Marco Martinez
CISP 310
Assignment 3b

Hierarchy Chart

```
3.0 main
        3.1 BubbleSort(in pArray as Array of Integers,in/out pIndex as Array of Integers,in Count as Integer)
        3.2 LinearSearch(in pArray as array of integers,in pIndex as array of integers,in Count as integer,in key as integer)
        3.3 DisplayArray(in pArray as array of integers,in pIndex as array of integers,in Count as integer)
        3.4 DisplaySearchResult(in key as integer,in location as integer)
```

Pseudo Code

Main Module

```
Begin

DEFINE BEGIN_DEFINE as String "                                   SEARCH AND SORT TEST ",0
DEFINE BORDER_DEFINE as String      "===============================================================================================",0
DECLARE array1 as Array of Integers {40,-10,400,20,-300,12,10,0}
DECLARE index1 as Array of Integers {0,1,2,3,4,5,6,7}
DECLARE length1 as Integer LENGTHOF array1
DECLARE array2 as Array of Integers {0,-10,-20,-30,50,100,200,300,-100,-80,1000,2000,-5000,60,70,550,-550,-300,-900,1010,2300}
DECLARE index2 as Array of Integers {0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20}
DECLARE length2 as Integer LENGTHOF array2
DECLARE array3 as Array of Integers {50,40,30,20,10}
DECLARE index3 as Array of Integers {0,1,2,3,4}
DECLARE length3 as LENGTHOF array3
DECLARE key1 as Integer -10
DECLARE key2 as Integer 1000
DECLARE key3 as Integer 0
DECLARE location1 as Integer
DECLARE location2 as Integer
DECLARE location3 as Integer
DECLARE msg1 as String "Unsorted array: "
DECLARE msg2 as String "Sorted array: "
DECLARE msg3 as String "Search found the value "
DECLARE msg4 as String " at position "

        Set ecx as 0
Do
        Save reg
        Call crlf
        Set edx as OFFSET BEGIN_DEFINE
        Set ecx as ecx + 1
        Set eax as ecx
        Call writeString
        Call writeInt
        Call crlf
        Load reg
        Save edx
        Set edx as OFFSET BORDER_DEFINE
```

```
Call writeString
Call crlf
Load edx

Save reg
Set edx as OFFSET msg1
Call writeString
Call DisplayArray(in ADDR array1,in ADDR index1,in length1)
Call BubbleSort(in ADDR array1,in/out ADDR index1,in length1)
Set edx as OFFSET msg2
Call writeString
Call DisplayArray(in ADDR array1,in ADDR index1,in length1)
Load reg

Save reg
Call LinearSearch(in ADDR array1,in ADDR index1,in length1,in key1)
Set edx as OFFSET msg3
Call writeString
Set edx as OFFSET msg4
Set location1 as eax
Call DisplaySearchResult(key1,location1)
Call crlf
Load reg

Save reg
Set edx as OFFSET msg1
Call writeString
Call DisplayArray(in ADDR array2,in ADDR index2,in length2)
Call BubbleSort(in ADDR array2,in/out ADDR index2,in length2
Set edx as OFFSET msg2
Call writeString
Call DisplayArray(in ADDR array2,in ADDR index2,in length2)
Load reg

Save reg
Call LinearSearch(in ADDR array2,in ADDR index2,in length2,in key2)
Set edx as OFFSET msg3
Call writeString
Set edx as OFFSET msg4
Set location2 as eax
Call DisplaySearchResult(in key2,in location2)
Call crlf
Load reg

Save reg
Set edx as OFFSET msg2
Call writeString
Call DisplayArray(in ADDR array3,in ADDR index3,in length3)
Call BubbleSort(in ADDR array3,in/out ADDR index3,in length3)
Set edx as OFFSET msg2
Call writeString
```

```
        Call DisplayArray(in ADDR array3,in ADDR index3,in length3)
        Load reg

        Save reg
        Call LinearSearch(in ADDR array3,in ADDR index3,in length3,in key3)
        Set edx as OFFSET msg3
        Call writeString
        Set edx as OFFSET msg4
        Set location3 as eax
        Call DisplaySearchResult(in key3,in location3)
        Call crlf
        Call crlf
        Load reg

        Set key1 as key1 + 10
        Set key2 as key2 + 10
        Set key3 as key3 + 10
        Set ecx as ecx + 1
While (ecx < 3)
End main

BubbleSort(in pArray as Array of Integers,in/out pIndex as Array of Integers,in Count as Integer)
Begin

DECLARE boolean swap

        Set swap as false
        Set ecx as Count
        Set ecx as ecx - 1
L1:
        Save ecx
        Set edi as pIndex
        Set ebx as [edi]
        Set ebx as ebx * 4

        L2:
                Set esi as pArray
                Set esi as esi + ebx
                Set eax as [esi]
                Set esi as pArray
                Set ebx as [edi+4]
                Set ebx as ebx * 4
                Set esi as pArray
                Set esi as esi + ebx
                If ([esi]>eax)
                        Set ebx as [edi+4]
                        Exchange ebx and [edi]
                        Set [edi+4] as ebx
                        Set swap as true
                End If
                Set edi as edi + 4
                Set ebx as [edi]
                Set ebx as ebx * 4
        While (ecx < Count-1)
        If(swap)
                Return
        End If
        Load ecx
While (ecx < Count)
Return

LinearSearch(in pArray as array of integers,in pIndex as array of integers,in Count as integer,in key as integer)
Begin
        Set eax as 0
        Set edx as 0
        Set ecx as Count
        Set edi as pIndex
        Set ebx as [edi]
        Set ebx as ebx * 2
Do
        Set esi as pArray
        Set esi as esi + ebx
        Set eax as [esi]
        If (eax == key)
                Set eax as edx
                Return
        End If
        Set edx as edx + 1
        Set edi as edi + 4
        Set ebx as [edi]
        Set ebx as ebx * 4
        Set ecx as ecx - 1
While (ecx>0)
        Set eax as -1
        Return

DisplayArray(in pArray as array of integers,in pIndex as array of integers,in Count as integer)
Begin
        Set ecx as Count
        Set edi as pIndex
        Set ebx as [edi]
        Set ebx as ebx * 4
Do
        Set esi as pArray
        Set esi as esi + ebx
        Set eax as [esi]
        Call writeInt
        Set edi as edi + 4
        Set ebx as [edi]
        Set ebx as ebx * 4
        Set ecx as ecx - 1
While (ecx>0)
```

```
        Call crlf
        Return

DisplaySearchResult(in key as integer,in location as integer)
Begin
        Set eax as key
        Call writeInt
        Call writeString
        Set eax as location
        Call writeInt
        Call crlf
        Set edx as 0
        Return
```

Assembly Source Code

```
;;      Author:         Marco Martinez
;;      Filename:       IndexedSortAndSearch.asm
;;      Version:        1.0
;;      Description:    Add a variable to the BubbleSort procedure in Section 9.5.1 that is set to 1 whenever a pair of
;;                              values is exchanged within the inner loop. Use this variable to exit the sort before its normal
;;                              completion if you discover that no exchanges took place during a complete pass through the
;;                              array. (This variable is commonly known as an exchange flag.)
;;      Date:           12/8
;;
;;      Program Change Log
;;      ==================
;;      Name            Date            Description
;;      Marco   12/8            Create baseline for IndexedSortAndSearch.asm
;;

INCLUDE Irvine32.inc


.data
BEGIN_DEFINE BYTE     "                                   SEARCH AND SORT TEST ",0
BORDER_DEFINE BYTE    "==========================================================================================",0
array1 DWORD 40,-10,400,20,-300,12,10,0
index1 DWORD 0,1,2,3,4,5,6,7
length1 DWORD LENGTHOF array1
array2 DWORD 0,-10,-20,-30,50,100,200,300,-100,-80,1000,2000,-5000,60,70,550,-550,-300,-900,1010,2300
index2 DWORD 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20
length2 DWORD LENGTHOF array2
array3 DWORD 50,40,30,20,10
index3 DWORD 0,1,2,3,4
length3 DWORD LENGTHOF array3
key1 DWORD -10
key2 DWORD 1000
key3 DWORD 0
location1 DWORD ?
```

```
location2 DWORD ?
location3 DWORD ?
msg1 BYTE "Unsorted array: ",0
msg2 BYTE "Sorted array: ",0
msg3 BYTE "Search found the value ",0
msg4 BYTE " at position ",0

.code
BubbleSort PROTO,
       pArray:PTR DWORD,
       pIndex:PTR DWORD,
       Count:DWORD

LinearSearch PROTO,
       pArray:PTR DWORD,
       pIndex:PTR DWORD,
       Count:DWORD,
       key:DWORD

DisplayArray PROTO,
       pArray:PTR DWORD,
       pIndex:PTR DWORD,
       Count:DWORD

DisplaySearchResult PROTO,
       key:DWORD,
       location:DWORD

main PROC

       mov ecx,0
Begin:
       pushad
       call crlf
       mov edx,OFFSET BEGIN_DEFINE
       add ecx,1
       mov eax,ecx
       call writeString
       call writeInt
       call crlf
       popad
       push edx
       mov edx,OFFSET BORDER_DEFINE
       call writeString
       call crlf
       pop edx

       pushad
       mov edx,OFFSET msg1
       call writeString
       INVOKE DisplayArray,ADDR array1,ADDR index1,length1
       INVOKE BubbleSort,ADDR array1,ADDR index1,length1
       mov edx,OFFSET msg2
       call writeString
       INVOKE DisplayArray,ADDR array1,ADDR index1,length1
       popad

       pushad
       INVOKE LinearSearch,ADDR array1,ADDR index1,length1,key1
       mov edx,OFFSET msg3
       call writeString
       mov edx,OFFSET msg4
       mov location1,eax
       INVOKE DisplaySearchResult,key1,location1
       call crlf
       popad

       pushad
       mov edx,OFFSET msg1
       call writeString
       INVOKE DisplayArray,ADDR array2,ADDR index2,length2
       INVOKE BubbleSort,ADDR array2,ADDR index2,length2
       mov edx,OFFSET msg2
       call writeString
       INVOKE DisplayArray,ADDR array2,ADDR index2,length2
       popad

       pushad
       INVOKE LinearSearch,ADDR array2,ADDR index2,length2,key2
       mov edx,OFFSET msg3
       call writeString
       mov edx,OFFSET msg4
       mov location2,eax
       INVOKE DisplaySearchResult,key2,location2
       call crlf
       popad

       pushad
       mov edx,OFFSET msg2
       call writeString
       INVOKE DisplayArray,ADDR array3,ADDR index3,length3
       INVOKE BubbleSort,ADDR array3,ADDR index3,length3
       mov edx,OFFSET msg2
       call writeString
       INVOKE DisplayArray,ADDR array3,ADDR index3,length3
       popad

       pushad
       INVOKE LinearSearch,ADDR array3,ADDR index3,length3,key3
       mov edx,OFFSET msg3
       call writeString
       mov edx,OFFSET msg4
```

```
       mov location3,eax
       INVOKE DisplaySearchResult,key3,location3
       call crlf
       call crlf
       popad

       add key1,10
       add key2,10
       add key3,10
       inc ecx
       cmp ecx,3
       jl Begin

       exit
main ENDP

BubbleSort PROC USES eax ebx ecx edx esi edi,
       pArray:PTR DWORD, ; pointer to array
       pIndex:PTR DWORD,
       Count:DWORD ; array size
       LOCAL swap:BYTE
       mov swap,0
       mov ecx,Count
       dec ecx ; decrement count by 1
L1:
       push ecx ; save outer loop count
       mov edi,pIndex
       mov ebx,[edi]
       shl ebx,2
L2:
       mov esi,pArray
       add esi,ebx
       mov eax,[esi]
       mov esi,pArray
       mov ebx,[edi+4]
       shl ebx,2
       mov esi,pArray
       add esi,ebx
       cmp [esi],eax; compare a pair of values
       jg L3
       mov ebx,[edi+4]
       xchg ebx,[edi]
       mov [edi+4],ebx
       inc swap
L3:
       add edi,4
       mov ebx,[edi]
       shl ebx,2
       loop L2 ; inner loop
       cmp swap,0
       je l4
```

```
        mov swap,0
        pop ecx ; retrieve outer loop count
        loop L1 ; else repeat outer loop
L4:
        ret
BubbleSort ENDP

LinearSearch PROC USES ebx ecx edx esi edi,
        pArray:PTR DWORD, ; pointer to array
        pIndex:PTR DWORD,
        Count:DWORD, ; array size
        key:DWORD
        mov eax,0
        mov edx,0
        mov ecx,Count
        mov edi,pIndex
        mov ebx,[edi]
        shl ebx,2
L1:
        mov esi,pArray
        add esi,ebx
        mov eax,[esi]
        cmp eax,key
        je Found
        inc edx
        add edi,4
        mov ebx,[edi]
        shl ebx,2
        dec ecx
        cmp ecx,0
        jg L1
        mov eax,-1
        jmp Return
Found:
        mov eax,edx
Return:
        ret
LinearSearch ENDP

DisplayArray PROC USES eax ebx ecx edx esi edi,
        pArray:PTR DWORD,
        pIndex:PTR DWORD,
        Count:DWORD

        mov ecx,Count
        mov edi,pIndex
        mov ebx,[edi]
        shl ebx,2
L1:
        mov esi,pArray
        add esi,ebx
        mov eax,[esi]
        call writeInt
        add edi,4
        mov ebx,[edi]
        shl ebx,2
        dec ecx
        cmp ecx,0
        jg L1
        call crlf
        ret
DisplayArray ENDP

DisplaySearchResult PROC USES eax ebx ecx esi edi,
        key:DWORD,
        location:DWORD,

        mov eax,key
        call writeInt
        call writeString
        mov eax,location
        call writeInt
        call crlf
        mov edx,0
        ret
DisplaySearchResult ENDP
end main
```

Listing File

```
Microsoft (R) Macro Assembler Version 14.15.26732.1           12/15/18 18:52:11
..\..\..\..\Documents\School Work\P310\thirdProject\3b\IndexedSortAndSearch.asm  Page 1 - 1


                             ;;     Author:       Marco Martinez
                             ;;     Filename:            IndexedSortAndSearch.asm
                             ;;     Version:             1.0
                             ;;     Description:  Add a variable to the BubbleSort procedure in Section 9.5.1 that is set to 1 whenever a pair
of
                             ;;                          values is exchanged within the inner loop. Use this variable to exit the sort before
its normal
                             ;;                          completion if you discover that no exchanges took place during a complete pass through
the
                             ;;                          array. (This variable is commonly known as an exchange flag.)
                             ;;     Date:         12/8
                             ;;
                             ;;     Program Change Log
                             ;;     ==================
                             ;;     Name          Date          Description
                             ;;     Marco  12/8          Create baseline for IndexedSortAndSearch.asm
                             ;;

                             INCLUDE Irvine32.inc
                            C ; Include file for Irvine32.lib             (Irvine32.inc)
                            C
                            C ;OPTION CASEMAP:NONE        ; optional: make identifiers case-sensitive
                            C
                            C INCLUDE SmallWin.inc        ; MS-Windows prototypes, structures, and constants
                            C .NOLIST
                            C .LIST
                            C
                            C INCLUDE VirtualKeys.inc
                            C ; VirtualKeys.inc
                            C .NOLIST
                            C .LIST
                            C
                            C
                            C .NOLIST
                            C .LIST
                            C


 00000000                    .data
 00000000 09 09 09 09 09     BEGIN_DEFINE BYTE     "                                    SEARCH AND SORT TEST ",0
          53 45 41 52 43
          48 20 41 4E 44
          20 53 4F 52 54
          20 54 45 53 54
```

```
         20 00
0000001B 3D 3D 3D 3D 3D     BORDER_DEFINE BYTE
      "===============================================================================================",0
         3D 3D 3D 3D 3D
         3D 3D 3D 3D 3D
         3D 3D 3D 3D 3D
         3D 3D 3D 3D 3D
         3D 3D 3D 3D 3D
         3D 3D 3D 3D 3D
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         3D 3D 3D 3D 3D
         3D 3D 3D 3D 3D
         3D 3D 3D 3D 3D
         3D 3D 3D 3D 3D
         00
0000007B 00000028           array1 DWORD 40,-10,400,20,-300,12,10,0
         FFFFFFF6
         00000190
         00000014
         FFFFFED4
         0000000C
         0000000A
         00000000
0000009B 00000000           index1 DWORD 0,1,2,3,4,5,6,7
         00000001
         00000002
         00000003
         00000004
         00000005
         00000006
         00000007
000000BB 00000008           length1 DWORD LENGTHOF array1
000000BF 00000000           array2 DWORD 0,-10,-20,-30,50,100,200,300,-100,-80,1000,2000,-5000,60,70,550,-550,-300,-900,1010,2300
         FFFFFFF6
         FFFFFFEC
         FFFFFFE2
         00000032
         00000064
         000000C8
         0000012C
         FFFFFF9C
         FFFFFFB0
         000003E8
         000007D0
         FFFFEC78
         0000003C
         00000046
         00000226
         FFFFFDDA
         FFFFFED4
         FFFFFC7C
         000003F2
         000008FC
00000113 00000000            index2 DWORD 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20
         00000001
         00000002
         00000003
         00000004
         00000005
         00000006
         00000007
         00000008
         00000009
         0000000A
         0000000B
         0000000C
         0000000D
         0000000E
         0000000F
         00000010
         00000011
         00000012
         00000013
         00000014
00000167 00000015            length2 DWORD LENGTHOF array2
0000016B 00000032            array3 DWORD 50,40,30,20,10
         00000028
         0000001E
         00000014
         0000000A
0000017F 00000000            index3 DWORD 0,1,2,3,4
         00000001
         00000002
         00000003
         00000004
00000193 00000005            length3 DWORD LENGTHOF array3
00000197 FFFFFFF6            key1 DWORD -10
0000019B 000003E8            key2 DWORD 1000
0000019F 00000000            key3 DWORD 0
000001A3 00000000            location1 DWORD ?
000001A7 00000000            location2 DWORD ?
000001AB 00000000            location3 DWORD ?
000001AF 55 6E 73 6F 72      msg1 BYTE "Unsorted array: ",0
         74 65 64 20 61
         72 72 61 79 3A
         20 00
000001C0 53 6F 72 74 65     msg2 BYTE "Sorted array: ",0
         64 20 61 72 72
         61 79 3A 20 00
000001CF 53 65 61 72 63     msg3 BYTE "Search found the value ",0
         68 20 66 6F 75
         6E 64 20 74 68
         65 20 76 61 6C
         75 65 20 00
000001E7 20 61 74 20 70     msg4 BYTE " at position ",0
         6F 73 69 74 69
         6F 6E 20 00

00000000                    .code
                            BubbleSort PROTO,
                                   pArray:PTR DWORD,
                                   pIndex:PTR DWORD,
                                   Count:DWORD

                            LinearSearch PROTO,
                                   pArray:PTR DWORD,
                                   pIndex:PTR DWORD,
                                   Count:DWORD,
                                   key:DWORD

                            DisplayArray PROTO,
                                   pArray:PTR DWORD,
                                   pIndex:PTR DWORD,
                                   Count:DWORD

                            DisplaySearchResult PROTO,
                                   key:DWORD,
                                   location:DWORD

00000000                    main PROC

00000000  B9 00000000                     mov ecx,0
00000005                    Begin:
00000005  60                       pushad
00000006  E8 00000000 E            call crlf
0000000B  BA 00000000 R            mov edx,OFFSET BEGIN_DEFINE
00000010  83 C1 01                 add ecx,1
00000013  8B C1                    mov eax,ecx
00000015  E8 00000000 E            call writeString
0000001A  E8 00000000 E            call writeInt
0000001F  E8 00000000 E            call crlf
00000024  61                       popad
00000025  52                       push edx
00000026  BA 0000001B R            mov edx,OFFSET BORDER_DEFINE
0000002B  E8 00000000 E            call writeString
00000030  E8 00000000 E            call crlf
```

```
00000035  5A                       pop edx

00000036  60                       pushad
00000037  BA 000001AF R            mov edx,OFFSET msg1
0000003C  E8 00000000 E            call writeString
                                   INVOKE DisplayArray,ADDR array1,ADDR index1,length1
00000041  FF 35 000000BB R *    push   length1
00000047  68 0000009B R   *     push   OFFSET index1
0000004C  68 0000007B R   *     push   OFFSET array1
00000051  E8 0000028B          *       call   DisplayArray
                                   INVOKE BubbleSort,ADDR array1,ADDR index1,length1
00000056  FF 35 000000BB R *    push   length1
0000005C  68 0000009B R   *     push   OFFSET index1
00000061  68 0000007B R   *     push   OFFSET array1
00000066  E8 000001CA          *       call   BubbleSort
0000006B  BA 000001C0 R            mov edx,OFFSET msg2
00000070  E8 00000000 E            call writeString
                                   INVOKE DisplayArray,ADDR array1,ADDR index1,length1
00000075  FF 35 000000BB R *    push   length1
0000007B  68 0000009B R   *     push   OFFSET index1
00000080  68 0000007B R   *     push   OFFSET array1
00000085  E8 00000257          *       call   DisplayArray
0000008A  61                       popad

0000008B  60                       pushad
                                   INVOKE LinearSearch,ADDR array1,ADDR index1,length1,key1
0000008C  FF 35 00000197 R *    push   key1
00000092  FF 35 000000BB R *    push   length1
00000098  68 0000009B R   *     push   OFFSET index1
0000009D  68 0000007B R   *     push   OFFSET array1
000000A2  E8 000001F0          *       call   LinearSearch
000000A7  BA 000001CF R            mov edx,OFFSET msg3
000000AC  E8 00000000 E            call writeString
000000B1  BA 000001E7 R            mov edx,OFFSET msg4
000000B6  A3 000001A3 R            mov location1,eax
                                   INVOKE DisplaySearchResult,key1,location1
000000BB  FF 35 000001A3 R *    push   location1
000000C1  FF 35 00000197 R *    push   key1
000000C7  E8 00000252          *       call   DisplaySearchResult
000000CC  E8 00000000 E            call crlf
000000D1  61                       popad

000000D2  60                       pushad
000000D3  BA 000001AF R            mov edx,OFFSET msg1
000000D8  E8 00000000 E            call writeString
                                   INVOKE DisplayArray,ADDR array2,ADDR index2,length2
000000DD  FF 35 00000167 R *    push   length2
000000E3  68 00000113 R   *     push   OFFSET index2
000000E8  68 000000BF R   *     push   OFFSET array2
000000ED  E8 000001EF          *       call   DisplayArray
                                   INVOKE BubbleSort,ADDR array2,ADDR index2,length2
```

```
000000F2  FF 35 00000167 R *    push   length2
000000F8  68 00000113 R   *     push   OFFSET index2
000000FD  68 000000BF R   *     push   OFFSET array2
00000102  E8 0000012E          *       call   BubbleSort
00000107  BA 000001C0 R             mov edx,OFFSET msg2
0000010C  E8 00000000 E             call writeString
                                    INVOKE DisplayArray,ADDR array2,ADDR index2,length2
00000111  FF 35 00000167 R *    push   length2
00000117  68 00000113 R   *     push   OFFSET index2
0000011C  68 000000BF R   *     push   OFFSET array2
00000121  E8 000001BB          *       call   DisplayArray
00000126  61                        popad

00000127  60                        pushad
                                    INVOKE LinearSearch,ADDR array2,ADDR index2,length2,key2
00000128  FF 35 0000019B R *    push   key2
0000012E  FF 35 00000167 R *    push   length2
00000134  68 00000113 R   *     push   OFFSET index2
00000139  68 000000BF R   *     push   OFFSET array2
0000013E  E8 00000154          *       call   LinearSearch
00000143  BA 000001CF R             mov edx,OFFSET msg3
00000148  E8 00000000 E             call writeString
0000014D  BA 000001E7 R             mov edx,OFFSET msg4
00000152  A3 000001A7 R             mov location2,eax
                                    INVOKE DisplaySearchResult,key2,location2
00000157  FF 35 000001A7 R *    push   location2
0000015D  FF 35 0000019B R *    push   key2
00000163  E8 000001B6          *       call   DisplaySearchResult
00000168  E8 00000000 E             call crlf
0000016D  61                        popad

0000016E  60                        pushad
0000016F  BA 000001C0 R             mov edx,OFFSET msg2
00000174  E8 00000000 E             call writeString
                                    INVOKE DisplayArray,ADDR array3,ADDR index3,length3
00000179  FF 35 00000193 R *    push   length3
0000017F  68 0000017F R   *     push   OFFSET index3
00000184  68 0000016B R   *     push   OFFSET array3
00000189  E8 00000153          *       call   DisplayArray
                                    INVOKE BubbleSort,ADDR array3,ADDR index3,length3
0000018E  FF 35 00000193 R *    push   length3
00000194  68 0000017F R   *     push   OFFSET index3
00000199  68 0000016B R   *     push   OFFSET array3
0000019E  E8 00000092          *       call   BubbleSort
000001A3  BA 000001C0 R             mov edx,OFFSET msg2
000001A8  E8 00000000 E             call writeString
                                    INVOKE DisplayArray,ADDR array3,ADDR index3,length3
000001AD  FF 35 00000193 R *    push   length3
000001B3  68 0000017F R   *     push   OFFSET index3
000001B8  68 0000016B R   *     push   OFFSET array3
000001BD  E8 0000011F          *       call   DisplayArray
```

```
000001C2  61                         popad

000001C3  60                         pushad
                                     INVOKE LinearSearch,ADDR array3,ADDR index3,length3,key3
000001C4  FF 35 0000019F R *    push   key3
000001CA  FF 35 00000193 R *    push   length3
000001D0  68 0000017F R   *     push   OFFSET index3
000001D5  68 0000016B R   *     push   OFFSET array3
000001DA  E8 000000B8          *       call   LinearSearch
000001DF  BA 000001CF R              mov edx,OFFSET msg3
000001E4  E8 00000000 E              call writeString
000001E9  BA 000001E7 R              mov edx,OFFSET msg4
000001EE  A3 000001AB R              mov location3,eax
                                     INVOKE DisplaySearchResult,key3,location3
000001F3  FF 35 000001AB R *    push   location3
000001F9  FF 35 0000019F R *    push   key3
000001FF  E8 0000011A          *       call   DisplaySearchResult
00000204  E8 00000000 E              call crlf
00000209  E8 00000000 E              call crlf
0000020E  61                         popad

0000020F  83 05 00000197 R           add key1,10
         0A
00000216  83 05 0000019B R           add key2,10
         0A
0000021D  83 05 0000019F R           add key3,10
         0A
00000224  41                         inc ecx
00000225  83 F9 03                   cmp ecx,3
00000228  0F 8C FFFFFDD7             jl Begin

                                     exit
0000022E  6A 00         *       push   +000000000h
00000230  E8 00000000 E   *     call   ExitProcess
00000235                     main ENDP

00000235                     BubbleSort PROC USES eax ebx ecx edx esi edi,
                                     pArray:PTR DWORD, ; pointer to array
                                     pIndex:PTR DWORD,
                                     Count:DWORD ; array size
                                     LOCAL swap:BYTE
00000235  55            *       push   ebp
00000236  8B EC         *       mov    ebp, esp
00000238  83 C4 FC      *       add    esp, 0FFFFFFFCh
0000023B  50            *       push   eax
0000023C  53            *       push   ebx
0000023D  51            *       push   ecx
0000023E  52            *       push   edx
0000023F  56            *       push   esi
00000240  57            *       push   edi
00000241  C6 45 FF 00                       mov swap,0
```

```
00000245  8B 4D 10                    mov ecx,Count
00000248  49                          dec ecx ; decrement count by 1
00000249                       L1:
00000249  51                          push ecx ; save outer loop count
0000024A  8B 7D 0C                    mov edi,pIndex
0000024D  8B 1F                       mov ebx,[edi]
0000024F  C1 E3 02                    shl ebx,2
00000252                       L2:
00000252  8B 75 08                    mov esi,pArray
00000255  03 F3                       add esi,ebx
00000257  8B 06                       mov eax,[esi]
00000259  8B 75 08                    mov esi,pArray
0000025C  8B 5F 04                    mov ebx,[edi+4]
0000025F  C1 E3 02                    shl ebx,2
00000262  8B 75 08                    mov esi,pArray
00000265  03 F3                       add esi,ebx
00000267  39 06                       cmp [esi],eax; compare a pair of values
00000269  7F 0B                       jg L3
0000026B  8B 5F 04                    mov ebx,[edi+4]
0000026E  87 1F                       xchg ebx,[edi]
00000270  89 5F 04                    mov [edi+4],ebx
00000273  FE 45 FF                    inc swap
00000276                       L3:
00000276  83 C7 04                    add edi,4
00000279  8B 1F                       mov ebx,[edi]
0000027B  C1 E3 02                    shl ebx,2
0000027E  E2 D2                       loop L2 ; inner loop
00000280  80 7D FF 00                        cmp swap,0
00000284  74 07                       je l4
00000286  C6 45 FF 00                        mov swap,0
0000028A  59                          pop ecx ; retrieve outer loop count
0000028B  E2 BC                       loop L1 ; else repeat outer loop
0000028D                       L4:
                                      ret
0000028D  5F                *       pop    edi
0000028E  5E                *       pop    esi
0000028F  5A                *       pop    edx
00000290  59                *       pop    ecx
00000291  5B                *       pop    ebx
00000292  58                *       pop    eax
00000293  C9                *       leave
00000294  C2 000C           *       ret    0000Ch
00000297                       BubbleSort ENDP

00000297                       LinearSearch PROC USES ebx ecx edx esi edi,
                                      pArray:PTR DWORD, ; pointer to array
                                      pIndex:PTR DWORD,
                                      Count:DWORD, ; array size
                                      key:DWORD
00000297  55                *       push   ebp
00000298  8B EC             *       mov    ebp, esp
```

```
0000029A  53            *       push   ebx
0000029B  51            *       push   ecx
0000029C  52            *       push   edx
0000029D  56            *       push   esi
0000029E  57            *       push   edi
0000029F  B8 00000000                         mov eax,0
000002A4  BA 00000000                         mov edx,0
000002A9  8B 4D 10                  mov ecx,Count
000002AC  8B 7D 0C                  mov edi,pIndex
000002AF  8B 1F                     mov ebx,[edi]
000002B1  C1 E3 02                  shl ebx,2
000002B4                    L1:
000002B4  8B 75 08                  mov esi,pArray
000002B7  03 F3                     add esi,ebx
000002B9  8B 06                     mov eax,[esi]
000002BB  3B 45 14                  cmp eax,key
000002BE  74 16                     je Found
000002C0  42                        inc edx
000002C1  83 C7 04                  add edi,4
000002C4  8B 1F                     mov ebx,[edi]
000002C6  C1 E3 02                  shl ebx,2
000002C9  49                        dec ecx
000002CA  83 F9 00                  cmp ecx,0
000002CD  7F E5                     jg L1
000002CF  B8 FFFFFFFF                         mov eax,-1
000002D4  EB 02                     jmp Return
000002D6                    Found:
000002D6  8B C2                     mov eax,edx
000002D8                    Return:
                                    ret
000002D8  5F            *       pop    edi
000002D9  5E            *       pop    esi
000002DA  5A            *       pop    edx
000002DB  59            *       pop    ecx
000002DC  5B            *       pop    ebx
000002DD  C9            *       leave
000002DE  C2 0010       *       ret    00010h
000002E1                    LinearSearch ENDP

000002E1                    DisplayArray PROC USES eax ebx ecx edx esi edi,
                                    pArray:PTR DWORD,
                                    pIndex:PTR DWORD,
                                    Count:DWORD

000002E1  55            *       push   ebp
000002E2  8B EC         *       mov    ebp, esp
000002E4  50            *       push   eax
000002E5  53            *       push   ebx
000002E6  51            *       push   ecx
000002E7  52            *       push   edx
000002E8  56            *       push   esi
```

```
000002E9  57             *       push   edi
000002EA  8B 4D 10                   mov ecx,Count
000002ED  8B 7D 0C                   mov edi,pIndex
000002F0  8B 1F                      mov ebx,[edi]
000002F2  C1 E3 02                   shl ebx,2
000002F5                        L1:
000002F5  8B 75 08                   mov esi,pArray
000002F8  03 F3                      add esi,ebx
000002FA  8B 06                      mov eax,[esi]
000002FC  E8 00000000 E              call writeInt
00000301  83 C7 04                   add edi,4
00000304  8B 1F                      mov ebx,[edi]
00000306  C1 E3 02                   shl ebx,2
00000309  49                         dec ecx
0000030A  83 F9 00                   cmp ecx,0
0000030D  7F E6                      jg L1
0000030F  E8 00000000 E              call crlf
                                     ret
00000314  5F             *       pop    edi
00000315  5E             *       pop    esi
00000316  5A             *       pop    edx
00000317  59             *       pop    ecx
00000318  5B             *       pop    ebx
00000319  58             *       pop    eax
0000031A  C9             *       leave
0000031B  C2 000C        *       ret    0000Ch
0000031E                        DisplayArray ENDP

0000031E                        DisplaySearchResult PROC USES eax ebx ecx esi edi,
                                     key:DWORD,
                                     location:DWORD,

0000031E  55             *       push   ebp
0000031F  8B EC          *       mov    ebp, esp
00000321  50             *       push   eax
00000322  53             *       push   ebx
00000323  51             *       push   ecx
00000324  56             *       push   esi
00000325  57             *       push   edi
00000326  8B 45 08                   mov eax,key
00000329  E8 00000000 E              call writeInt
0000032E  E8 00000000 E              call writeString
00000333  8B 45 0C                   mov eax,location
00000336  E8 00000000 E              call writeInt
0000033B  E8 00000000 E              call crlf
00000340  BA 00000000                       mov edx,0
                                     ret
00000345  5F             *       pop    edi
00000346  5E             *       pop    esi
00000347  59             *       pop    ecx
00000348  5B             *       pop    ebx
```

```
00000349  58             *       pop    eax
0000034A  C9             *       leave
0000034B  C2 0008        *       ret    00008h
0000034E                     DisplaySearchResult ENDP
                             end main
```

```
Structures and Unions:

                N a m e                 Size
                                        Offset      Type

CONSOLE_CURSOR_INFO  . . . . . .     00000008
  dwSize . . . . . . . . . . . .     00000000      DWord
  bVisible . . . . . . . . . . .     00000004      DWord
CONSOLE_SCREEN_BUFFER_INFO . . .     00000016
  dwSize . . . . . . . . . . . .     00000000      DWord
  dwCursorPosition . . . . . . .     00000004      DWord
  wAttributes  . . . . . . . . .     00000008      Word
  srWindow . . . . . . . . . . .     0000000A      QWord
  dwMaximumWindowSize  . . . . .     00000012      DWord
COORD  . . . . . . . . . . . . .     00000004
  X  . . . . . . . . . . . . . .     00000000      Word
  Y  . . . . . . . . . . . . . .     00000002      Word
FILETIME . . . . . . . . . . . .     00000008
  loDateTime . . . . . . . . . .     00000000      DWord
  hiDateTime . . . . . . . . . .     00000004      DWord
FOCUS_EVENT_RECORD . . . . . . .     00000004
  bSetFocus  . . . . . . . . . .     00000000      DWord
FPU_ENVIRON  . . . . . . . . . .     0000001C
  controlWord  . . . . . . . . .     00000000      Word
  statusWord . . . . . . . . . .     00000004      Word
  tagWord  . . . . . . . . . . .     00000008      Word
  instrPointerOffset . . . . . .     0000000C      DWord
  instrPointerSelector . . . . .     00000010      DWord
  operandPointerOffset . . . . .     00000014      DWord
  operandPointerSelector . . . .     00000018      Word
INPUT_RECORD . . . . . . . . . .     00000014
  EventType  . . . . . . . . . .     00000000      Word
  Event  . . . . . . . . . . . .     00000004      XmmWord
  bKeyDown . . . . . . . . . . .     00000000      DWord
  wRepeatCount . . . . . . . . .     00000004      Word
  wVirtualKeyCode  . . . . . . .     00000006      Word
  wVirtualScanCode . . . . . . .     00000008      Word
  uChar  . . . . . . . . . . . .     0000000A      Word
  UnicodeChar  . . . . . . . . .     00000000      Word
  AsciiChar  . . . . . . . . . .     00000000      Byte
  dwControlKeyState  . . . . . .     0000000C      DWord
  dwMousePosition  . . . . . . .     00000000      DWord
  dwButtonState  . . . . . . . .     00000004      DWord
  dwMouseControlKeyState . . . .     00000008      DWord
  dwEventFlags . . . . . . . . .     0000000C      DWord
  dwSize . . . . . . . . . . . .     00000000      DWord
  dwCommandId  . . . . . . . . .     00000000      DWord
  bSetFocus  . . . . . . . . . .     00000000      DWord
KEY_EVENT_RECORD . . . . . . . .     00000010
  bKeyDown . . . . . . . . . . .     00000000      DWord
  wRepeatCount . . . . . . . . .     00000004      Word
  wVirtualKeyCode  . . . . . . .     00000006      Word
  wVirtualScanCode . . . . . . .     00000008      Word
  uChar  . . . . . . . . . . . .     0000000A      Word
  UnicodeChar  . . . . . . . . .     00000000      Word
  AsciiChar  . . . . . . . . . .     00000000      Byte
  dwControlKeyState  . . . . . .     0000000C      DWord
MENU_EVENT_RECORD  . . . . . . .     00000004
  dwCommandId  . . . . . . . . .     00000000      DWord
MOUSE_EVENT_RECORD . . . . . . .     00000010
  dwMousePosition  . . . . . . .     00000000      DWord
  dwButtonState  . . . . . . . .     00000004      DWord
  dwMouseControlKeyState . . . .     00000008      DWord
  dwEventFlags . . . . . . . . .     0000000C      DWord
SMALL_RECT . . . . . . . . . . .     00000008
  Left . . . . . . . . . . . . .     00000000      Word
  Top  . . . . . . . . . . . . .     00000002      Word
  Right  . . . . . . . . . . . .     00000004      Word
  Bottom . . . . . . . . . . . .     00000006      Word
SYSTEMTIME . . . . . . . . . . .     00000010
  wYear  . . . . . . . . . . . .     00000000      Word
  wMonth . . . . . . . . . . . .     00000002      Word
  wDayOfWeek . . . . . . . . . .     00000004      Word
  wDay . . . . . . . . . . . . .     00000006      Word
  wHour  . . . . . . . . . . . .     00000008      Word
  wMinute  . . . . . . . . . . .     0000000A      Word
  wSecond  . . . . . . . . . . .     0000000C      Word
  wMilliseconds  . . . . . . . .     0000000E      Word
WINDOW_BUFFER_SIZE_RECORD  . . .     00000004
  dwSize . . . . . . . . . . . .     00000000      DWord


Segments and Groups:

                N a m e                 Size     Length   Align   Combine Class

FLAT . . . . . . . . . . . . . .    GROUP
STACK  . . . . . . . . . . . . .    32 Bit  00001000 Para   Stack   'STACK'
_DATA  . . . . . . . . . . . . .    32 Bit  000001F5 Para   Public  'DATA'
_TEXT  . . . . . . . . . . . . .    32 Bit  0000034E Para   Public  'CODE'


Procedures, parameters, and locals:

                N a m e                 Type     Value    Attr
```

```
BubbleSort . . . . . . . . . . .    P Near  00000235 _TEXT      Length= 00000062 Public STDCALL
  pArray . . . . . . . . . . . .    DWord   bp + 00000008
  pIndex . . . . . . . . . . . .    DWord   bp + 0000000C
  Count  . . . . . . . . . . . .    DWord   bp + 00000010
  swap . . . . . . . . . . . . .    Byte    bp - 00000001
  L1 . . . . . . . . . . . . . .    L Near  00000249 _TEXT
  L2 . . . . . . . . . . . . . .    L Near  00000252 _TEXT
  L3 . . . . . . . . . . . . . .    L Near  00000276 _TEXT
  L4 . . . . . . . . . . . . . .    L Near  0000028D _TEXT
CloseFile  . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
CloseHandle  . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
Clrscr . . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
CreateFileA  . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
CreateOutputFile . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
Crlf . . . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
Delay  . . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
DisplayArray . . . . . . . . . .    P Near  000002E1 _TEXT      Length= 0000003D Public STDCALL
  pArray . . . . . . . . . . . .    DWord   bp + 00000008
  pIndex . . . . . . . . . . . .    DWord   bp + 0000000C
  Count  . . . . . . . . . . . .    DWord   bp + 00000010
  L1 . . . . . . . . . . . . . .    L Near  000002F5 _TEXT
DisplaySearchResult  . . . . . .    P Near  0000031E _TEXT      Length= 00000030 Public STDCALL
  key  . . . . . . . . . . . . .    DWord   bp + 00000008
  location . . . . . . . . . . .    DWord   bp + 0000000C
DumpMem  . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
DumpRegs . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ExitProcess  . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
FileTimeToDosDateTime  . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
FileTimeToSystemTime . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
FlushConsoleInputBuffer  . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
FormatMessageA . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetCommandLineA  . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetCommandTail . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetConsoleCP . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetConsoleCursorInfo . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetConsoleMode . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetConsoleScreenBufferInfo . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetDateTime  . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetFileTime  . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetKeyState  . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetLastError . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetLocalTime . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetMaxXY . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetMseconds  . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetNumberOfConsoleInputEvents  .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetProcessHeap . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetStdHandle . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetSystemTime  . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetTextColor . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
GetTickCount . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
Gotoxy . . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
```

```
HeapAlloc  . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
HeapCreate . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
HeapDestroy  . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
HeapFree . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
HeapSize . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
IsDigit  . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
LinearSearch . . . . . . . . . .    P Near  00000297 _TEXT      Length= 0000004A Public STDCALL
  pArray . . . . . . . . . . . .    DWord   bp + 00000008
  pIndex . . . . . . . . . . . .    DWord   bp + 0000000C
  Count  . . . . . . . . . . . .    DWord   bp + 00000010
  key  . . . . . . . . . . . . .    DWord   bp + 00000014
  L1 . . . . . . . . . . . . . .    L Near  000002B4 _TEXT
  Found  . . . . . . . . . . . .    L Near  000002D6 _TEXT
  Return . . . . . . . . . . . .    L Near  000002D8 _TEXT
LocalFree  . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
MessageBoxA  . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
MsgBoxAsk  . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
MsgBox . . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
OpenInputFile  . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ParseDecimal32 . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ParseInteger32 . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
PeekConsoleInputA  . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
Random32 . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
RandomRange  . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
Randomize  . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadChar . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadConsoleA . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadConsoleInputA  . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadDec  . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadFile . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadFloat  . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadFromFile . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadHex  . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadInt  . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadKeyFlush . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadKey  . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ReadString . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
SetConsoleCursorInfo . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
SetConsoleCursorPosition . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
SetConsoleMode . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
SetConsoleScreenBufferSize . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
SetConsoleTextAttribute  . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
SetConsoleTitleA . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
SetConsoleWindowInfo . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
SetFilePointer . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
SetLocalTime . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
SetTextColor . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
ShowFPUStack . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
Sleep  . . . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
StrLength  . . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
Str_compare  . . . . . . . . . .    P Near  00000000 FLAT Length= 00000000 External STDCALL
```

```
Str_copy . . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
Str_length . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
Str_trim . . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
Str_ucase  . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
SystemTimeToFileTime . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WaitMsg  . . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteBinB  . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteBin . . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteChar  . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteConsoleA  . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteConsoleOutputAttribute  . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteConsoleOutputCharacterA . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteDec . . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteFile  . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteFloat . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteHexB  . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteHex . . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteInt . . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteStackFrameName  . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteStackFrame  . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteString  . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteToFile  . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
WriteWindowsMsg  . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External STDCALL
main . . . . . . . . . . . . . .	P Near	 00000000 _TEXT	Length= 00000235 Public STDCALL
  Begin  . . . . . . . . . . . .	L Near	 00000005 _TEXT	
printf . . . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External C
scanf  . . . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External C
wsprintfA  . . . . . . . . . . .	P Near	 00000000 FLAT	Length= 00000000 External C


Symbols:

                N a m e                 Type     Value    Attr

@CodeSize  . . . . . . . . . . .	Number	 00000000h   
@DataSize  . . . . . . . . . . .	Number	 00000000h   
@Interface . . . . . . . . . . .	Number	 00000003h   
@Model . . . . . . . . . . . . .	Number	 00000007h   
@code  . . . . . . . . . . . . .	Text   	 _TEXT
@data  . . . . . . . . . . . . .	Text   	 FLAT
@fardata?  . . . . . . . . . . .	Text   	 FLAT
@fardata . . . . . . . . . . . .	Text   	 FLAT
@stack . . . . . . . . . . . . .	Text   	 FLAT
ALT_MASK . . . . . . . . . . . .	Number	 00000003h   
BEGIN_DEFINE . . . . . . . . . .	Byte	 00000000 _DATA	
BORDER_DEFINE  . . . . . . . . .	Byte	 0000001B _DATA	
CAPSLOCK_ON  . . . . . . . . . .	Number	 00000080h   
CREATE_ALWAYS  . . . . . . . . .	Number	 00000002h   
CREATE_NEW . . . . . . . . . . .	Number	 00000001h   
CTRL_MASK  . . . . . . . . . . .	Number	 0000000Ch   
CreateFile . . . . . . . . . . .	Text   	 CreateFileA
```

```
DO_NOT_SHARE . . . . . . . . . .    Number  00000000h
ENABLE_ECHO_INPUT  . . . . . . .    Number  00000004h
ENABLE_LINE_INPUT  . . . . . . .    Number  00000002h
ENABLE_MOUSE_INPUT . . . . . . .    Number  00000010h
ENABLE_PROCESSED_INPUT . . . . .    Number  00000001h
ENABLE_PROCESSED_OUTPUT  . . . .    Number  00000001h
ENABLE_WINDOW_INPUT  . . . . . .    Number  00000008h
ENABLE_WRAP_AT_EOL_OUTPUT  . . .    Number  00000002h
ENHANCED_KEY . . . . . . . . . .    Number  00000100h
FALSE  . . . . . . . . . . . . .    Number  00000000h
FILE_APPEND_DATA . . . . . . . .    Number  00000004h
FILE_ATTRIBUTE_ARCHIVE . . . . .    Number  00000020h
FILE_ATTRIBUTE_COMPRESSED  . . .    Number  00000800h
FILE_ATTRIBUTE_DEVICE  . . . . .    Number  00000040h
FILE_ATTRIBUTE_DIRECTORY . . . .    Number  00000010h
FILE_ATTRIBUTE_ENCRYPTED . . . .    Number  00004000h
FILE_ATTRIBUTE_HIDDEN  . . . . .    Number  00000002h
FILE_ATTRIBUTE_NORMAL  . . . . .    Number  00000080h
FILE_ATTRIBUTE_NOT_CONTENT_INDEXED .Number  00002000h
FILE_ATTRIBUTE_OFFLINE . . . . .    Number  00001000h
FILE_ATTRIBUTE_READONLY  . . . .    Number  00000001h
FILE_ATTRIBUTE_REPARSE_POINT . .    Number  00000400h
FILE_ATTRIBUTE_SPARSE_FILE . . .    Number  00000200h
FILE_ATTRIBUTE_SYSTEM  . . . . .    Number  00000004h
FILE_ATTRIBUTE_TEMPORARY . . . .    Number  00000100h
FILE_BEGIN . . . . . . . . . . .    Number  00000000h
FILE_CURRENT . . . . . . . . . .    Number  00000001h
FILE_DELETE_CHILD  . . . . . . .    Number  00000040h
FILE_END . . . . . . . . . . . .    Number  00000002h
FILE_READ_DATA . . . . . . . . .    Number  00000001h
FILE_SHARE_DELETE  . . . . . . .    Number  00000004h
FILE_SHARE_READ  . . . . . . . .    Number  00000001h
FILE_SHARE_WRITE . . . . . . . .    Number  00000002h
FILE_WRITE_DATA  . . . . . . . .    Number  00000002h
FOCUS_EVENT  . . . . . . . . . .    Number  00000010h
FORMAT_MESSAGE_ALLOCATE_BUFFER .    Number  00000100h
FORMAT_MESSAGE_FROM_SYSTEM . . .    Number  00001000h
FormatMessage  . . . . . . . . .    Text    FormatMessageA
GENERIC_ALL  . . . . . . . . . .    Number  10000000h
GENERIC_EXECUTE  . . . . . . . .    Number  20000000h
GENERIC_READ . . . . . . . . . .    Number  -80000000h
GENERIC_WRITE  . . . . . . . . .    Number  40000000h
GetCommandLine . . . . . . . . .    Text    GetCommandLineA
HANDLE . . . . . . . . . . . . .    Text    DWORD
HEAP_GENERATE_EXCEPTIONS . . . .    Number  00000004h
HEAP_GROWABLE  . . . . . . . . .    Number  00000002h
HEAP_NO_SERIALIZE  . . . . . . .    Number  00000001h
HEAP_REALLOC_IN_PLACE_ONLY . . .    Number  00000010h
HEAP_ZERO_MEMORY . . . . . . . .    Number  00000008h
IDABORT  . . . . . . . . . . . .    Number  00000003h
IDCANCEL . . . . . . . . . . . .    Number  00000002h
```

```
IDCLOSE  . . . . . . . . . . . .     Number  00000008h
IDCONTINUE . . . . . . . . . . .     Number  0000000Bh
IDHELP . . . . . . . . . . . . .     Number  00000009h
IDIGNORE . . . . . . . . . . . .     Number  00000005h
IDNO . . . . . . . . . . . . . .     Number  00000007h
IDOK . . . . . . . . . . . . . .     Number  00000001h
IDRETRY  . . . . . . . . . . . .     Number  00000004h
IDTIMEOUT  . . . . . . . . . . .     Number  00007D00h
IDTRYAGAIN . . . . . . . . . . .     Number  0000000Ah
IDYES  . . . . . . . . . . . . .     Number  00000006h
INVALID_HANDLE_VALUE . . . . . .     Number  -00000001h
KBDOWN_FLAG  . . . . . . . . . .     Number  00000001h
KEY_EVENT  . . . . . . . . . . .     Number  00000001h
KEY_MASKS  . . . . . . . . . . .     Number  0000001Fh
LEFT_ALT_PRESSED . . . . . . . .     Number  00000002h
LEFT_CTRL_PRESSED  . . . . . . .     Number  00000008h
MB_ABORTRETRYIGNORE  . . . . . .     Number  00000002h
MB_APPLMODAL . . . . . . . . . .     Number  00000000h
MB_CANCELTRYCONTINUE . . . . . .     Number  00000006h
MB_DEFBUTTON1  . . . . . . . . .     Number  00000000h
MB_DEFBUTTON2  . . . . . . . . .     Number  00000100h
MB_DEFBUTTON3  . . . . . . . . .     Number  00000200h
MB_DEFBUTTON4  . . . . . . . . .     Number  00000300h
MB_HELP  . . . . . . . . . . . .     Number  00004000h
MB_ICONASTERISK  . . . . . . . .     Number  00000040h
MB_ICONERROR . . . . . . . . . .     Number  00000010h
MB_ICONEXCLAMATION . . . . . . .     Number  00000030h
MB_ICONHAND  . . . . . . . . . .     Number  00000010h
MB_ICONINFORMATION . . . . . . .     Number  00000040h
MB_ICONQUESTION  . . . . . . . .     Number  00000020h
MB_ICONSTOP  . . . . . . . . . .     Number  00000010h
MB_ICONWARNING . . . . . . . . .     Number  00000030h
MB_OKCANCEL  . . . . . . . . . .     Number  00000001h
MB_OK  . . . . . . . . . . . . .     Number  00000000h
MB_RETRYCANCEL . . . . . . . . .     Number  00000005h
MB_SYSTEMMODAL . . . . . . . . .     Number  00001000h
MB_TASKMODAL . . . . . . . . . .     Number  00002000h
MB_USERICON  . . . . . . . . . .     Number  00000080h
MB_YESNOCANCEL . . . . . . . . .     Number  00000003h
MB_YESNO . . . . . . . . . . . .     Number  00000004h
MENU_EVENT . . . . . . . . . . .     Number  00000008h
MOUSE_EVENT  . . . . . . . . . .     Number  00000002h
MessageBox . . . . . . . . . . .     Text    MessageBoxA
NULL . . . . . . . . . . . . . .     Number  00000000h
NUMLOCK_ON . . . . . . . . . . .     Number  00000020h
OPEN_ALWAYS  . . . . . . . . . .     Number  00000004h
OPEN_EXISTING  . . . . . . . . .     Number  00000003h
PeekConsoleInput . . . . . . . .     Text    PeekConsoleInputA
RIGHT_ALT_PRESSED  . . . . . . .     Number  00000001h
RIGHT_CTRL_PRESSED . . . . . . .     Number  00000004h
ReadConsoleInput . . . . . . . .     Text    ReadConsoleInputA
```

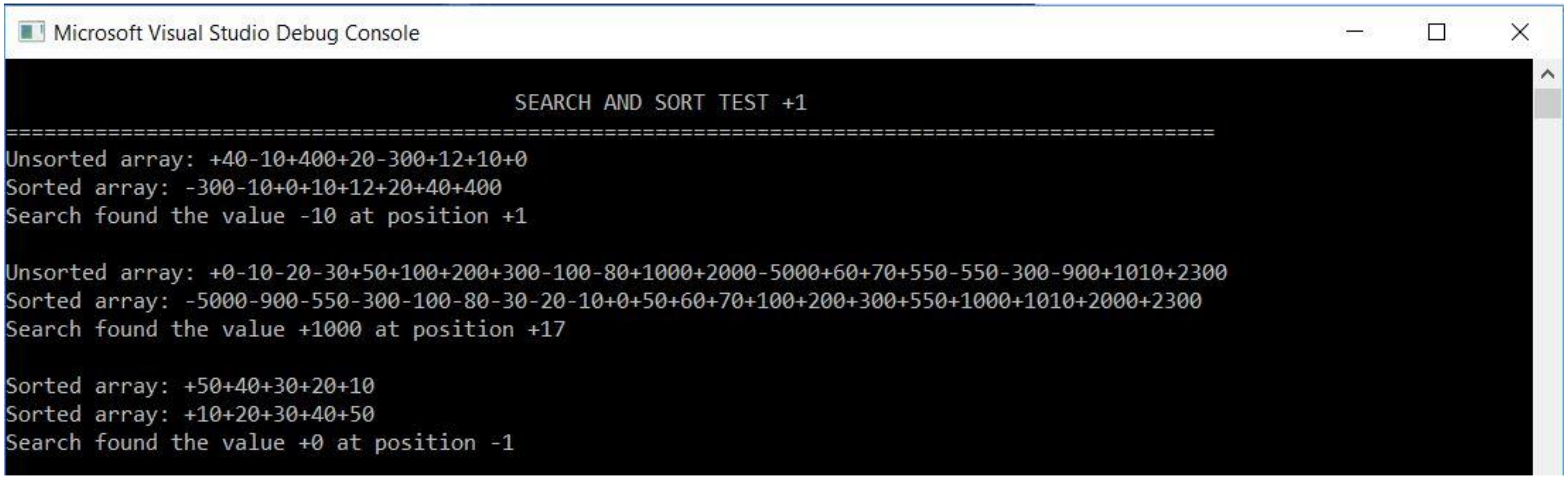
```
ReadConsole  . . . . . . . . . .    Text    ReadConsoleA
SCROLLLOCK_ON  . . . . . . . . .    Number  00000040h
SHIFT_MASK . . . . . . . . . . .    Number  00000010h
SHIFT_PRESSED  . . . . . . . . .    Number  00000010h
STD_ERROR_HANDLE . . . . . . . .    Number  -0000000Ch
STD_INPUT_HANDLE . . . . . . . .    Number  -0000000Ah
STD_OUTPUT_HANDLE  . . . . . . .    Number  -0000000Bh
SetConsoleTitle  . . . . . . . .    Text    SetConsoleTitleA
TAB  . . . . . . . . . . . . . .    Number  00000009h
TRUE . . . . . . . . . . . . . .    Number  00000001h
TRUNCATE_EXISTING  . . . . . . .    Number  00000005h
VK_11  . . . . . . . . . . . . .    Number  000000BDh
VK_12  . . . . . . . . . . . . .    Number  000000BBh
VK_ADD . . . . . . . . . . . . .    Number  0000006Bh
VK_BACK  . . . . . . . . . . . .    Number  00000008h
VK_CANCEL  . . . . . . . . . . .    Number  00000003h
VK_CAPITAL . . . . . . . . . . .    Number  00000014h
VK_CLEAR . . . . . . . . . . . .    Number  0000000Ch
VK_CONTROL . . . . . . . . . . .    Number  00000011h
VK_DECIMAL . . . . . . . . . . .    Number  0000006Eh
VK_DELETE  . . . . . . . . . . .    Number  0000002Eh
VK_DIVIDE  . . . . . . . . . . .    Number  0000006Fh
VK_DOWN  . . . . . . . . . . . .    Number  00000028h
VK_END . . . . . . . . . . . . .    Number  00000023h
VK_ESCAPE  . . . . . . . . . . .    Number  0000001Bh
VK_EXECUTE . . . . . . . . . . .    Number  0000002Bh
VK_F10 . . . . . . . . . . . . .    Number  00000079h
VK_F11 . . . . . . . . . . . . .    Number  0000007Ah
VK_F12 . . . . . . . . . . . . .    Number  0000007Bh
VK_F13 . . . . . . . . . . . . .    Number  0000007Ch
VK_F14 . . . . . . . . . . . . .    Number  0000007Dh
VK_F15 . . . . . . . . . . . . .    Number  0000007Eh
VK_F16 . . . . . . . . . . . . .    Number  0000007Fh
VK_F17 . . . . . . . . . . . . .    Number  00000080h
VK_F18 . . . . . . . . . . . . .    Number  00000081h
VK_F19 . . . . . . . . . . . . .    Number  00000082h
VK_F1  . . . . . . . . . . . . .    Number  00000070h
VK_F20 . . . . . . . . . . . . .    Number  00000083h
VK_F21 . . . . . . . . . . . . .    Number  00000084h
VK_F22 . . . . . . . . . . . . .    Number  00000085h
VK_F23 . . . . . . . . . . . . .    Number  00000086h
VK_F24 . . . . . . . . . . . . .    Number  00000087h
VK_F2  . . . . . . . . . . . . .    Number  00000071h
VK_F3  . . . . . . . . . . . . .    Number  00000072h
VK_F4  . . . . . . . . . . . . .    Number  00000073h
VK_F5  . . . . . . . . . . . . .    Number  00000074h
VK_F6  . . . . . . . . . . . . .    Number  00000075h
VK_F7  . . . . . . . . . . . . .    Number  00000076h
VK_F8  . . . . . . . . . . . . .    Number  00000077h
VK_F9  . . . . . . . . . . . . .    Number  00000078h
VK_HELP  . . . . . . . . . . . .    Number  0000002Fh
```

```
VK_HOME  . . . . . . . . . . . .    Number   00000024h
VK_INSERT  . . . . . . . . . . .    Number   0000002Dh
VK_LBUTTON . . . . . . . . . . .    Number   00000001h
VK_LCONTROL  . . . . . . . . . .    Number   000000A2h
VK_LEFT  . . . . . . . . . . . .    Number   00000025h
VK_LMENU . . . . . . . . . . . .    Number   000000A4h
VK_LSHIFT  . . . . . . . . . . .    Number   000000A0h
VK_MENU  . . . . . . . . . . . .    Number   00000012h
VK_MULTIPLY  . . . . . . . . . .    Number   0000006Ah
VK_NEXT  . . . . . . . . . . . .    Number   00000022h
VK_NUMLOCK . . . . . . . . . . .    Number   00000090h
VK_NUMPAD0 . . . . . . . . . . .    Number   00000060h
VK_NUMPAD1 . . . . . . . . . . .    Number   00000061h
VK_NUMPAD2 . . . . . . . . . . .    Number   00000062h
VK_NUMPAD3 . . . . . . . . . . .    Number   00000063h
VK_NUMPAD4 . . . . . . . . . . .    Number   00000064h
VK_NUMPAD5 . . . . . . . . . . .    Number   00000065h
VK_NUMPAD6 . . . . . . . . . . .    Number   00000066h
VK_NUMPAD7 . . . . . . . . . . .    Number   00000067h
VK_NUMPAD8 . . . . . . . . . . .    Number   00000068h
VK_NUMPAD9 . . . . . . . . . . .    Number   00000069h
VK_PAUSE . . . . . . . . . . . .    Number   00000013h
VK_PRINT . . . . . . . . . . . .    Number   0000002Ah
VK_PRIOR . . . . . . . . . . . .    Number   00000021h
VK_RBUTTON . . . . . . . . . . .    Number   00000002h
VK_RCONTROL  . . . . . . . . . .    Number   000000A3h
VK_RETURN  . . . . . . . . . . .    Number   0000000Dh
VK_RIGHT . . . . . . . . . . . .    Number   00000027h
VK_RMENU . . . . . . . . . . . .    Number   000000A5h
VK_RSHIFT  . . . . . . . . . . .    Number   000000A1h
VK_SCROLL  . . . . . . . . . . .    Number   00000091h
VK_SEPARATER . . . . . . . . . .    Number   0000006Ch
VK_SHIFT . . . . . . . . . . . .    Number   00000010h
VK_SNAPSHOT  . . . . . . . . . .    Number   0000002Ch
VK_SPACE . . . . . . . . . . . .    Number   00000020h
VK_SUBTRACT  . . . . . . . . . .    Number   0000006Dh
VK_TAB . . . . . . . . . . . . .    Number   00000009h
VK_UP  . . . . . . . . . . . . .    Number   00000026h
WINDOW_BUFFER_SIZE_EVENT . . . .    Number   00000004h
WriteConsoleOutputCharacter  . .    Text     WriteConsoleOutputCharacterA
WriteConsole . . . . . . . . . .    Text     WriteConsoleA
array1 . . . . . . . . . . . . .    DWord    0000007B _DATA
array2 . . . . . . . . . . . . .    DWord    000000BF _DATA
array3 . . . . . . . . . . . . .    DWord    0000016B _DATA
black  . . . . . . . . . . . . .    Number   00000000h
blue . . . . . . . . . . . . . .    Number   00000001h
brown  . . . . . . . . . . . . .    Number   00000006h
cyan . . . . . . . . . . . . . .    Number   00000003h
exit . . . . . . . . . . . . . .    Text     INVOKE ExitProcess,0
gray . . . . . . . . . . . . . .    Number   00000008h
green  . . . . . . . . . . . . .    Number   00000002h
```

```
index1 . . . . . . . . . . . . . .	DWord	 0000009B _DATA	
index2 . . . . . . . . . . . . . .	DWord	 00000113 _DATA	
index3 . . . . . . . . . . . . . .	DWord	 0000017F _DATA	
key1 . . . . . . . . . . . . . . .	DWord	 00000197 _DATA	
key2 . . . . . . . . . . . . . . .	DWord	 0000019B _DATA	
key3 . . . . . . . . . . . . . . .	DWord	 0000019F _DATA	
length1  . . . . . . . . . . . . .	DWord	 000000BB _DATA	
length2  . . . . . . . . . . . . .	DWord	 00000167 _DATA	
length3  . . . . . . . . . . . . .	DWord	 00000193 _DATA	
lightBlue  . . . . . . . . . . . .	Number	 00000009h   
lightCyan  . . . . . . . . . . . .	Number	 0000000Bh   
lightGray  . . . . . . . . . . . .	Number	 00000007h   
lightGreen . . . . . . . . . . . .	Number	 0000000Ah   
lightMagenta . . . . . . . . . . .	Number	 0000000Dh   
lightRed . . . . . . . . . . . . .	Number	 0000000Ch   
location1  . . . . . . . . . . . .	DWord	 000001A3 _DATA	
location2  . . . . . . . . . . . .	DWord	 000001A7 _DATA	
location3  . . . . . . . . . . . .	DWord	 000001AB _DATA	
magenta  . . . . . . . . . . . . .	Number	 00000005h   
msg1 . . . . . . . . . . . . . . .	Byte	 000001AF _DATA	
msg2 . . . . . . . . . . . . . . .	Byte	 000001C0 _DATA	
msg3 . . . . . . . . . . . . . . .	Byte	 000001CF _DATA	
msg4 . . . . . . . . . . . . . . .	Byte	 000001E7 _DATA	
red  . . . . . . . . . . . . . . .	Number	 00000004h   
white  . . . . . . . . . . . . . .	Number	 0000000Fh   
wsprintf . . . . . . . . . . . . .	Text   	 wsprintfA
yellow . . . . . . . . . . . . . .	Number	 0000000Eh   

	   0 Warnings
	   0 Errors
```

Console Screenshot



Microsoft Visual Studio Debug Console

```
                                       SEARCH AND SORT TEST +1
==============================================================================================
Unsorted array: +40-10+400+20-300+12+10+0
Sorted array: -300-10+0+10+12+20+40+400
Search found the value -10 at position +1

Unsorted array: +0-10-20-30+50+100+200+300-100-80+1000+2000-5000+60+70+550-550-300-900+1010+2300
Sorted array: -5000-900-550-300-100-80-30-20-10+0+50+60+70+100+200+300+550+1000+1010+2000+2300
Search found the value +1000 at position +17

Sorted array: +50+40+30+20+10
Sorted array: +10+20+30+40+50
Search found the value +0 at position -1
```