Trabalho Prático 01:
Analisador Léxico e Tabela de Símbolos

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Sumário

1   Introdução

O programa pas-c é um projeto desenvolvido na aula de Compiladores do Curso de Engenharia da Computação do CEFET-MG. Pas-c é a linguagem homônima, definida para esse compilador, cuja semântica dos comandos e expressões é a tradicional de linguagens como Pascal e C (daí seu nome).

1.1   A Linguagem Pas-c

Definimos a gramática da linguagem:

```
 1  program ::= [ var decl−list ] begin stmt−list end
 2  decl−list ::= decl ";" { decl ";"}
 3  decl ::= ident−list is type
 4  ident−list ::= identifier {"," identifier }
 5  type ::= int | string
 6  stmt−list ::= stmt ";" { stmt ";"}
 7  stmt ::= assign−stmt | if−stmt | do−stmt | read−stmt | write−stmt
 8  assign−stmt ::= identifier ":=" simple_expr
 9  if−stmt ::= if condition then stmt−list end
10            | if condition then stmt−list else stmt−list end
11  condition ::= expression
12  do−stmt ::= do stmt−list stmt−suffix
13  stmt−suffix ::= while condition
14  read−stmt ::= in "(" identifier ")"
15  write−stmt ::= out "(" writable ")"
16  writable ::= simple−expr
17  expression ::= simple−expr | simple−expr relop simple−expr
18  simple−expr ::= term | simple−expr addop term
19  term ::= factor−a | term mulop factor−a
20  fator−a ::= factor | not factor | "−" factor
21  factor ::= identifier | constant | "(" expression ")"
22  relop ::= "=" | ">" | ">=" | "<" | "<=" | "<>"
23  addop ::= "+" | "−" | or
24  mulop ::= "*" | "/" | and
25  constant ::= integer_const | literal
26  integer_const ::= nozero {digit} | "0"
27  literal ::= " {" {caractere} "}"
28  identifier ::= ( letter ) { letter | digit }
29            | "_" ( letter | digit ) { letter | digit }
30  letter ::= [A−Za−z]
31  digit ::= [0−9]
32  nozero ::= [1−9]
33  caractere ::= um dos 256 caracteres do conjunto ASCII,
34            exceto "{", "}" e quebra de linha
35
```

2   Uso do compilador

2.1   Compilando o Compilador Pas-c

Para compilar o seu código (neste momento, apenas como analizador léxico), basta ter um compilador G++ versão 4.8 ou superior com cmake instalado em sua máquina.

Na pasta do projeto execute o comando:

```
1  make
```

Esse comando deverá gerar a seguinte seqûencia de comandos:

```
1  g++ −Iinclude −c −Wall −g −DRUN_TESTS src/Scanner.cpp −o src/Scanner.o
2  g++ −Iinclude −c −Wall −g −DRUN_TESTS src/TestCase.cpp −o src/TestCase.o
3  g++ −Iinclude −c −Wall −g −DRUN_TESTS src/Token.cpp −o src/Token.o
4  g++ −Iinclude −c −Wall −g −DRUN_TESTS src/main.cpp −o src/main.o
5  g++  src/Scanner.o src/TestCase.o src/Token.o src/main.o −o pasc
```

Pronto! Agora o executável **pasc** está pronto para compilar seus programas em Pas-c!

2.2   Compilando um programa em Pas-c

Para executar o compilador, basta executar o comando:

```
pasc caminho_para_seu_codigo.pasc
```

3 A Implementação do Compilador

3.1 A abordagem utilizada na implementação

3.2 A Estrutura do Projeto

O projeto segue a estrutura básica de todo projeto em C++, contendo uma pasta **include** e, dentro desta, separados por módulos, os headers (.h) com as declarações das classes. A pasta **src** contém a implementação das classes, bem como a função principal **main**:

```
include/ -- Pasta para os headers
include/frontend -- pasta contendo as definições para os analisadores.
include/backend -- ainda por fazer.
include/test -- Pasta com os headers referentes aos testes unitários
src/ -- Implementação das classes
tests/ -- Pasta com a implementação dos testes unitários
```

3.3 Principais Classes da Aplicação

- **Token:** A classe Token descreve a unidade lógica mais básica do compilador. Ela apresenta apenas um valor, em formato de cadeia de caracteres, e seu **Tipo**, a ser elucidado no próximo item.

- **TokenType:** TokenType trata-se apenas de um enum, que define, através de um bitmap, a lista de tokens reconhecidos pelo compilador, bem como um tipo UNKNOWN, para todo e qualquer token que não corresponder a nenhuma definição da linguagem.

- **Scanner:** O analisador léxico está concentrado basicamente na classe Scanner. Essa classe contém os métodos **getNumerical**, **getLiteral** e **getOperator**, que são responsáveis por captar os tokens, bem como o método **getString**. Este último é necessário por que uma vez que se abre um caracter delimitador de string, espacos em brancos passam a ser caracteres significativos. Também estão definidos nessa classe os contadores de linhas e colunas do código-fonte.

- **Scope:** É a classe que definie o escopo de uma variável. Cada instância de Scope contém uma tabela com os símbolos daquele escopo e um ponteiro para seu "escopo pai".

4   Resultados dos testes especificados

Os testes aqui realizados não exibem a tabela de símbolos: Esta é responsabilidade do analizador Sintático, que será realizado na próxima etapa. Nosso projeto tem uma classe Scope, justamente para compreender essa situação, que ainda não está preparada.

4.1   Teste 1

Código fonte testado:

```
 1  var
 2    a, b, c is int;
 3     result is int
 4  begin
 5    in (a);
 6    in (c);
 7    b := 10;
 8     result := (a * c)/(b + 5 − 345);
 9    out(result);
10  end
```

Saída encontrada:

```
 1  Opening file tests/test1.psc ...
 2  Token found: (TOK_VAR)
 3  Token found: (TOK_ID, a)
 4  Token found: (TOK_COMMA)
 5  Token found: (TOK_ID, b)
 6  Token found: (TOK_COMMA)
 7  Token found: (TOK_ID, c)
 8  Token found: (TOK_IS)
 9  Token found: (TOK_INT)
10  Token found: (TOK_SEMICOLON)
11  Token found: (TOK_ID, result)
12  Token found: (TOK_IS)
13  Token found: (TOK_INT)
14  Token found: (TOK_BEGIN)
15  Token found: (TOK_IN)
16  Token found: (TOK_PAR_OPEN)
17  Token found: (TOK_ID, a)
18  Token found: (TOK_PAR_CLOSE)
19  Token found: (TOK_SEMICOLON)
20  Token found: (TOK_IN)
21  Token found: (TOK_PAR_OPEN)
22  Token found: (TOK_ID, c)
23  Token found: (TOK_PAR_CLOSE)
24  Token found: (TOK_SEMICOLON)
25  Token found: (TOK_ID, b)
26  Token found: (TOK_ASSIGN)
27  Token found: (TOK_INT, 10)
28  Token found: (TOK_SEMICOLON)
29  Token found: (TOK_ID, result)
30  Token found: (TOK_ASSIGN)
31  Token found: (TOK_PAR_OPEN)
32  Token found: (TOK_ID, a)
33  Token found: (TOK_MULT)
34  Token found: (TOK_ID, c)
35  Token found: (TOK_PAR_CLOSE)
```

```
36   Token found: (TOK_DIV)
37   Token found: (TOK_PAR_OPEN)
38   Token found: (TOK_ID, b)
39   Token found: (TOK_ADD)
40   Token found: (TOK_INT, 5)
41   Token found: (TOK_SUB)
42   Token found: (TOK_INT, 345)
43   Token found: (TOK_PAR_CLOSE)
44   Token found: (TOK_SEMICOLON)
45   Token found: (TOK_OUT)
46   Token found: (TOK_PAR_OPEN)
47   Token found: (TOK_ID, result)
48   Token found: (TOK_PAR_CLOSE)
49   Token found: (TOK_SEMICOLON)
50   Token found: (TOK_END)
```

4.2   Teste 2

Código fonte testado:

```
1    a, _ is int;
2    b is int;
3    nome is string;
4    begin
5     in (a);
6     in (nome);
7     b := a * a;
8     b := b + a/2 * (3 + 5);
9     out (nome);
10    out(b);
11   end.
```

Saída encontrada:

```
1    Opening file tests/test2.psc ...
2    Token found: (TOK_ID, a)
3    Token found: (TOK_COMMA)
4    ERROR in line 1, column 5: Unknown Token found: (TOK_UNKNOWN, _)
5    Token found: (TOK_IS)
6    Token found: (TOK_INT)
7    Token found: (TOK_SEMICOLON)
8    Token found: (TOK_ID, b)
9    Token found: (TOK_IS)
10   Token found: (TOK_INT)
11   Token found: (TOK_SEMICOLON)
12   Token found: (TOK_ID, nome)
13   Token found: (TOK_IS)
14   Token found: (TOK_STRING)
15   Token found: (TOK_SEMICOLON)
16   Token found: (TOK_BEGIN)
17   Token found: (TOK_IN)
18   Token found: (TOK_PAR_OPEN)
19   Token found: (TOK_ID, a)
20   Token found: (TOK_PAR_CLOSE)
21   Token found: (TOK_SEMICOLON)
22   Token found: (TOK_IN)
23   Token found: (TOK_PAR_OPEN)
24   Token found: (TOK_ID, nome)
```

```
25   Token found: (TOK_PAR_CLOSE)
26   Token found: (TOK_SEMICOLON)
27   Token found: (TOK_ID, b)
28   Token found: (TOK_ASSIGN)
29   Token found: (TOK_ID, a)
30   Token found: (TOK_MULT)
31   Token found: (TOK_ID, a)
32   Token found: (TOK_SEMICOLON)
33   Token found: (TOK_ID, b)
34   Token found: (TOK_ASSIGN)
35   Token found: (TOK_ID, b)
36   Token found: (TOK_ADD)
37   Token found: (TOK_ID, a)
38   Token found: (TOK_DIV)
39   Token found: (TOK_INT, 2)
40   Token found: (TOK_MULT)
41   Token found: (TOK_PAR_OPEN)
42   Token found: (TOK_INT, 3)
43   Token found: (TOK_ADD)
44   Token found: (TOK_INT, 5)
45   Token found: (TOK_PAR_CLOSE)
46   Token found: (TOK_SEMICOLON)
47   Token found: (TOK_OUT)
48   Token found: (TOK_PAR_OPEN)
49   Token found: (TOK_ID, nome)
50   Token found: (TOK_PAR_CLOSE)
51   Token found: (TOK_SEMICOLON)
52   Token found: (TOK_OUT)
53   Token found: (TOK_PAR_OPEN)
54   Token found: (TOK_ID, b)
55   Token found: (TOK_PAR_CLOSE)
56   Token found: (TOK_SEMICOLON)
57   Token found: (TOK_END)
58   ERROR in line 11, column 4: Unknown Token found: (TOK_UNKNOWN, .)
```

4.3   Teste 3

Código fonte testado:

```
1    var
2     _cont  is  int ;
3     media, altura,  soma_  is  int ;
4     begin
5     _cont := 5;
6     soma = 0;
7     do
8
9     write({Altura: });
10    in  (altura);
11    soma := soma altura;
12    _cont := _cont − 1;
13
14    while(_cont);
15    out({Media: });
16    out (soma / qtd);
17    end
```

Saída encontrada:

```
 1  Opening file  tests/test3.psc ...
 2  Token found: (TOK_VAR)
 3  Token found: (TOK_ID, _cont)
 4  Token found: (TOK_IS)
 5  Token found: (TOK_INT)
 6  Token found: (TOK_SEMICOLON)
 7  Token found: (TOK_ID, media)
 8  Token found: (TOK_COMMA)
 9  Token found: (TOK_ID, altura)
10  Token found: (TOK_COMMA)
11  Token found: (TOK_ID, soma)
12  ERROR in line 3, column 21: Unknown Token found: (TOK_UNKNOWN, _)
13  Token found: (TOK_IS)
14  Token found: (TOK_INT)
15  Token found: (TOK_SEMICOLON)
16  Token found: (TOK_BEGIN)
17  Token found: (TOK_ID, _cont)
18  Token found: (TOK_ASSIGN)
19  Token found: (TOK_INT, 5)
20  Token found: (TOK_SEMICOLON)
21  Token found: (TOK_ID, soma)
22  Token found: (TOK_EQUALS)
23  Token found: (TOK_INT, 0)
24  Token found: (TOK_SEMICOLON)
25  Token found: (TOK_DO)
26  Token found: (TOK_ID, write)
27  Token found: (TOK_PAR_OPEN)
28  Token found: (TOK_STR, Altura: )
29  Token found: (TOK_PAR_CLOSE)
30  Token found: (TOK_SEMICOLON)
31  Token found: (TOK_IN)
32  Token found: (TOK_PAR_OPEN)
33  Token found: (TOK_ID, altura)
34  Token found: (TOK_PAR_CLOSE)
35  Token found: (TOK_SEMICOLON)
36  Token found: (TOK_ID, soma)
37  Token found: (TOK_ASSIGN)
38  Token found: (TOK_ID, soma)
39  Token found: (TOK_ID, altura)
40  Token found: (TOK_SEMICOLON)
41  Token found: (TOK_ID, _cont)
42  Token found: (TOK_ASSIGN)
43  Token found: (TOK_ID, _cont)
44  Token found: (TOK_SUB)
45  Token found: (TOK_INT, 1)
46  Token found: (TOK_SEMICOLON)
47  Token found: (TOK_WHILE)
48  Token found: (TOK_PAR_OPEN)
49  Token found: (TOK_ID, _cont)
50  Token found: (TOK_PAR_CLOSE)
51  Token found: (TOK_SEMICOLON)
52  Token found: (TOK_OUT)
53  Token found: (TOK_PAR_OPEN)
54  Token found: (TOK_STR, Media: )
55  Token found: (TOK_PAR_CLOSE)
56  Token found: (TOK_SEMICOLON)
```

```
57   Token found: (TOK_OUT)
58   Token found: (TOK_PAR_OPEN)
59   Token found: (TOK_ID, soma)
60   Token found: (TOK_DIV)
61   Token found: (TOK_ID, qtd)
62   Token found: (TOK_PAR_CLOSE)
63   Token found: (TOK_SEMICOLON)
64   Token found: (TOK_END)
```

4.4 Teste 4

Código fonte testado:

```
 1   var
 2
 3    i, j, k, @total, 1soma is int;
 4    begin
 5   i := 4 * (5−3 * 50 / 10;
 6   j := i * 10;
 7   k := i* j / k;
 8   k := 4 + a $;
 9   out(i);
10   out(j);
11   out(k);
12    end
```

Saída encontrada:

```
 1   Opening file  tests/test4.psc ...
 2   Token found: (TOK_VAR)
 3   Token found: (TOK_ID, i)
 4   Token found: (TOK_COMMA)
 5   Token found: (TOK_ID, j)
 6   Token found: (TOK_COMMA)
 7   Token found: (TOK_ID, k)
 8   Token found: (TOK_COMMA)
 9   ERROR in line 3, column 11: Unknown Token found: (TOK_UNKNOWN, @)
10   Token found: (TOK_ID, total)
11   Token found: (TOK_COMMA)
12   Token found: (TOK_INT, 1)
13   Token found: (TOK_ID, soma)
14   Token found: (TOK_IS)
15   Token found: (TOK_INT)
16   Token found: (TOK_SEMICOLON)
17   Token found: (TOK_BEGIN)
18   Token found: (TOK_ID, i)
19   Token found: (TOK_ASSIGN)
20   Token found: (TOK_INT, 4)
21   Token found: (TOK_MULT)
22   Token found: (TOK_PAR_OPEN)
23   Token found: (TOK_INT, 5)
24   Token found: (TOK_SUB)
25   Token found: (TOK_INT, 3)
26   Token found: (TOK_MULT)
27   Token found: (TOK_INT, 50)
28   Token found: (TOK_DIV)
29   Token found: (TOK_INT, 10)
30   Token found: (TOK_SEMICOLON)
```

```
31   Token found: (TOK_ID, j)
32   Token found: (TOK_ASSIGN)
33   Token found: (TOK_ID, i)
34   Token found: (TOK_MULT)
35   Token found: (TOK_INT, 10)
36   Token found: (TOK_SEMICOLON)
37   Token found: (TOK_ID, k)
38   Token found: (TOK_ASSIGN)
39   Token found: (TOK_ID, i)
40   Token found: (TOK_MULT)
41   Token found: (TOK_ID, j)
42   Token found: (TOK_DIV)
43   Token found: (TOK_ID, k)
44   Token found: (TOK_SEMICOLON)
45   Token found: (TOK_ID, k)
46   Token found: (TOK_ASSIGN)
47   Token found: (TOK_INT, 4)
48   Token found: (TOK_ADD)
49   Token found: (TOK_ID, a)
50   ERROR in line 8, column 12: Unknown Token found: (TOK_UNKNOWN, $)
51   Token found: (TOK_SEMICOLON)
52   Token found: (TOK_OUT)
53   Token found: (TOK_PAR_OPEN)
54   Token found: (TOK_ID, i)
55   Token found: (TOK_PAR_CLOSE)
56   Token found: (TOK_SEMICOLON)
57   Token found: (TOK_OUT)
58   Token found: (TOK_PAR_OPEN)
59   Token found: (TOK_ID, j)
60   Token found: (TOK_PAR_CLOSE)
61   Token found: (TOK_SEMICOLON)
62   Token found: (TOK_OUT)
63   Token found: (TOK_PAR_OPEN)
64   Token found: (TOK_ID, k)
65   Token found: (TOK_PAR_CLOSE)
66   Token found: (TOK_SEMICOLON)
67   Token found: (TOK_END)
```

4.5   Teste 5

Código fonte testado:

```
1    var
2
3    j, k is int;
4    a, j real;
5
6    begin
7    read(j);
8    read(K);
9
10   if (k <> 0)
11   result := j/k
12   else
13   result := 0
14   end;
15
```

```
16   out( result );
17   end
```

Saída encontrada:

```
 1   Opening file  tests/test5.psc ...
 2   Token found: (TOK_VAR)
 3   Token found: (TOK_ID, j)
 4   Token found: (TOK_COMMA)
 5   Token found: (TOK_ID, k)
 6   Token found: (TOK_IS)
 7   Token found: (TOK_INT)
 8   Token found: (TOK_SEMICOLON)
 9   Token found: (TOK_ID, a)
10   Token found: (TOK_COMMA)
11   Token found: (TOK_ID, j)
12   Token found: (TOK_ID, real)
13   Token found: (TOK_SEMICOLON)
14   Token found: (TOK_BEGIN)
15   Token found: (TOK_ID, read)
16   Token found: (TOK_PAR_OPEN)
17   Token found: (TOK_ID, j)
18   Token found: (TOK_PAR_CLOSE)
19   Token found: (TOK_SEMICOLON)
20   Token found: (TOK_ID, read)
21   Token found: (TOK_PAR_OPEN)
22   Token found: (TOK_ID, K)
23   Token found: (TOK_PAR_CLOSE)
24   Token found: (TOK_SEMICOLON)
25   Token found: (TOK_IF)
26   Token found: (TOK_PAR_OPEN)
27   Token found: (TOK_ID, k)
28   Token found: (TOK_DIFF)
29   Token found: (TOK_INT, 0)
30   Token found: (TOK_PAR_CLOSE)
31   Token found: (TOK_ID, result)
32   Token found: (TOK_ASSIGN)
33   Token found: (TOK_ID, j)
34   Token found: (TOK_DIV)
35   Token found: (TOK_ID, k)
36   Token found: (TOK_ELSE)
37   Token found: (TOK_ID, result)
38   Token found: (TOK_ASSIGN)
39   Token found: (TOK_INT, 0)
40   Token found: (TOK_END)
41   Token found: (TOK_SEMICOLON)
42   Token found: (TOK_OUT)
43   Token found: (TOK_PAR_OPEN)
44   Token found: (TOK_ID, result)
45   Token found: (TOK_PAR_CLOSE)
46   Token found: (TOK_SEMICOLON)
47   Token found: (TOK_END)
```

4.6 Teste 6

Código fonte testado:

```
1   var
2    a, b, c, maior is int;
3    nomecompletodoalunodeposgraduacao is string;
4    start
5   read(a);
6   read(b);
7   read(c;
8
9    maior := 0;
10   if ( a>b and a>c ) then
11   maior := a;
12   else
13   if (b>c) then
14   maior := b;
15   else
16   maior := c;
17   end
18   end
19   Out({Maior idade: });
20   out(maior);
21   end
```

Saída encontrada:

```
1   Opening file tests/test6.psc ...
2   Token found: (TOK_VAR)
3   Token found: (TOK_ID, a)
4   Token found: (TOK_COMMA)
5   Token found: (TOK_ID, b)
6   Token found: (TOK_COMMA)
7   Token found: (TOK_ID, c)
8   Token found: (TOK_COMMA)
9   Token found: (TOK_ID, maior)
10  Token found: (TOK_IS)
11  Token found: (TOK_INT)
12  Token found: (TOK_SEMICOLON)
13  ERROR in line 3, column 2: Unknown Token found: (TOK_UNKNOWN,
         nomecompletodoalunodeposgraduacao)
14  Token found: (TOK_IS)
15  Token found: (TOK_STRING)
16  Token found: (TOK_SEMICOLON)
17  Token found: (TOK_ID, start)
18  Token found: (TOK_ID, read)
19  Token found: (TOK_PAR_OPEN)
20  Token found: (TOK_ID, a)
21  Token found: (TOK_PAR_CLOSE)
22  Token found: (TOK_SEMICOLON)
23  Token found: (TOK_ID, read)
24  Token found: (TOK_PAR_OPEN)
25  Token found: (TOK_ID, b)
26  Token found: (TOK_PAR_CLOSE)
27  Token found: (TOK_SEMICOLON)
28  Token found: (TOK_ID, read)
29  Token found: (TOK_PAR_OPEN)
30  Token found: (TOK_ID, c)
```

```
31  Token found: (TOK_SEMICOLON)
32  Token found: (TOK_ID, maior)
33  Token found: (TOK_ASSIGN)
34  Token found: (TOK_INT, 0)
35  Token found: (TOK_SEMICOLON)
36  Token found: (TOK_IF)
37  Token found: (TOK_PAR_OPEN)
38  Token found: (TOK_ID, a)
39  Token found: (TOK_GT)
40  Token found: (TOK_ID, b)
41  Token found: (TOK_AND)
42  Token found: (TOK_ID, a)
43  Token found: (TOK_GT)
44  Token found: (TOK_ID, c)
45  Token found: (TOK_PAR_CLOSE)
46  Token found: (TOK_THEN)
47  Token found: (TOK_ID, maior)
48  Token found: (TOK_ASSIGN)
49  Token found: (TOK_ID, a)
50  Token found: (TOK_SEMICOLON)
51  Token found: (TOK_ELSE)
52  Token found: (TOK_IF)
53  Token found: (TOK_PAR_OPEN)
54  Token found: (TOK_ID, b)
55  Token found: (TOK_GT)
56  Token found: (TOK_ID, c)
57  Token found: (TOK_PAR_CLOSE)
58  Token found: (TOK_THEN)
59  Token found: (TOK_ID, maior)
60  Token found: (TOK_ASSIGN)
61  Token found: (TOK_ID, b)
62  Token found: (TOK_SEMICOLON)
63  Token found: (TOK_ELSE)
64  Token found: (TOK_ID, maior)
65  Token found: (TOK_ASSIGN)
66  Token found: (TOK_ID, c)
67  Token found: (TOK_SEMICOLON)
68  Token found: (TOK_END)
69  Token found: (TOK_END)
70  Token found: (TOK_ID, Out)
71  Token found: (TOK_PAR_OPEN)
72  Token found: (TOK_STR, Maior idade: )
73  Token found: (TOK_PAR_CLOSE)
74  Token found: (TOK_SEMICOLON)
75  Token found: (TOK_OUT)
76  Token found: (TOK_PAR_OPEN)
77  Token found: (TOK_ID, maior)
78  Token found: (TOK_PAR_CLOSE)
79  Token found: (TOK_SEMICOLON)
80  Token found: (TOK_END)
```

4.7   Teste 7

Código fonte testado:

```
 1   var
 2       s, p is int;
 3       var is int;
 4
 5   begin
 6       s := 0;
 7
 8       do
 9           out({Valor a ser somado: });
10           in(p);
11           s := s+p;
12       while p!=0;
13
14       out({Total a pagar: R$});
15       out(s);
16   end.
```

Saída encontrada:

```
 1   Opening file  tests/test7.psc ...
 2   Token found: (TOK_VAR)
 3   Token found: (TOK_ID, s)
 4   Token found: (TOK_COMMA)
 5   Token found: (TOK_ID, p)
 6   Token found: (TOK_IS)
 7   Token found: (TOK_INT)
 8   Token found: (TOK_SEMICOLON)
 9   Token found: (TOK_VAR)
10   Token found: (TOK_IS)
11   Token found: (TOK_INT)
12   Token found: (TOK_SEMICOLON)
13   Token found: (TOK_BEGIN)
14   Token found: (TOK_ID, s)
15   Token found: (TOK_ASSIGN)
16   Token found: (TOK_INT, 0)
17   Token found: (TOK_SEMICOLON)
18   Token found: (TOK_DO)
19   Token found: (TOK_OUT)
20   Token found: (TOK_PAR_OPEN)
21   Token found: (TOK_STR, Valor a ser somado: )
22   Token found: (TOK_PAR_CLOSE)
23   Token found: (TOK_SEMICOLON)
24   Token found: (TOK_IN)
25   Token found: (TOK_PAR_OPEN)
26   Token found: (TOK_ID, p)
27   Token found: (TOK_PAR_CLOSE)
28   Token found: (TOK_SEMICOLON)
29   Token found: (TOK_ID, s)
30   Token found: (TOK_ASSIGN)
31   Token found: (TOK_ID, s)
32   Token found: (TOK_ADD)
33   Token found: (TOK_ID, p)
34   Token found: (TOK_SEMICOLON)
35   Token found: (TOK_WHILE)
36   Token found: (TOK_ID, p)
```

```
37   ERROR in line 12, column 12: Unknown Token found: (TOK_UNKNOWN, !)
38   Token found: (TOK_EQUALS)
39   Token found: (TOK_INT, 0)
40   Token found: (TOK_SEMICOLON)
41   Token found: (TOK_OUT)
42   Token found: (TOK_PAR_OPEN)
43   Token found: (TOK_STR, Total a pagar: R$)
44   Token found: (TOK_PAR_CLOSE)
45   Token found: (TOK_SEMICOLON)
46   Token found: (TOK_OUT)
47   Token found: (TOK_PAR_OPEN)
48   Token found: (TOK_ID, s)
49   Token found: (TOK_PAR_CLOSE)
50   Token found: (TOK_SEMICOLON)
51   Token found: (TOK_END)
52   ERROR in line 16, column 4: Unknown Token found: (TOK_UNKNOWN, .)
```

4.8   Teste 8

Código fonte testado:

```
1    var
2        n, c, r is int;
3
4    begin
5        out({Digite um numero: });
6        in(n);
7
8        c:=1;
9        do
10           out(n);
11           out({ x });
12           out(c);
13           out({ = });
14           out(n*c);
15           out({\n});
16       while c !=10;
17
18   end.
```

Saída encontrada:

```
1    Opening file  tests/test8.psc ...
2    Token found: (TOK_VAR)
3    Token found: (TOK_ID, n)
4    Token found: (TOK_COMMA)
5    Token found: (TOK_ID, c)
6    Token found: (TOK_COMMA)
7    Token found: (TOK_ID, r)
8    Token found: (TOK_IS)
9    Token found: (TOK_INT)
10   Token found: (TOK_SEMICOLON)
11   Token found: (TOK_BEGIN)
12   Token found: (TOK_OUT)
13   Token found: (TOK_PAR_OPEN)
14   Token found: (TOK_STR, Digite um numero: )
15   Token found: (TOK_PAR_CLOSE)
16   Token found: (TOK_SEMICOLON)
```

```
17  Token found: (TOK_IN)
18  Token found: (TOK_PAR_OPEN)
19  Token found: (TOK_ID, n)
20  Token found: (TOK_PAR_CLOSE)
21  Token found: (TOK_SEMICOLON)
22  Token found: (TOK_ID, c)
23  Token found: (TOK_ASSIGN)
24  Token found: (TOK_INT, 1)
25  Token found: (TOK_SEMICOLON)
26  Token found: (TOK_DO)
27  Token found: (TOK_OUT)
28  Token found: (TOK_PAR_OPEN)
29  Token found: (TOK_ID, n)
30  Token found: (TOK_PAR_CLOSE)
31  Token found: (TOK_SEMICOLON)
32  Token found: (TOK_OUT)
33  Token found: (TOK_PAR_OPEN)
34  Token found: (TOK_STR,  x )
35  Token found: (TOK_PAR_CLOSE)
36  Token found: (TOK_SEMICOLON)
37  Token found: (TOK_OUT)
38  Token found: (TOK_PAR_OPEN)
39  Token found: (TOK_ID, c)
40  Token found: (TOK_PAR_CLOSE)
41  Token found: (TOK_SEMICOLON)
42  Token found: (TOK_OUT)
43  Token found: (TOK_PAR_OPEN)
44  Token found: (TOK_STR,  = )
45  Token found: (TOK_PAR_CLOSE)
46  Token found: (TOK_SEMICOLON)
47  Token found: (TOK_OUT)
48  Token found: (TOK_PAR_OPEN)
49  Token found: (TOK_ID, n)
50  Token found: (TOK_MULT)
51  Token found: (TOK_ID, c)
52  Token found: (TOK_PAR_CLOSE)
53  Token found: (TOK_SEMICOLON)
54  Token found: (TOK_OUT)
55  Token found: (TOK_PAR_OPEN)
56  Token found: (TOK_STR, \n)
57  Token found: (TOK_PAR_CLOSE)
58  Token found: (TOK_SEMICOLON)
59  Token found: (TOK_WHILE)
60  Token found: (TOK_ID, c)
61  ERROR in line 16, column 13: Unknown Token found: (TOK_UNKNOWN, !)
62  Token found: (TOK_EQUALS)
63  Token found: (TOK_INT, 10)
64  Token found: (TOK_SEMICOLON)
65  Token found: (TOK_END)
66  ERROR in line 18, column 4: Unknown Token found: (TOK_UNKNOWN, .)
```