PPL language

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Introduction

PPL is the **Parenthesis Programming Language**, in which all elements (statements, parameters, blocks) are enclosed in parentheses. PPL includes a preprocessor to simplify the writing programs and reduce the number of parentheses.

There are some PPL languages (see References), and this language is not the latest with such abbreviation. The only thing that unites all these languages is the abbreviation.

PPL was developed with Microsoft Developer Studio ,C#, without using any third party packages.

The main PPL feature – extensibility, using functionalities of C# and adding user's libraries by means of creating DLLs in accordance with template, described in this tutorial.

PPL supports 2 modes:

ppl (base) mode, which syntax is similar to language LISP, math and logical expressions in prefix notation (**ppl expression**).

Examples:

```
var (x [0]);
set(x) (+(1)(2));
if(==(x) (1)) …
```

scr (preprocessor) mode, which syntax is similar to language C, math and logical expressions in infix notation (**scr expression**).

Examples:

```
var x = 0;
set x = 1 + 2;
if (x == 1)…
```

PPL includes 2 levels of parsing - code written in scr mode translates to ppl mode before executing, parser on each level creates syntax tree.

CPPL and WPPL utilities call PPL API functions, PPL API may be used in other user applications. Mode scr or ppl is set depending on file extension is being executed or by means of the command code, mode scr makes coding easier as it does not require statements to be enclosed in parentheses. By default mode is **ppl**.

Preprocessor includes the following statements – **var, const, array, set, write#, call** and following compound statements (blocks) – **function, for, if, else, switch, case, default**.

All ppl mode statements except above mentioned may be also added to scr code in format ppl.

Data are saved as Unicode symbols, digital data convert to string,

Examples:

```
        set  x = 5.2; saved as "5.2"
```

Boolean values are saved as strings - "True" and "False":

```
        set x = True;
```

Execution of the program in the language PPL is carried out by means of the utilities cppl.exe or wppl.exe, which control commands are listed in section [Keywords](#).

There are different statement formats for ppl mode and scr mode if a statement belongs to two modes.

Base Concepts
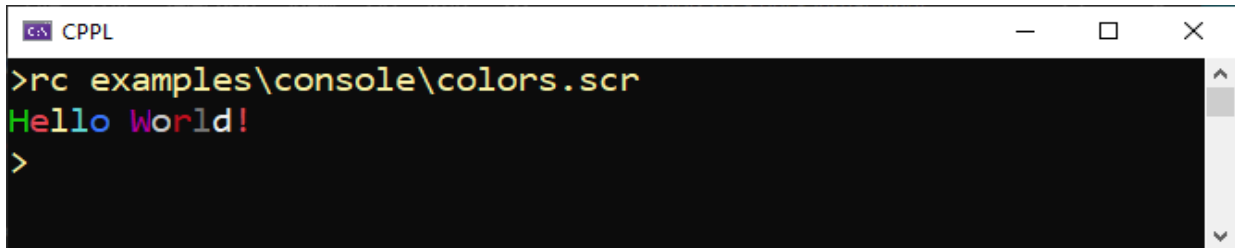
As is customary in many programming language guides the first ppl program is:
write("Hello World!");
without main function.

Another example with using Console and String libraries:
File examples\console\colors.scr:

```
var text = "Hello World!";
array colors[] = {Green,Red,Yellow,Cyan,Blue,Black,
                  Magenta,Gray,DarkRed,DarkGray,White,Red};

array ArrayChars[0];
call String.ToCharArray(text, getname(ArrayChars));

for(i,0,length(text))
{
    // function with 1 argument not need operator call
    Console.ForegroundColor(colors[i]);
    Console.Write(ArrayChars[i]);
};
Console.DefaultColors();
write();    // to new line
```

More 4 samples to illustrate the possibilities of PPL:

```
1.
>rc examples\cowsay\cowsay1.scr
array cow[] =
{
"   _____   ",
"< P P L >",
" ------ ",
"        \    ^__^",
"         \   (oo)_____",
"            (__)\       )\/\",
"                ||----w |",
"                ||     ||"
};

Console.Clear();
for(i,0,length(cow))
{
    Console.SetCursorPosition(0)(i);
    Console.Write(cow[i]);
}
Console.SetCursorPosition(0)(length(cow));
```



```
2.  Added loading of second file, function call, creation node and
array under this node
>rc examples\cowsay\cowsay2.scr

3. Added second operator 'for' to move cow
>rc examples\cowsay\cowsay3.scr

4. Added passing data as arguments when calling command readcode
>rc examples\cowsay\cowsay4.scr 1 1 10
```

Trees

All information is stored in PPL as several kinds of Trees –
root, NS, Functions, Aliases, Configuration and may be displayed on Screen, saved and
restored.
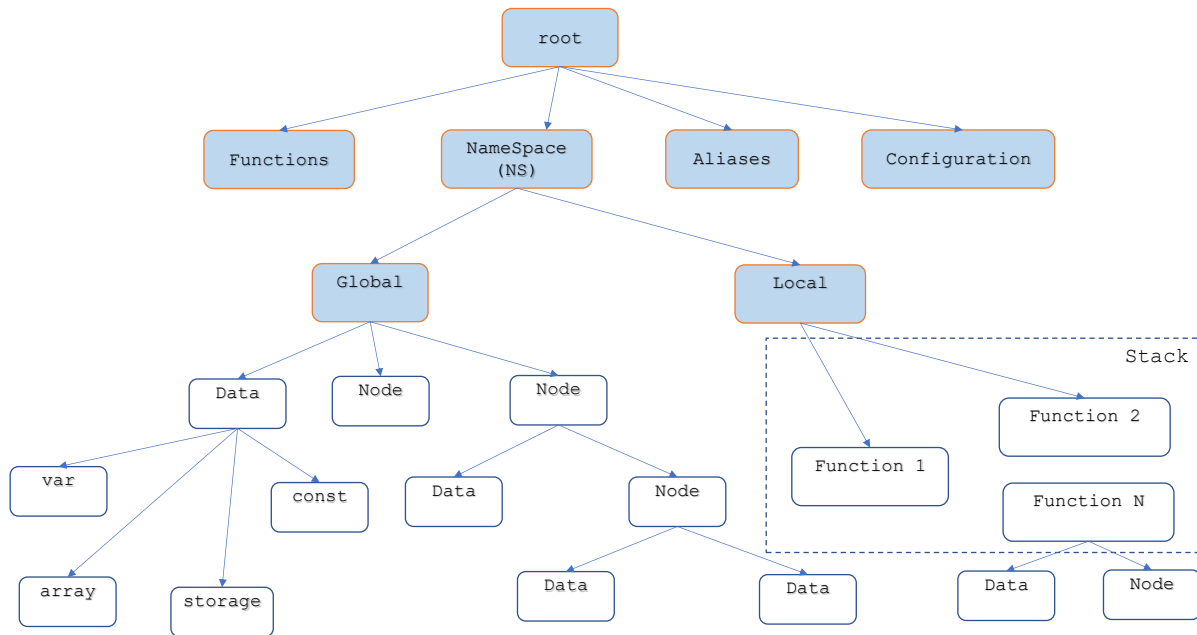
Blue nodes are created automatically when Cppl.exe loads or re-created by command **init**.

By default Tree **Functions** is filling from file Functions\mathlogic.ppl, defined as
"**default_loaded_functions**" in file Configuration.data, it may be changed by user on other
one, to display its contents perform:

```
>display Functions;
```

User may perform command **readcode (rc)** to read files with user's functions and add these
functions to Tree **Functions** or to node, created under Tree **Functions**.
Tree **Functions (or nodes under** Tree **Functions) saves only functions, not data (see examples
6-8 in function)**.
Examples:

```
>d Functions
-----Functions-----
-N2      Sum       [function]
---L0    result
---L1    n1
---L2    n2
```

```
---N1    #         [internal_block]
-----N2 set
-------L0          result
-------N3          +
---------L0        n1
---------L1        n2
```

Adding functions to node under Tree Functions:
```
>createnode Functions.Calc;
function
(
  Functions.Calc.Sum(result)(n1)(n2)
  (
    (set(result)(+(n1)  (n2)))
  )
);
>d Functions
-----Functions-----
-N2      Calc    [Node]
---N3    Sum     [function]
-----L0 result
-----L1 n1
-----L2 n2
-----N1 #         [internal_block]
-------N2         set
---------L0       result
---------N3       +
-----------L0     n1
-----------L1     n2
```

Tree **Aliases** is filling from file **Aliases.data**, to display its contents perform:
```
>display Aliases;
```

Tree **Configuration** is filling from file **Configuration.data**, to display its contents perform:
```
>display Configuration;
```

Any public variables (var, const, array, storage and node) are saved in Tree **Global** as common data for all functions and for code without functions(in "main function").

Public functions are available to functions from any node in Tree **Global**.

Private variables and functions are available to functions in the node, that they belong to only. Full name variables and functions include name of node.

Example:

```
createnode N1;
   function
   (
      N1.f()
      (
         (write("public function N1.f"))
         (N1._f())
      )
   );

   function
   (
      N1._f()      // private
      (
         (write("private function N1._f"))
         (write(N2.x))
         //(write(N2._x))     // Error: [GetValue] [N2._x] private
                                          object, no access
         //(N2._f())          // Error: [Traversal] [N2._f] private
                                          function, no access
      )
   );

createnode N2;
   var(N2.x["public var N2.x"]);
   var(N2._x["private var N2._x"]);
   function
   (
      N2._f()    // private
      (
         (write("private function N2._f"))
      )
   );

N1.f();
write(N2.x);
//write(N2._x);    // Error: [GetValue] [N2._x] private object, no
                    access
```

Variables for functions are created in Tree **Local**, to display its contents perform in function:
```
>display Local
```
When exiting a function, its variables are deleted.

For illustration difference between modes scr and ppl consider the following Examples:

```
>rc Examples\scr\for.scr
=== scr code for preprocessor ===
var begin = 0;
var end = 3;
for(i,begin + 1,end + 1,1)
{
  write(i);
}
=== generated by preprocessor ppl code ===
>var (begin[0]);
>var (end[3]);
>loop (i)( + ( begin )( 1 ) )( + ( end )( 1 ) )( 1 )
(
  do
  (
    (write(i))
  )
);
=== results ===
1
2
3
```

Statement terminator ';' always follows after each type of statements in scr mode.
In ppl mode statement terminator ';' does not follow after statements within compound statements(blocks) – loop, switch,if,function.

Examples in ppl mode:
```
loop (i)(0)(3)(1)
(
   do
   (
     (write(hello))
     (write(world))
   )
);
```

Comments

Two kinds of commentaries are possible:
/*…*/ - for several lines of code
and
// - for one line of code or part of line.

Configuration

Configuration is defined in the file **Configuration.data**, meaning of its members is explained in this tutorial.

```
(Configuration
   (default_loaded_functions  [Functions\mathlogic.ppl])
   (Code                      [ppl])
   (debugppl                  [no])
   (delete all in readcode    [yes])
   (log                       [no])
   (stay_interactive          [no])
   (ReplaceMathLogicOperators [no])
   (OFD_port                  [11000])
   //(UserFunctions1          [Functions\*.ppl])
   //(UserFunctions2          [Functions\*.ppl])
   (UserImport1               [Directory])
   (UserImport2               [Math])
   //(UserImport3             [String])
)
```

Identifiers and DNS

Names of nodes, variables, arrays, storage and functions contain any symbols, first symbol is any upper or lower case letter or any of the following symbols: _$# , but not a digit. Variables with first symbol _ in name are hidden or private variables (see hidden variables).
Length of identifiers is not limited. Do not set keywords, their aliases and names of Libraries as identifiers.
When data is created, its full name and saved address are added to **Data Names Structure (DNS)**. DNS creates separately for non-functions identifiers in Global and for each function in Local, function DNS will be destroyed when exiting the function.
Symbolic values are enclosed in quotation marks, to include a quotation mark in a symbolic expression, precede it with backslash.
Example:
```
"123\"qwe" => "123"qwe"
```
Backslash before the last quote mark it is backslash, not quote mark.
```
"123\qwe\" => "123\qwe\"
```

Public and private variables

Variables, constants, arrays, storage and functions, whose names start with **underscore** are private, all other are public.
Examples:
```
>createnode N1;
>var(N1.x["public var N1.x"]);
>var(N1._x["private var N1._x"]);
```

```
function
(
    N1._f()      // private
    (
        (write("private function N1._f"))
        (write(N1.x))
        (write(N1._x))
    )
);
```

Error occurs when re-creating a variable, it is possible to delete this variable and to create again:

```
>var(x);
>var(x);    // re-creation
Error: [FuncCreateVariables] name [x] already exists
>del x;
>var(x);
```

Compound statements (blocks)

The following blocks **for, if, else** include one or several statements enclosed in curly brackets:

```
if (x == 1)
{
    write("COMPOUND");
    write("STATEMENTS");
}
else
{
    write("compound");
    write("statements");
}
```

When only one statement (**not compound statement**) is in curly brackets it is possible to omit brackets:

```
if (x == 1)
    write("COMPOUND");
else
    write("statements");
```

```
if (x == 1)                              // right
{
    if (y == 2)
       write("right sample");
}
```

```
if (x == 1)                              // wrong
    if (y == 2)
    {
        write("wrong sample");
    }
```

Libraries

Default name of library is **Main**, it loads always when Cppl.exe or Wppl.exe starts. It is possible to set in file **Configuration.data** as **"UserImportN"** names of additional libraries initialization loaded . To display list of loaded libraries perform:

```
>importlist;
Main
Directory
Math
```

To display contents of any library perform:
<name of library>.help
or **help** for Main library

Example:

```
>Directory.help;
help
GetFiles
GetDirectories
SetCurrentDirectory
GetCurrentDirectory
```

To get short information about any library function perform:
<name of library>.help(function name)

```
>Math.help(Sinh)
    Returns the hyperbolic sine of the specified angle:
    Math.Sinh(double value)
```

```
For Main Library help  or ?:
>? d
        display | d [root|NS|Aliases|Functions|Local|node name]
        display NS.namespace.name]
```

Keywords

All keywords are divided into 9 groups and presented below:

Service Commands
help, version, cls, shell, init, code, showcode, readcode, fdreadcode,
createpplcode, display, displaynodes, dn, dstree, datanames, suspend,
resume, debugppl, traceppl, recreate, log, exit

Special Commands
import, importlist, eval, length, calc, sleep,
isexist, isdigits, isinteger, isalldigits, isallinteger, iseven, isodd,
del, getbykey, getbyvalue, set, setkvp, getvalue, getname

Nodes and Leaves
createnode, copynode, getnodes, getleaves

Variables and Arrays
var, const, array, realloc

Storage
storage, sinit, sget, sset, swrite, sinfo, ssetrow

Backup and Recovery
savedata, readdata

Control Flow
if, else, switch, case, default, loop, do, for, break, continue

Input Output
write, writeline (write#), writearray, readline

Functions
function, funclist, funcname, argc, getargname, call, return
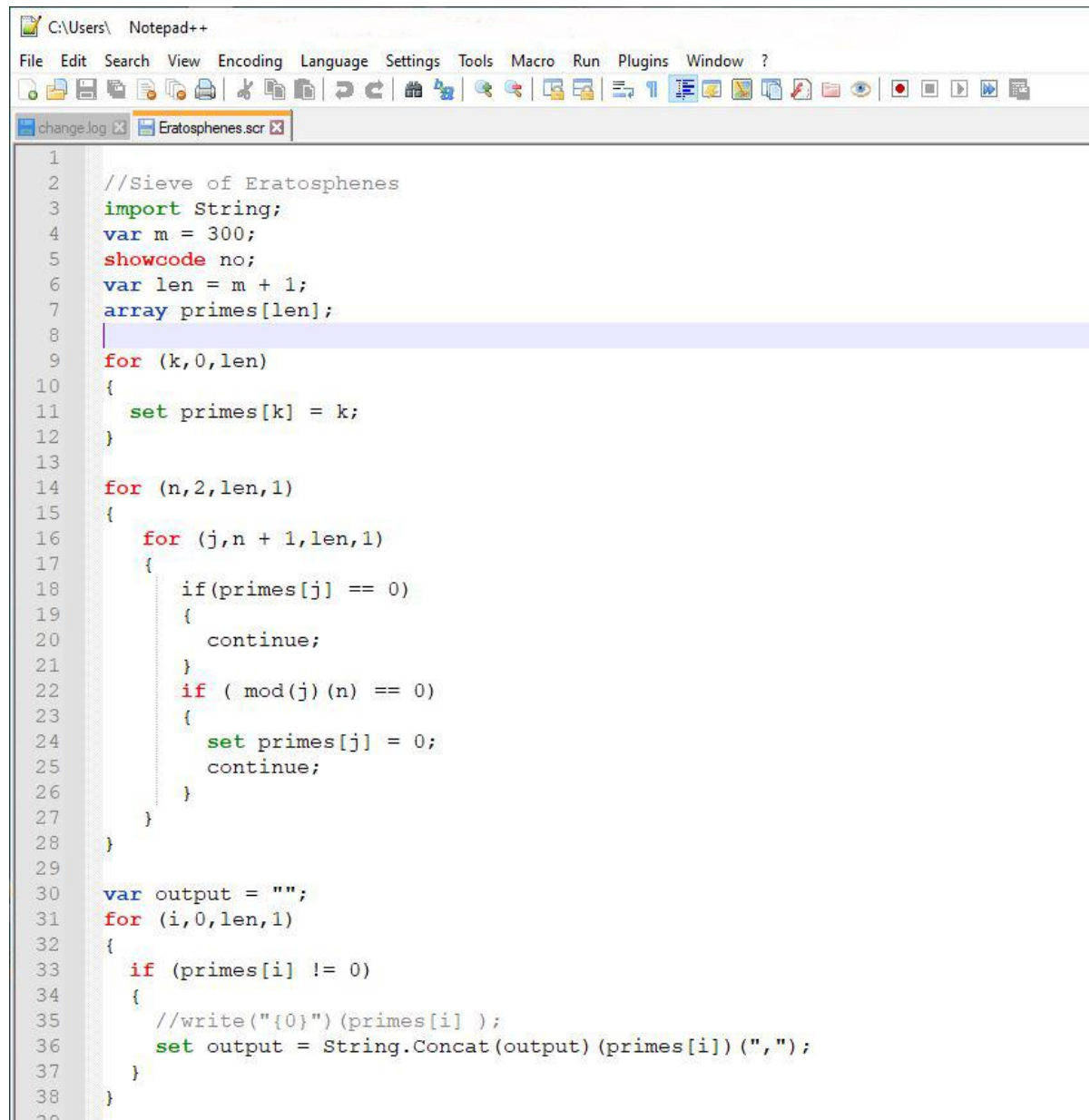
Delegates and callbacks
delegate,dlgtinstant,dlgtset,dlgtcall,callback

Special variables, constants and words
empty – see methods ArrayList.Add, Queue.Enqueue, Stack.Push
tab,comma,space – see String.Split, String.Splitcsv.

Highlighing keywords support is provided in Notepad++ :

```
//Sieve of Eratosphenes
import String;
var m = 300;
showcode no;
var len = m + 1;
array primes[len];

for (k,0,len)
{
  set primes[k] = k;
}

for (n,2,len,1)
{
   for (j,n + 1,len,1)
   {
      if(primes[j] == 0)
      {
        continue;
      }
      if ( mod(j)(n) == 0)
      {
        set primes[j] = 0;
        continue;
      }
   }
}

var output = "";
for (i,0,len,1)
{
  if (primes[i] != 0)
  {
    //write("{0}")(primes[i] );
     set output = String.Concat(output)(primes[i])(",");
  }
}
```

CPPL utility

Command-line REPL utility **cppl.exe** is a PPL interpreter which syntax and keywords are given in this tutorial. This utility is written in C# without any third party packages.

These are following subdirectories and files used to work with cppl.exe
Subdirectories:
\Data
\Examples
\Functions
Files:
Aliases.data
Configuration.data
CPPL.exe, OFD.exe,

There are 2 operating modes in accordance with cppl.exe arguments:
1. **NonInteractive mode**
Execute program in file with extension scr or ppl.

      cppl.exe file [arg1 arg2 ...]

      file := file.ppl|file.scr

If arguments are present, they override the variables 1, 2 and so on in the body of the called file. Number between two symbols $ is the serial number of argument.
An error occurs if arguments quantity less than max variable number.
Value of argument is literal, not command.
When value of **stay_interactive** in file **Configuration.data = "no"** cppl.exe finishes after program execution**,** when value of **stay_interactive** = **"yes"** cppl.exe does not finish and continues in interactive mode.

Example:
File example.scr
```
var $1$ = $2$;
>cppl.exe example.scr x 2;
```

2.**Interactive mode**
      cppl.exe
Command input from standard input stream.
To get list of commands and their short explanation perform **help** (or ?).
Examples:
```
>? Display;
        display [root|NS|Aliases]
>? d;
        display [root|NS|Aliases]
```

Prompt "**>**" appears on Screen before each command.
Examples:
```
>display;
-N1     NS
---N2   Global
```

In addition to commands required to work with scr/ppl programs, cppl.exe allows you to execute all Windows commands and save the results. Command **shell** uses for that.
Examples:
```
>var (x);
>set(x)(shell(cd));      // output is saved in var x
>write(x);
```

The following often used commands and operators with one parameter may be used with or without parentheses around arguments:
help (?), import, readcode (rc),showcode, createnode, isexist, display (d), del, code, debugppl.

WPPL utility

WPPL.exe is also a PPL interpreter, its functionalities are liked cpp.exe. WPPL.exe is WPF Application, runs in interactive mode only.

```
WPPL                                                                    —  □  ×
File  Data
 init    cls    display    importlist   ppl ˅   ☑ showcode  ☐ debugppl  ☐ log        help
>showcode;
>version
version 1.0.6
>help
>



----------Init----------
-N0    root
---N1  NS
-----N2 Global
-----N2 Local
code: ppl
debugppl = no
log = no
stay_interactive = no
Imported [Directory]
Imported [Math]
ShowCode=yes


        ----------Main----------
----------------Service Commands--------------------
    help        version     cls         shell       init        code
    showcode    readcode    fdreadcode  dstree      display     createppl
    datanames   suspend     resume      debugppl    log         exit
----------------Special Commands-----------------
    import      importlist  eval        length      exist       del
    getbyname   getbyvalue  set         getvalue    getname
----------------Nodes-----------------------------
    createnode  copynode
----------------Variables and Arrays----------------
    var         const       array       realloc
```

Top part is used as input any PPL commands, down part is for results presentation. Also service commands may be performed by menu and wpf controls over top part.
The following dialogs are used to perform service commands:

Clicking on **CreatePPL in Menu** opens the following dialog:

```
CreatePPLDlg                                                              ×

SCR filename: PL\PPL\PPL\WPPL\bin\Debug\netcoreapp3.1\Examples\rc.scr    Browse

 PPL filename: C:\Users\ok21\MyProjects.Work\C#2\PPL\PPL\PPL\WPPL\bin\   CreatePPL
```

Clicking on **ReadCode in Menu** opens the following dialog:

Clicking on **ReadData in Menu** opens the following dialog:

Clicking on **SaveData in Menu** opens the following dialog:

Clicking on button **display** opens the following dialog:

```
RootTreeDlg                                    —    □    ✕

▲ root
   ▲ NS
        Global
        Local
   ▷ Functions
   ▷ Aliases
   ▲ Configuration
        default_loaded_functions       [Functions\mathlogic.ppl]
        Code     [ppl]
        debugppl          [no]
        log      [no]
        stay_interactive        [no]
        OFD_port         [11000]
        ReplaceMathLogicOperators       [no]
        UserImport1     [Directory]
        UserImport2     [Math]
```
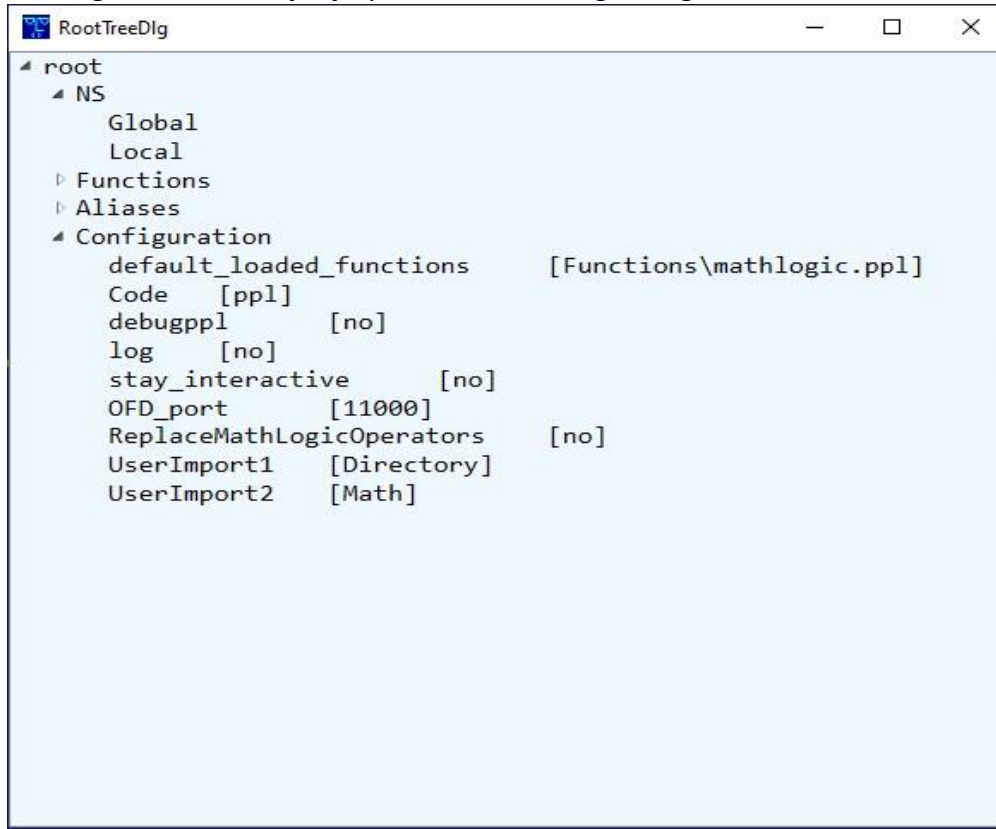
History of commands is supported by buttons **PgUp** and **Pgdn**.
WPPL.exe is an example of using the PPL API, which can be easily used in the user's application.

PPL Assistant

PPL Assistant displays format commands in ppl and scr modes. As well this application displays format methods in additional libraries.
Files JsonHelp*.json are generated by utility CreateUserLibCode.exe (version 1.0.15).
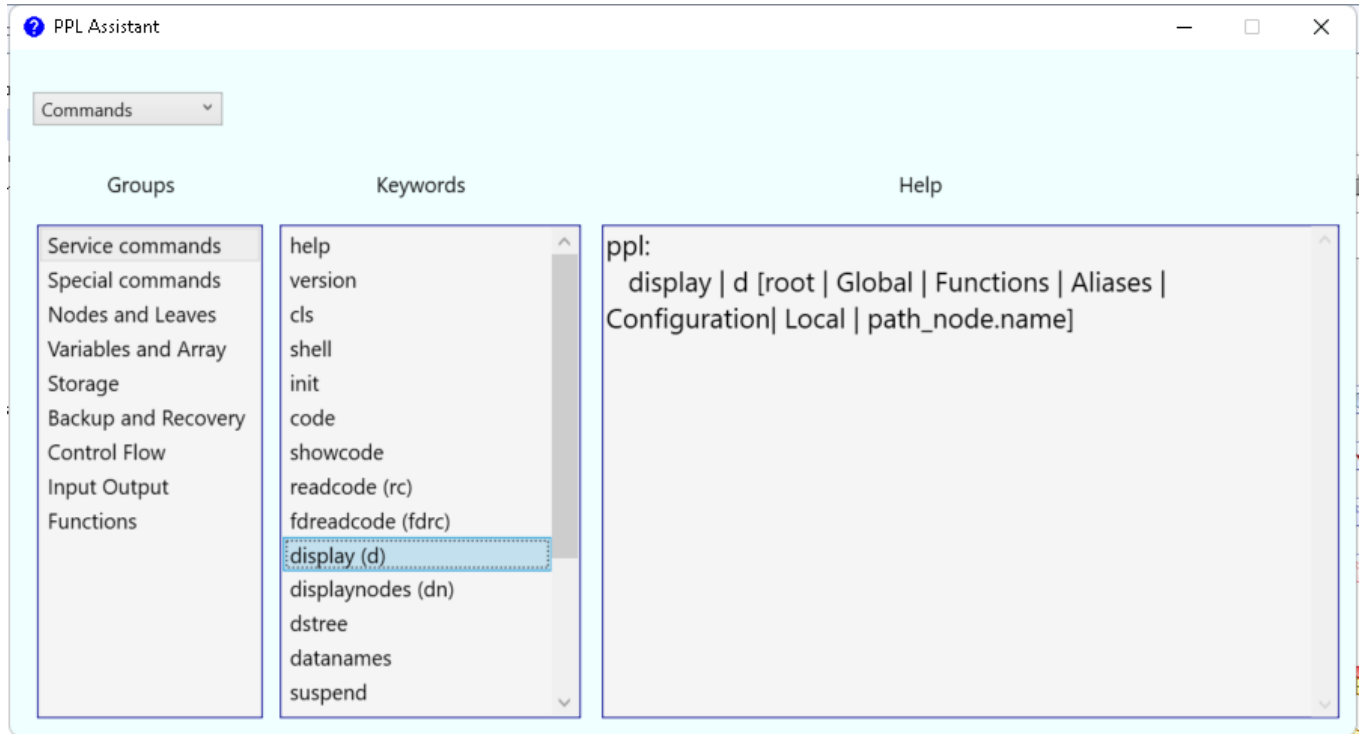
Service Commands

help

Displays keywords list for Library by <name> or
format of command from Main library.
Library must be loaded before (see <import>)
by default name = Main, this library is loaded automatically
Format: **help | ? [<library name>] | keyword**

```
CPPL                                                                    —    □    ×
>?
        ----------Main----------
--------------------------Service Commands----------------------------
        help        version     cls         shell       init        code
        showcode    readcode    fdreadcode  dstree      display     displaynodes
        datanames   suspend     resume      debugppl    traceppl    recreate
        log         exit        createpplcode
--------------------------Special Commands----------------------------
        import      importlist  eval        length      del
        isexist     isdigits    isinteger   calc        sleep
        isalldigits isallinteger iseven     isodd
        getbykey    getbyvalue  set         getvalue    getname
-------------------------Nodes and Leaves-----------------------------
        createnode  copynode    getnodes    getleaves
-----------------------Variables and Arrays---------------------------
        var         const       array       realloc
-----------------------------Storage----------------------------------
        storage     sinit       sget        sset
        swrite      sinfo       ssetrow
---------------------Backup and Recovery------------------------------
        savedata    readdata
-------------------------Control Flow---------------------------------
        if          else        switch      case        default
        loop        do          for         break       continue
-------------------------Input Output---------------------------------
        write       write#      writeline   writearray  readline
---------------------------Functions----------------------------------
        function    call        funclist    funcname    argc        return

        to get short explanation of each command: help command
>
```

Examples:
```
>? Code;
     Sets mode for Console input or displays on Screen
     code ppl | scr
>? "display"    // only display in quotes
     display | d [root|NS|Aliases|Functions|Local|node name]
     display [NS.namespace.name]
```
Any other library has function help for display its contents.
<name of library>.help [(keyword)]
```
>Matrix.help (Rotate)
```

version

Display current version
Format: **version**

cls

Clears the Screen

Format: **cls**

shell

Executes Windows Console Commands, several commands are hash symbol separated.
Results of shell are saved and can be displayed by commands **write** or by **debugppl yes**
Format: **shell (command with parameters[#command with parameters])**
Examples:

```
>write(shell (cd:\));
>debugppl yes;
>shell (dir /b tests#cd);
```

init

Deletes all data and functions and creates new root, use this command for console
input only.
Format: **init**

code

Sets mode for Console input or displays it on Screen.
Mode scr is more convenient for writing code with blocks and for using infix
expressions. But in other cases there is no difference.
Format: **code [ppl|scr]**
default - ppl
It is possible to set **code** in file **Configuration.data**.

showcode

Shows or hides on Screen ppl_code when command readcode is executed or displays
showcode value on Screen
Format: **showcode [yes|no]**
Default: no
Examples:

```
>showcode no;
```

readcode

Reads file with code in format scr or ppl.
At the end of the execution readcode the previous code will be set.
Format: **readcode | rc <file.scr|ppl> [arg1 arg2 …]**
If arguments are present, they override the variables 1, 2 and so on in
the body of the called file.
Number between two symbols $ is the serial number of argument.
An error occurs if arguments quantity less than max variable number.
Arguments are literals, not commands.
If **delete_all_in_readcode = yes** in **Configuration.data** command

delete all is added automatically as first command when first command **readcode** is called.

The file being called can also include readcode commands. Files called by command readcode can be of different formats - .scr or .ppl.

If caller script and internal scripts are in the same path you can omit path for internals. You can specify relative path from cppl.exe or full path, including drive:

```
>rc path\caller.scr
call internal script:
      rc internal.scr
or    rc path\internal.scr or rc drive:\path\internal.scr
```

Example

```
1.
    > Directory.SetCurrentDirectory(examples\ppl);
    >rc loop.ppl;  // or rc examples\ppl\loop.ppl
    loop (i)(0)(3)(1)
    (
       do
       (
          (write("PPL"))
          (write("ppl"))
       )
    );
2. File example.scr
    var $1$ = $2$;
    >rc example.scr x 2;

3. reading script with command readcode inside:
File main.scr:
    write("main script");
    rc examples\rc\first.scr;
    rc examples\rc\second.scr;
    write("return from main script");
File first.scr:
    write("first script");
    rc examples\rc\third.scr;
    write("return from first script");
File second.scr:
    write("second script");
File third.scr:
    write("third script");

    > rc examples\rc\main.scr;
Results:
    main script
    first script
    third script
    return from first script
    second script
    return from main script
```

fdreadcode

Like readcode with using FileDialog to select file. This command loads ofd.exe and sets connection with **cppl.exe** via UDP protocol, port defined in file **Configuration.data** as **OFD_port**.
Format: **fdreadcode|fdrc**

createpplcode

Creates file in format ppl from file in format scr.
Format: **createpplcode|cpc (file.scr)(file.ppl)**
Examples
```
>createpplcode (ttt.scr) (ttt.ppl);
>cpc (ttt.scr) (ttt.ppl);
```

display

Displays nodes(N) and leaves(L) in Tree, alias – d.
Format:
display | d [root | Global | Functions | Aliases | Configuration| Local | path_node.name]

default: Global
Examples:
```
 >array(y[2])(0);
 >d;
-N  NS
---N  Global
-----N  y
-------L0              [0]
-------L1              [0]
>d Global.y;
>d y;
>d Functions.Sum;
```

displaynodes

Displays nodes(N) only, alias – dn.
Format:
displaynodes | dn [root | Global | Functions | Aliases | Configuration| Local | path_node.name]

Example:

```
>dn Functions
-----Functions-----
-N3      Sum       [function]
---N1    #         [internal_block]
-----N2 set
-------N3          +
-N3      Sub       [function]
---N1    #         [internal_block]
-----N2 set
-------N3          -

....................................
```

dstree

Displays function syntax tree with nodes(N) and leaves(L) of code.
dstree displays all function tree within function.
Format: **dstree() | dstree**

Examples:
```
>rc examples\scr\func7.scr

function func(n,m)
{
    write#("{0} {1}", n , m);
    dstree;
}
func(aaa)(111);

Result:

aaa 111
-----Syntax Tree-----
-N3     func     [function]
---L0     n
---L1     m
---N4     #          [internal_block]
-----N5 write
-------L0          "{0} {1}"
-------L1          n
-------L2          m
-----N5 dstree
-------L0
```

datanames

Displays contents of DNS.
Format: **datanames [Local]**
Examples:

```
>var(x);
>createnode Node1;
>array(Node1.arr[5]);
>datanames;
-----Global_dns-----
        _main0   var
        _main1   var
        _main2   var
        empty    const
        x
Node1    arr
>datanames Local;    // for using in functions
-----Local dns-----
```

suspend and resume

Stops script to perform manually one or several commands,
for exit – **resume**
Format: **suspend**
Examples:

```
>Enter:
>d
-N1     NS
---N1   Global
>resume  // continue script execution
```

debugppl

Displays information about creation and deletion variables, results operations and duration or displays debugppl value on Screen.
Format: **debugppl [yes|no]**
It is possible to set **debugppl** in file **Configuration.data**.
Example:

```
>var(x)
>debugppl yes
>duration = 0.0015026
>del x
leaf [x] is deleted
>duration = 0.0054401
```

traceppl

Displays all commands and function names on screen during the execution of commands. By default – traceppl no.
Format: **traceppl [yes|no]**
Example:
>traceppl yes;

recreate

Permits recreation vars,arrays, storage and nodes. By default – recreate no;
Format: **recreate [yes|no]**
Example:

```
>recreate yes;
>code scr;
code: scr
>var x;
>var x;
>recreate no;
>var x;
Error: [FuncCreateVariables] name [x] already exists
```

log

Writes commands and results to logfile in directory **Log** or displays log value on Screen.
Format: **log [yes|no]**
It is possible to set **log** in file **Configuration.data**.
Opened logfile will be closed by command init or exit.

exit

Exit from Cppl.exe (**exit**) or exit from script (**exit()**).

Special Commands

import

Loads Library, name of Library is name of DLL.
Format: **import <Library name>**
Examples:
```
>import Math;
```

importlist

Displays list of loaded Libraries
Format: **importlist**
Examples:
```
>importlist;
Main
Math
```

eval

Performs string in format ppl.
Format: **eval <ppl expression>[<result>]**
result:=var_name to save result
Examples

```
Ex. 1
> var (sum);
>var(x["+(2)(3)"]);
>d;
-N1     NS
---N2   Global
-----L0 sum
-----L1 x          ["+(2)(3)"]
---N2   Local
>eval(x)(sum)
>d
-N1     NS
---N2   Global
-----L0 sum        [5]
-----L1 x          ["+(2)(3)"]
---N2   Local

Ex. 2
array y[] = {"+(3)(5)","+(4)(6)"};
for(j,0,length(y))
{
   eval(y[j]);
};

Ex.3
var(x);
eval("+(1)(2)")(x);
write("{0} = {1}")(getname(x))(getvalue());
x = 3
```

length

Returns length of value for var | const or length array | storage
Format: **length (var | const name | array name|storage name)**
Examples:

```
>array (y[3]);
>length(y);
result = 3
>var (x["Hello!"]);
>length(x);
result = 6
```

isexist

Determines whether var, array or storage with specified name exists or not in Global or Local, returns "**True**" or "**False**".
Format: **isexist(name) | isexist name**
name:= [NS.][namespace.][node.]name
Example:

```
1.
>debugppl yes
>var (x);
>isexist x;
result=True
2.
> createnode Functions.New
> isexist Functions.New
result=True
```

isdigits

Checks is value of var or member of array or storage digital, returns "**True**" or "**False**".
Format**: isdigits(var name | member of array or storage | literal) |**
       isdigits var name | member of array or storage | literal

```
Example:
>var(x[1.1]);
>isdigits x;
result=True
```

isinteger

Checks is value of var or member of array or storage integer, returns, returns "**True**" or "**False**".
Format**: isinteger(var name | member of array or storage | literal) |**
       isinteger var name | member of array or storage | literal

```
Example:
>var(x[1]);
>isinteger x;
result=True
```

isalldigits

Checks is all members of array or storage digital, returns, returns "**True**" or "**False**".

Format: **isalldigits(member of array or storage) |**

isalldigits member of array or storage

Example:
```
>array(x)(1)(2)(3);
>isalldigits x;
result=True
```

isallinteger

Checks is all members of array or storage integer, returns, returns "**True**" or "**False**".

Format: **isallinteger(member of array or storage) |**

isallinteger member of array or storage

Example:
```
> array(x)(1)(2)(3);
>isallinteger x;
result=True
```

iseven, isodd

Checks is integer value even or odd, returns "**True**" or "**False**".

Format:

iseven(var name | member of array or storage | literal) |
iseven var name | member of array or storage | literal

isodd(var name | member of array or storage | literal) |
isodd var name | member of array or storage | literal

del

Deletes any kinds of data from Global or Local Tree, also deletes nodes from Functions.
Format: **del fullname**
To delete all Global contents**: del all**
If **delete_all_in_readcode = yes** in **Configuration.data** command
delete all adds automatically as first command when command **readcode** is
called. Otherwise all data will be saved in memory, if necessary add this command
manually.
fullname:= node path.name
node path:= node path | node
Example:

```
>createnode Node1;
>var(Node1.x);
>del Node1.x;


>createnode Functions.Geo
>del Functions.Geo
```

For re-run script, that creates array:

```
>if(==(isexist(y)) (True))
(
    (del y)
);
>array(y[5]);
```

calc

Calculates infix notation math. expression and writes result on screen.
Format: **calc math.expression**
Example:

```
>var (x[1]);
>calc x + 2*Math.PI();
7.283185307179586
```

sleep

Suspends the interpreter for the specified number of milliseconds
Format: **sleep(msec)**
Example:

```
>sleep(100);
```

getbykey

Gets value from array by name.
Format: **getbykey(name array)(name element)**
Example:

```
See example in readdata
>getbykey(Colors)(Black);
result = 0
```

if key is absent return **nan**.

getbyvalue

Gets name from array by value.
Format: **getbyvalue(name array)(value element)**
Example:

```
See example in readdata
>getbyvalue(Colors)(0);
result = Black
```

if value is absent return **nan**.

set

Sets value for variable and array element
Format for **ppl code**:
set (var_name | array_name [index]) (value | array_name [index])
index:=value| ppl expression
Format for **scr code**:
set var_name | array_name [index] = value | scr expression
index:=value| scr expression

Command **set** checks whether index is out of bounds.
Examples:

```
>code ppl:
>var (x);
>set(x)(+(1)(2));
>array(y[3]);
>set(y[+(1)(2)])(0);

>code scr:
>var x;
>set x = 1;
>array y[3];
>set y[x + 1] = 2 + 3;
>set y[0] = y[1];
```

To calculate indexes command set in scr-mode creates temporary variables and
deletes them at the end:

```
>code scr;
>array (a)(1)(2)(3)(4)(5)(6)(7);
>set a[1+2] = a[2+2]+ 1;

Generated ppl-code:
array (a)(1)(2)(3)(4)(5)(6)(7);
var (#0[ + (1)  (2) ]);
var (#1[ + (2)  (2) ]);
set (a[#0])(+(a[#1])(1));
del #0;
del #1;
```

setkvp

Sets key and value array element
Formats for **ppl code**:
setkvp(array_name [index])(key)(value | ppl expression)
index:=value| ppl expression

Command **set** checks whether index is out of bounds. For setting key and value
command **set** checks whether key already exists in array.
To get key and value it is possible by commands **getbykey** and **getbyvalue**.

```
    >code ppl:
>array(y[3]);
>setkvp(y[0])(+(1)(2));
>setkvp(y[1])(one)(1);
>setkvp(y[2])(two)(2);

>code scr:
>var x = 1;
>array y[3];
>setkvp y[x + 1] = five,2 + 3;
>setkvp y[0] = null, 0;
```

getvalue

Returns value of single var|const or array element.
Error: when argument is literal or not existed variable.
Format: **getvalue (var_name) | getvalue(array_name[index]**
index:= value|ppl expression
Alias: get
Examples:

```
>array (y[3])(999);
>write("getvalue(y[0]) = {0}")(getvalue (y[0]));
result: getvalue (y[0]) = 999
```

getname

Returns name of single var|const | array | array element as string.
Error: when argument is literal or not existed variable.
Format: **getname (name)**
Examples:

```
>var (x[ppl]);
>write("{0} = {1}")(getname x)(getvalue x);
x = ppl
```

Using operators getvalue and getname in function see examples\scr\func4.scr

Nodes and Leaves

createnode

Creates node in path, default path is "**Global**", it is possible to create nodes in Global, Local and Functions Trees. It will be error if name already exists (see recreate).

Format: **createnode(path.name) | createnode path.name**
Examples:

```
> createnode (Node)
> createnode Node.SubNode
>d
-N1      NS
---N1    Global
-----N2 Node
-------N3        SubNode

>createnode Functions.Geo
```

copynode

Copies one or more times node from path with new name, by default path is "Global"
Format:
copynode (src node)(dst node)[number of copies]
default number of copies: 1
Examples:

```
>rc tests\struct\personglob.ppl
>createnode Person;
>var(Person.Name);
>var(Person.Family);
>var(Person.DOB);
>var(Person.Gender);
>array(Person.cars[3]);
>copynode(Person)(Team);
Info [FuncCopyNode] Global node [Team] is created
>set(Team.Name)(Oscar);
>set(Team.Family)(Ko);
>set(Team.DOB)(2050);
>set(Team.Gender)(m);
>set(Team.cars[0])(Juke)(Nissan);
>set(Team.cars[1])(Qashqai)(Nissan);
>d
-N1      NS
---N2    Global
-----N3 Person   [Node]
-------L0        Name
-------L1        Family
```

```
-------L2         DOB
-------L3         Gender
-------N4         cars      [Array 3]
---------L0       #
---------L1       #
---------L2       #
-----N3 Team      [Person]
-------L0         Name      [Oscar]
-------L1         Family    [Ko]
-------L2         DOB       [2050]
-------L3         Gender    [m]
-------N1         cars      [Array 3]
---------L0       Juke      [Nissan]
---------L1       Qashqai [Nissan]
---------L2       #
---N2    Local
```

getnodes

Creates ppl_array with fullnames of nodes till defined nesting. Processing results of commands getnodes and getleaves allows to find required information in hierarchical data dtructure.

Format:

getnodes (top node)[(nesting)]("ppl_array")

Number of required nesting it is possible to get by command displaynode.

If (nesting) do not set node names under top_node will be saved in ppl_array.

For example there is file Data\Mng2.data

```
(Staff
   (Marketing
      (Managers
         (Personal Data1 [base]
            (Name [Benjamin])
            (Salary [6000])
            (Hobby
               (sport [tennis])
               (music [jazz])
            )
         )
      )
      (Clerks
         (Personal Data2 [base]
            (Name [Oliver])
            (Salary [4000])
         ……..
```

Read it:

```
>readdata (data\Mng2.data);
>d
-N2      NS
---N3    Global
```

```
     -----N4 Staff
     -------N5        Marketing
     ---------N6       Managers
     -----------N7   Personal Data1   [base]
     ------------L0 Name      [Benjamin]
     ------------L1 Salary   [6000]
     ------------N8 Hobby
     --------------L0        sport    [tennis]
     --------------L1        music    [jazz]
     ---------N6      Clerks
     -----------N7   Personal Data2   [base]
     ------------L0 Name      [Oliver]
     ------------L1 Salary   [4000]
```

or

```
     >dn Staff
     -----Variables  and arrays-----
     -N4       Staff
     ---N5   Marketing
     -----N6 Managers
     -------N7          Personal Data1   [base]
     ---------N8        Hobby
     -----N6 Clerks
     -------N7          Personal Data2   [base]
     -------N7          Personal Data3   [base]
     ---------N8        Hobby
     -------N7          Personal Data4   [base]
     -------N7          Personal Data5   [base]
     ---------N8        Hobby
```

Get fullnames of nodes till nesting 7 and save in ppl_array "persons":

```
>getnodes(Staff)(7)("persons");
>d persons
-----Variables  and arrays-----
-N4       persons [Array 21]
---L0   #       [Staff.Marketing.Managers.Personal Data1]
---L1   #       [Staff.Marketing.Clerks.Personal Data2]
---L2   #       [Staff.Marketing.Clerks.Personal Data3]
---L3   #       [Staff.Marketing.Clerks.Personal Data4]
---L4   #       [Staff.Marketing.Clerks.Personal Data5]
---L5   #       [Staff.Finance.Managers.Personal Data6]
---L6   #       [Staff.Finance.Managers.Personal Data7]
---L7   #       [Staff.Finance.Managers.Personal Data8]
---L8   #       [Staff.Finance.Clerks.Personal Data9]
---L9   #       [Staff.Finance.Clerks.Personal Data10]
---L10  #       [Staff.Finance.Clerks.Personal Data11]
---L11  #       [Staff.Operations management.Managers.Personal
                                        Data12]
---L12  #       [Staff.Operations management.Managers.Personal
                                        Data13]
---L13  #       [Staff.Operations management.Clerks.Personal Data14]
---L14  #       [Staff.Operations management.Clerks.Personal Data15]
---L15  #       [Staff.Operations management.Clerks.Personal Data16]
```

```
---L16  #        [Staff.Operations management.Clerks.Personal Data17]
---L17  #        [Staff.Operations management.Clerks.Personal Data18]
---L18  #        [Staff.Operations management.Clerks.Personal Data19]
---L19  #        [Staff.Human Resource.Managers.Personal Data20]
---L20  #        [Staff.Human Resource.Clerks.Personal Data21]
```

getleaves

Creates ppl_array whose elements have names and values of node:
Format:
getleaves(node)("ppl_array")
Example:
See previous example with command getnodes

```
>getleaves(Staff.Marketing.Managers.Personal Data1)("property")
>d property
-----Variables  and arrays-----
-N4     property          [Array 2]
---L0   "Name"  [Benjamin]
---L1   "Salary"          [6000]
```

Full code of file Data\mng2.scr to find persons with salary = 2000:

```
var tmp;
var salary;
var name;
readdata (data\Mng2.data);
getnodes(Staff)(7)("persons");
for(i,0,length(persons))
{
 if (isexist(property) == True)
 {
  del property;
 }
 getleaves(persons[i])("property");
 for(j,0,length(property))
 {
    set tmp = getname(property[j].name);
   if (tmp == "Name")
   {
      set name = property[j].value;
   }
   if (tmp == "Salary")
   {
     set salary = property[j].value;
     if (salary == 2000)
     {
        write("Name = {0,-15}\tSalary = {1}")(name)(salary);
     }
   }
 }
}
>rc data\mng2.scr
```

```
result:
Name = Charlotte        Salary = 2000
Name = Olivia           Salary = 2000
Name = Felix            Salary = 2000
Name = James            Salary = 2000
Name = Sophia           Salary = 2000
```

Arithmetic operators

+, -, *, /, ^, %, ++, --
    and their aliases:
    sum, sub, mul, div, pow, mod (see Aliases.data).
    To use these aliases set **yes** for **ReplaceMathLogicOperators** in Configuration.data.
    By default **ReplaceMathLogicOperators = no** to decrease processing time.
    These are binary operators.
    Do not confuse with functions names in **Mathlogic.ppl**:
    Sum, Sub, Mul, Div, Pow
    Examples in ppl prefix notation:

```
+(x)(y)
*(+(x)(y))(-(z)(3))
```

    Examples in scr infix notation:

```
>code scr;
> var z = x  + y;
> var z  = (x  + y) * (z - 3);
```

    Example with Aliases:

```
> var z = (2 plus 3)  mul 4;
```

Logical operators

<, <=, >, >=, ==, !=, &&, ||, xor
    xor only for ppl mode
    and their aliases:
    lt, le, gt, ge, eq, ne, and, or   (see Aliases.data).
    To use these aliases set **yes** for **ReplaceMathLogicOperators** in Configuration.data.
    By default **ReplaceMathLogicOperators = no** to decrease processing time.
    These are binary operators.
    Do not confuse with functions names in **Mathlogic.ppl**:
    LT, LE, GT, GE, EQ, NE, AND, OR,XOR
    Examples in ppl prefix notation:

```
==(x)(y)
&&(==(x)(y))(==(z)(3))
```

    Examples in scr infix notation:

```
x == y
(x == y) && (z == 3)
```

Variables and Arrays

var

Creates a single variable in Global or in Local function scope. It will be error if name already exists (see recreate).
Format **ppl**:
var (name)| (name[init value])
name:= [node path]name
node path:= node. | node
init value:= value| ppl expression
ppl expression:=value | prefix notation expression
Examples:

```
>var (greeting["Hello"]);
>var (x);
>var (y[+(2)(3)]);
```

Format **scr**:
var name|name = init value
name:= node path.name
node path:= node. | node
init value:= value| scr expression
scr expression:= value | infix notation expression
Examples:

```
>code scr;
>createnode N1;
>createnode N1.N2;
>var greeting = "Hello";
>var x;
>var N1.N2.z = 2 + 3;
```

const

Creates a single constant variable in Global or in Local function scope. It will be error if name already exists (see recreate).

Format ppl:
const (name[init value])
name:= [node.]name
init value:= value| ppl expression
ppl expression:=value | prefix notation expression
Example:

```
>const (x[0])
>const (y[+(2)(3)]);
```

Format **scr**:

const name = init value

name:= node path.name

node path:= node. | node

init value:= value| scr expression

scr expression:= value | infix notation expression

Examples:

```
>createnode N1;
>code scr;
>const greeting = "Hello";
>const radian = 180 / Math.PI();
result = 57.29577951308232
```

array

Creates single-dimensional array in Global or in Local function scope. It will be error if array with same name already exists (see recreate).

Format **ppl**:

array(name [length]) [(init value)]

array(name)(1st item)(2nd item)…

name:= node path.name

node path:= node. | node

length:= value| ppl expression

init value:= value| ppl expression

item:= value| ppl expression

ppl expression:=value | prefix notation expression

Examples:

```
>var(x[10]);
>array(y[3]);
>array(y[/(x)(2)])(0);          // init by 0 all 5 elements
>array(y[x])(*(x)(3));          // init by 30 all 10 elements
>array(y)(1)(x)(+(1)(2));       // init 3 elements array = 1,10,3
```

Format **scr**:

array name[length];

array name [length] = init value;

array name [] = {1st item, 2nd item,…};

name:= node path.name

node path:= node. | node

length:= value| scr expression

init value:= value| scr expression

item:= value| scr expression

scr expression:=value | infix notation expression

Examples:
```
>code scr;
>array y[3];
>array y[1+2] = 0;          // init by 0 all 3 elements
>array y[] = {1,2,1+2};    // init 3 elements array = 1,2,3
>var x = 1;
>array y[x+2];
```
To access an array element you need to calculate index as a separate variable:
```
>code scr;
>var x = 1;
>array y[] = {1,2,3,4,5};
var index = x + 1;
>write(y[index]);        // or write(y[2])
Only operator set can use index as expression
>set y[x + 1] = 100;
```
In the following sample array with **length = 0** is created preliminary and reallocated in function **Directory.GetDirectories**   in accordance with real length:
```
>array Dir.dir [0];
>call Directory.GetDirectories(getname(Dir.dir), "c:\\users\\");
```

realloc

Changes length of array, all elements are saved in changed array.
Format: **realloc(array name)(new length) [(init_value)]**
Examples:

```
>array(y[5])(0);
>realloc(y)(10);
>d;
-N1     NS
---N2   Global
-----N3 y          [Array 10]
-------L0          #          [0]
-------L1          #          [0]
-------L2          #          [0]
-------L3          #          [0]
-------L4          #          [0]
-------L5          #
-------L6          #
-------L7          #
-------L8          #
-------L9          #
---N2   Local
>realloc(y)(3);
>d;
-N1     NS
---N2   Global
-----N3 y          [Array 3]
-------L0          #          [0]
-------L1          #          [0]
-------L2          #          [0]
---N2   Local
```

If init_value is specified all its value will be set in all elements of the new array. If init_value is not specified old values are saved in the new array.
Size of the new array can be smaller or larger than the old one.

It is possible to use realloc for storage on Row level.

```
>rc examples\scr\testswrite.scr
>>storage(s)(3)(4)(5);
>realloc(s.0.0.Row)(3);
>ssetrow(s)(0)(0)  (1)(2)(3);
>sinit(s)(0);
>realloc(s.0.1.Row)(10);
>ssetrow(s)(0)(1)  (1)(2)(3)(4)(5)(6)(7)(8)(9)(10);
>realloc(s.0.2.Row)(15);
>ssetrow(s)(0)(2)  (1)(2)(3)(4)(5)(6)(7)(8)(9)(10)(11)(12)(13)(14)(15);
>realloc(s.1.1.Row)(10);
>ssetrow(s)(1)(1)  (1)(2)(3)(4)(5)(6)(7)(8)(9)(10);
>realloc(s.2.1.Row)(10);
>ssetrow(s)(2)(1)  (1)(2)(3)(4)(5)(6)(7)(8)(9)(10);
>swrite(s);
     0   1   2   3   4   5   6   7   8   9   10  11  12  13  14

-------------------------------------------NS.Global.s.0-------------------------------------------
[0]  0   0   0
[1]  1   2   3   4   5   6   7   8   9   10
[2]  1   2   3   4   5   6   7   8   9   10  11  12  13  14  15
[3]  0   0   0   0   0
-------------------------------------------NS.Global.s.1-------------------------------------------
[0]  0   0   0   0   0
[1]  1   2   3   4   5   6   7   8   9   10
[2]  0   0   0   0   0
[3]  0   0   0   0   0
-------------------------------------------NS.Global.s.2-------------------------------------------
[0]  0   0   0   0   0
[1]  1   2   3   4   5   6   7   8   9   10
[2]  0   0   0   0   0
[3]  0   0   0   0   0
```

Storage

Service of multi-dimensional arrays is realized by storage operators in mode ppl (parameters with prefix expressions in parentheses, but may be used also in mode scr (see Examples 3).

storage

Creates single variable, single-dimensional or multi-dimensional array with dimension from 1 to N in Global or in Local function scope. It will be error if name already exists (see recreate).
Storage contains several levels of arrays,name of the topmost level is name of storage,name of the bottommost arrays in each level is **Row**. Names of intermediate levels are array index in level. To set different length arrays on Row level use realloc.
 (see examples\scr\testswrite.scr).
Format **ppl**:
Format: **storage (name)[(length dim1)][(length dim2)]…**
name:= node path.name
node path:= node. | node
length:= value| ppl expression
ppl expression:=value | prefix notation expression
Examples:

```
(1)
>storage (x); - variable
>d;
-N1     NS
---N1   Global
-----L0 x
```

```
(2)
>storage (x)(2); – single-dimensional array
>d;
-N1     NS
---N1   Global
-----N3 x       [Storage 1 2]
-------N4       Row     [Array 2]
---------L0     #
---------L1     #
[Storage 1 2] – dimension length
```

```
(3)
>code ppl
>storage (x)(+(2)(3)) – single -dimensional array [Storage 1 5]
or same result
>code scr;
>var y = 2 + 3;
>storage (x)(y); // single-dimensional array, length = 5
(4)storage (x)(2)(3)   - two-dimensional array
```

```
>d
-N1      NS
---N2    Global
-----N3 x        [Storage 2 2x3]
-------N4        0       [Array element]
---------N5      Row     [Array 3]
----------L0     #
----------L1     #
----------L2     #
-------N4        1       [Array element]
---------N5      Row     [Array 3]
----------L0     #
----------L1     #
----------L2     #
[Storage 2 2x3] - dimension length x length
```

```
(5) storage(x)(3)(4)(5)(100) – four-dimensional array
```

sinit

Init storage
Format: **sinit (name)(init value)**
init value:= value| ppl expression
Examples:
```
>storage (x)(2)(3);
>sinit (x)(0);
-N1      NS
---N2    Global
-----N3 x        [Storage 2 2x3]
-------N4        0       [Array element]
---------N5      Row     [Array 3]
----------L0     #       [0]
----------L1     #       [0]
----------L2     #       [0]
-------N4        1       [Array element]
---------N5      Row     [Array 3]
----------L0     #       [0]
----------L1     #       [0]
----------L2     #       [0]
```

sget

Gets value of element in storage
Format: **sget (name)(index1)(index2)...**
Examples:
```
>sget(stor);      // get value of single-variable
>sget(stor)(0);  // get value of single-dimensional array,index=0
```

```
        // get value of two-dimensional array,stor[0][0]
        >sget(stor)(0)(0);
```

sset

Sets value for element in storage
Format: **sset (name)(index1)(index2)(value)**
Examples:
```
>sset(stor)(0); // set value of single-variable = 0

// set value of single-dimensional array,stor[0]= 1
>sset(stor)(0)(1);

// set value of two-dimensional array,stor[0][0] = 1
>sset(stor)(0)(0)(1);
```

swrite

Displays elements values of storage
Format: **swrite(name) [(max_window_width = 100)]**
Limit for CPPL.exe max_window_width = `Console.WindowWidth` = 120
NoLimit for WPPL.exe
Examples:
```
>storage (x)(3);
>sinit(x)(0);
>swrite(x)(50);
        0                   1                   2
-------------------NS.Global--------------------
[x]     0                   0                   0
```

```
>storage(s)(5)(3)
>sinit(s)(0)
>swrite(s)
        0                                       1                                       2
------------------------------------------------NS.Global.s--------------
[0]     0                                       0                                       0
[1]     0                                       0                                       0
[2]     0                                       0                                       0
[3]     0                                       0                                       0
[4]     0                                       0                                       0



>swrite(s)(30)
        0           1           2
---------NS.Global.s---------
[0]     0           0           0
[1]     0           0           0
[2]     0           0           0
```

```
[3]        0              0              0
[4]        0              0              0
```

```
>storage(xxx)(3)(3)(5)
>sinit(xxx)(0)
>swrite(xxx)(40)
     0    1    2    3    4

------------NS.Global.xxx.0------------
[0]  0    0    0    0    0
[1]  0    0    0    0    0
[2]  0    0    0    0    0
------------NS.Global.xxx.1------------
[0]  0    0    0    0    0
[1]  0    0    0    0    0
[2]  0    0    0    0    0
------------NS.Global.xxx.2------------
[0]  0    0    0    0    0
[1]  0    0    0    0    0
[2]  0    0    0    0    0
```

sinfo

Displays length of each dimension in storage
Format: **sinfo(name)**
Examples:
>sinfo(y);
result = Storage 1 5   // single-dimensional array length 5
After using realloc for storage Row it will be written:
>storage(s)(3)(5);
>realloc(s)(0)(10);
>sinfo(s);
result = Storage 2 reallocated

ssetrow

Sets value for elements of the lowest level.
Format: **ssetrow(name)(ind1)(ind2)(indN)... (elem1)(elem2)(elemM)...**
Examples:
```
// N = 2, M=3
>storage(y)(2)(3);
>ssetrow(y)(0)(1)(2)(3);
>ssetrow(y)(1)(4)(5);
>ssetrow(y)(1)(4)(5)(6)(7)(8);
```

```
Error: [FuncStorageSetRow] wrong format, number of parameters
 [7] > [5]
>swrite(y);
-----------------------------------------NS.Global.y--------------------------------------------
[0]     1                          2                          3
[1]     4                          5
```

Backup & Recovery

savedata

Saves data from node to file with extension **.data** or **.json**
If node is root, all root contents will be saved.
Format: **savedata(filename.data | filename.json)[(node)]**
Default node: **NS.Global**
Examples:
1.
```
>createnode Node1;
>var(Node1.x[0])(Node1.y[1]);
>savedata (Examples\ppl\f3.json)(Global.Node1);
```
2.
```
>savedata(Data\Colors1.data)(Colors);
```
3.
```
>rc examples\ppl\json.ppl;
>createnode Node1;
>var(Node1.x[0])(Node1.y[1])(a[2])(b[3]);
>array(y[3])(0);
>set(y[0])(one)(1);
>set(y[1])(two)(2);
>set(y[2])(three)(3);
>var(c[true])(d[family]);
>array(cars)(Ford)(Nissan)(Renault);
>savedata (Examples\ppl\f3.json);
>shell(type f3.json)
{
"Global":
   {
   "Node1": "Node"
     {
     "x":0,
     "y":1
     },
     "a":2,
     "b":3,
   "y":
     [
     1,
     2,
```

```
      3
      ],
      "c":"true",
      "d":"family",
   "cars":
      [
      "Ford",
      "Nissan",
      "Renault"
      ]
   }
 }
```

readdata

Reads data from file file with extension **.data** to Aliases, Configuration and NS.Global node,**not to Local.**
Format: **readdata(filename.data)[(node)]**
Default node: **NS.Global**

Examples:
```
>readdata(Data\Colors.data)
>d
-N  NS
---N  Global
-----N  Colors
-------L0       Black    [0]
-------L1       Blue     [9]
-------L2       Cyan     [11]
-------L3       DarkBlue        [1]
-------L4       DarkCyan        [3]
-------L5       DarkGray        [8]
-------L6       DarkGreen       [2]
-------L7       DarkMagenta     [5]
-------L8       DarkRed [4]
-------L9       DarkYellow      [6]
-------L10      Gray     [7]
-------L11      Green    [10]
-------L12      Magenta [13]
-------L13      Red      [12]
-------L14      White    [15]
-------L15      Yellow   [14]
```
```
Each item in such array has key (Black, Blue,…) and value(0,9,…), use
getbykey and getbyvalue.
```

Control Flow

if, else

The meaning of the block "if-else" does not differ from the generally accepted.
About using statements terminator ";" in if see Base Concepts.

Format **ppl**:
```
if(condition)
(
   (statement)
   (statement)
   [(else
       (
         (statement)
          (statement)
       )
     )]
 );
```
Here expression in prefix notation.
Statement in ppl mode.

Format **scr**:
```
if (condition)
{
     statement;
     statement;
   [else
   {
     statement;
     statement;
   }]
}
```
Here expression in infix notation.
Statement in ppl or scr mode.

Example ppl mode:

```
var(x[1]);
var(y[1]);
if (==(x)(y))
(
    (write(true))
    (write(TRUE))
  (else
    (
       (write(false))
       (write(FALSE))
    )
  )
);
true
TRUE
>write(end);
end
```

Example scr mode:

```
var x = 1;
var y = 1;
if ( x == y )
{
    write(true);
    write(TRUE);
  else
  {
    write(false);
    write(FALSE);
  }
}
write(end);
```

switch, case, default

switch statement – for select one from several case blocks to be   executed.
About using statements terminator ";" in switch see Base Concepts.

Format **ppl**:
```
  switch(expression)
     (
        (case1) [(case2)…]
          (
            (statement)
            (statement)
           …
          )
        (caseN) …
          (
            (statement)
            (statement)
           …
          )


         …
       [ (default)
        (
            (statement)
            (statement)
     …
       ) ]
     );
```
Here expression in prefix notation.
Statement in ppl mode.

Format scr:
```
switch(expression)
{
   case <value>:
   case <value>:
       statement;
   break;
   case <value>:
     [   statement;
   break;
   default:
      statement;
   break; ]
}
```
Here expression in infix notation.
Statement in ppl or scr mode.

Examples:
Format ppl:
1.

```
switch(x)
(
   (1)(3)
   (
      (write("Cases 1 & 3"))
   )
);
```

2.

```
var (x[1]);
switch (x)
   (
    (1)(3)
    (
       (write("Case 1 & 3"))
    )
    (2)
    (
       (write("Case 2"))
    )
    (default)
    (
       (write("Default"))
    )
  );
Result:
   Case 1 & 3
```

1. Format scr

```
var x = 2;
switch(x)
{
   case 1: case 3:
      write("Case 1 & 3");
   break;
   case 2:
      write("Case 2");
   break;
   default:
      write("Default");
   break;
}
```

loop,do

Iteration block for ppl mode only.
About using statements terminator ";" in loop see Base Concepts.

Format:
```
loop (iteration var)(begin)(end)[(increment)]   or
 loop () //infinity loop
 (do
   (
     (statement)
     (statement)
      …
   )
 )
begin:= value|ppl expression
end:= value|ppl expression
increment:= value|ppl expression
```
By default increment = 1. Increment may positive or negative.
Statement in ppl mode.

Examples:
```
loop (i)(0)(10)(1)      // or loop (i)(10)(0)(-1)
(do
  (
    (write("i = {0}")(i))
  )
);
```

See infinity example – greatest common factor (gcf) calculation in for

for

Iteration block for scr mode only.
About using statements terminator ";" in for see Base Concepts.

Format:
```
for(iteration var, begin, end [, increment])   or
for()  // infinity for
{
   statement;
   statement;
   …
}
```
By default increment = 1. Increment may positive or negative.
Statement in ppl or scr mode.
Examples:
```
var x;
for(i, 0, 10, 1)
{
   set x = i * 2;          // scr statement
   write("x = {0}")(x);    // ppl statement
}
```

Example with Infinity for:

```
showcode no;
// Euclidean algorithm
function gcd(x0,y0,z)
{
   // x0, y0 may be digital constants,not variables
   var x = x0;
   var y = y0;
   if(isinteger (x) == "False")
   {
     write("not integer value x={0}")(x);
     return;
   }
   if(isinteger (y) == "False")
   {
     write("not integer value y={0}")(y);
     return;
   }

   for()   // infinity for
   {
    if (x > y)
    {
       set x = x - y; // or Sub(x)(x)(y);
    }
    if (x < y)
    {
       set y = y - x;   // or Sub(y)(y)(x);
    }
    if (x == y)
    {
        set z = x;
        return;
    }
   }
}
var z = 0;
gcd(14144)(26163)(z);
write(gcd = {0})(z);
del all;

//result
gcd = 17;
```

break

Exit from loop (ppl mode) or from for (scr mode) or end of case in switch block.
Example:
```
for(i, 0, 4, 1)
{
  if (i == 2)
  {
    write("true i = {0}")(i);
    break;
  }
};
```

continue

Continue executing in loop (ppl mode) or in for (scr mode).
Example:
```
loop(x)(0)(5)(1)
(do
   (
      (write("x={0}") (x) )
      (if (==(x)(3))
         (
            (write("x = {0} continue") (x) )
            (continue)
         )
      )
   )
);
```

Input and Output

write

Writes the string value to the standard output stream.

String interpolation ($`"x"`) is not supported. If string value contains `"Error:"` it will be wrote in red color in cppl.exe or in wppl.exe.

Format:

write(value) | write(c# format)(value)(value)…

value:=value | ppl expression with prefix notation

Example:

```
>var (x[0]);
>write(x);
>write("{0}{1}")("x=")(x); // like c# write("{0}{1}")("x=",x);
//quote in string
>write("ppl\"language");   // ppl"language
//tab in string
>write("ppl\tlanguage");   // ppl language
//newline in string
>write("ppl\r\nlanguage");   // ppl
                                    //language
>write(12col);
Result: 12col
>write("Error: wrong name {0}")(12col);
Result: Error: wrong name 12col
```

This operator is used in ppl and scr mode.

```
>code scr;
>var x = 2*5;          // scr expression is calculated in var
>write("{0} {1}")( "x = " )(x);
>code ppl
>write("{0}")(*(2)(5));    // ppl expression
```

write#, writeline

Like as write, for mode scr only, arguments are not enclosed in parentheses.

Format:

write#(arg) | write#("c# format", arg1 , arg2,…)

writeline(arg) | writeline("c# format", arg1 , arg2,…)

arg:= <literal> | <scr expression with infix notation>

Example:

```
>write#("{0} {1}", aaaa,1+3)
Result: aaaa 4
```

writearray

Writes array contents to the standard output stream.
Format:
writearray ([node.]array_name) | [node.]array_name
Examples:
1.

```
>rc examples\scr\whitearray.scr
>function
(
  func  ()
  (
    (array (y  )(1)(2)(3))
    (writearray(y))
    (writearray(N.Y))
  )
);
>createnode N;
>array (N.Y  )(10)(20)(30);
>writearray(N.Y);
-----Array N.Y-----
[0]     10
[1]     20
[2]     30
>func();
-----Array y-----
[0]      1
[1]      2
[2]      3
-----Array N.Y-----
[0]     10
[1]     20
[2]     30
```

2.

```
>storage(x)(2)(3);
>sinit(x)(0);
// write the bottommost arrays in storage
>writearray(x.0.Row);
>writearray(x.1.Row);
```

3.

```
>storage(s)(2)(3);
>sinit(s)(0);
>d;
-N1      NS
---N2    Global
-----N3 s       [Storage 2 2x3]
-------N4        0      [Array element]
---------N5      Row    [Array 3]
-----------L0    #      [0]
-----------L1    #      [0]
```

```
----------L2     #          [0]
-------N4        1          [Array element]
--------N5       Row        [Array 3]
----------L0     #          [0]
----------L1     #          [0]
----------L2     #          [0]
---N2    Local
>set(s.0.Row[0])(zero)(00)
>set(s.0.Row[1])(one)(1)
>set(s.0.Row[2])(two)(2)
>writearray(s.0.Row)
[0]      zero     00
[1]      one      1
[2]      two      2
```

readline

Reads the next line of characters from the standard input stream. Result will be passed to calling operator.
Format: **readline()**
Examples:

```
var(x);
>set(x)(readline());
>Enter:
>>Hello
>d;
-N1      NS
---N1    Global
-----L0 x        [Hello]
```

Functions

Standard functions library **mathlogic.ppl**, defined in file **Configuration.data** as **default_loaded_functions**, loads automatically or reloads when command **init** executes. It includes the following functions:

Sum (result)(n1)[(n2)]
Sub (result)(n1)[(n2)]
Mult (result)(n1)[(n2)]
Div (result)(n1)[(n2)]
Pow (result, n1, n2)
PlusPlus (result)   // like c#: ++(var)
MinusMinus (result)   // like c#: --(var)
LT (result, n1, n2)
LTEQ (result, n1, n2)
GT (result, n1, n2)
GTEQ (result, n1, n2)
EQ (result, n1, n2)
NOTEQ (result, n1, n2)
AND (result, n1, n2)
OR (result, n1, n2)
XOR (result, n1, n2)

These functions replace using prefix notations. Result are returned in 1st parameter and does not transferred to the next command:

```
>var (z[0]);
>var(x[1]);
>set(z)(Sum(x)(1));    // error
>Sum(z)(x)(1));        // right
```

Examples:

```
1.
>var(x[1]);
>var(z);
>Sum(z)(x)(1);  // set z = x + 1
>Sum(x)(2);     // set x = x + 2
>d
-N2      NS
---N3   Global
-----L4 x        [3]
-----L5 z        [2]
```

```
2. This sample returns wrong result:
>var(x[5]);
>Sum(x)(x)(2);
>d x
-----Variables  and arrays-----
-L4     x        [5]
```

```
>Sum(x)(2);    // right, x = x + 2
```

```
      3.
      >code scr;
      >call Sum(x,2,3);
      >call Sum(x,2+3);
      >Sum(x)(+(2)(3));
```

User may create own functions file, like mathlogic.ppl, and set it in file **Configuration.data** as **UserFunctionsN** or load it:

```
>rc user_functions.ppl|scr;
```

function

Functions must be declared before called.
Functions are saved in Tree **Functions** or in Tree **Global** for later call.
Functions return data via parameters, like a classic procedure.
When function is called **by name** (in mode ppl or scr) each argument must be enclosed in parentheses.
When function is called by command **'call'** (in mode scr only) each argument not must
 be enclosed in parentheses.

Limitations:
1. For passing array member use 2 arguments **(sample)**:
        array name,   index array member.
2. If argument value will be changed in function this argument can be used only one
       time when function is called(see example **Sum_wrong_result**).

Format **ppl**:
Statement terminator ';' does not follow after statements within function.
function
(
   name
   parameter_list
   (function body)
);
name::= identifier
parameter_list::= parameter [parameter_list]
parameter::= (identifier) | (identifier[default value]) | empty
function body::= (statement1) [(statement2) (statementN)]
identifier::= [var] | [array] :<name>

Format **scr**:
Statement terminator '**;**' always follows after each type of statements.
function   name
               (parameter_list)
         {
                function body
         }
name::= identifier
parameter_list::= parameter, [parameter_list]
parameter::=
        identifier | identifier[default value] | identifier = default value | empty
function body::= statement1 [statement2   statementN]
identifier::= [var] | [array] :<name>
By default parameter type is var.

Examples:

```
>code scr
1.Function func ()
{
    write#("func");
}
2. function func (n,m[10])    //= func (var:n,var:m[10])   or
                              //function func (n,m = 10)

{
    write#(funcname());
}
3.function func (array: n)
{    write#( funcname());     }
```

```
3. code ppl;
function
(
  test2(n)
  (
     (write(n))
  )
);
function
(
 test()
 (
     (loop (i)(0)(5)(1)
      (do
       (
          (test2(i))
       )
      )
     )
 )
);
test();      // function call
```

```
5.
code scr;    // (see  examples\scr\func.scr)
function sum_arr(array:n,array:m)
{
//  dstree;
  for(i,0,length(n),1)
  {
    write#("[{0}]   [{1}]" ,i, n[i] + m[i]);
  }
}
```

```
    array x[] = {1,2,3,4,5};
    array y[] = {6,7,8,9,10};
    sum_arr(x)(y);   // function call

    result:
    [0]   [7]
    [1]   [9]
    [2]   [11]
    [3]   [13]
    [4]   [15]
```

In the following example (see examples\scr\func4.scr) parameter index default
value = 0 and this parameter may be omitted when the function is called.
Array and member array index are passed as 2 arguments.

```
6. code scr;
function func (array:arr, var:index[0])
{
   write#("{0}[{1}] = {2}",getargname(arr),index, arr[index]);
}
array y[] = {1,2,3,4};
func(y);
call func(y);     // same as previous line
call func(y,0);
call func(y,1);
call func(y,2);
=========result==========
y[0] = 1
y[0] = 1
y[0] = 1
y[1] = 2
y[2] = 3
```

```
7.   Call function from node saved in Tree Global
code ppl;
createnode New;
function
(
      New.func(name)      // public
      (
        (write(name))
      )
);
function
(
      New._hfunc(name)   // private
      (
        (write(name))
      )
)
New.func("Greetings!");
8. Call function from node saved in Tree Functions
```

```
code ppl;
createnode Functions.New;
    function
    (
       Functions.New.func(name)      // public
       (
          (write(name))
          (Functions.New._hfunc(name))


       )
    );
    function
    (
       Functions.New._hfunc(name)     // private
       (
          (write(name))
       )
    )

Functions.New.func("Greetings!");
```

```
9. Recursion example
var tmp = 0;
function  rec(x)
{
    set tmp = tmp + 1;
    write#("tmp={0}",tmp);
    if (tmp == x)
      {
         return;
      }
    rec(x);
}
rec(5);
```

Examples using public and private functions in Trees Functions and Global it is possible to find in directory Examples\Access.

call

Command `'call'` calls function in mode **scr**, it is possible to use expression in infix
notation as arguments. Do not enclose in parentheses each argument when function
is called by this manner.
Format:
call function_name(arg1,arg2,…)
Examples:

```
1.
>code scr
>var x = 0;
>call Sum(x,4 + 1);
>d x
-----Variables  and arrays-----
-L1      x         [5]


1.Call function without arguments or with one not-expression
argument by command 'call' and directly(without 'call') is same:
call func(123);    same as   func(123);

2. To get return of function, called by 'call',
   run 'debugppl yes' before:

>debugppl yes;
>call (Math.PI());
result = 3.141592653589793

3. For transfer return of function to the next command
    do not use 'call'
>write#( Math.PI() );
 result = 3.141592653589793
4.
>write#(call Math.PI());    // error
>set x = call Math.PI();    // error
>set x = Math.PI();
3.141592653589793
```

return

Exit from function or from script.
Example:
```
function f()
{
   for(i, 0, 5, 1)
   {
      write(i);
      if (i == 3)
      {
         return;
      }
   };
};
f();
write("end of script");
```

funclist

Displays function names and their parameters from node Functions.
Format:
funclist| finclist()
Example:
>funclist;
```
-----Function List-----
Sum   (result, n1, n2)
Sub   (result, n1, n2)
Mult  (result, n1, n2)
Div   (result, n1, n2)
Pow   (result, n1, n2)
PlusPlus   (result)
MinusMinus   (result)
LT   (result, n1, n2)
LTEQ   (result, n1, n2)
GT   (result, n1, n2)
GTEQ   (result, n1, n2)
EQ   (result, n1, n2)
NOTEQ   (result, n1, n2)
AND   (result, n1, n2)
OR   (result, n1, n2)
XOR   (result, n1, n2)
```

funcname

Returns the current function name.
Format:
funcname()
Example:
```
>write(funcname());
main
```

argc

Returns number of arguments
Format:
argc()
Example:
```
function Sum (result,n1,n2 = "")
{
    write#("argc = {0}",argc());
    if (argc() == 2)
      set result = result + n1;
    else
      set result = n1 + n2;
}
>code scr;
> var x = 0;
>call Sum(x,1);
>write#("x = {0}",x);
Result:
argc = 2
x = 1
```

getargname

Returns argument name by parameter name
Format:
getargname (parameter_name)
Example:
```
function a(n)
{
  write#("arg_name for param {0} =
      {1}]",getname(n),getargname("n"));
}
var i = 0;
a(i);
//result:
//arg_name for param n = [i]
```

Delegates and callbacks

There are 4 operators for using delegates:
delegate – creation delegate
dlgtinstant – creation delegate instant
dlgtset - setting the function to delegate instant
dlgtcall – call function by delegate instant

delegate

> delegate is created as an array whose elements define the method parameters**.**
> Prefix "**delegate_**" **is added to delegate name** for internal using.
> Format:
> **delegate | dlgt(delegate name)(param1)(param2)...**
> **param:= var | var:<name> | array | array:<name>**

dlgtinstant

> dlgtinsant is created as an array with 2 elements, first is delegate name, second is empty and will be set by dlgtset. Delegate parameters types must be matched types of function parameters . Prefix **"dlgtinstant_"** is added to delegate instant name for internal using.
> Format:
> **dlgtinstant <delegate instant name><delegate name>**
> Example:

```
>dlgt (dd)(var:x)(array)
>dlgtinstant (instant)(dd)
>d
-N2     NS
---N3   Global
-----L0 empty    (const)
-----N4 delegate_dd      [Array 2]
-------L0        #       [var:x]
-------L1        #       [array]
-----N4 dlgtinstant_instant     [Array 2]
-------L0        #       ["delegate_dd"]
-------L1        #
```

dlgtset

dlgtset sets function name as second element in **dlgtinstant** array.

Format:

dlgtset (delegate instant name)(function name)

Example:

```
// see previous example with dlgt and dlgtinstant
function f1(var:x,array:arr)
{
    write#("x = [{0}]",x);
    writearray(arr);
}
>dlgtset(instant)(f1);
```

dlgtcall

dlgtcall calls function defined in dlgtset.

Format:

dlgtcall(delegate instant name)(arg1)(arg2)(arg3)…

Example:

```
// see previous examples with dlgt, dlgtinstant and dlgtset
var z = "qqq";
array y[] = {1,2,3};
dlgtcall(instant)(z)(y);
result:
x = [qqq]
-----Array arr-----
[0]      1
[1]      2
[2]      3
```

See the following samples with delegates:

Examples\callfunc\dlgt.scr

Examples\callfunc\dlgt2.scr

callback

callback invokes synchronous callback method.

Format:

callback (callback name)(arg1)(arg2)(arg3)...

Example:

```
function cb(var:n)
{
    write#("Test {0} callback",n);
}
function f(array:x,var:str)
{
    callback(x)(str);
}
dlgt (dd)(var:n);
dlgtinstant(instant)(dd);
dlgtset(instant)(cb);
f(instant)("PPL");
```

See the following sample with callback:

Examples\callfunc\callback.scr

Additional functionalities

The following below-mentioned additional DLLs with C# functionalities are added and this list will be expanded.

There are two types of methods called from additional DLLs:

- methods that return result, this result may be used in the next operation, for example:

```
var result = Math.Max(10)(20);
```

- methods that not return result, for example:

```
ArrayList.Remove(arrlist, item1);
```

Methods of second type of may be called by command 'call' in scr-format:

```
call ArrayList.Remove(arrlist, item1);
```

write#("ArrayList.Contains item1 = {0}",   ArrayList.Contains(arrlist)(item1));   // right
write#("ArrayList.Contains item1 = {0}",   call ArrayList.Contains(arrlist)(item1)); // wrong

In the following sample it is created wrapper for calling method that returns result (examples\lib\char.scr):

```
code scr;
function GetChar(result,text,index)
{
   set result  =  String.Char(text)(index);
}
var char;
var text = "Hello";
for(i,0,length(text))
{
   call GetChar(char,text,i);
   write(char);
}
```

To get list of methods of additional loaded DLLs:

<DLLname>.help

Math

    Methods:

Max	E	PI
Min	Exp	
BigMul	Floor	
Sqrt	Log	
Round	Log10	
Abs	Pow	
Acos	Sign	
Asin	Sin	
Atan	Tan	
Atan2	Truncate	
Ceiling	Tanh	
Cos	Cosh	
DivRem	Sinh	

To get short help of every method in Math.DLL:
>Math.help[(method name)];

Returns the larger of two double-precision floating-point numbers:
Math.Max(double d1)(double d2)

Returns the smaller of two double-precision floating-point numbers:
Math.Min(double d1)(double d2)

Produces the full product of two 32-bit numbers:
Math.BigMul(Int32 n1)(Int32 n2)

Returns the square root of a specified number: **Math.Sqrt(double d1)**

Rounds a double-precision floating-point value to a specified number:
Math.Round (double value)[(Int32 digits)]

Returns the absolute value of a double-precision floating-point number:
Math.Abs(double value)

Returns the angle whose cosine is the specified number**: Math.Acos(double d)**
Returns the angle whose sine is the specified number: **Math.Asin(double d)**

Returns the angle whose tangent is the specified number**: Math..Atan(double d)**

Returns the angle whose tangent is the quotient of two specified numbers:
Math.Atan2(double d1)(double d2)

Returns the smallest integral value greater than or equal to the specified number: **Math.Ceiling(double d)**

Returns the cosine of the specified angle: **Math.Cos(double d)**

Returns the remainder in an output parameter: **Math.DivRem(Int64 n1)(Int64 n2)**

Represents the ratio of the circumference of a circle to its diameter: **Math.PI()**

Represents the natural logarithmic base: **Math.E()**

Returns e raised to the specified power: **Math.Exp(double value)**

Returns the largest integral value less than or equal to the specified number: **Math.Floor(double value)**

Returns the logarithm of a specified number: **Math.Log(double value)**

Returns the base 10 logarithm of a specified number: **Math.Log10(double value)**

Returns a specified number raised to the specified power: **Math.Pow(double value)(double power)**

Returns an integer that indicates the sign of a double-precision floating-point number: **Math.Sign(double value)**

Returns the sine of the specified angle: **Math.Sin(double value)**

Returns the tangent of the specified angle: **Math.Tan(double value)**

Calculates the integral part of a number: **Math.Truncate(double value)**

Returns the hyperbolic tangent of the specified angle: **Math.Tanh(double value)**

Returns the hyperbolic cosine of the specified angle: **Math.Cosh(double value)**

Returns the hyperbolic sine of the specified angle: **Math.Sinh(double value)**

String

Methods:

Compare	**Replace**
Concat	**DeleteEndOfLine**
Contains	**StartsWith**
Format	**Substring**
IndexOf	**ToCharArray**
LastIndexOf	**ToLower**
Insert	**ToUpper**
Remove	**Trim**
Split	**Char**
SplitCsv	

To get short help of every method in String.DLL:
>String.help[(method name)];

Returns signed int as string: **String.Compare(stringA)(stringB)**

Returns concatenation of several strings: **String.Concat(string1)(string2)**...

Returns true|false: **String.Contains(string)(specified substring)**

Converts the value of objects to string based on the formats specified and returns result:
String.Format(format)(string1)(string2)...
Example:
```
String.Format("{0} {1}")("qwe")("zxc")
result = qwe zxc
```
Returns a new string in which a specified number of characters from the current string are deleted:
String.Remove(string)(startIndex)(number of deleted symbols)
Example:
>rc examples\lib\StringRemove.scr
```
import String;
array primes = {1,2,3,5,7};
var output = "";
for(i,0,length(primes),1)
{
  set output = String.Concat(output)(primes[i])(",");
}
var index = length(output) - 1;
set output = String.Remove(output)(index)(1);  //remove the
 latest ','
write(output);
 Result:1,2,3,5,7
```

Returns a new string in which all occurrences of a specified Unicode character or string in the current string are replaced with another specified Unicode character or string:
String.Replace(string)(old value)(new value)

Determines whether this string instance starts with the specified character:
Returns **True|False**: **String.StartsWith(string)(value)**

Retrieves a substring from this instance. The substring starts at a specified character position and has a specified length:
String.Substring(string)(startIndex)(length)

Writes the characters in this instance to a Unicode character array:
String.ToCharArray(string)(node_of PPL_chars_array)
node_of PPL_chars_array is string in quotes or value of variable.

```
Example:
>array chars[0];
>String.ToCharArray("qwerty")(getname(chars));
>writearray(chars)
-----Array chars-----
[0]      q
[1]      w
[2]      e
[3]      r
[4]      t
[5]      y
```

Returns a copy of this string converted to lowercase: **String.ToLower(string)**

Returns a copy of this string converted to uppercase: **String.ToUpper(string)**

Returns a new string in which all leading and trailing occurrences of a set of specified characters from the current string are removed:
String.Trim(string)[(trim chars string)]
```
>String.Trim(" abcde")(" ae");
result = bcd
```

Returns one character from string: **String.Char(string)(index)**

Returns the reallocated string array that contains the substrings in this instance that are delimited by elements of a specified string array or in special string var, string array must be created before with size = 0:

String.Split(string)("ppl_array_separators")(getname(ppl_array_result))   or
String.Split(string)("var_separator")(getname(ppl_array_result))
Use   comma instead of ','
**   space instead of ' '**
**   tab instead of '\t'**

Example:
> var text;
```
>set text = File.ReadAllText("Data\test.csv");
>array separator[] = {comma,tab,space};
>array split_text_array[0];
>String.Split(text)("separator")(getname(split_text_array));
```

Returns the reallocated string array that contains the substrings in this instance that are delimited by separator of a specified string var, string array must be created before with size = 0.
If substring surrounded by quotes it may contain separator
(see example\lib\splitcsv.scr):

array ppl_array_result[0];
String.SplitCsv(string)("var_separator")("ppl_array_result")
Use   comma instead of ','
**   space instead of ' '**
**   tab instead of '\t'**

Do not use whitespace as separator:

Example:
Returns string from File.ReadAllText without EndOfLine: **DeleteEndOfLine(string)**
```
>rc Examples\Lib\FilesplitCsv.scr

var text = File.ReadAllText("examples\lib\splitcsv.txt");
array splitcsv_text[0];   // array with results
String.SplitCsv(text)(comma)(getname(splitcsv_text));
File.WriteAllText("text")("examples\lib\splitcsv_copy.txt");
```

Reports the zero-based index of the first occurrence of the specified string in this instance:
String.IndexOf (string)(value)(index)

Reports the zero-based index of the last occurrence of the specified string in this instance:
String.LastIndexOf (string)(value)(index)

Returns a new string in which a specified string is inserted at a specified index position in this instance:
String.Insert (string)(start index)(string to insert)

Directory

Methods:

> **GetFiles**
> **GetDirectories**
> **SetCurrentDirectory**
> **GetCurrentDirectory**
> **GetParent**
> **CreateDirectory**
> **Exists**
> **Delete**

To get short help of every method in Directory.DLL:
> Directory.help[(method name)];

Writes the names of files (including their paths) in the specified directory to
node_of_PPL_array, created before with size = 0:
array node_of_PPL_array [0];
Directory.GetFiles("node_of_PPL_array")("path")
node of PPL array is string in quotes or value of variable or
getname(**node_of_PPL_array**).
Example:
1.
```
>array files[0];
>Directory.GetFiles("files") ( "c:\" );
or
var (x["files"]);
>Directory.GetFiles(x)(path);


2.
>rc examples\lib\WriteFilesInDir.scr

    function WriteFilesInDirectory (array:arr,dir)
    {
      Array arr[0];
      Directory.GetFiles(arr)(dir);
      writearray(arr);
    }
    WriteFilesInDirectory ("files")("c:\");

Result:
-----Arr files-----
[0]     c:\DumpStack.log.tmp
[1]     c:\hiberfil.sys
[2]     c:\pagefile.sys
[3]     c:\swapfile.sys
```

Writes the names of files (including their paths) in the specified directory to **node_of_PPL_array**, created before with size = 0:

array node_of_PPL_array [0];
Directory.GetDirectories("node_of_PPL_array")("path")

node of PPL array is string in quotes or value of variable or getname(**node_of_PPL_array**).

Example:
```
array dir[0];
Directory.GetDirectories("dir")("c:\Users");
or
var (x["dir"]);
```
Sets the current working directory to the specified directory:
Directory.SetCurrentDirectory("path")

Gets the current working directory: **Directory.GetCurrentDirectory()**

Returns parent fullname: **Directory.GetParent("path")**

Returns CreationTime: **Directory.CreateDirectory("path")**

Returns **True** or **False** : **Directory.Exists("path")**

Deletes the specified directory and any subdirectories and files in the directory
Returns **True** or **False**: **Directory.Delete("path")**

Array

Methods:

Max	**Min**	**Sum**
Mean	**Sum2**	**Sub2**
Mult2	**Div2**	**Sort**
Reverse	**IndexOf**	**LastIndexOf**

To get short help of every method in ArrayDLL: **Array.help[(method name)];**

Returns result:	**Array.Max("ppl_array")**
Returns result:	**Array.Min("ppl_array")**
Returns result:	**Array.Sum("ppl_array")**
Returns result :	**Array.Average("ppl_array")**

Math operations with 2 array, result is saved in **result_ppl_array:**

Array.Sum2("ppl_array1")("ppl_array2")("result_ppl_array")
Array.Sub2("ppl_array1")("ppl_array2")("result_ppl_array")
Array.Mult2("ppl_array1")("ppl_array2")("result_ppl_array")
Array.Div2("ppl_array1")("ppl_array2")("result_ppl_array")

Replaces source array:	**Array.Sort("ppl_array") ("double"|"string")**
Replaces source array:	**Array.Reverse("ppl_array")**
Returns result:	**Array.IndexOf("ppl_array")(value)**
Returns result**:**	**Array.LastIndexOf("ppl_array")(value)**

Example:

```
Import Array;
array arr[] = {-4,4, -3,3,-2,2};
Array.Sort("arr")("double");
writearray(arr);
Array.Reverse("arr");
writearray(arr);
=====result=====
-----Array arr----- double------------
[0]      -4
[1]      -3
[2]      -2
[3]      2
[4]      3
[5]      4
-----Array arr----- double------------
[0]      4
[1]      3
[2]      2
[3]      -2
[4]      -3
[5]      -4
See samples in Examples\lib\Array.scr.
```

The following collections are supported: **ArrayList, Queue,Stack, Dictionary**.

ArrayList

Methods:

Create	**ToArray**	**Count**
Write	**Reverse**	**Get**
Add	**Remove**	**Set**
Clear	**Insert**	**Delete**
Contains	**IndexOf**	
AddArray	**Sort**	

To get short help of every method in ArrayList.DLL: **ArrayList.help[(method name)];**

Creates ArrayList object: **ArrayList.Create(name)**
It is possible to create ArrayList repeatedly, in this case previous data removed.

Writes all array_list_names or all elements from the specified array_list to the standard output stream: **ArrayList.Write()** or **ArrayList.Write(arrlist name)**

Adds a string to the end of the ArrayList: **ArrayList.Add(arrlist name)(string)**
To add empty string use keyword **empty**:
Example:

```
>ArrayList.Create(ar)
>ArrayList.Add(ar)(empty)
```

Adds node of PPL array to the end of the ArrayList:
ArrayList.AddArray("PPL array")(arrlist name)
Name of PPL array is **string in quotes** or value of variable with value = name of PPL array .

Removes all elements from the ArrayList: **ArrayList.Clear(arrlist name)**

Determines whether an element is in the ArrayList, returns "**True**" or "**False**":
ArrayList.Contains(arrlist name)(string)

Writes all elements from arrlist to PPL array created before with size = 0 and reallocated in **ArrayList. ToArray** with size of arrlist name:
array "ppl_array"[0];
ArrayList. ToArray(arrlist name)(getname("ppl_array"))
Name of PPL array is **string in quotes** or value of variable with value = name of PPL array .
Error: If PPL array exists.

Reverses the order of the elements in the ArrayList: **ArrayList.Reverse(arrlist name)**

Removes the first occurrence of a specific object from the ArrayList:
ArrayList.Remove(arrlist name)(string)

Inserts an element into the ArrayList at the specified index:
ArrayList.Insert(arrlist name)(index)(element)
To insert empty string use keyword **empty**.

Returns the zero-based index of the first occurrence of a value in the ArrayList:
ArrayList.IndexOf(arrlist name)(value)

Sorts the elements in the ArrayList: **ArrayList.Sort(arrlist name)**

Returns the number of elements actually contained in ArrayList: **ArrayList.Count(arrlist name)**

The following example includes all ArrayList methods:
```
>rc Examples\lib\ArrayList.scr
    >import ArrayList;
    >ArrayList.Create("al1");
    >createnode Private;
    >array(Private.src)(ONE)(TWO)(THREE);
    >var(x["Private.src"]);
    >ArrayList.AddArray(x)(al1);
    >ArrayList.Write(al1);
    >ArrayList.Add(al1)(empty);
    >ArrayList.Add(al1)(2two);
    >ArrayList.Add(al1)(3three);
    >ArrayList.Add(al1)(1one);
    >write("=====Added objects=====");
    >ArrayList.Write(al1);
    >ArrayList.Remove(al1)(1one);
    >ArrayList.Remove(al1)(1one); // // error: 1one does not exist
    >write("=====Removed objects=====");
    >ArrayList.Write(al1);
    >ArrayList.Reverse(al1);
    >write("=====Reverse=====");
    >ArrayList.Write(al1);
    >write("ArrayList.Contains 1one" = {0})(ArrayList.Contains(al1)
                                            (1one));
    >ArrayList.Insert(al1)(2)(4four);
    >write("ArrayList.Contains 4four" = {0})(ArrayList.Contains(al1)
                                            (4four));
    >ArrayList.IndexOf(al1)(3three);
    >ArrayList.Sort(al1);
    >write("=====Sort=====");
    >ArrayList.Write(al1);
    >array (N1.dst_arr[0]);
    >ArrayList.ToArray(al1)(getname(N1.dst_arr));
```

```
>ArrayList.Clear(al1);
>d;
        Result:
Imported [ArrayList]
al1
        ONE
        TWO
        THREE
=====Added objects=====
al1
        ONE
        TWO
        THREE

        2two
        3three
        1one
Warning: [ArrayList.FuncRemove] element [1one] does not exist
=====Removed objects=====
al1
        ONE
        TWO
        THREE

        2two
        3three
=====Reverse=====
al1
        3three
        2two

        THREE
        TWO
        ONE
ArrayList.Contains 1one" = False
ArrayList.Contains 4four" = True
=====Sort=====
al1

        2two
        3three
        4four
        ONE
        THREE
        TWO
-N1   NS
---N2 Global
-----N3    Private     [Node]
-------N4  src   [Array 3]
---------L0      #      [ONE]
---------L1      #      [TWO]
---------L2      #      [THREE]
```

```
-------N4  dst_arr     [Array 7]
--------L0      #
--------L1      #     [2two]
--------L2      #     [3three]
--------L3      #     [4four]
--------L4      #     [ONE]
--------L5      #     [THREE]
--------L6      #     [TWO]
-----L11   x     ["Private.src"]
---N2 Local
```

Returns value of ArrayList member by index:
ArrayList.Get(arrlist_name)(index)

Set value of ArrayList member by index:
ArrayList.Set(arrlist_name)(index)(value)

Example:
```
>import ArrayList
Imported [ArrayList]
>ArrayList.Create(x)
>ArrayList.Add(x)(qqq)
>ArrayList.Add(x)(zzz)
>ArrayList.Get(x)(0)
result = qqq
>ArrayList.Set(x)(0)(aaa)
>ArrayList.Get(x)(0)
result = aaa
```

Delete all ArrayList objects:
ArrayList .Delete();

Queue

Methods:

Create	**Peek**
Count	**Clear**
Write	**Contains**
Enqueue	**AddArray**
Dequeue	**ToArray** **Delete**

To get short help of every method in Queue.DLL:
Queue. help[(method name)]

Creates Queue object: **Queue.Create(queue name)**

Returns the number of elements actually contained in Queue: **Queue.Count(queue name)**

Writes queue names or all elements from the specified queue to the standard output stream:
Queue.Write() or Queue.Write(name)

Adds an object to the end of the Queue: **Queue.Enqueue(queue name)(string)**
To add empty string use keyword **empty**.

Removes and returns the object at the beginning of the Queue:
Queue.Dequeue(queue name)

Returns the object at the beginning of the Queue without removing it:
Queue.Peek(queue name)

Removes all objects from the Queue: **Queue.Clear(queue name)**

Determines whether an element is in the Queue, returns "**True**" or "**False**":
Queue.Contains(queue name)(string)

Adds PPL array to the Queue: **Queue.AddArray("PPL array") (queue name)**

Writes all elements from Queue to the PPL array created before with size = 0:
array "ppl_array"[0];
Queue.ToArray(queue name) (""ppl_array"")

Delete all Queue objects: **Queue.Delete();**

Examples of code with Dictionary methods in **examples\lib\Queue.ppl**

Stack

Methods:

Create	**Peek**	
Count	**Clear**	
Write	**Contains**	
Push	**AddArray**	
Pop	**ToArray**	**Delete**

To get short help of every method in Stack.DLL:
>Stack.help[(method name)]

Creates Stack object: **Stack.Create(stack name)**

Returns the number of elements actually contained in Stack: **Stack.Count(stack name)**

Writes stack names or all elements from the specified stack to the standard output stream:
Stack.Write() or Stack.Write(stack name)

Inserts an object at the top of the stack: **Stack.Push(stack name)(string)**
To insert empty string use keyword **empty**.

Removes and returns the object at the top of the Stack:
Stack.Pop(stack name)

Returns the object at the top of the Stack without removing it:
Stack.Peek(stack name)

Removes all objects from the Stack: **Stack.Clear(stack name)**

Determines whether an element is in the Stack, returns "**True**" or "**False**":
Stack.Contains(stack name)(string)

Adds PPL array to the Stack: **Stack.AddArray) ("PPL array")(stack name)**

Writes all elements from Stack to the PPL array created before with size = 0:
array "ppl_array"[0];
Stack.ToArray(stack name) (""ppl_array"")

Delete all Queue objects: **Stack.Delete();**

Examples:

```
>import Stack
Imported [Stack]
>Stack.Create(s)
>Stack.Push(s)(one)
>Stack.Push(s)(two)
>Stack.Push(s)(three)
>debugppl yes
>Stack.Pop(s)
result = three
>Stack.Pop(s)
result = two
>Stack.Pop(s)
result = one
>Stack.Pop(s)
result = empty
```

Examples of code with Stack methods in **examples\lib\Stacks.ppl**

Dictionary

Methods:

Create	**ContainsKey**	
Count	**ContainsValue**	
Add	**Remove**	
Write	**AddArray**	
Clear	**ToArray**	**Delete**

To get short help of every method in Dictionary.DLL:
>**Dictionary.help[(method name)]**

Creates Dictionary object: **Dictionary.Create(dictionary name)**

Returns the number of elements actually contained in Dictionary:
Dictionary.Count(dictionary name)

Adds the specified key and value to the Dictionary:
Dictionary.Add(dictionary name)(key)(value)

Writes dictionary names or all elements from the specified Dictionary to the standard output
stream: **Dictionary.Write() or Dictionary.Write(dictionary name)**

Removes all keys and values from the Dictionary: **Dictionary.Clear(dictionary name)**

Determines whether the Dictionary contains the specified key, returns **True** or **False**:
Dictionary.ContainsKey(dictionary name)(key)

Removes the value with the specified key from the Dictionary:
Dictionary.Remove(dictionary name)(value)

Determines whether the Dictionary contains a specific value, returns **True** or **False**:
Dictionary.ContainsValue(dictionary name)(value)

Adds PPL array to the Dictionary: **Dictionary.AddArray("PPL array")(dictionary name)**

Write all elements from Dictionary to new PPL array created before with size = 0:
array "ppl_array"[0];
Dictionary.ToArray(dictionary name) (""ppl_array"")

Delete all Queue objects: **Dictionary.Delete();**

Examples of code with Dictionary methods in **examples\lib\Dictionary.ppl**

Convert

Methods:

> **StringToInt32Array**
> **StringToHexArray**
> **HexToBin**
> **BinToHex**
> **IntToHex**
> **HexToInt**
> **IntToBin**
> **BinToInt**

To get short help of every method in Convert.DLL:
>Convert.help[(method name)];

String chararacters converts to int32 array created before with size = 0 and reallocated in
Convert.StringToInt32Array with size of string_chararacters:
Convert.StringToInt32Array(string_chararacters)("Int32 "ppl_array"")

String chararacters converts to hex array created before with size = 0 and reallocated in
Convert.StringToHexArray with size of string_chararacters:
Convert.StringToHexArray(string_chararacters)("Hex "ppl_array"")

All below mentioned methods convert data in accordance with method name and return:
Returns string bin: **Convert.HexToBin(string with hex value)**
Returns string hex: **Convert.BinToHex(string with bin value)**
Returns string hex: **Convert.IntToHex(string with Int32 value)**
Returns string Int32: **Convert.HexToInt(string with hex value)**
Returns string bin: **Convert.IntToBin(string with Int32 value)**
Returns string Int32: **Convert.BinToInt(string with bin value)**

Examples:
See Examples\lib\Convert.scr

```
>array Int32[0];
>Convert.StringToInt32Array("12345")("Int32")
Info [CreateArrayFormat2] Global array [Int32] is created
>writearray(Int32)
-----Array Int32-----
[0]      49
[1]      50
[2]      51
[3]      52
[4]      53
```

```
>array Hex[0];
>Convert.StringToHexArray("12345")("Hex")
>writearray(Hex)
-----Array Hex-----
[0]      31
[1]      32
[2]      33
[3]      34
[4]      35
```

Examples:

```
>debugppl yes
>Convert.HexToBin(16);
result = 10110
>Convert.BinToHex(1111111)
result = 7F
>Convert.IntToHex(256)
result = 100
```

Excel

The following methods may be used for reading from XLSX files to two-dimensional storage or writing from two-dimensional storage to XLSX files.

Methods:

> **Open**
> **Close**
> **Read**
> **CreateWorkBook**
> **Write**
> **SaveAs**

To get short help of every method in Excel.DLL:
> Excel.help[(method name)];

Opens XLSX file for reading:
Excel.Open(filename.xlsx)

Closes XLSX file after reading or writing:
Excel.Close()

Reads opened XLSX to storage, size of storage must be enough to save Excel cells:
Excel.Read("sheet")("left top")("right down")("storage")
Example:

"left top": "A1"
"right down": "H10"

Creates workbook for writing:
Excel.CreateWorkBook()

Writes storage to Excel cells, quantity of cells must be enough to save storage:
Excel.Write("sheet")("left top")("right down")("storage")

Saves created XLSX file after writing:
Excel.SaveAs(filename.xlsx)

Examples:
see file Examples\Excel\test.scr

```
import Excel;
Excel.Open("$1$\examples\Excel\example.xlsx");
Excel.Read("Sheet1")("A1")("H10")("Example_XLSX");
Excel.Close();
swrite(Example_XLSX);
```

```
Excel.CreateWorkBook();
Excel.Write("Sheet1")("A1")("H10")("Example_XLSX");
Excel.SaveAs("$1$\examples\Excel\example2.xlsx");
Excel.Close();
```

>rc examples\excel\test.scr c:\path
Parameter **c:\path** overrides the variable **1** in file test.scr.

File

Methods:

ReadAllText	**ReadAllLines**
WriteAllText	**WriteAllLines**
Exists	**Delete**

Returns all contents of text file:**File.ReadAllText(filename)**

Creates a new file, write the contents to the file, and then closes the file:
File.WriteAllText(var_ppl)(filename)

Determines whether the specified file exists, returns **True** or **False**: **File.Exists(filename)**

Returns string array with lines of text file:**File.ReadAllLines(filename)(""ppl_array"")**
Example:

```
>File.ReadAllLines("examples\lib\split.txt")("x")
>d
-N1    NS
---N2   Global
-----N3 x     [Array 2]
-------L0     #    [1,2,3,4,5,6,7,8,9,10,]
-------L1     #    [11,12,13,14,15,16,17,18,19,20]
```

Creates a new file, writes one or more strings to the file, and then closes the file:
File.WriteAllLines(""ppl_array"")(filename)

Deletes the specified file**: File.Delete(filename)**

Random

Methods:

Create	**NextDouble**
Next	**NextInt64**
NextBytes	**NextSingle**

Creates Random object: **Random.Create(name)[(Seed)]**

Returns a non-negative random integer: **Random.Next(random_name)**

Returns a non-negative random integer that is less than the specified maximum:
Random.Next(random_name) (maxValue)

Returns a random integer that is within a specified range:
Random.Next(random_name) (minValue)(maxValue)

Creates random numbers and writes them to the of a specified **"ppl_array"** created before
with size = 0:
Random.NextBytes(random name)(""ppl_array"")(quantity of random elements)

Returns a random floating-point number that is greater than or equal to 0.0, and less than 1.0:
Random.NextDouble(random name)

Returns a non-negative random integer: **Random.NextInt64(random name)**

Returns a non-negative random integer that is less than the specified maximum:
Random.NextInt64(random name)(maxValue)

Returns a random integer that is within a specified range:
Random.NextInt64(random name)(minValue)(maxValue)

Returns a random floating-point number that is greater than or equal to 0.0, and less than 1.0:
Random.NextSingle(random name)

Examples:

```
>debugppl yes;
>import Random
Imported [Random]
>Random.Create(r)
>Random.Next(r)(0)(10)
Result = 2
>array x[0];
>Random.NextBytes(r)(x)(5)
>writearray(x)
-----Array x-----
[0]    #    5
[1]    #    121
[2]    #    226
[3]    #    108
[4]    #    61
```

Console

Methods:

ForegroundColor	**Beep**
BackgroundColor	**Clear**
ForegroundPromptColor	**SetCursorPosition**
DefaultColors	**GetCursorPosition**
Write	

Sets the foreground color of the console:
Console.ForegroundColor(color)
Sets the background color of the console:
Console.BackgroundColor(color)
Sets the prompt foreground color of the console**:**
Console.ForegroundPromptColor(color)
Sets the default foreground, background and ForegroundPromptColor color of the console:
Console.DefaultColors()

Writes the text representation of the specified value or values to the standard output stream: **Console.Write [(format)](string)(string)**
Plays the sound of a beep through the console speaker:
Console.Beep (frequency)(duration)
frequency - 37 to 32767 hertz
duration - msec
Clears the console buffer and corresponding console window of display information:
Console.Clear()
Sets the position of the cursor:
Console.SetCursorPosition(left column cursor position)(top row cursor position)
Gets the position of the cursor**:**
Console.GetCursorPosition ()
Returns '**left column cursor position, top row cursor position'**

See examples in examples\Console.

Vector

For using with library MathNet.Numerics and others. Using Vector and Matrix libraries significantly increases program performance.
Methods:

      Vector.Create ("vector_name")(length)(type)
      type:= double|float|decimal|bool|int|uint|long|ulong|string
      types in accordance with value types in
      https://docs.microsoft.com/en-us/dotnet/csharp/language-reference/builtin-types/built-in-types
      Vector.Get(vector_name)(index);
      Vector.Set(vector_name)(index)(value);
      Vector.Add("vector_name")("“ppl_array”")

      Write to line - "**row**"
      Write not nullable data to column - "**col**"
      Write all data to column - "**col0**"
      Vector.Write("vector_name")[("row"|"col"|"col0")]
      Vector.WriteNames()
      Vector.Delete("vector_name")
      Vector.DeleteAll()

      Examples:

```
>import Vector;
>array v[] = {1,2,3,4,5};
>call Vector.Create ("V",5,int);
>call Vector.Add("V",getname(v));
> call Vector.Write("V");
=====vector V=====
1    2    3    4    5
>call Vector.Set("V",0,0);
> call Vector.Write("V",col);
=====vector V=====
        [1]    2
        [2]    3
        [3]    4
        [4]    5
>call Vector.Delete("V");
```

      See examples in **examples\MatrixVector.**

Matrix

For using with library MathNet.Numerics and others.

Methods:

       Create ("matrix_name")(rows)(columns)(type)

       type:= double|float|decimal|bool|int|uint|long|ulong|string

       types in accordance wth value types in

        https://docs.microsoft.com/en-us/dotnet/csharp/language-reference/builtin-types/built-in-types

       Get("matrix_name")(index row)(index_column)

       Set("matrix_name")(index row)(index_column)(value)

       AddArrayToRow ("matrix_name")(row)(""ppl_array"")

       AddArrayToColumn ("matrix_name")(column)(""ppl_array"")

       Write to line - "**row**"

       Write not nullable data to column - "**col**"

       Write all data to column - "**col0**"

       Write("matrix_name")[("row"|"col"|"col0")]

       WriteNames()

       Delete("matrix_name")

       DeleteAll()

       Rotate("matrix_name")("cw" | "ccw")   - for square matrix only

Example:

```
>import Matrix;
>call Matrix.Create ("A",3,3,float);
>array r1[] = {1,2,3};
>array r2[] = {4,5,6};
>array r3[] = {7,8,9};
>call Matrix.AddArrayToRow ("A",0, getname(r1));
>call Matrix.AddArrayToRow ("A",1, getname(r2));
>call Matrix.AddArrayToRow ("A",2, getname(r3));
>call Matrix.Write("A");
>call Matrix.Delete("A");
```

See examples in **examples\MatrixVector.**

MN_Numerics
For using MathNet.Numerics.dll
Methods:

       Matrix("matrix_name")(rows)(columns)   // like as Matrix.CreateDouble
       Vector("vector_name")(length)   // like as Vector.CreateDouble
       AddRowToMatrix("matrix_name")(""ppl_array"")   // like as Matrix.AddRow
       AddColumnToMatrix("matrix_name")(""ppl_array"") // like as Matrix .AddColumn
       AddDataToVector("vector_name")(""ppl_array"")   // like as Vector.Add

       Linear Equation Systems:
       See detailed information: **https://numerics.mathdotnet.com/LinearEquations.html**
       Solve("matrix_name")("vector_name")(""ppl_array"_result")

       DeleteAll()   // delete all matrix and name
       DeleteMatrix("matrix_name")
       DeleteVector("vector_name")

       For operations with vectors and matrices It is possible to use methods from
       MN_Numerics.Matrix and MN_Numerics.Vector
       or from
       Matrix and Vector, **but not**   **together**.

       Example: (see examples\mnn\lesrow2.scr)

```
      //linear equation systems
// AX = B
// Creation rows as "ppl_array"s
// Creation Matrix.matrix
// Creation Vector.vector
import Matrix;
import Vector;
import MN_Numerics;
Matrix.DeleteAll();
Vector.DeleteAll();
write("-----Creation Matrix.matrix  & Vector.vector-----");
call Matrix.Create("A",3,3,double);
array row1[] = {3,2,-1};
array row2[] = {2,-2,4};
array row3[] = {-1,0.5,-1};
call Matrix.AddArrayToRow("A",0,getname(row1));    // fill matrix
call Matrix.AddArrayToRow("A",1,getname(row2));
call Matrix.AddArrayToRow("A",2,getname(row3));

call Vector.Create("B",3,double);
array vector[]  = {1,-2,0};    // create vector as "ppl_array"
call Vector.Add("B",getname(vector));       // fill vector
```

```
array X[length(vector)]  = 0;   // create result as "ppl_array"
call MN_Numerics.Solve("A","B",getname(X));
writearray(X);   Vector.Delete("B");
        del all;           // remove all arrays in ppl
        results:
        -----Array X-----
        [0]    #              1
        [1]    #              -1.9999999999999996
        [2]    #              -1.999999999999993
```

Constants: to get list of constants from MathNet.Numerics:
>MN_Numerics.help();

Examples:
```
>debugppl yes
>import MN_Numerics;
>MN_Numerics.Pi()
result = 3.141592653589793
>MN_Numerics.E()
result = 2.718281828459045
```

Structure of User's DLL

Directory Template is the example for creation user's DLL, see Template.cs.

Example:
```
>import Template
>Template.sum(1)(2)
result = 3

>Template.help
help
sum
>Template.help(sum)
     Returns sum of two double-precision floating-point numbers:
     Template.sum(double d1)(double d2)
```

Add in Project Dependensies the project **PPL**
Utility **createulc.exe** creates code for User's DLL .
-creation code without methods:
createulc.exe <name user DLL> [path]
Example:
```
createulc.exe MyLib
=====see result here=====
using System;
using System.Collections.Generic;
namespace PPLNS
{
 public class MyLib : AbstractClass
 {
  //  ppl & help_dict in Abstract Class
  //public PPL ppl;
  //Dictionary<string, string> help_dict = new Dictionary<string,
                         string>();
  public MyLib(PPL ppl)
  {
   this.ppl = ppl;
  }
  //=========================================================
  public void AddToKeywordDictionary()
  {
   keyword_dict = new Dictionary<string, PPL.OperatorDelegate>();
   keyword_dict.Add("help", FuncHelp);
   keyword_dict.Add("keyword", FuncKeyword);
   // add here other methods & their keywords
   //...

   // add here short help
```

```
    //help_dict.Add("keyword","short help lines, divided by   EndOfLine");
    //...
    try
    {
      if (ppl.ImportList.ContainsKey("MyLib") == false)
      {
          foreach (KeyValuePair<string, PPL.OperatorDelegate> pair in keyword_dict)
            ppl.processing.keyword_dict.Add("MyLib." + pair.Key, pair.Value);
          ppl.ImportList.Add("MyLib", this);
      }
    }
    catch (Exception io)
    { }
  }
  //=========================================================
  public bool FuncKeyword(List<string> parameters, ref string result, Composite node = null)
  {
    try
    {
      //...
    }
    catch (Exception ex)
    {
      ppl.print("Error: ...");
      return false;
    }
    return true;
  }
 }
}
```

-creation code with methods:
createulc.exe
When utility createulc.exe runs without arguments all data is defined in file **Config.cfg**
Example:
name = Test
// fullpath where to save generated file or empty
path =
methods = Sum,Sub,Mult,Div
createulc.exe generates 2 files:
- **<name>.cs** , this file must be added to user's dll project
- **<name>.json** , this file must be added to directory JsonHelp for Assistant.exe

Examples of code

See Examples\scr\Eratosphenes.scr
mode scr

```
//Sieve of Eratosphenes
import String;
var n = 100;
var len = n + 1;
array primes[len];

for(i,0,len)
  set primes[i] = i;

for(i,2,len,1)
{
   for(j,i + 1,len,1)
   {
      if(primes[j] == 0)
        continue;

      if ( mod(j)(i) == 0)
      {
         set primes[j] = 0;
         continue;
      }
   }
}

var output = "";
for(i,0,len,1)
{
  if (primes[i] != 0)
  {
    //write("{0}")(primes[i] );
    set output = String.Concat(output)(primes[i])(",");
  }
}

var index = length(output) - 1;
set output = String.Remove(output)(index)(1);  // remove the
                                               //  latest ','
write#("{0}",output );
```

Examples\scr\erato.scr
This samples significantly improves performance because all calculations are performed in
Erato.DLL and data are saved by Vector.DLL.

```
// calculations in library Erato.dll
import Vector;
import Erato;
debugppl yes;
Vector.DeleteAll();

var m = 1000;
var len = m + 1;
array primes[len];
for (k,0,len)
  set primes[k] = k;
call Vector.Create("VPrimes",m + 1,int);
call Vector.Add("VPrimes",getname(primes));

call Erato.Solve("VPrimes");
var output = "";
var tmp;
for (i,0,len)
{
  set tmp = Vector.Get("VPrimes")(i);
  if (tmp != 0)
    set output = String.Concat(output)(tmp)(",");
}

var index = length(output) - 1;
set output = String.Remove(output)(index)(1);
writeline("{0}",output );
```

The following example performs copying elements from two dimensional storage to one
dimensional array
see examples\scr\copyto.scr

```
// copy row  elements  from first column to last column
// prepare before call destination array
function CopyRowElementsToArray(src,row,first_element,last_element,dst)
{
  write#(src={0}  row={1} first_element ={2}  last_element={3} dst={4})
     (getname(src), row, first_element, last_element, getname(dst));

  for(i, first_element, last_element + 1)
  {
    set dst[i] = sget(src)(row)(i);
  }
```

```
}
//=====================================
// copy column elements from first row to last row
// prepare before call destination array function
CopyColumnElementsToArray(src,column,first_element,last_element,dst)
{
   write#(src={0}  column={1} first_element ={2}  last_element={3} dst={4})
      (getname(src), column, first_element, last_element, getname(dst));

   for(i, first_element,l ast_element + 1)
   {
     set dst[i] = sget(src)(i)(column);
   }
}
//=====================================

import String;
storage(src)(8)(8);
var tmp = 0;
for(i,0,8)
{
  for(j,0,8)
  {
   PlusPlus(tmp);
   sset(src)(i)(j)(tmp);
  }
}
swrite(src);

array dst_row[6];
write#("function CopyRowElementsToArray");
call CopyRowElementsToArray(src,1, 0, 5, dst_row);

var output = "";
var index;

for(i,0,6)
{
  set output = String.Concat(output)(dst_row[i])(",");
};

set index = length(output) - 1;
set output = String.Remove(output)(index)(1); //remove the latest ','
write#("{0}", output );

set output = "";
array dst_column[8];
write#("function CopyColumnElementsToArray");
```

```
call CopyColumnElementsToArray(src, 7, 0, 7, dst_column);

for(i,0,8)
{
  set output = String.Concat(output)(dst_column[i])(",");
};

set index = length(output) - 1;
set output = String.Remove(output)(index)(1); //remove the latest ','
write("{0}")(output );
```

```
>rc examples\scr\copyto.scr;
results:
      0       1       2       3       4       5       6       7
---------------------------------------------NS.Global.src---------------------------------------------
[0]   0       1       2       3       4       5       6       7
[1]   8       9       10      11      12      13      14      15
[2]   16      17      18      19      20      21      22      23
[3]   24      25      26      27      28      29      30      31
[4]   32      33      34      35      36      37      38      39
[5]   40      41      42      43      44      45      46      47
[6]   48      49      50      51      52      53      54      55
[7]   56      57      58      59      60      61      62      63
function CopyRowElementsToArray
src=src  row=1 first_element =0  last_element=5 dst=dst_row
8,9,10,11,12,13
function CopyColumnElementsToArray
src=src  column=7 first_element =0  last_element=7 dst=dst_column
7,15,23,31,39,47,55,63
```

Open console window:
cmd
and run:
examples.bat
callfunc.bat
with numerous examples of code.

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