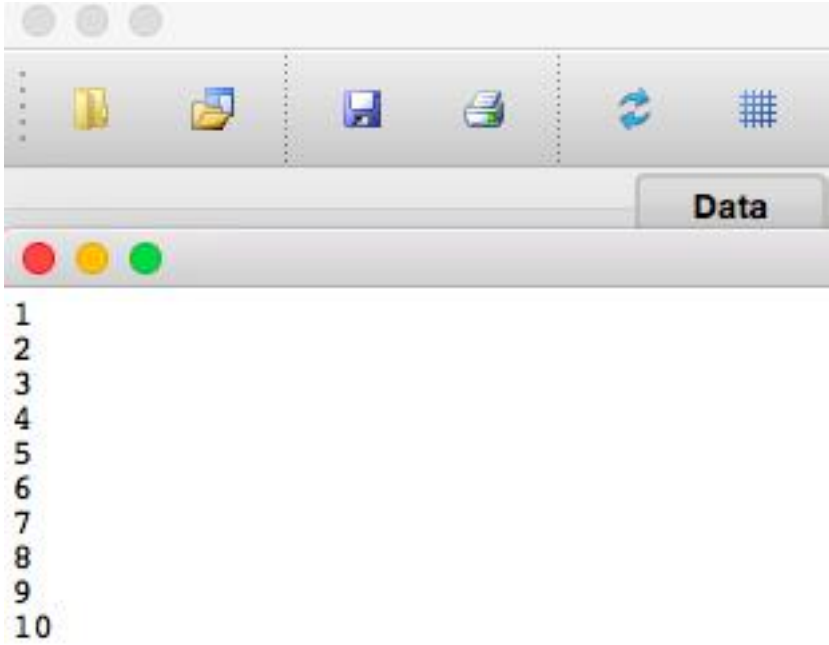


## while 语句

Pascal 源码	三地址码	汇编代码
<pre>program test3; var     i:integer; begin     i:=0;     while (i&lt;10) do     begin         i:=i+1;         writeln(i);     end; end.</pre>	<pre>entry main sp = sp - 4 point int t0 t0 = bp - 4 *t0 = 0 label L0 point int t0 t0 = bp - 4 var boolean t1 t1 = *t0 &lt; 10 if_false t1 goto L1 point int t0 t0 = bp - 4 point int t2 t2 = bp - 4 var int t3 t3 = *t2 + 1 *t0 = t3 point int t0 t0 = bp - 4 var int t2 t2 = *t0 println t2 goto L0 label L1</pre>	汇 编 代 码 可 在 Assemble/3.asm 中查看

	sp = sp + 4	
--	-------------	--

运行结果:



### if 语句

Pascal 源码	三地址码	汇编代码
<pre> program test4; var     a,b:integer; begin     a := 123;     b := 345;     if (a&gt;b) then         writeln(100)     else         writeln(99); end. </pre>	<pre> entry main sp = sp - 8 point int t0 t0 = bp - 4 *t0 = 123 point int t0 t0 = bp - 8 *t0 = 345 point int t0 t0 = bp - 4 point int t1 t1 = bp - 8 var boolean t2 t2 = *t0 &gt; *t1 if_false t2 goto L0 println 100 goto L1 </pre>	<p>汇 编 代 码 可 在          Assemble/4.asm 中查看</p>

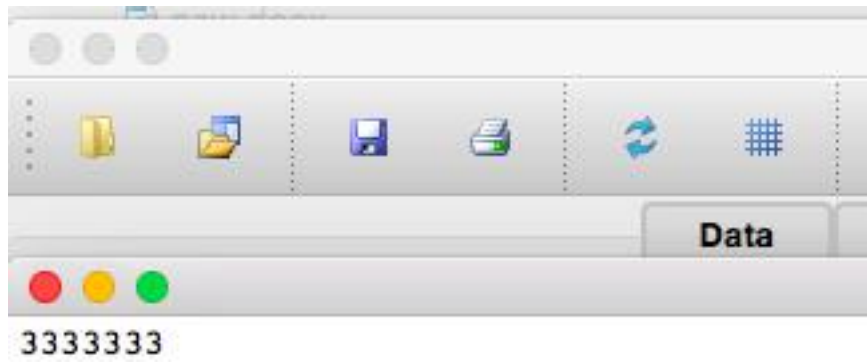
	<pre> label L0 println 99 label L1 sp = sp + 8 </pre>	
--	---	--



### case 语句

Pascal 源码	三地址码	汇编代码
<pre> program test5; var     c:integer; begin     c:=3;     case (c) of 1:writeln(1111111); 2:writeln(2222222); 3:writeln(3333333); 4:writeln(4444444);     end; end. </pre>	<pre> entry main sp = sp - 4 point int t0 t0 = bp - 4 *t0 = 3 point int t0 t0 = bp - 4 goto L0 Label L2 println 1111111 goto L1 Label L3 println 2222222 goto L1 Label L4 println 3333333 goto L1 Label L5 println 4444444 goto L1 label L0 if *t0 == 1 then goto L2 </pre>	<p>汇 编 代 码 可 在 Assemble/5.asm 中查看</p>

	<pre> if *t0 == 2 then goto L3 if *t0 == 3 then goto L4 if *t0 == 4 then goto L5 label L1 sp = sp + 4 </pre>	
--	--	--

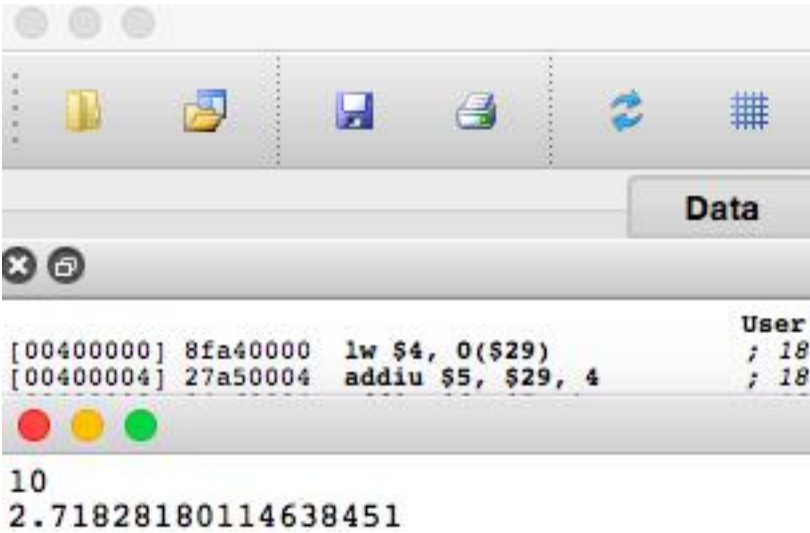


# 浮点数处理

Pascal 源码	三地址码	汇编代码
<pre> program test6; var     n,fact,i:longint;     a:real; begin     read(n);     fact:=1;     a:=1.0;     for i:=1 to n do         begin             fact:=fact*i;             a:=a+1/fact;         end;     writeln(a); end. </pre>	<pre> entry main sp = sp - 20 point int t0 t0 = bp - 4 read t0 point int t0 t0 = bp - 8 *t0 = 1 point double t0 t0 = bp - 20 *t0 = 1 point int t0 t0 = bp - 12 point int t1 t1 = bp - 4 *t0 = 1 var int t2 t2 = -1 label L0 var int t3 t3 = *t0 != *t1 if_false t3 goto L1 </pre>	<p>汇 编 代 码 可 在 Assemble/6.asm 中查看</p>

	<pre>point int t4 t4 = bp - 8 point int t5 t5 = bp - 8 point int t6 t6 = bp - 12 var int t7 t7 = *t5 * *t6 *t4 = t7 point double t4 t4 = bp - 20 point double t5 t5 = bp - 20 point int t6 t6 = bp - 8 var double t7 t7 = 1 / *t6 var double t6 t6 = *t5 + t7 *t4 = t6 *t0 = *t0 + t2 goto L0 label L1 label L2 var int t3 t3 = *t0 == *t1 if_false t3 goto L3 point int t4 t4 = bp - 8 point int t5 t5 = bp - 8 point int t6 t6 = bp - 12 var int t7 t7 = *t5 * *t6 *t4 = t7 point double t4 t4 = bp - 20 point double t5 t5 = bp - 20 point int t6 t6 = bp - 8 var double t7 t7 = 1 / *t6</pre>	
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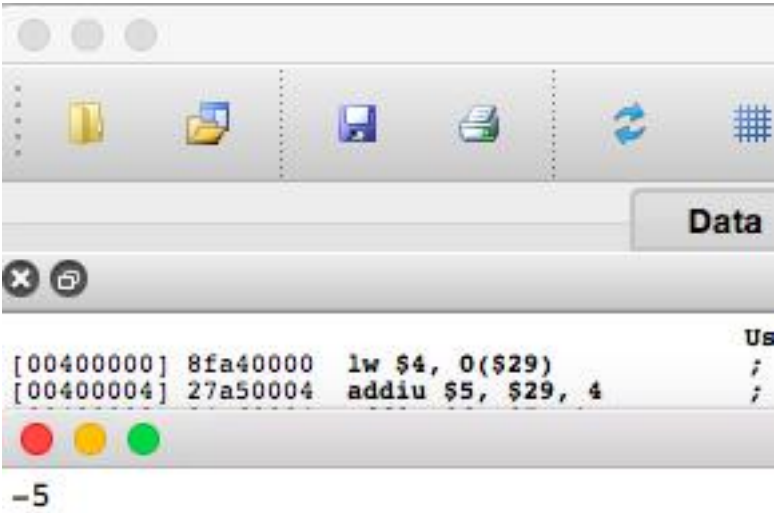
	<pre> var double t6 t6 = *t5 + t7 *t4 = t6 *t0 = *t0 + t2 goto L2 label L3 point double t1 t1 = bp - 20 var double t3 t3 = *t1 println t3 sp = sp + 20 </pre>	
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### 函数调用

Pascal 源码	三地址码	汇编代码
<pre> program test7; var     n, sum:integer; function nabs(x:integer):integer; begin     nabs:=0-x; end; begin     n:=5; </pre>	<pre> entry _nabs sp = sp - 4 point int t0 t0 = bp - 4 point int t1 t1 = bp + 8 var int t2 t2 = 0 - *t1 *t0 = t2 sp = sp + 4 ret </pre>	<p>汇 编 代 码 可 在 Assemble/7.asm 中查看</p>

<pre> sum:=nabs(n); writeln(sum); end. </pre>	<pre> entry main sp = sp - 8 point int t0 t0 = bp - 4 *t0 = 5 point int t0 t0 = bp - 8 point int t1 t1 = bp - 4 arg *t1 call _nabs point int t1 t1 = sp - 12 var int t2 t2 = *t1 *t0 = t2 point int t0 t0 = bp - 8 var int t1 t1 = *t0 println t1 sp = sp + 8 </pre>	
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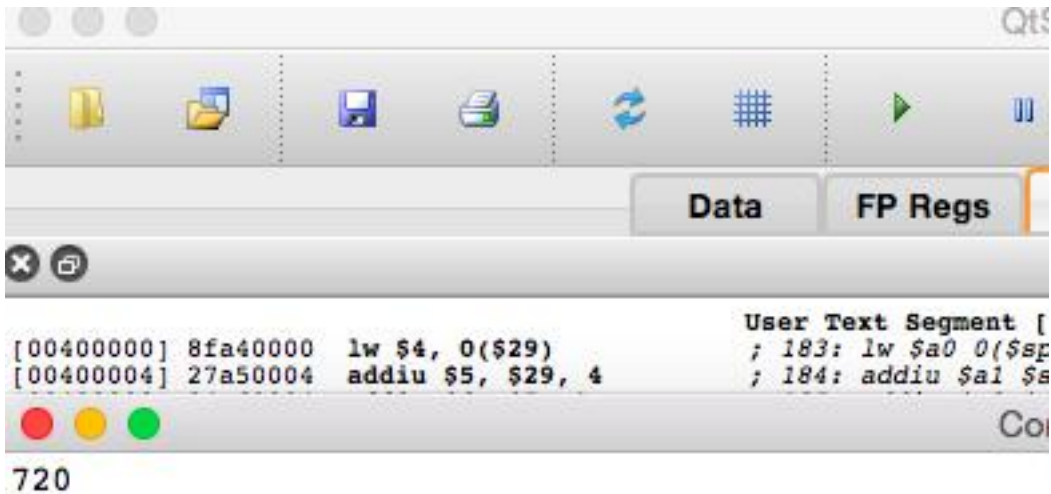
递归调用

Pascal 源码	三地址码	汇编代码
program test8;	entry _fact	汇 编 代 码 可 在



<pre> var     n:longint; function fact(x:longint):longin t; begin     if    (x=0)    then fact:=1 else fact := x * fact(x-1); end; begin     n:=3;     n:=fact(fact(n));     writeln(n); end. </pre>	<pre> sp = sp - 4 point int t0 t0 = bp + 8 var boolean t1 t1 = *t0 == 0 if_false t1 goto L0 point int t0 t0 = bp - 4 *t0 = 1 goto L1 label L0 point int t0 t0 = bp - 4 point int t1 t1 = bp + 8 point int t2 t2 = bp + 8 var int t3 t3 = *t2 - 1 arg t3 call _fact point int t2 t2 = sp - 12 var int t3 t3 = *t2 var int t2 t2 = *t1 * t3 *t0 = t2 label L1 sp = sp + 4 ret entry main sp = sp - 4 point int t0 t0 = bp - 4 *t0 = 3 point int t0 t0 = bp - 4 point int t1 t1 = bp - 4 arg *t1 call _fact point int t1 t1 = sp - 12 </pre>	<p>Assemble/8.asm 中查看</p>
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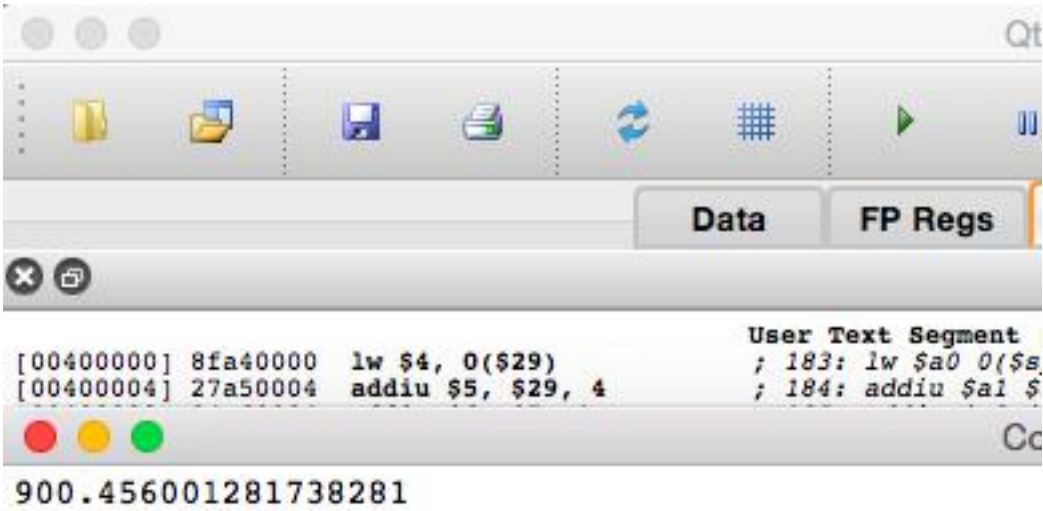
	<pre> var int t2 t2 = *t1 arg t2 call _fact point int t1 t1 = sp - 12 var int t2 t2 = *t1 *t0 = t2 point int t0 t0 = bp - 4 var int t1 t1 = *t0 println t1 sp = sp + 4 </pre>	
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### 结构体

Pascal 源码	三地址码	汇编代码
<pre> program test9; var     a:record         a:real;         b:integer;     end;     sum:real; </pre>	<pre> entry main sp = sp - 20 point record t0 t0 = bp - 12 point double t1 t1 = t0 + 0 *t1 = 123.456 point record t0 t0 = bp - 12 </pre>	<p>汇 编 代 码 可 在 Assemble/9.asm 中查看</p>

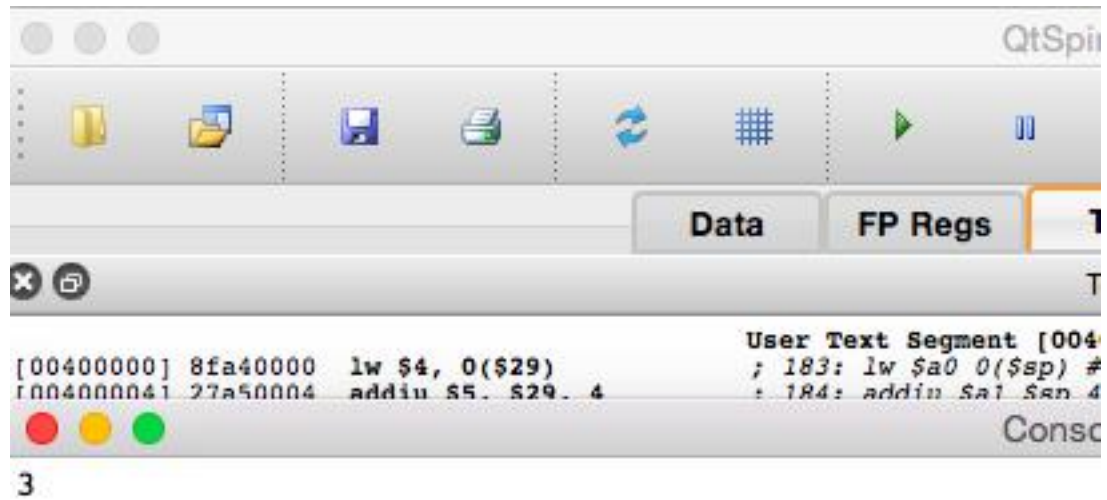
<pre> begin   a.a := 123.456;   a.b := 777;   sum := a.a + a.b;   writeln(sum); end. </pre>	<pre> point int t1 t1 = t0 + 8 *t1 = 777 point double t0 t0 = bp - 20 point record t1 t1 = bp - 12 point double t2 t2 = t1 + 0 point record t1 t1 = bp - 12 point int t3 t3 = t1 + 8 var double t1 t1 = *t2 + *t3 *t0 = t1 point double t0 t0 = bp - 20 var double t1 t1 = *t0 println t1 sp = sp + 20 </pre>	
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### 常数计算优化

Pascal 源码	三地址码	汇编代码
program test10;	entry main	汇 编 代 码 可 在

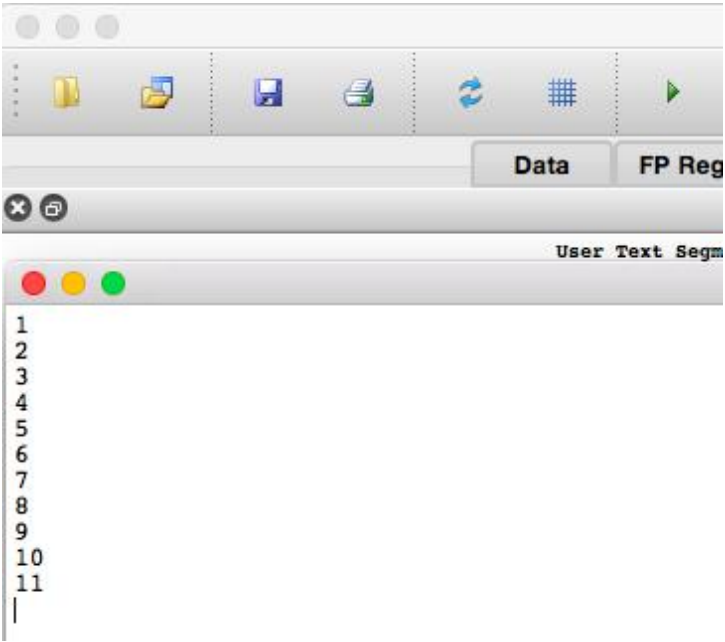
<pre> var     a:integer; begin     a:=1 + (2*3 div 4 +5 * 6) div 7-2;     writeln(a); end. </pre>	<pre> sp = sp - 4 point int t0 t0 = bp - 4 *t0 = 3 point int t0 t0 = bp - 4 var int t1 t1 = *t0 println t1 sp = sp + 4 </pre>	<p>Assemble/10.asm 中查看</p>
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repeat

Pascal 源码	三地址码	汇编代码
<pre> program test11; var     n,i:integer; begin     n:=10;     i:=0;     repeat         i:=i+1;         writeln(i);     until i&gt;n; end. </pre>	<pre> entry main sp = sp - 8 point int t0 t0 = bp - 4 *t0 = 10 point int t0 t0 = bp - 8 *t0 = 0 label L0 point int t0 t0 = bp - 8 point int t1 t1 = bp - 8 var int t2 t2 = *t1 + 1 </pre>	<p>汇 编 代 码 可 在 Assemble/11.asm 中查看</p>

	<pre> *t0 = t2 point int t0 t0 = bp - 8 var int t1 t1 = *t0 println t1 point int t0 t0 = bp - 8 point int t1 t1 = bp - 4 var boolean t2 t2 = *t0 &gt; *t1 if_false t2 goto L0 sp = sp + 8 </pre>	
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嵌套函数

Pascal 源码	三地址码	汇编代码
<pre> program test12; var     n,m:integer; function minsquare(x,y:integer) </pre>	<pre> entry _minsquare sp = sp - 8 point int t0 t0 = bp - 8 point int t1 </pre>	汇 编 代 码 可 在 Assemble/12.asm 中查看

<pre> :integer; var     temp:integer;      function min(x,y:integer):integ er;     begin         if (x&lt;y) then min:=x else min:=y;         end;  begin     temp:=min(x,y);  minsquare:=temp*temp; end; begin     n:=3;     m:=4;     n:=minsquare(n,m);     writeln(n); end. </pre>	<pre> t1 = bp + 12 arg *t1 point int t1 t1 = bp + 8 arg *t1 call _min point int t1 t1 = sp - 12 var int t2 t2 = *t1 *t0 = t2 point int t0 t0 = bp - 4 point int t1 t1 = bp - 8 point int t2 t2 = bp - 8 var int t3 t3 = *t1 * *t2 *t0 = t3 sp = sp + 8 ret entry _min sp = sp - 4 point int t0 t0 = bp + 12 point int t1 t1 = bp + 8 var boolean t2 t2 = *t0 &lt; *t1 if_false t2 goto L0 point int t0 t0 = bp - 4 point int t1 t1 = bp + 12 *t0 = *t1 goto L1 label L0 point int t0 t0 = bp - 4 point int t1 t1 = bp + 8 *t0 = *t1 label L1 </pre>	
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	<pre>sp = sp + 4 ret entry main sp = sp - 8 point int t0 t0 = bp - 4 *t0 = 3 point int t0 t0 = bp - 8 *t0 = 4 point int t0 t0 = bp - 4 point int t1 t1 = bp - 4 arg *t1 point int t1 t1 = bp - 8 arg *t1 call _minsquare point int t1 t1 = sp - 12 var int t2 t2 = *t1 *t0 = t2 point int t0 t0 = bp - 4 var int t1 t1 = *t0 println t1 sp = sp + 8</pre>	
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