PART 2

As this is a course from scratch, there are things that many people know. If you are one of them, skip them, but most of the readers won't do it. That´s why I added that info.

NUMERICAL SYSTEM

The three most used numerical systems are: binary, decimal and hexadecimal.

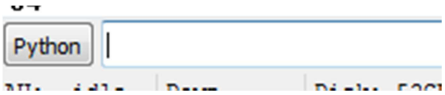
The basic concept of each one is the following:

BINARY: numbers are represented with two characters. 1 and 0 that's why it is called like that.

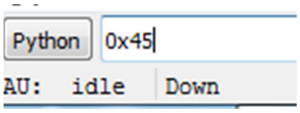
DECIMAL: all numbers are represented with 10 characters. (From 0 to 9)

HEXADECIMAL: all numbers are represented with characters from 0 to F (from 0 to 9, plus A, B, C, D, E y F. (16 in total)

In IDA, in the bottom part, there is a bar to execute PYTHON commands. This will help us shift from one to the other easily.



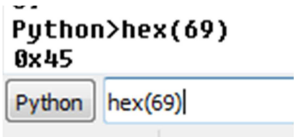
If I type, for example, 0x45, it interprets it as hexadecimal for the **0x** at the beginning. We can convert from hexadecimal to decimal just pressing ENTER.



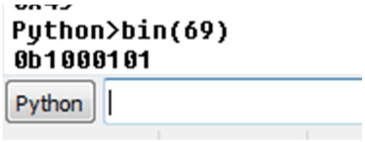
After pressing ENTER:

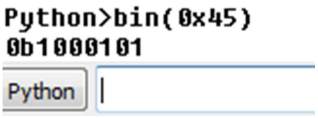
The result is 69 that is 0x45 hex converted to decimal.

If we want to convert the number from decimal to hexadecimal, we use the **hex()** function:

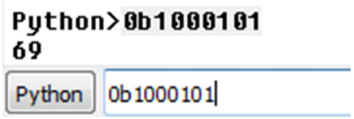


To convert it into binary, we use bin()



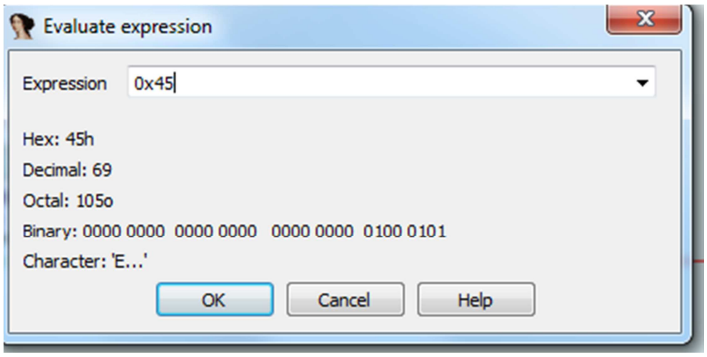


The result is 1000101. **0b**, at the beginning, means binary. We can convert it from binary to decimal or hexadecimal.



Any number typed directly after pressing ENTER will be shown in decimal. To convert it into hexadecimal or binary, we should use the Python functions hex() or bin().

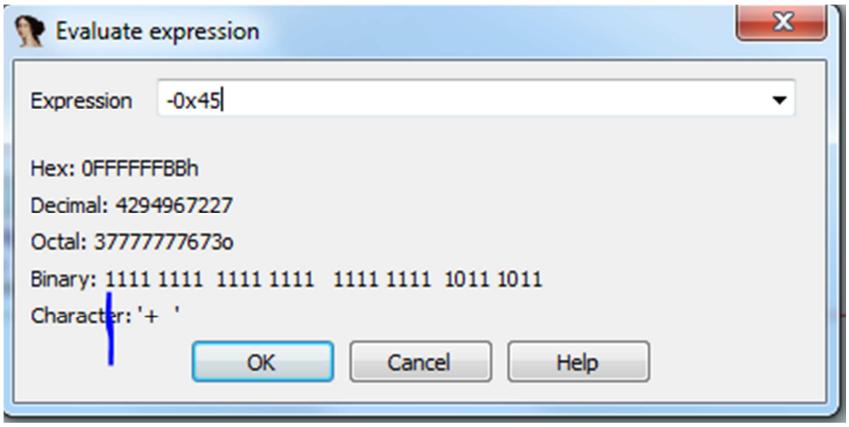
To make conversions, IDA has an integrated calculator in VIEW-CALCULATOR in which we can see any number converted into all numerical systems at the same time. It also shows the character of the value. In this case, 0x45 corresponds to E.



NEGATIVE NUMBERS IN HEXADECIMAL

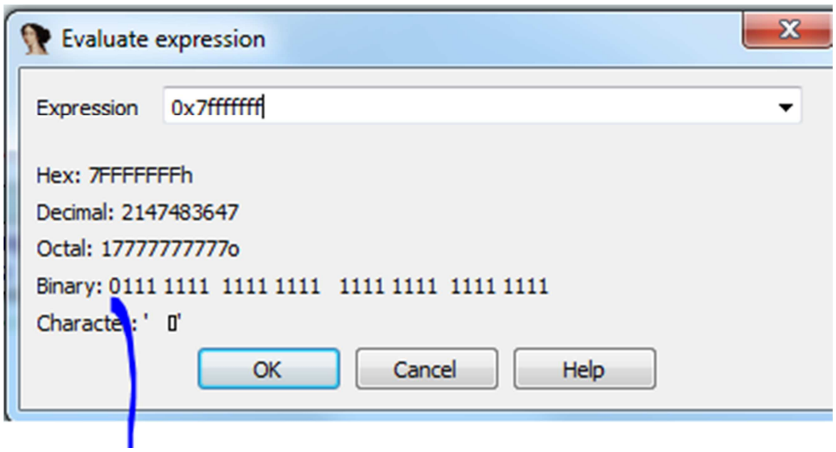
In almost every moment, we will work in hex, but the question is how is a negative hex number represented in 32 bits?

In a 32-bit binary number we use the first bit to mean if it is 0 (positive) or 1 (negative)



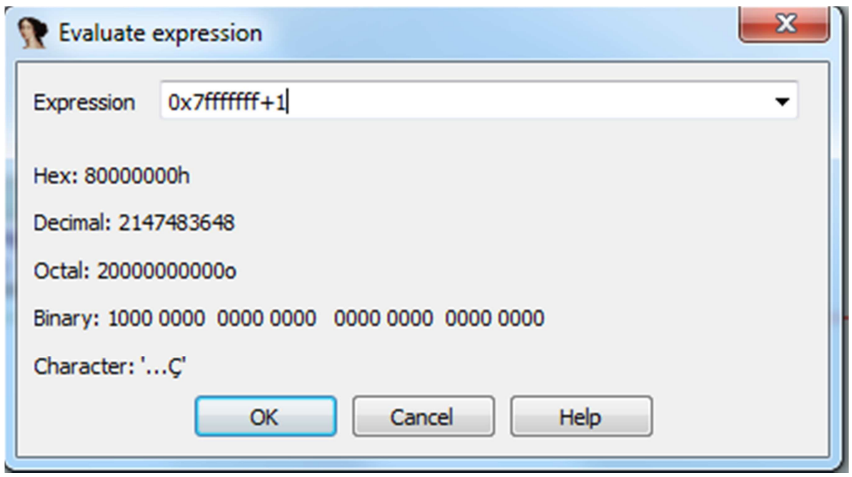
We see that a value, e.g, -0x45 in hex can be represented as 0xFFFFFFBB and that its first byte is 1 in binary.

In this way, the minimum positive value is 0 obviously, but what should be the greatest positive value we can represent?



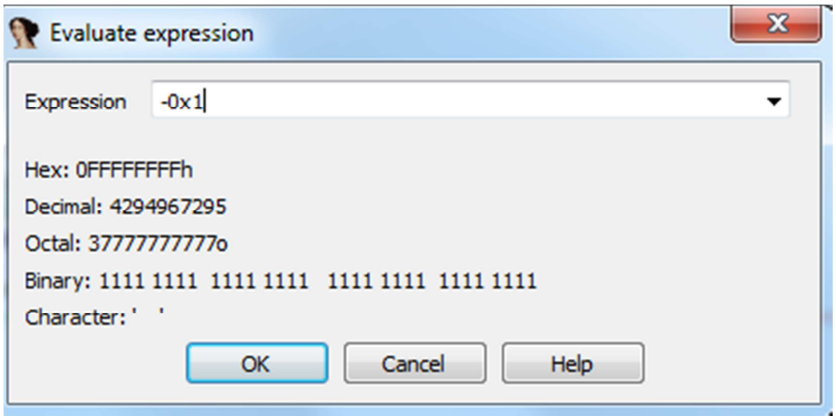
0x7FFFFFFF is the greatest positive value if we consider the sign, then after adding 1, all of the other bits are 1. The greatest value must change to 1 to continue.

If we add it 1.



The first bit changes to 1 and the rest is 0.

This evaluator considers all numbers as positive unless we add “-“ at the beginning. For example:



The minimum negative value -1 corresponds to 0xFFFFFFFF and the greatest negative value will be 0x80000000.

If we don't consider the sign in an operation, then all the values will be positive from 0 to 0xFFFFFFFF.

But considering the sign we will have the positive values from 0x0 to 0x7FFFFFFF and the negative values from 0xFFFFFFFF to 0x80000000.

POSITIVE VALUES

000000000 equals 0 decimal

000000001 equals 1 decimal

……..

……..

7FFFFFFF equals 2147483647 decimal (the greatest positive value)

NEGATIVE VALUES

FFFFFFFF equals -1 decimal

FFFFFFFE equals -2 decimal

……

……

80000000 equals -2147483648 decimal (the greatest negative value)

Hexadecimal	Decimal sin signo	Decimal con signo
0x7FFFFFFF	2.147.483.647	2.147.483.647
0x00000001	1	1
0x00000000	0	0
0xFFFFFFFF	4.294.967.295	-1
0x80000000	2.147.483.648	-2.147.483.648

ASCII CHARACTERS

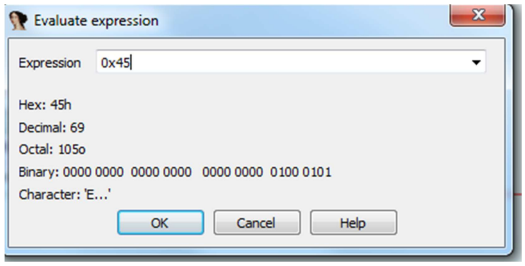
One of the topics we must know too is the way our system writes data on screen. It assigns each character a hex value to interpret them as letters, numbers, symbols, etc.

In the first row, we see the decimal value, in the second one is the hex value and in third one is the character, for example, if I want to write a space, I have to use 0x20 or 32 decimal. Any character we need being a letter or number we can see it in the next chart.

Dec.	Hex.	Cara	Dec.	Hex.	Cara	Dec.	Hex.	Cara
32	20	esp	64	40	@	96	60	`
33	21	!	65	41	A	97	61	a
34	22	"	66	42	B	98	62	b
35	23	#	67	43	C	99	63	c
36	24	$	68	44	D	100	64	d
37	25	%	69	45	E	101	65	e
38	26	&	70	46	F	102	66	f
39	27	'	71	47	G	103	67	g
40	28	(	72	48	H	104	68	h
41	29	)	73	49	I	105	69	i
42	2A	*	74	4A	J	106	6A	j
43	2B	+	75	4B	K	107	6B	k
44	2C	,	76	4C	L	108	6C	l
45	2D	-	77	4D	M	109	6D	m
46	2E	.	78	4E	N	110	6E	n
47	2F	/	79	4F	O	111	6F	o
48	30	0	80	50	P	112	70	p
49	31	1	81	51	Q	113	71	q
50	32	2	82	52	R	114	72	r
51	33	3	83	53	S	115	73	s
52	34	4	84	54	T	116	74	t
53	35	5	85	55	U	117	75	u

54	36	6	86	56	V	118	76	v
55	37	7	87	57	W	119	77	w
56	38	8	88	58	X	120	78	x
57	39	9	89	59	Y	121	79	y
58	3A	:	90	5A	Z	122	7A	z
59	3B	;	91	5B	[	123	7B	{
60	3C	<	92	5C	\	124	7C	|
61	3D	=	93	5D	]	125	7D	}
62	3E	>	94	5E	^	126	7E	~
63	3F	?	95	5F		127	7F	

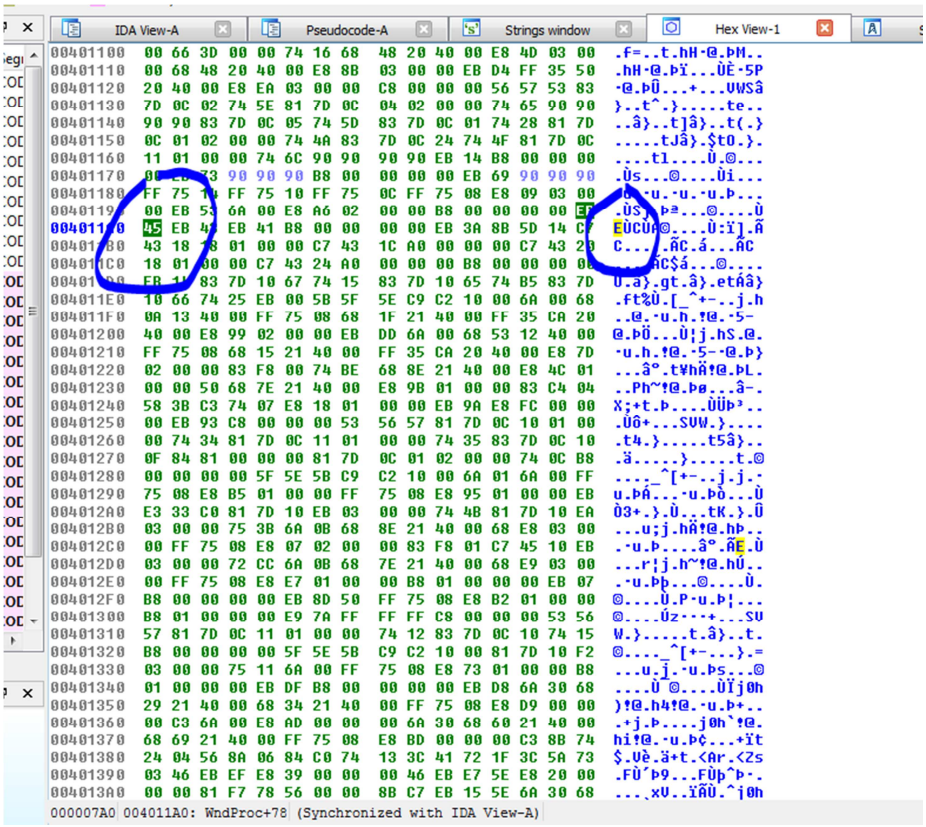
IDA calculator evaluates expressions and shows the correspondent characters. **0x45** is the character **E**.



33	21	!	65	41	A	97	61	a
34	22	"	66	42	B	98	62	b
35	23	#	67	43	C	99	63	c
36	24	$	68	44	D	100	64	d
37	25	%	69	45	E	101	65	e
38	26	&	70	46	F	102	66	f
39	27	'	71	47	G	103	67	g
40	28	(	72	48	H	104	68	h
41	29	)	73	49	I	105	69	i
42	2A	*	74	4A	J	106	6A	j

Another way to see this is using the Python function chr()

In the HEX DUMP Windows there is a column that also shows the characters.



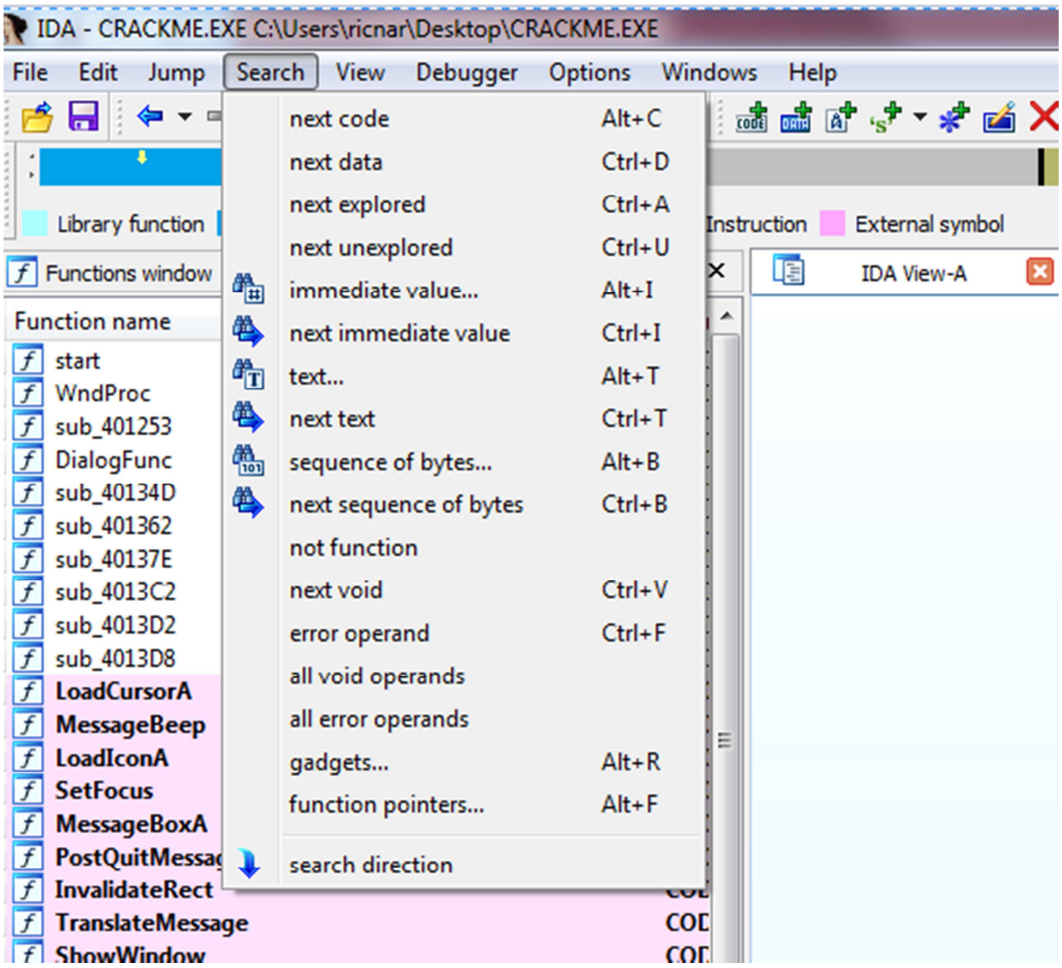
There, we see the **45** in the right column represented by **E**.

SEARCHING POSSIBILITIES

We see the option SEARCH in the menu and if we are in the disassembly or IDA-VIEW tab we have many searching options that are easy to interpret.

If we shift to the disassembly window and the SEARCH submenus are not present, we should click on any instruction to change the focus and make it appear.

Some options in the next image correspond to plugins added to my IDA. So you won't see them in the IDA you downloaded.



NEXT CODE

This will search for the next instruction interpreted as CODE. If there is a part that is not detected as code, it will skip it.

Search completed. Found at 004011A1.
Search completed. Found at 004011A3.
Search completed. Found at 004011A5.
Search completed. Found at 004011AA.
Search completed. Found at 004011AC.
Search completed. Found at 004011AF.
Search completed. Found at 004011B6.

NEXT DATA

This will search for the next instruction interpreted as DATA o data handling in any section.

```
CODE:0040156C                   jmp     ds:PrintDlgA
CODE:0040156C ; ---------------------------------------------------------
CODE:00401572                   align 100h
CODE:00401600                   dd 280h dup(?)
CODE:00401600 CODE              ends
CODE:00401600
DATA:00402000 ; Section 2. (virtual address 00002000)
DATA:00402000 ; Virtual size                  : 00001000 (   4096.)
DATA:00402000 ; Section size in file          : 00000200 (    512.)
DATA:00402000 ; Offset to raw data for section: 00000C00
DATA:00402000 ; Flags C0000040: Data Readable Writable
DATA:00402000 ; Alignment     : default
DATA:00402000 ; ===========================================================
DATA:00402000
DATA:00402000 ; Segment type: Pure data
DATA:00402000 ; Segment permissions: Read/Write
DATA:00402000 DATA              segment para public 'DATA' use32
DATA:00402000                   assume cs:DATA
DATA:00402000                   ;org 402000h
DATA:00402000                   db    0
DATA:00402001                   db    0
DATA:00402002                   db    0
DATA:00402003                   db    0
DATA:00402004 ; HWND hWnd
DATA:00402004 hWnd              dd 0                    ; DATA XREF: sta
DATA:00402004                                           ; start+CF↑r ...
DATA:00402008                   db    0
DATA:00402009                   db    0
DATA:0040200A                   db    0
DATA:0040200B                   db    0
```

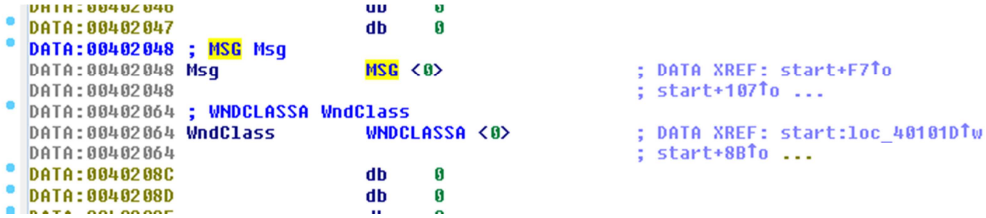
In this case, it detected a dword (dd) in that address that doesn't correspond to any instruction, obviously, if we continue searching, it will search for the next **data**. Here, we see the data section below if I search again.

```
DATA:00402002                   db    0
DATA:00402003                   db    0
DATA:00402004 ; HWND hWnd
DATA:00402004 hWnd              dd 0                    ; DATA XREF: start+C8↑w
DATA:00402004                                           ; start+CF↑r ...
DATA:00402008                   db    0
DATA:00402009                   db    0
```

I see that it stops in an address where there is info on the right side meaning that it is a place where it will work with data.

It continues skipping addresses with just zeros and without any reference. It shows just the places with possible data the program uses.

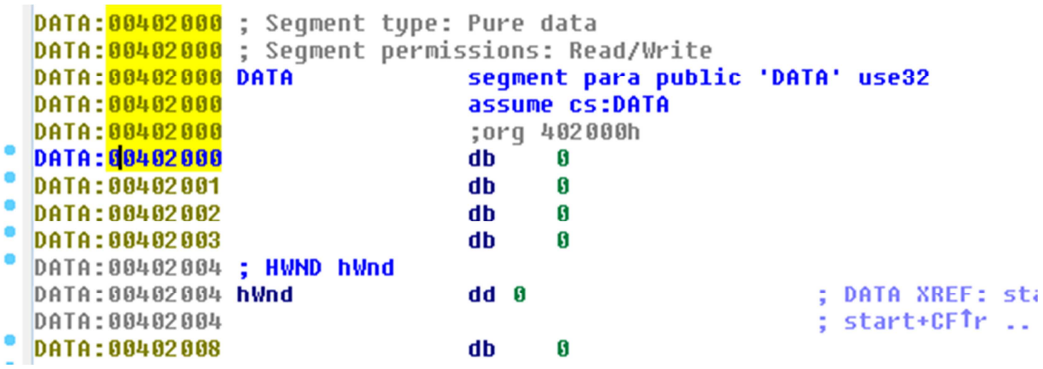
Search completed. Found at 00402004.
Search completed. Found at 00402048.



It will skip everything not detected as data used by the program and it will search for the next one.

SEARCH EXPLORED AND UNEXPLORED

The first one will skip for code or data detected and the second one for zones not detected as valid code or data.



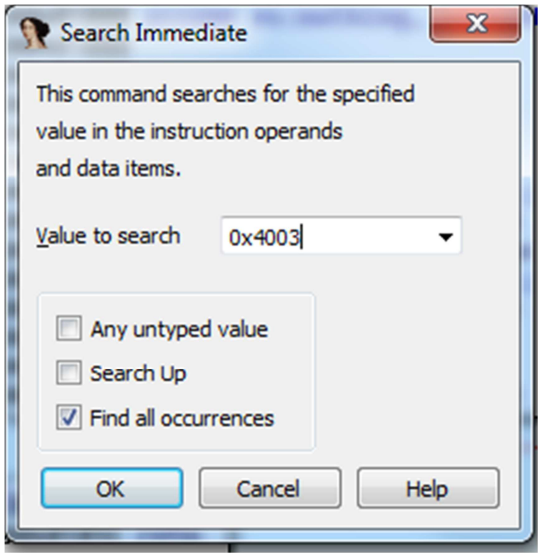
The zone with 0’s in 0x402000 is found with SEARCH UNEXPLORED.

Search completed. Found at 00402000.
Search completed. Found at 00402000.
Search completed. Found at 00402001.
Search completed. Found at 00402001.
Search completed. Found at 00402002.
Search completed. Found at 00402003.
Search completed. Found at 00402008

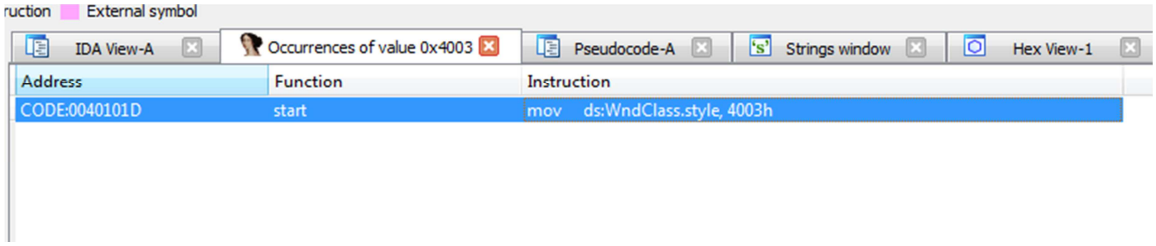
Repeating this search it skips the data in 0x402004 because it detected as EXPLORED.

SEARCH INMEDIATE VALUE - SEARCH NEXT INMEDIATE VALUE

It will search for the constant we write between the instructions and data.

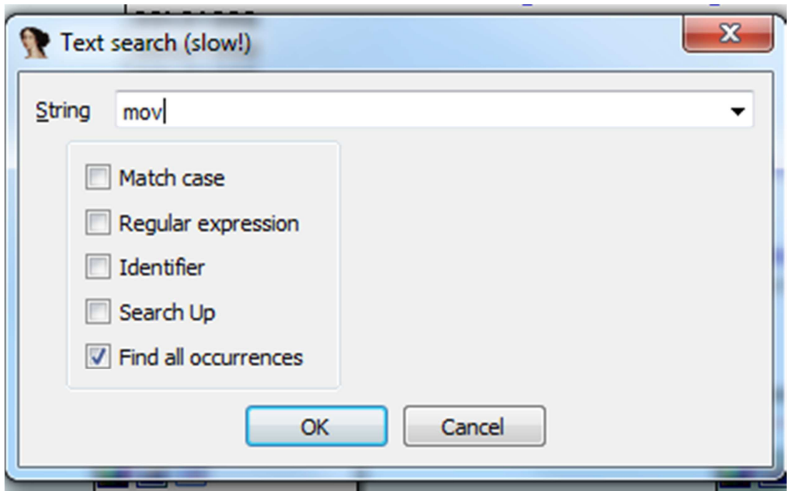


If we check FIND ALL OCURRENCES, it will search for all and if we don't, it will search for one by one. In that case, we should use SEARCH NEXT INMEDIATE VALUE to repeat the search.



SEARCH TEXT –SEARCH NEXT TEXT

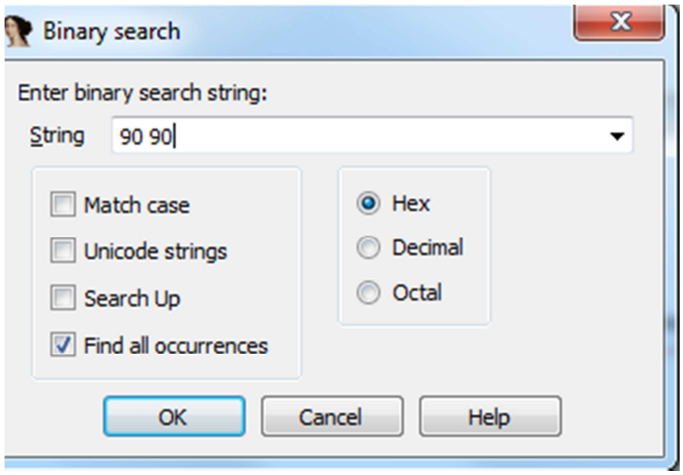
It will search for the text we type or also regular expressions.



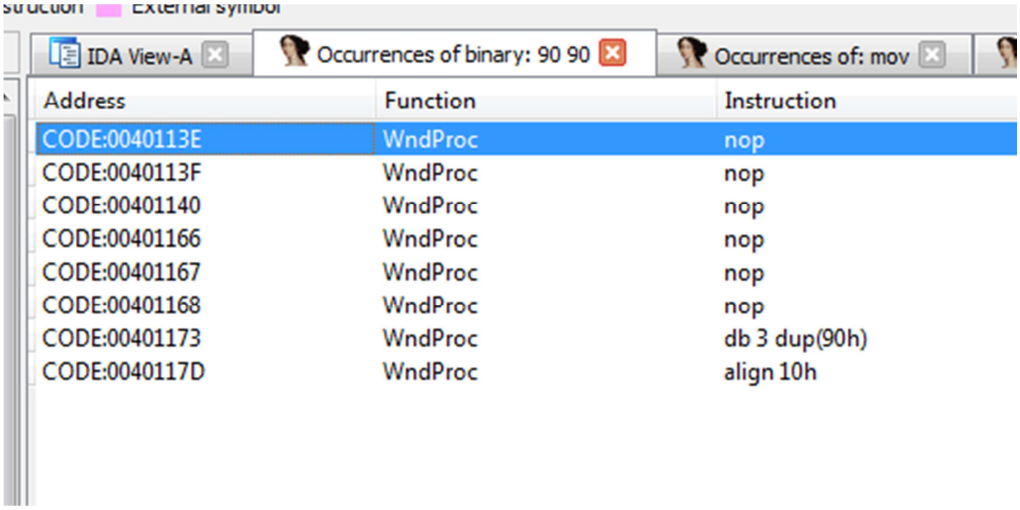
Address	Function	Instruction	
CODE:00401007	start	mov	ds:hInstance, eax
CODE:0040101D	start	mov	ds:WndClass.style, 4003h
CODE:00401027	start	mov	ds:WndClass.lpfnWndProc, offset WndProc
CODE:00401031	start	mov	ds:WndClass.cbClsExtra, 0
CODE:0040103B	start	mov	ds:WndClass.cbWndExtra, 0
CODE:00401045	start	mov	eax, ds:hInstance
CODE:0040104A	start	mov	ds:WndClass.hInstance, eax
CODE:00401057	start	mov	ds:WndClass.hIcon, eax
CODE:00401068	start	mov	ds:WndClass.hCursor, eax
CODE:0040106D	start	mov	ds:WndClass.hbrBackground, 5
CODE:00401077	start	mov	ds:WndClass.lpszMenuName, offset aMenu ; "MENU"
CODE:00401081	start	mov	ds:WndClass.lpszClassName, offset ClassName ; "No need to disasm...
CODE:004010C8	start	mov	ds:hWnd, eax
CODE:0040116C	WndProc	mov	eax, 0
CODE:00401176	WndProc	mov	eax, 0
CODE:0040119A	WndProc	mov	eax, 0
CODE:004011A5	WndProc	mov	eax, 0
CODE:004011AC	WndProc	mov	ebx, [ebp+lParam]
CODE:004011AF	WndProc	mov	dword ptr [ebx+18h], 118h
CODE:004011B6	WndProc	mov	dword ptr [ebx+1Ch], 0A0h
CODE:004011BD	WndProc	mov	dword ptr [ebx+20h], 118h
CODE:004011C4	WndProc	mov	dword ptr [ebx+24h], 0A0h
CODE:004011CB	WndProc	mov	eax, 0
CODE:0040127F	sub_401253	mov	eax, 0
CODE:004012CC	sub_401253	mov	[ebp+arg_8], 3EBh
CODE:004012E9	sub_401253	mov	eax, 1
CODE:004012F0	sub_401253	mov	eax, 0
CODE:00401300	sub_401253	mov	eax, 1
CODE:00401320	DialogFunc	mov	eax, 0
CODE:0040133F	DialogFunc	mov	eax, 1
CODE:00401346	DialogFunc	mov	eax, 0
CODE:0040137E	sub_40137E	mov	esi, [esp+arg_0]
CODE:00401383	sub_40137E	mov	al, [esi]
CODE:004013A8	sub_40137E	mov	eax, edi
CODE:004013C6	sub_4013C2	mov	bl, [esi]
CODE:004013D4	sub_4013D2	mov	[esi], al

If we check search just one, we will need SEARCH NEXT TEXT to continue searching.

SEARCH SEQUENCE OF BYTES

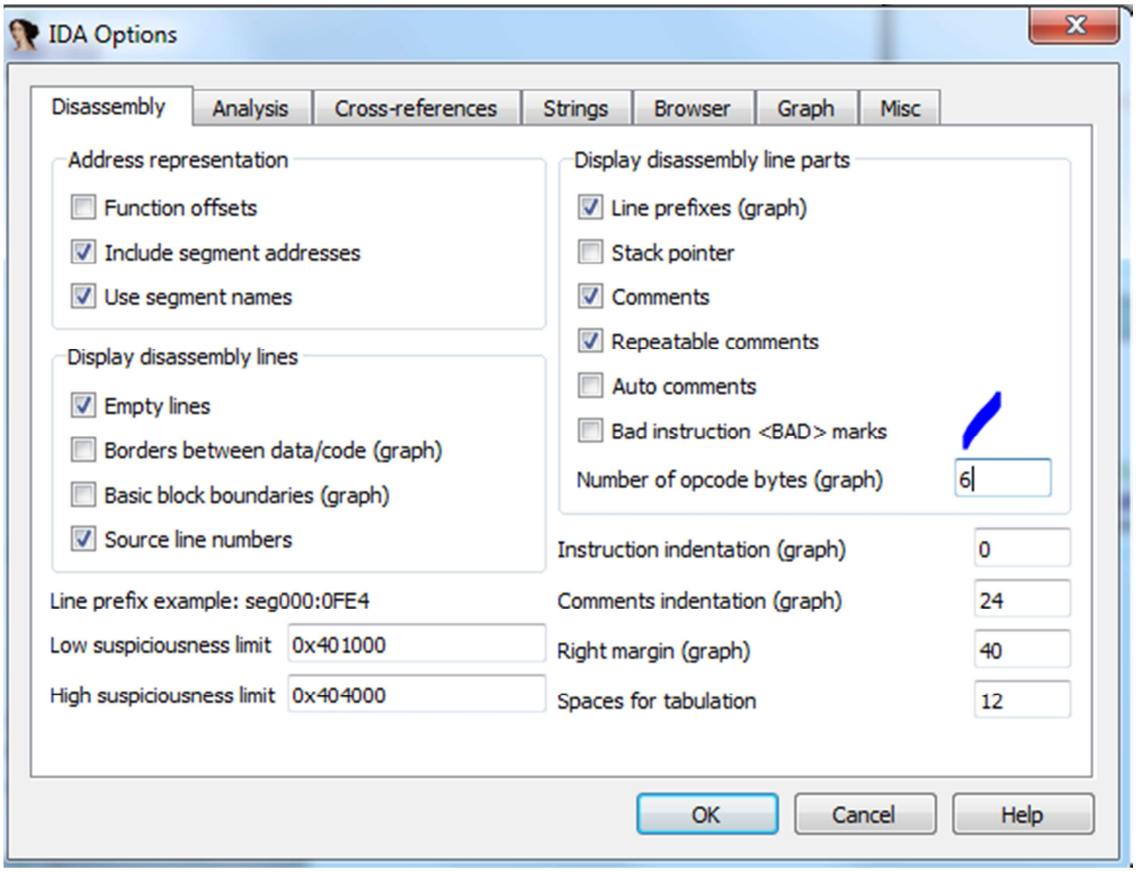


It will search for the sequence of hex bytes we type in the executable.

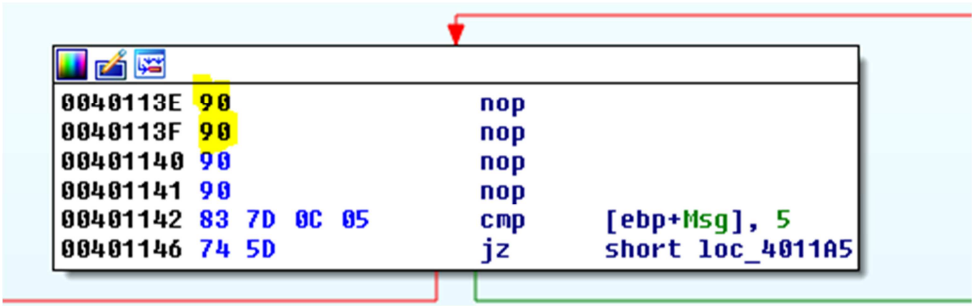


If we double click on the first one, for example.

And in IDA options we type 6 to show just 6 bytes maximum for each instruction.



It found the 90 90 we asked it.



SEARCH NOT FUNCTION

Search for the next address where it finds something detected as an incomplete function.

Search completed. Found at 004013D7.

```
CODE:004013D6 sub_4013D2      endp
CODE:004013D6
CODE:004013D7 ; ---------------------------------------------------------------------
CODE:004013D7                 retn
CODE:004013D8
CODE:004013D8 ; =============== S U B R O U T I N E =======================================
CODE:004013D8
CODE:004013D8
CODE:004013D8 sub_4013D8      proc near               ; CODE XREF: WndProc+110↑p
CODE:004013D8
CODE:004013D8 arg_0           = dword ptr  4
```

There is a RET alone that is not detected as a function. Sometimes, there are functions that IDA could not detect as functions but they have valid code.

Those are the most important search functions in the IDA menu. Of course, having the opportunity of using Python scripts, we could create better search possibilities with some code lines.

Every search we do is logged in a tab that is always there until we close it.

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We go step by step to understand it better.

Until part 3

Ricardo Narvaja

Translated by: @IvinsonCLS