Basics of Programming. Introduction

Course Basics of Programming Semester 1, FIIT

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Resources & Timetable of our classes

- **Internet resources**
  - Course forum topic forum.mmcs.sfedu.ru
  - Moodle environment for practice pascalabc.net edu.mmcs.sfedu.ru
  - Site of PascalABC.NET Development Environment http://pascalabc.net
- **Timetable of classes**
  - *Lectures* :

Tuesday

11.55 – 13.30

13.45 – 15.00 (from 13 of September, every other week)

Friday

8.00 – 9.35

9.50 – 11.25

Programming as a human activity

- Programming is a part of the human activity of every person
- In everyday life, we take actions, make decisions using some algorithms
- Many tasks today require automation in the form of a computer programming
- The number of such tasks is growing
- Every year new areas of human life are covered by the computer programming. The areas where programming is involved are: machine learning, images recognition, robot programming, etc.
- We need to learn **how to write computer programs** using some programming language and learning some of **standard computer algorithms**

Algorithms

- The main concept in the field of CS is the **Algorithm**
- An **algorithm** is a set of instructions for solving a problem

Example. How to register in a moodle system?

- * Step 1. Open browser and type the address **edu.mmcs.sfedu.ru**
- * Step 2. Press the button "Register" (Register)
- * Step 3. Enter your email address (@sfedu), name and password
- * Step 4. Go to your e-mail and confirm the registration

- Many other algorithms surround us in real life
- Algorithm in computer science (CS) is adapted to solve a problem using computer
- Our task is to study the process of algorithms creation and the process of computer programs writing

Main definitions

- An **algorithm** is a set of commands to solve a problem
- A **program** is an algorithm written in some **Programming Language**
- **Algorithm steps** are called commands
- The **simplest steps of a program** are called **statements** (or operators)

Some Programming Languages:

Java	JavaScript	Scratch
Kotlin	Go	Perl
C	Swift	Assembler
C++	**Delphi Pascal**	**PascalABC.NET**
Python	Basic	
C#	Haskell	

We will use PascalABC.NET. Why?

- **Traditional Pascal:**
  - Was developed for teaching schoolchildren and students in the 70s of the XX century. Was created by the scientist Niklaus Wirth
- **PascalABC.NET :**
  - is created in our institute
  - is oriented on modern programming
  - makes it possible to write code compactly and clearly
  - includes baseline Pascal, Delphi Pascal, .NET extensions (similar to C#)
- As a result, after 1 semester:
  - 1. We will study all basic constructions of modern programming languages
  - 2. We will move to the industrial C# language

Let's start programming !

Variables

Some preliminary concepts

Variable – memory cell that has a name, type and value

5	2.5	Hello
a	r	s

Type of a variable – defines set of values that a variable can take

Main types:

```
integer     5 -3  2019
real        2.5  3.33
string      'Hello'  'Student'  '2019'
```

Comment. Every variable in a moment can have only one value

5	6
a	a

Variable Definition

Every variable must be defined before using it in a program. When we define a variable, we specify its **name** and **type**:

```
var a: integer;
var r: real;
var s: string;
```

semicolon
after every definition

var – **keyword** (boldface)

What could be a name? **Name of a variable** is any sequence of letters & digits, started with letter:

```
i   r   s   a123   Count0   NumberOfPupil   _System
```

Bad name: `123a`

Underline symbol is a letter too!

Assigning value to a variable

```
a := 5;
```

assignment **statement**

In memory:

5
a

stored value

Memory cell can store only one value! Old value is erased!

```
a := 6;
```

6
a

Statement is a minimal action in a programming language

Calculations

How to calculate an expression?

Simply write it and assign to a variable!

```
a := 3 + 4;
```

expression

Step 1. Expression is calculated

Step 2. The result is assigned to variable

7

a

Variables in expressions

- How to calculate an expression with variables?

```
x := 3;
y := 4;
a := x + y;
```

- **Step 1.** If the expression contains variables, then the values are substituted into place of variables:

```
a := 3 + 4;
```

- **Step 2.** Expression is calculated
- **Step 3.** The result is assigned to a variable

First program in PascalABC.NET

```
var x,y: integer;
var a: integer;

begin
    x := 3;
    y := 4;
    a := x + y;
    Write(a);
end.
```

```
7
```

definition section

statements section

Write statement outputs the results to an output window (console window)

output window (console)

We can move variable definitions into the statements section

```
begin
    var x,y: integer;
    var a: integer;
    x := 3;
    y := 4;
    a := x + y;
    Write(a);
end.
```

How the program is executed?

Press ▶ on a toolbar

The special program – PascalABC.NET **Compiler** – will start

Compiler verifies program and if it has no errors, compiler generates so called **machine codes**

Machine codes are executed by Central Microprocessor (CPU)

```
begin
    var x,y: integer;
    var a: integer;
    x := 3;
    y := 4;
    a := x + y;
    Write(a);
end.
```

```
7
```

Compiler

```
5:          x := 3;
mov dword [rip-0x11d212], 0x3
6:          y := 4;
mov dword [rip-0x11d218], 0x4
7:          a := x + y;
mov ecx, [rip-0x11d222]
add ecx, [rip-0x11d224]
mov [rip-0x11d226], ecx
8:          Write(a);
mov rcx, 0x7fff94d9c158
call 0x5f5e0aa0
mov [rbp-0x10], rax
mov rcx, [rbp-0x10]
mov eax, [rip-0x11d243]
mov [rcx+0x8], eax
mov rcx, [rbp-0x10]
call 0xffffffffffffe758
```

Machine codes

are executed by Central Microprocessor:its performance is **3 000 000 000** of commands per second

Modifying program (1)

```
begin
    var x,y: integer;
    var a: integer;
    x := 3;
    y := 4;
    a := x + y;
    Write(x,y,a);
end.
```

```
347
```

Oops! Output is bad! No spaces between elements

Modifying program (2)

```
begin
    var x,y: integer;
    var a: integer;
    x := 3;
    y := 4;
    a := x + y;
    print(x,y,a);
end.
```

```
3  4  7
```

Use **Print** instead **Write** to output spaces between elements

Modifying program (3)

```
begin
    var x,y: integer;
    var a: integer;
    x := 3;
    y := 4;
    a := x + y;
    print($'{x} + {y} = {a}');
end.
```

Interpolated string (with **$**)
all the expressions and variables within the braces are replaced by its values

```
3  + 4 = 7
```

Modifying program (4)

```
begin
    var x,y: integer;
    var a: integer;
    x := 3;
    y := 4;
    a := x + y;
    writelnFormat('{0} + {1} = {2}', x, y ,a);
end.
```

```
3  + 4 = 7
```

Formatted output
all the numbers within the braces are replaced by values of variables

Thus, about output:

1.

```
begin
  var n:integer;
  n := 5;
  n:= n * n;
  print('n =',n); // n = 25
end.
```

```
begin
  write('2+');      { без перехода }
  writeln('2=?');  { переход на новую строку}
  writeln('Ответ: 4');
end.
```

2.

```
begin
  var a:=1.2;
  var b:=4;
  var c:=a+b;
  WritelnFormat ('f ({0}, {1}) = {2}', a, b, c);
end.
```

3.

```
begin
  var x := 5;
  var y := 6;
  var res := x + y;
  Print($'Сумма {x} + {y} = {res}');
end.
```

Arithmetic operations and expressions

Common method:

```
begin
   var a := 6; // Assigning value 6
   a:= a + 2; // Increasing by 2
   a:= a - 2; // Reduction of 2
   a:= a * 3; // Multiplication by 3
   a:= a / 2; // division
   print(a**2); // a is a base number, 2 is an exponent
end.
```

Short method:

```
begin
      var a := 6; // Assigning value 6
      a+= 2; // Increasing by 2
      a-= 2; // Reduction of 2
      a*= 3; // Multiplication by 3
      a/= 2; // division
end.
```

Data input

```
begin
  var n:integer; // n is a variable of integer type
  read(n); // input some value to store it in n variable
end.
```

```
begin
  var n:real; // n is a variable of real type - floating point number
  read(n);// input some value to store it in n variable
end.
```

```
begin
  // x1 is a variable of integer type & we input some value to store it in x1:
  var x1:=ReadInteger('please, enter x1');
  // x2 is a variable of real type & we input some value to store it in x2:
  var x2:=ReadReal('please, enter x2');
  var (y1,y2):=ReadInteger2('please, enter two numbers'); ;
  var (z1,z2,z3):=ReadInteger3;
end.
```

Tasks

- To do: tasks 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Follow the rules to make the tasks

1. Save your files with names as it is given in tasks (e.g. `task-04.pas`).
2. Give meaningful names to your variables.
3. Use comments to make the program clear.
4. Give the task of the program as a comment before the program code. Use curly braces for comments:

•Program1.pas*

```
{Find the distance between two points on the plane;
coordinates (x1,y1) and (x2,y2) are given. }

begin
  Writeln('coordinates of the first point:');
```

copy & paste the text of the task in the form of comment before the code

Example

Sample 1:

To do: Calculate the expression. The values of `x`, `y` and `z` are entered.

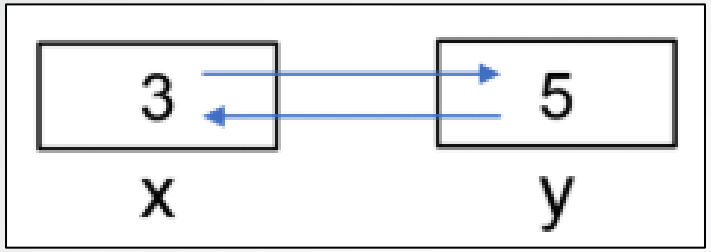
$$\frac{x + \sin x}{y - \sin z} + \ln(x + \sin x)$$

The resulting example:

```
Input x
3
Input y
4
Input z
5
The result = 1.77800712886037
```

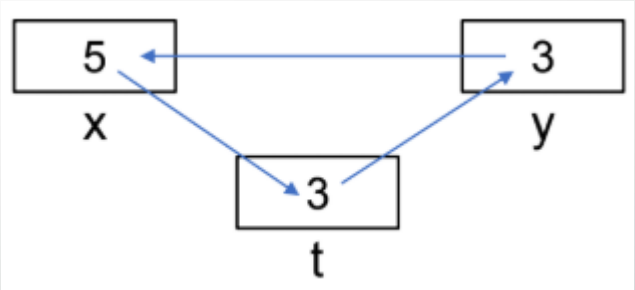
[Program name: L1sample1.pas]

Interchange x and y



Solution 1. Using temporary variable:

```
var t := x;
x := y;
y := t;
```



Solution 2. Using multiple assignment:

```
(x,y) := (y,x);
```

Q & A