To:
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MODULE Y
THE C/C++, main() AND COMMAND-LINE ARGUMENT

My Training Period: xx hours

Note:
Examples compiled using Microsoft Visual C++/.Net, empty win32 console mode application. Some examples also tested using Borland C++ Builder 5.02. **gcc** compilation example is given at the end of this Module. For the main() command line arguments and **pointer** story, please read C & + + Pointers, Section 8.9. For wide character and Unicode wmain() version please refer to Win32 Locale, Unicode & Wide Characters (Story) and Windows Win32 Users & Groups (implementation). for the dllmain() please refer to Win32 programming

C and C++ main() and command line arguments abilities:

- Able to understand and use a portable main() versions and their variation.
- Able to understand and use programs that accept command-line arguments.
- Able to build programs that accept command-line arguments.
- Able to build programs that can run with options/switches.

Y.1 The main Function and Program Execution

- The 'concepts' discussed in this Module may be very useful for UNIX/Linux (or command line tools for Microsoft Windows) programmers because of the extensive usage of the command-line programs or tools.
- A special function called main() is the starting point of execution for all C and C++ programs. It is not predefined by the compiler; so that, it must be supplied in the program.
- If your code adheres to the Unicode programming model, then you can use the wide-character version of main(), wmain(), but it is implementation dependent.
- The main() function serves as the starting point for program execution. It usually controls program execution by directing the calls to other functions in the program.
- A program usually stops executing at the end of main(), denoted by closing curly brace (}), although it can terminate at other points in the program for a variety of reasons such as the forced program termination by using the exit() function.
- As you have learned before, functions within the program body perform one or more specific tasks. The main() function can call these functions to perform their respective tasks as shown in the following program skeleton.

```
int main()
{
    // a function call…
    MyFunction();
    …
    // another function call…
    YourFunction();
    …
    // another function call…
    OurFunction();
    …
    return 0;
}
```

- When main() calls another function, it passes execution control to the function, then, execution begins at the first statement in the function. A function returns control to main() when a return statement is executed or when the end of the function is reached denoted by the closing curly brace.
- If you aware, all the program examples presented in this tutorial do not have parameters in the main () function. Actually there are others version, that you can declare main() function, to have parameters, as any other functions but with a few exceptions.
- As explained before in Function, the term parameter or formal parameter refers to the identifier that receives a value passed to a function. When one function calls another, the called function receives values for its parameters from the calling function.
- These values are called arguments. The parameter just acts as a placeholder. You can declare parameters to main() so that it can receive arguments from the command line using the following format:

```
int main(int argc, char *argv[ ])
{
  ...
  return 0;
}
```

- Or something like this:

```
int main(int argc, char *argv[ ], char *envp[ ])
{
  ...
  return 0;
}
```

- There is no prototype declared for main(), and as a conclusion, we have main() that can be defined with zero, two, or three parameters as shown below.

```
int main(void)
{
  //...
  return 0;
}

int main(int argc, char *argv[])
{
  //...
  return 0;
}

// implementation dependant
int main(int argc, char *argv[], char *envp[])
{
  //...
  return 0;
}
```

- When you want to pass information to the main() function, the parameters are traditionally named argc and argv, although for C compiler does not require these names.
- The types for argc and argv are defined by the C language. Traditionally, if a third parameter is passed to main(), that parameter is named envp, a Microsoft extension to the ANSI C (ISO/IEC C) standard (or env for Borland®).
- The following table lists some description of the parameters.

Parameter	Description
`argc`	For **argument count**, an integer that contains the count of arguments that follows in argv. Since the **program name** is considered an argument, the argc parameter is always greater than or equal to 1. Type is int.
`*argv[]/**argv`	For **argument vector**, an array of null-terminated strings representing command-line arguments entered by the user of the program. All elements of the argv array are pointers to strings. By convention, argv[0] is the command with which the program is invoked, that is the **program name**; then, argv[1] is the first command-line argument, and so on, until argv[argc], which is always NULL pointer. The first command-line argument is always argv[1] and the last one is argv[argc–1]. All elements of the argv array are pointers to strings. Type is char.
`*envp[]` `*env(Borland®)`	Is an array of pointers to environment variables. The envp array is terminated by a null pointer. This is a Microsoft extension to the ANSI C standard and also used in Microsoft C++. It is an array of strings representing the variables set in the user's environment. This array is terminated by a NULL entry. It can be declared as an array of pointers to char(char *envp[ ]) or as a pointer to pointers to char(char **envp). If your program uses wmain() instead of main(), use the wchar_t() data type instead of char. The environment block passed to main() and wmain() is a *frozen* copy of the current environment. If you subsequently change the environment via a call to putenv() or _wputenv(), the current environment (as returned by getenv()/_wgetenv() and the _environ()/ _wenviron() variable) will change, but the block pointed to by envp will not change. This argument is ANSI compatible in C, but not in C++. It is also a common extension in many Linux/UNIX® systems.

Table Y.1: main() parameters

- A program invoked with no command-line arguments will receive a value of one for argc, as the program name of the executable file is placed in argv[0]. Strings pointed to by argv[1] through argv[argc–1] represent program parameters.
- The simplest illustration is the echo program, which echoes its command-line arguments on a single line, separated by blanks as shown below when you run at the command prompt of Windows Operating System.

```
echo Hello world!
```

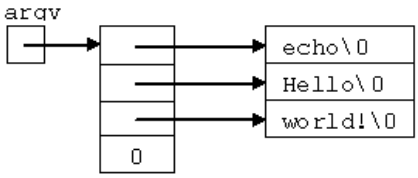
- Prints the output:

```
Hello world!
```

- As explained before, by convention, argv[0] is the program name by which the program was invoked, so argc is at least 1. If argc is 1, there are no command-line arguments after the program name.
- In the example above, argc is 3, and…

```
argv[0] is echo      - the program name
argv[1] is Hello     - string
argv[2] is world!    - string
```

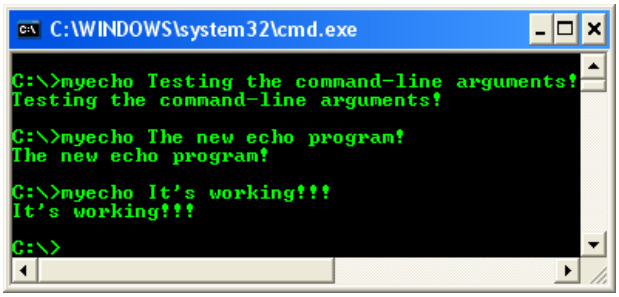
- The first optional argument is argv[1] and the last is argv[argc-1]; additionally the standard requires that argv[argc] be NULL pointer. The explanation can be illustrated as shown below.



- The following program example is the version of echo program that treats argv as an array of character pointers:

```
// program & file names, myecho.exe
// compiled using Visual C++ .Net
#include <stdio.h>

// echo command-line argument
// using array of character pointers
int main(int argc, char *argv[])
{
    int i;
    for(i=1; i<argc; i++)
        printf("%s%s", argv[i],(i<argc-1)? " ":"");
    printf("\n");
    return 0;
}
```

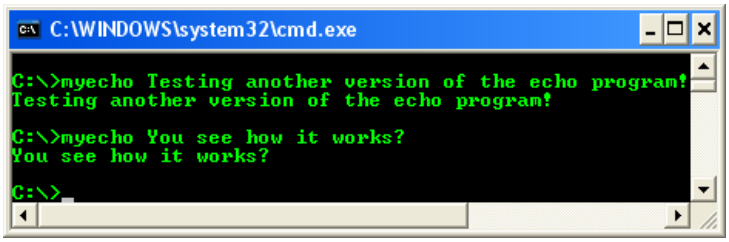
- Run the myecho.exe at console/command prompt where the executable program is located, to see the output. For the following output, **myecho.exe** is at the **C:** drive.



- Since argv is a pointer to an array of pointers, we can manipulate the pointer rather than the index of the array.
- The next variation is based on incrementing argv, which is a pointer to pointer to char, while argc is counted down.

```
// program & file names, myecho.exe
// compiled using Visual C++ .Net
#include <stdio.h>

// another version of the myecho program,
// command-line argument
int main(int argc, char *argv[])
{
    while(--argc > 0)
        printf("%s%s",*++argv, (argc > 1) ? " ": "");
    printf("\n");
    return 0;
}
```

- The output:



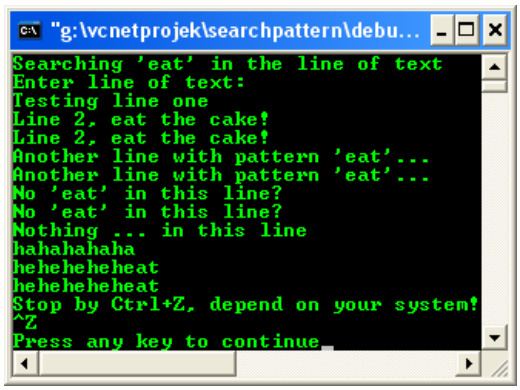
- Since argv is a pointer to the beginning of the array of argument strings, incrementing it by 1 (++argv) makes it point at the original argv[1] instead of argv[0].
- Each successive increment moves it along to the next argument; *argv is then the pointer to that argument. At the same time, argc is decremented; when it becomes zero, there are no arguments left to print. Alternatively we could write the printf() statement as:

```
printf((argc > ?) ? "%s ": "%s", *++argv);
```

- This shows that the format argument of printf() can also be an expression.
- Consider the following program example, very simple text pattern search program.

```
// searchpattern.cpp, compiled using Visual C++ .Net
#include <stdio.h>
// maximum input line length
#define MAXLINE 100

// function prototypes...
int getline(char line[ ], int max);
int strindex(char source[ ], char searchfor[ ]);

// pattern to be searched for in the line
char pattern[ ] = "eat";

// find/display all line matching pattern
main()
{
    char line[MAXLINE];
    int found = 0;

    printf("Searching \'eat\' in the line of text\n");
    printf("Enter line of text:\n");
    while(getline(line, MAXLINE) > 0)
        if(strindex(line, pattern) >= 0)
        {
            printf("%s", line);
            found++;
        }
        return found;
}

// getline(), get line into string str, return the length
int getline(char str[ ], int lim)
{
   int count, i;
   i=0;

   while(--lim > 0 && (count=getchar()) != EOF && count != '\n')
        str[i++] = count;
    if(count=='\n')
        str[i++] = count;
    str[i]='\0';
    return i;
}
// strindex, return index of t in str, -1 if none
int strindex(char str[], char t[])
{
    int i, j, k;
    for(i=0;str[i]!='\0';i++)
    {
        for(j=i, k=0; t[k] != '\0' && str[j] == t[k]; j++, k++)
            ;
        if(k > 0 && t[k] == '\0')
            return i;
    }
    return -1;
}
```

- The above program named **searchpattern** and when the **searchpattern.exe** is run, the output is shown below.

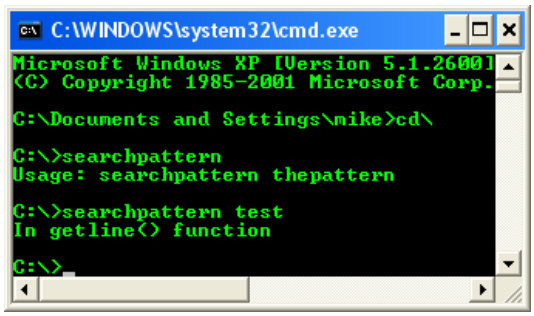


Y.2 Command Line Argument

- Let change the program so that the pattern to be matched is specified by the first argument on the command line. As an example, let create a simple program skeleton.

```
// searchpattern.cpp, compiled using VC++ .Net, not usable...just program skeleton
#include <stdio.h>
#include <string.h>
#define MAXLINE 100

int getline(char *line, int max)
{
   printf("In getline() function\n");
   // put getting line of text codes here…
   return 0;
}

// find and print lines that match pattern from the 1st argument
main(int argc, char *argv[])
{
    char line[MAXLINE];
    int found = 0;

    // if just program name (argc = 1), then...
    if(argc != 2)
        printf("Usage: searchpattern thepattern\n");

    // if the program name with switch/option (argc = 2), then...
    else

          while(getline(line, MAXLINE) > 0)
          {
             if(strstr(line, argv[1]) != NULL)
             {
                printf("%s", line);
                found++;}
             }
          return found;
}
```

- The output when running the program at command prompt or where the **searchpattern.exe** is located is shown below.

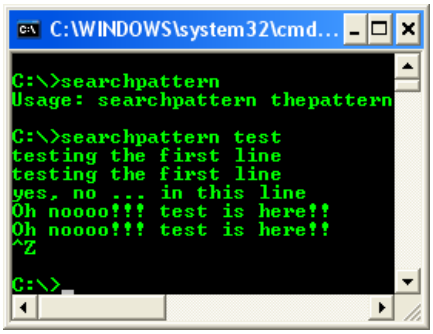


- And the following is the working program example of the **searchpattern**, using command line argument.

```
// searchpattern.cpp, compiled using VC++ .Net
#include <stdio.h>
#include <string.h>
#define MAXLINE 100

int getline(char *line, int max)
{
   int count, i;
   i=0;
```

```
    while(--max > 0 && (count=getchar()) != EOF && count != '\n')
        line[i++] = count;
    if(count=='\n')
        line[i++] = count;
    line[i]='\0';
    return i;
}

// find and print lines that match the pattern from the 1st argument
main(int argc, char *argv[])
{
    char line[MAXLINE];
    int found = 0;

    // if just program name (argc = 1), then...
    if(argc != 2)
        printf("Usage: searchpattern thepattern\n");
    // if the program name with switch/option (argc = 2), then...
    else

     while(getline(line, MAXLINE) > 0)
     {
        if(strstr(line, argv[1]) != NULL)
        {
           printf("%s", line);
          found++;
         }
      }
    return found;
}
```

- The output, when running the **searchpattern.exe** at C: (or run it where ever the **searchpattern.exe** is located):



- The standard library function strstr(a, b) returns a pointer to the first occurrence of the string b in the string a, or NULL if there is none. It is declared in <string.h> or C++ wrapper <cstring>.
- The program skeleton can now be expanded to illustrate further the pointer constructions. Suppose we want to allow 2 optional arguments (or switches). The first one is: to print all line except those that match the pattern; the second one is: precede each printed line by its line number.

Y.3 Command line and switches/options

- For C/C++ programs on UNIX/Linux systems or Windows command line, conventionally, an argument that begins with a minus sign introduces an optional flag or parameter, normally called switch or option.
- For Windows, the forward slash (/) also used together with the switches. For example, if we choose –v (for inversion) to signal the inversion, and –n (for number) to request line numbering, then the command line:

    searchpattern –v –n *thepattern*

- Will print each line that doesn't match the pattern, preceded by its line number.
- Optional arguments should be permitted in any order, and the rest of the program should be independent of the number of arguments that were present.
- Furthermore, it is also convenient for users if option arguments can be combined, as in the following command line:

    searchpattern –vn *thepattern*

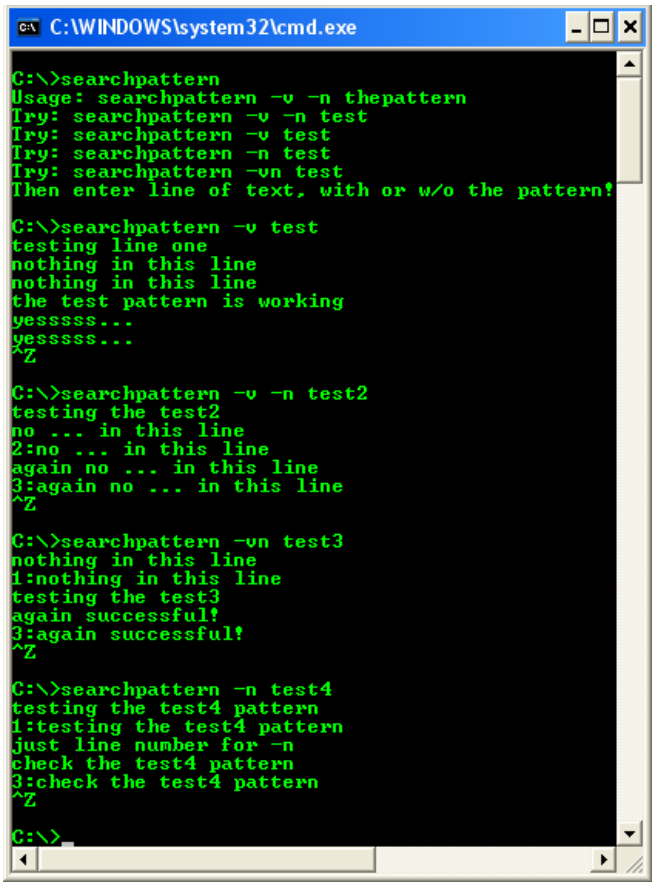
- The following is the working program example.

```
// searchpattern.cpp, compiled using VC++ .Net
#include <stdio.h>
#include <string.h>
```

```
// maximum input line length
#define MAXLINE 100

int getline(char line[], int max)
{
   int count, i;
   i=0;

   while(--max > 0 && (count=getchar()) != EOF && count != '\n')
         line[i++] = count;
     if(count=='\n')
         line[i++] = count;
     line[i]='\0';
   return i;
}

// find all line of text matching pattern supplied by command line argument
main(int argc, char *argv[])
{
      char line[MAXLINE];
      long linenum = 0;
      int theoption, except = 0, number = 0, found =0;

      // check the minus sign....
      while(--argc > 0 && (*++argv)[0] == '-')
            // check the option...
            while(theoption = *++argv[0])
                  switch (theoption)
            {
                  case 'v':
                        except = 1;
                        break;
                  case 'n':
                        number = 1;
                        break;
                  default:
                        printf("searchpattern: illegal option %s\n", theoption);
                        argc = 0;
                        found = -1;
                        break;
            }
            if(argc != 1)
            {
                  // some help...
                  printf("Usage: searchpattern -v -n thepattern\n");
                  printf("Try: searchpattern -v -n test\n");
                  printf("Try: searchpattern -v test\n");
                  printf("Try: searchpattern -n test\n");
                  printf("Try: searchpattern -vn test\n");
                  printf("Then enter line of text, with or w/o the pattern!\n");
            }
            else
                  while(getline(line, MAXLINE) > 0)
                  {
                        linenum++;
                        if((strstr(line,*argv) != NULL) != except)
                        {
                              if(number)
                                    printf("%ld:", linenum);
                              printf("%s", line);
                              found++;
                        }
                  }
                  return found;
         }
```

- The output when running the **searchpattern.exe** at the command prompt **C:** (or run it where it is located). For Borland 5.02, you have to run the full command line as shown below.

```
searchpattern –v –n test
```



- The parameters argc and argv are modifiable and retain their last-stored values between program startup and program termination.
- For wide-character, Microsoft implementation, the declaration syntax for wmain() is as follows:

```
int wmain( )
{
  //...
  return 0;
}
```

- Or, optionally:

```
int wmain(int argc, wchar_t *argv[], wchar_t *envp[])
{
  //...
  return 0;
}
```

- For Microsoft implementation please refer to Win32 Locale, Unicode & Wide Characters (Story) and Windows Win32 Users & Groups for wmain().
- For Borland®, env[ ] is used instead of envp[ ]. For UNIX/Linux, please check their documentation.
- The types for argc and argv are defined by the language. The names argc, argv, and envp are traditional, but are not required by the compiler. So, you may use other name isn't it? Then try it yourself :o).
- Alternatively, the main() and wmain() functions can be declared as returning void (no return value). If you declare main() or wmain() as returning void, you cannot return an exit code to the parent process or operating system using a return statement.
- To return an exit code when main() or wmain() is declared as void, you must use the exit() function from **stdlib.h**.

Y.4 Some main() Function Restrictions

- Several restrictions apply to the main() function that do not apply to any other C/C++ functions. The main() function compared to normal function:

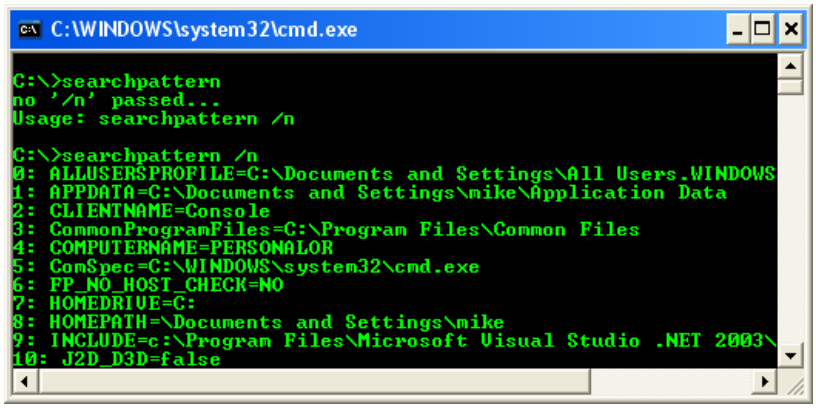
1. Cannot be overloaded.
2. Cannot be declared as inline.
3. Cannot be declared as static.
4. Cannot have its address taken.
5. Cannot be called.

- The following example shows how to use the argc, argv, and envp arguments to main():

```
// main() arguments program example, C++ codes
#include <iostream>
// for Borland 5.02 you may use <string.h> instead of <cstring>
```

```
// and comment out the 'using namespace std';
#include <cstring>
using namespace std;

int main(int argc, char *argv[], char *envp[])
{
   // the default is no line numbers.
   int LineNum = 0;

   // if /n is passed to the .exe program, display
   // numbered listing of environment variables.
   // if program name and switch/option... AND stricmp...
   if((argc == 2) && stricmp(argv[1], "/n" ) == 0)
      LineNum = 1;
   else
      cout<<"no \'/n\' passed..."<<endl;

   // walk through the list of strings until a NULL is encountered.
   for(int i = 0; envp[i] != NULL; ++i)
   {
      if(LineNum)
      cout<<i<<": "<<envp[i]<<"\n";
   }
   cout<<"Usage: searchpattern /n\n";
   return 0;
}
```

- The output, when **searchpattern.exe** run at command prompt (or where ever the **.exe** is located), depends on your environment setting, is shown below.



Y.5 Parsing C Command-Line Arguments – Microsoft Implementation

- For information, Microsoft uses Microsoft C Runtime (CRT) for C codes; that is Microsoft C version (mix of standard C and Microsoft C).
- Microsoft C startup code uses the following rules when interpreting arguments given on the operating system command line:

1. Arguments are delimited by white space, which is either a space or a tab.
2. A string surrounded by double quotation marks is interpreted as a single argument, regardless of white space contained within. A quoted string can be embedded in an argument. Note that the caret (^) is not recognized as an escape character or delimiter.
3. A double quotation mark preceded by a backslash, \", is interpreted as a literal double quotation mark (").
4. Backslashes are interpreted literally, unless they immediately precede a double quotation mark.
5. If an even number of backslashes is followed by a double quotation mark, then one backslash (\) is placed in the argv array for every pair of backslashes (\\), and the double quotation mark (") is interpreted as a string delimiter.
6. If an odd number of backslashes is followed by a double quotation mark, then one backslash (\) is placed in the argv array for every pair of backslashes (\\) and the double quotation mark is interpreted as an escape sequence by the remaining backslash, causing a literal double quotation mark (") to be placed in argv.

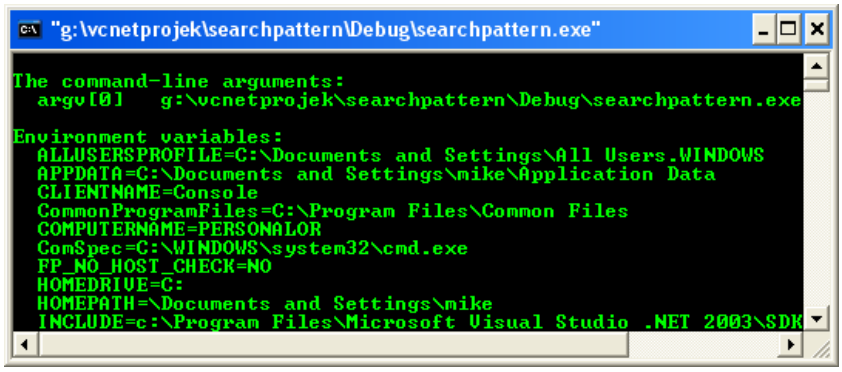
- The following list illustrates the above listed rules by showing the interpreted result passed to argv for several examples of command-line arguments. The output listed in the second, third, and fourth columns is from the following program example.

Command-Line Input	argv[1]	argv[2]	argv[3]
"a b c" d e	a b c	d	e
"ab\"c" "\\" d	ab"c	\	d
a\\\b d"e f"g h	a\\\b	de fg	h
a\\\"b c d	a\"b	c	d
a\\\\"b c" d e	a\\b c	d	e

Table Y.2

```
// searchpattern.cpp, compiled using VC++ .Net and Borland C++ 5.02
// run on windows machine...
#include <stdio.h>

int main(int argc,          /* number of strings in array argv */
    char *argv[ ],          /* array of command-line argument strings */
    char **envp)            /* array of environment variable strings */
{
    int count;

    /* display each command-line argument. */
    printf("\nThe command-line arguments:\n");
    for(count = 0; count < argc; count++)
        printf("  argv[%d]   %s\n", count, argv[count]);

    /* display each environment variable.*/
    printf("\nEnvironment variables:\n");
    while(*envp != NULL)
        printf("  %s\n", *(envp++));
    return 0;
}
```

- The output, when running the **.exe**, depends on your environment setting, is shown below:



- For windows system, you can put the command line program (executable programs) in the **System32** folder, and then you can run it from any relative or absolute path. For Linux it is **sbin** or **bin**.
- Program example compiled using gcc.

```
/ ***************cmdline.c*************** */
/ ************Run on FeDorA 3 Machine******* */
#include <stdio.h>

int main(int argc,   /* number of strings in array argv */
    char *argv[ ],      /* array of command-line argument strings */
    char **envp)        /* array of environment variable strings */
{
    int count;

    /* display each command-line argument. */
    printf("\nThe command-line arguments:\n");
    for(count = 0; count < argc; count++)
        printf("  argv[%d]   %s\n", count, argv[count]);

    /* display each environment variable. */
    printf("\nEnvironment variables:\n");
    while(*envp != NULL)
        printf("  %s\n", *(envp++));

    return 0;
}

[bodo@bakawali ~]$ gcc cmdline.c -o cmdline
[bodo@bakawali ~]$ ./cmdline

The command-line arguments:
  argv[0]   ./cmdline

Environment variables:
  HOSTNAME=bakawali
  TERM=xterm
  SHELL=/bin/bash
  HISTSIZE=1000
  SSH_CLIENT=::ffff:203.106.94.71 4136 22
  SSH_TTY=/dev/pts/4
  USER=bodo
  LS_COLORS=no=00:fi=00:di=00;34:ln=00;36:pi=40;33:so=00;35:bd=40;33;01:
```

```
cd=40;33;01:or=01;05;37;41:mi=01;05;37;41:ex=00;32:*.cmd=00;32:*.exe=00;32:*.com=00;32:
*.btm=00;32:*.bat=00;32:*.sh=00;32:*.csh=00;32:*.tar=00;31:*.tgz=00;31:*.arj=00;31:*.taz=00;31:
*.lzh=00;31:*.zip=00;31:*.z=00;31:*.Z=00;31:*.gz=00;31:*.bz2=00;31:*.bz=00;31:*.tz=00;31:
*.rpm=00;31:*.cpio=00;31:*.jpg=00;35:*.gif=00;35:*.bmp=00;35:*.xbm=00;35:*.xpm=00;35:*.
png=00;35:*.tif=00;35:
 KDEDIR=/usr
 MAIL=/var/spool/mail/bodo
 PATH=/usr/kerberos/bin:/usr/local/bin:/bin:/usr/bin:/usr/X11R6/bin:/home/bodo/bin
 INPUTRC=/etc/inputrc
 PWD=/home/bodo
 LANG=en_US.UTF-8
 SSH_ASKPASS=/usr/libexec/openssh/gnome-ssh-askpass
 SHLVL=1
 HOME=/home/bodo
 LOGNAME=bodo
 SSH_CONNECTION=::ffff:203.106.94.71 4136 ::ffff:203.106.94.94 22
 LESSOPEN=|/usr/bin/lesspipe.sh %s
 G_BROKEN_FILENAMES=1
 _=./cmdline
```

----------o0o ----------

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Further related reading:

1. Check the best selling C and C++ books at Amazon.com.
2. Win32 Locale, Unicode & Wide Characters (Story) and Windows Win32 Users & Groups (implementation) for Multibytes, Unicode characters and Localization.
3. Windows Dynamic-Link Library, DLL story and program examples can be found Win32 DLL tutorials.
4. Windows implementation of processes, threads and synchronization using C can be found Win32 processes and threads tutorials.
5. Windows Services story can be found Windows Services tutorials.