Software Reverse Engineering

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Overview

Reverse engineering in the context of software refers to the process of analyzing a software application to understand its design, architecture, functionality, and behavior, typically without access to its source code. This process involves dissecting the software to recreate a higher-level representation of its components, logic, or operation.

Key Purposes of Reverse Engineering in Software

1. **Understanding Legacy Systems**: Gaining insights into old or undocumented systems to update, maintain, or integrate them with newer technologies.
2. **Debugging and Bug Fixing**: Diagnosing and fixing issues when source code is unavailable or incomplete.
3. **Security Analysis**: Identifying vulnerabilities, understanding malware behavior, or assessing security mechanisms.
4. **Interoperability**: Developing software that interacts with or extends existing systems without relying on proprietary source code.
5. **Educational Purposes**: Learning how software operates or how certain algorithms are implemented.
6. **Competitive Analysis**: Studying competitors' software to glean features or innovations (though this might raise ethical or legal concerns).
7. **License Compliance**: Verifying that a product complies with license agreements or doesn't infringe intellectual property rights.

Techniques Used in Reverse Engineering

- **Static Analysis**: Examining a program's code, binaries, or resources without executing it. Tools like disassemblers (e.g., IDA Pro) and decompilers (e.g., Ghidra) are often used.
- **Dynamic Analysis**: Observing the behavior of a program while it is running, using tools like debuggers (e.g., GDB) or monitoring software.
- **Binary Analysis**: Analyzing the executable file to understand its machine-level instructions and reconstruct higher-level logic.
- **Protocol Analysis**: Inspecting communication protocols to determine how software interacts with other systems or devices.
- **Code Recovery**: Using decompilers or reconstructing pseudo-source code from machine code to study the software.

Legal and Ethical Considerations

Reverse engineering can be legally sensitive, as it may infringe on intellectual property laws or software licensing agreements. However, it is allowed under certain circumstances, such as:

- **Fair Use**: For purposes like interoperability or educational study.
- **Compliance with Law**: To uncover vulnerabilities or assess software integrity. Always consult legal advice or organizational policies before engaging in reverse engineering.

Tools -

- gdb, Ollydbg, xdbg32, xdbg64, Ghidra, Binary Ninja etc.
- Assembly Language Compilers – Masm, Nasm

Some Terms:

Crackmes - The files you practice reverse engineering on are called **crackmes**.

To get crackmes files visit https://crackmes.one/ it contains something about 4000 **crackmes** files.

##

Let's crack a software.

crackme

```
→ yt file crackme
crackme: ELF 64-bit LSB executable, x86-64, version 1 (SYSV), dynamically linked, interpreter /lib64/ld-linux-x86-64
.so.2, BuildID[sha1]=60bbafef09bf85f7b59c933c41ec32d82859bbd4, for GNU/Linux 3.2.0, not stripped
→ yt ./crackme
Enter Password
12345678
Wrong password.
→ yt
```

Here, we use **gdb** to do this.

So, we need to load our executable in gdb debugger.

```
→ yt gdb crackme
GNU gdb (Ubuntu 9.2-0ubuntu1~20.04) 9.2
Copyright (C) 2020 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
    <http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from crackme...
(No debugging symbols found in crackme)
(gdb)
```

Here, **gdb shell** is opened.

Run –

Run your program.

```
(gdb) run
Starting program: /home/hellsender/yt/crackme
Enter Password
abcdef
Wrong password.
[Inferior 1 (process 19741) exited normally]
(gdb)
```

Jaisa ki hum jante hai ki hum jo bhi logic likhte hai use function ke andar rkhte hai.

Info function:

To show all function of executable.

Use it before run the program in gdb. Because it will show lots of functions, **executable function and libraries function** which is used compile and execute the executable.

Joki humare kam ke nhi hai.

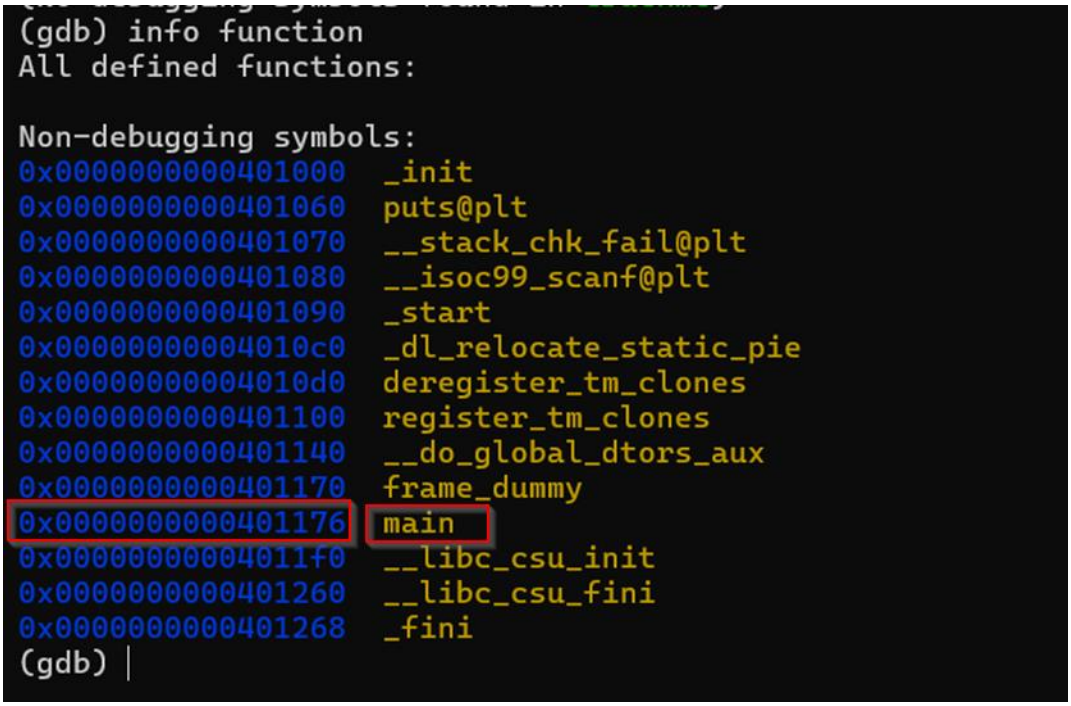
Or **exit** from the gdb and **load** and **info function**.

As you can see there are lots of function if we run and show functions

```
(gdb) run
Starting program: /home/ubuntu/Youtube/reverse-engineering/crackme
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
Enter Password
wer
Wrong password.
[Inferior 1 (process 91349) exited normally]
(gdb) info function
All defined functions:

File ../argp/argp-fmtstream.h:
266:    size_t __argp_fmtstream_point(argp_fmtstream_t);
220:    int __argp_fmtstream_putc(argp_fmtstream_t, int);
207:    int __argp_fmtstream_puts(argp_fmtstream_t, const char *);
230:    size_t __argp_fmtstream_set_lmargin(argp_fmtstream_t, size_t);
242:    size_t __argp_fmtstream_set_rmargin(argp_fmtstream_t, size_t);
254:    size_t __argp_fmtstream_set_wmargin(argp_fmtstream_t, size_t);
194:    size_t __argp_fmtstream_write(argp_fmtstream_t, const char *, size_t);
```

```
File ../argp/argp.h:
526:    void __argp_usage(const struct argp_state *);
544:    int __option_is_end(const struct argp_option *);
532:    int __option_is_short(const struct argp_option *);

File ../bits/stdlib-bsearch.h:
20:     void *__GI_bsearch(const void *, const void *, size_t, size_t, __compar_fn_t);

File ../csu/libc-start.c:
234:    int __libc_start_main_impl(int (*)(int, char **, char **), int, char **, int (*)(int, char **, char **), void (*)(vo

File ../elf/dl-sysdep.c:
266:    void _dl_show_auxv(void);
82:     Elf64_Addr _dl_sysdep_start(void **, void (*)(const Elf64_Phdr *, Elf64_Word, Elf64_Addr *, Elf64_auxv_t *));
261:    void _dl_sysdep_start_cleanup(void);

File ../elf/dl-tls.c:
630:    void *__GI__dl_allocate_tls(void *);
527:    void *__GI__dl_allocate_tls_init(void *, _Bool);
640:    void __GI__dl_deallocate_tls(void *, _Bool);
```

Here, you can see very less functions are showing without run the executable.



Here, main is entry point program executing. And left side is their address. It's very useful. If we need to point it then we can use it's address.

Jaise ki man lo kisi variable ki value dekhni hai to hum kh skte hai ki is address pr jo value hai use dikhao. Jo kuchh bhi hai dikhao.

Disassemble:

Ab hum ise **disassemble** krenge. **Disassemble** krne ke liye hum nam likh skte hai ya fir address.

```
(gdb) disassemble main
Dump of assembler code for function main:
   0x0000000000401176 <+0>:     endbr64
   0x000000000040117a <+4>:     push   %rbp
   0x000000000040117b <+5>:     mov    %rsp,%rbp
   0x000000000040117e <+8>:     sub    $0x10,%rsp
   0x0000000000401182 <+12>:    mov    %fs:0x28,%rax
   0x000000000040118b <+21>:    mov    %rax,-0x8(%rbp)
   0x000000000040118f <+25>:    xor    %eax,%eax
   0x0000000000401191 <+27>:    lea    0xe6c(%rip),%rdi        # 0x402004
   0x0000000000401198 <+34>:    call   0x401060 <puts@plt>
   0x000000000040119d <+39>:    lea    -0xc(%rbp),%rax
   0x00000000004011a1 <+43>:    mov    %rax,%rsi
   0x00000000004011a4 <+46>:    lea    0xe68(%rip),%rdi        # 0x402013
   0x00000000004011ab <+53>:    mov    $0x0,%eax
   0x00000000004011b0 <+58>:    call   0x401080 <__isoc99_scanf@plt>
```

```
   0x00000000004011b5 <+63>:    mov    -0xc(%rbp),%eax
   0x00000000004011b8 <+66>:    cmp    $0x539,%eax
   0x00000000004011bd <+71>:    jne    0x4011cd <main+87>
   0x00000000004011bf <+73>:    lea    0xe50(%rip),%rdi        # 0x402016
   0x00000000004011c6 <+80>:    call   0x401060 <puts@plt>
   0x00000000004011cb <+85>:    jmp    0x4011d9 <main+99>
   0x00000000004011cd <+87>:    lea    0xe54(%rip),%rdi        # 0x402028
   0x00000000004011d4 <+94>:    call   0x401060 <puts@plt>
   0x00000000004011d9 <+99>:    nop
   0x00000000004011da <+100>:   mov    -0x8(%rbp),%rax
   0x00000000004011de <+104>:   xor    %fs:0x28,%rax
   0x00000000004011e7 <+113>:   je     0x4011ee <main+120>
   0x00000000004011e9 <+115>:   call   0x401070 <__stack_chk_fail@plt>
   0x00000000004011ee <+120>:   leave
   0x00000000004011ef <+121>:   ret
End of assembler dump.
(gdb)
```

It is in **AT&T** flavor of assembly.

We need to set assembly flavor **Intel**. Because we are not more familier with **AT&T** flavor.

```
End of assembler dump.
(gdb) set disassembly-flavor
att    intel
(gdb) set disassembly-flavor intel
```

Disassemble again

```
(gdb) disassemble main
Dump of assembler code for function main:
   0x0000000000401176 <+0>:     endbr64
   0x000000000040117a <+4>:     push   rbp
   0x000000000040117b <+5>:     mov    rbp,rsp
   0x000000000040117e <+8>:     sub    rsp,0x10
   0x0000000000401182 <+12>:    mov    rax,QWORD PTR fs:0x28
   0x000000000040118b <+21>:    mov    QWORD PTR [rbp-0x8],rax
   0x000000000040118f <+25>:    xor    eax,eax
   0x0000000000401191 <+27>:    lea    rdi,[rip+0xe6c]        # 0x402004
   0x0000000000401198 <+34>:    call   0x401060 <puts@plt>
   0x000000000040119d <+39>:    lea    rax,[rbp-0xc]
   0x00000000004011a1 <+43>:    mov    rsi,rax
   0x00000000004011a4 <+46>:    lea    rdi,[rip+0xe68]        # 0x402013
   0x00000000004011ab <+53>:    mov    eax,0x0
   0x00000000004011b0 <+58>:    call   0x401080 <__isoc99_scanf@plt>
   0x00000000004011b5 <+63>:    mov    eax,DWORD PTR [rbp-0xc]
   0x00000000004011b8 <+66>:    cmp    eax,0x539
   0x00000000004011bd <+71>:    jne    0x4011cd <main+87>
   0x00000000004011bf <+73>:    lea    rdi,[rip+0xe50]        # 0x402016
   0x00000000004011c6 <+80>:    call   0x401060 <puts@plt>
   0x00000000004011cb <+85>:    jmp    0x4011d9 <main+99>
   0x00000000004011cd <+87>:    lea    rdi,[rip+0xe54]        # 0x402028
   0x00000000004011d4 <+94>:    call   0x401060 <puts@plt>
   0x00000000004011d9 <+99>:    nop
   0x00000000004011da <+100>:   mov    rax,QWORD PTR [rbp-0x8]
   0x00000000004011de <+104>:   xor    rax,QWORD PTR fs:0x28
   0x00000000004011e7 <+113>:   je     0x4011ee <main+120>
   0x00000000004011e9 <+115>:   call   0x401070 <__stack_chk_fail@plt>
   0x00000000004011ee <+120>:   leave
   0x00000000004011ef <+121>:   ret
End of assembler dump.
(gdb)
```

Here, we can see this is converted in Intel assembly.

Let's begin reverse engineering.

There are lots of intructions.

First, we need to focus on **call instruction**. Kahan se kahan call ho rha hai program ka flow kaise hai.

Upar hum dekh skte hai ki sabse phla call puts function ko hua hai. agar hum puts function ke bare me janna chahte hai to.

```
man puts
```

```
ubuntu@ip-172-31-8-118: ~/Y  ubuntu@ip-172-31-8-118: ~
PUTS(3)                                          Linux Programmer's Manual

NAME
       fputc, fputs, putc, putchar, puts - output of characters and strings

SYNOPSIS
       #include <stdio.h>

       int fputc(int c, FILE *stream);

       int fputs(const char *s, FILE *stream);

       int putc(int c, FILE *stream);

       int putchar(int c);

       int puts(const char *s);
```

```
DESCRIPTION
       fputc() writes the character c, cast to an unsigned char, to stream.

       fputs() writes the string s to stream, without its terminating null byte ('\0').

       putc() is equivalent to fputc() except that it may be implemented as a macro which evaluat

       putchar(c) is equivalent to putc(c, stdout).

       puts() writes the string s and a trailing newline to stdout.

       Calls  to  the functions described here can be mixed with each other and with calls to otl
       output stream.
```

Yh bs print krne ka kam krta hai.

To hume yha samjh aaya sbse phla call print krne ko kr rha hai.

Ab chlte hai next call ki taraf. Next call lg rha hai scnaf ko as we know scanf is used to read data from user(take input).

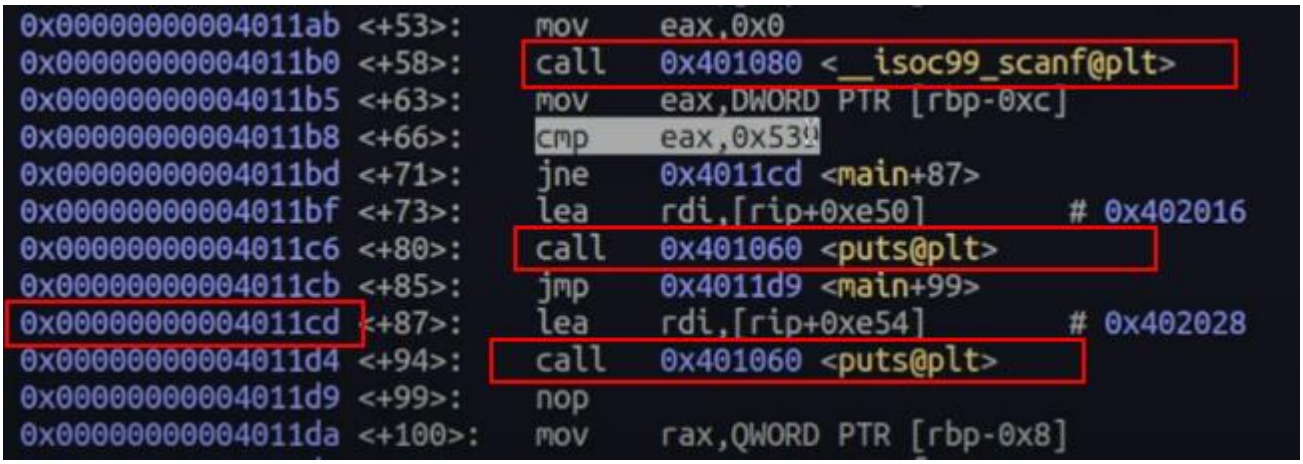
Agar hum program run krke dekhe to. Hum dekh skte hai ki user se input lene ka kam ho rha hai.

```
ubuntu@ip-172-31-8-118:~$ ./crackme
Enter Password
123456
```

Aage bdte hai humne dekha tha ki input ke bad do bar puts tha lekin yha pr ek hi bar print hua.

```
ubuntu@ip-172-31-8-118:~$ ./crackme
Enter Password
123456
Wrong password.
ubuntu@ip-172-31-8-118:~$
```

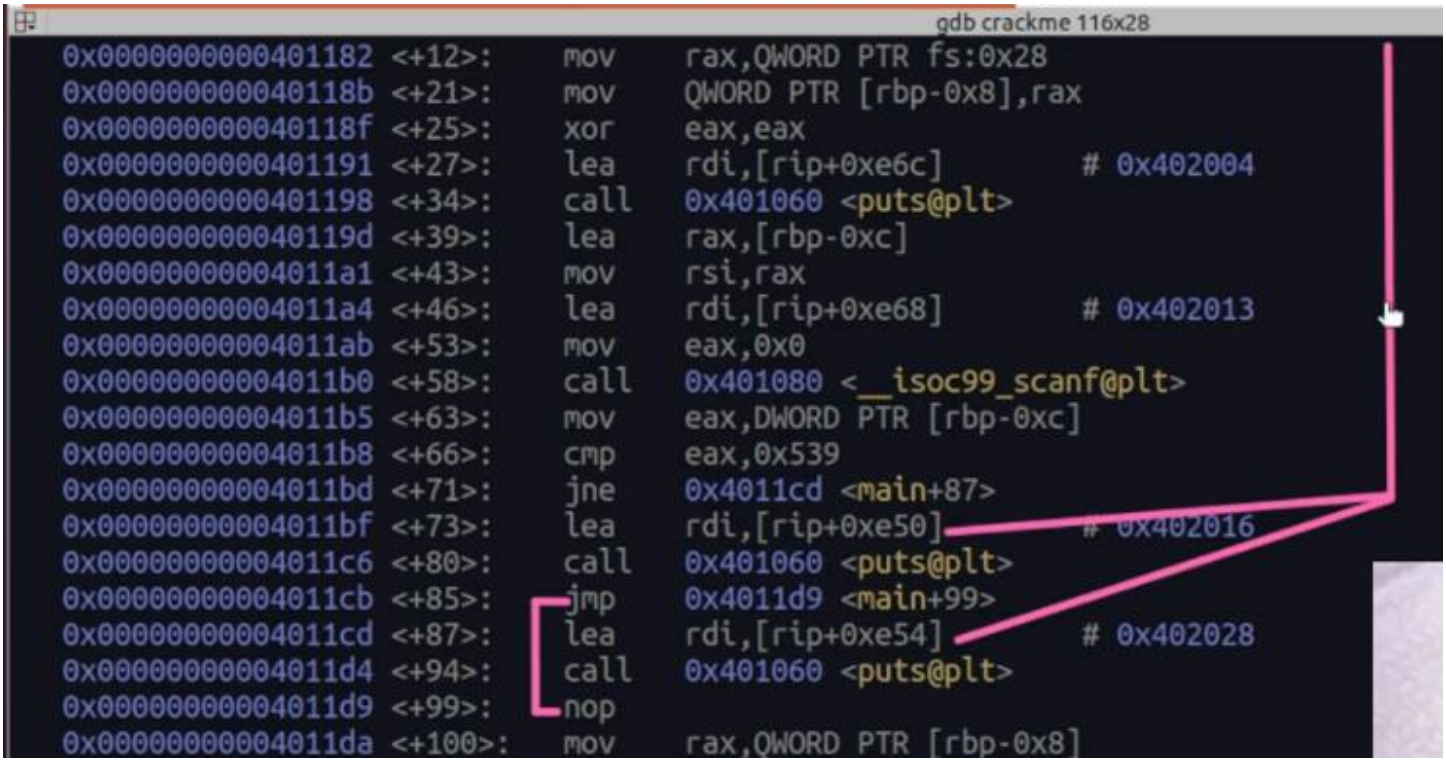
Iska mtlb program beech ke section ko skip kr hai hai jump kr rha hai.



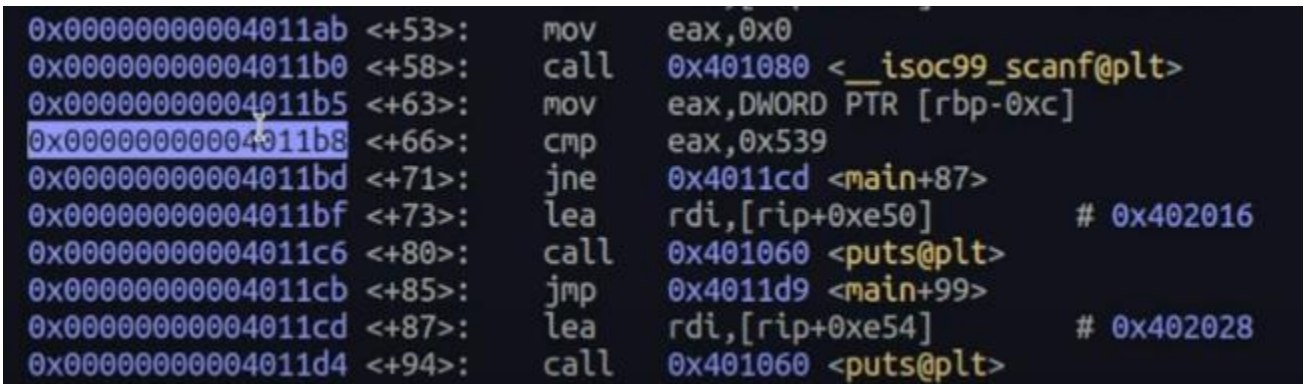
Yha pr password compare ho rha hai. agar equal nhi hui to jne intrunction chal rha hai to program to exit kr de rha hai.

And **lea** works as **mov** instruction.

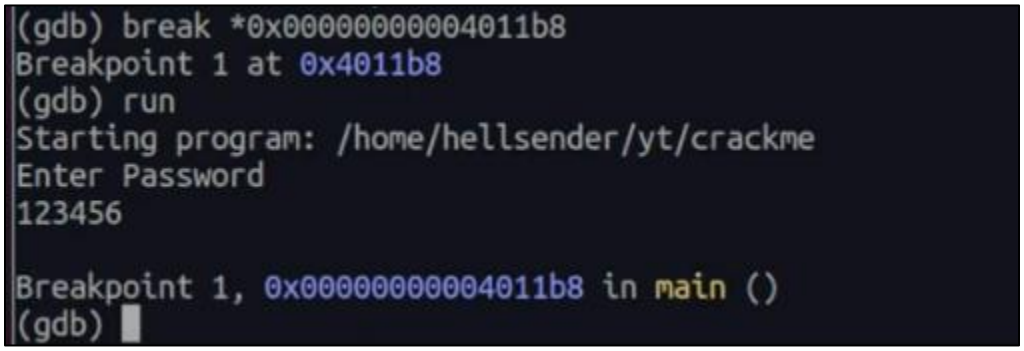
Code flow



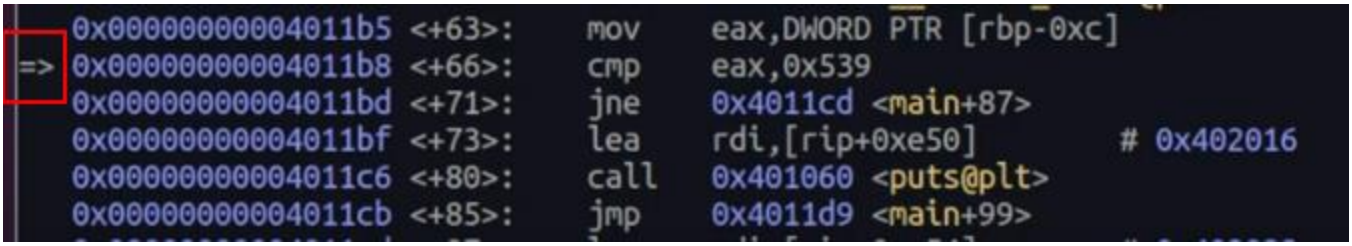
Here, we use debugger to show execution flow.



We put a breakpoint on here, to pause and execute step by step.



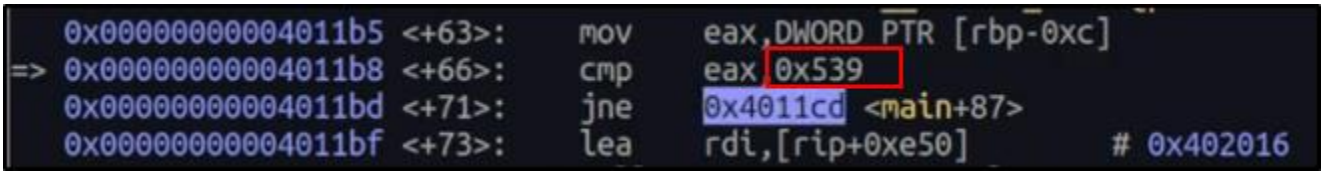
Yha humne address **cmp** ke address pr break point lagaya. Aur run kiya aur jaise hi humne password diya isne breakpoint ko hit kiya.



Aur hum dekh skte hai ki break point lg chuka hai.

Iska bad hum register ka information dekhte hai. ki kaun se register me kitna value hai.

```
End of assembler dump.
(gdb) info registers
rax            0x1e240             123456
rbx            0x4011f0            4198896
rcx            0x0                 0
rdx            0x0                 0
rsi            0x0                 0
rdi            0x7fffffffd950      140737488345424
rbp            0x7fffffffdea0      0x7fffffffdea0
rsp            0x7fffffffde90      0x7fffffffde90
r8             0xa                 10
r9             0x0                 0
r10            0x7ffff7f5bac0      140737353464512
r11            0x0                 0
r12            0x401090            4198544
r13            0x7fffffffdf90      140737488347024
r14            0x0                 0
r15            0x0                 0
rip            0x4011b8            0x4011b8 <main+66>
eflags         0x206               [ PF IF ]
cs             0x33                51
ss             0x2b                43
```



As we can see **rax and eax** value are not same then it will jump **0x4011cd.**

And we can both are hex value then let's see in decimal value.

```
(gdb) print 0x1e240
$1 = 123456
(gdb)
```

Ab hum next instruction pr chalte hai.

```
(gdb) nexti
0x00000000004011bd in main ()
(gdb)
```

Yha hum next instruction pr aa gye.

```
   0x00000000004011b8 <+66>:    cmp    eax,0x539
=> 0x00000000004011bd <+71>:    jne    0x4011cd <main+87>
   0x00000000004011bf <+73>:    lea    rdi,[rip+0xe50]        # 0x402016
   0x00000000004011c6 <+80>:    call   0x401060 <puts@plt>
```

One thing to noted, yh line abhi execute nhi ki gyi hai.

Hum fir next instruction pr chalte hai. using ni command **ni** and **nexti** are same.

```
End of assembler dump.
(gdb) ni
0x00000000004011cd in main ()
```

Dissambler me dekhte hai

```
End of assembler dump.
(gdb) disassemble main
```

```
=> 0x00000000004011d4 <+94>:    call   0x401060 <puts@plt>
   0x00000000004011d9 <+99>:    nop
   0x00000000004011da <+100>:   mov    rax,QWORD PTR [rbp-0x8]
   0x00000000004011de <+104>:   xor    rax,QWORD PTR fs:0x28
   0x00000000004011e7 <+113>:   je     0x4011ee <main+120>
```

Again **ni**

```
End of assembler dump.
(gdb) ni
Wrong password.
0x00000000004011d9 in main ()
(gdb)
```

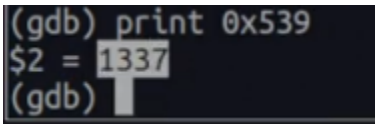
Jaisa ki humne galat password dala tha

To humne dekha ki hum wrong password ke sath bahar aa chuke hai.

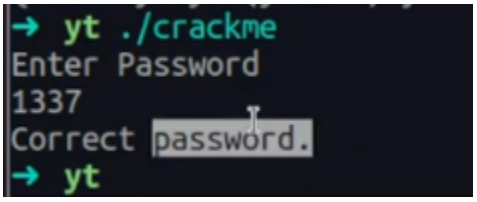
```
0x00000000004011b8 <+66>:    cmp    eax,0x539
0x00000000004011bd <+71>:    jne    0x4011cd <main+87>
0x00000000004011bf <+73>:    lea    rdi,[rip+0xe50]        # 0x402016
0x00000000004011c6 <+80>:    call   0x401060 <puts@plt>
0x00000000004011cb <+85>:    jmp    0x4011d9 <main+99>
0x00000000004011cd <+87>:    lea    rdi,[rip+0xe54]        # 0x402028
0x00000000004011d4 <+94>:    call   0x401060 <puts@plt>
```

Agar hume beech ke **call** ko access krna hai to hume **cmp** ki value equal krni hogi.

To hum check krte hai **eax** me to user ka value store ho rha hai but **0x539** kaun si value hai.



Yha dekh skte hai ki **0x539, 1337** ki hex value hai.



So, this is the correct value.

==========

How to remove breakpoint.

1. **List all breakpoints**: Use the info breakpoints command to list all breakpoints along with their numbers.

```
(gdb) info breakpoints
```

2. **Remove a specific breakpoint**: Use the delete command followed by the breakpoint number.

```
(gdb) delete 1
```

This removes breakpoint number 1.

3. **Remove all breakpoints**: To remove all breakpoints at once, use:

```
(gdb) delete
```

4. **Optional confirmation (if prompted)**: If GDB prompts for confirmation to delete multiple breakpoints, type y or yes to confirm.

Notes:

- If you want to disable a breakpoint temporarily without deleting it, use the disable command instead of delete.

```
(gdb) disable 1
```

- To re-enable a disabled breakpoint, use:

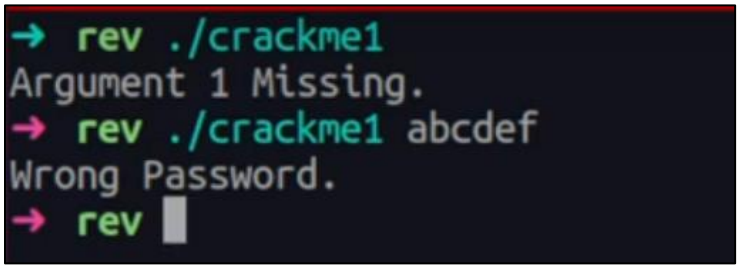
```
(gdb) enable 1
```

Summery Table:

Command	Description

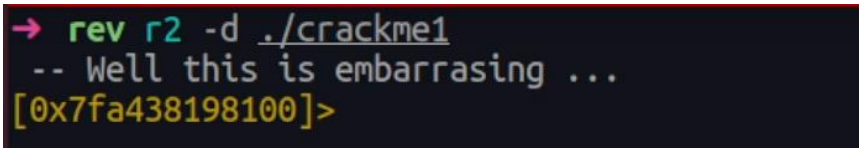
##

Challenge 2 - Find the correct password of crackme1



Here, we will use **radare2** to do this. Radare2 can convert our assembly language code in high level language.

Let's start **radare2**. It is known as **r2**.



Radare2 apne aap se kuchh nhi krta hume isse khte pdta hai ki binary ko read kr lo apne apne andar le aao.

Here, we run command **aaa** to analyze the binary.

```
[0x7fa438198100]> aaa
[x] Analyze all flags starting with sym. and entry0 (aa)
[x] Analyze function calls (aac)
[x] Analyze len bytes of instructions for references (aar)
[x] Finding and parsing C++ vtables (avrr)
[x] Skipping type matching analysis in debugger mode (aaft)
[x] Propagate noreturn information (aanr)
[x] Use -AA or aaaa to perform additional experimental analysis.
[0x7fa438198100]>
```

Show all functions. Use **afl** command.

```
[0x77ea02461290]> afl
0x00401060    1     11 sym.imp.puts
0x00401070    1     11 sym.imp.__stack_chk_fail
0x00401080    1     11 sym.imp.__isoc99_scanf
0x00401090    1     47 entry0
0x004010d0    4     31 sym.deregister_tm_clones
0x00401100    4     49 sym.register_tm_clones
0x00401140    3     32 entry.fini0
0x00401170    1      6 entry.init0
0x00401260    1      5 sym.__libc_csu_fini
0x00401268    1     13 sym._fini
0x004011f0    4    101 sym.__libc_csu_init
0x004010c0    1      5 sym._dl_relocate_static_pie
0x00401176    6    122 main
0x00401000    3     27 sym._init
```

Put a breakpoint on **main**. Use **db main** command. Means **debug breakpoint**.

```
[0x77ea02461290]>
[0x77ea02461290]> db main
[0x77ea02461290]>
```

Now, we use **dc** command to run the program and it will hit breakpoint. And pause. **dc** means debug continue. In **radare2** everything happens with debug.

```
[0x77ea02461290]> dc
INFO: hit breakpoint at: 0x401176
[0x00401176]>
```

This is address of main function

And here we can see our shell address is also changed.

Ab hume iski disassembly code dekhna hai. to hum run karenge **pdf** command.

```
[0x00401176]> pdf
            ;-- rax:
            ;-- r13:
            ;-- rip:
            ; DATA XREF from entry0 @ 0x4010b1(r)
┌ 122: int main (int argc, char **argv, char **envp);
│ afv: vars(2:sp[0x10..0x14])
            0x00401176 b    f30f1efa        endbr64
            0x0040117a      55              push rbp
            0x0040117b      4889e5          mov rbp, rsp
            0x0040117e      4883ec10        sub rsp, 0x10
            0x00401182      64488b0425..    mov rax, qword fs:[0x28]
            0x0040118b      488945f8        mov qword [var_8h], rax
            0x0040118f      31c0            xor eax, eax
            0x00401191      488d3d6c0e..    lea rdi, str.Enter_Password ; 0x402004 ; "Enter Password"
            0x00401198      e8c3feffff      call sym.imp.puts           ; int puts(const char *s)
            0x0040119d      488d45f4        lea rax, [var_ch]
            0x004011a1      4889c6          mov rsi, rax
            0x004011a4      488d3d680e..    lea rdi, [0x00402013]       ; "%d"
            0x004011ab      b800000000      mov eax, 0
            0x004011b0      e8cbfeffff      call sym.imp.__isoc99_scanf ; int scanf(const char *format)
            0x004011b5      8b45f4          mov eax, dword [var_ch]
            0x004011b8      3d39050000      cmp eax, 0x539              ; 1337
        ┌─< 0x004011bd      750e            jne 0x4011cd
        │   0x004011bf      488d3d500e..    lea rdi, str.Correct_password. ; 0x402016 ; "Correct password."
        │   0x004011c6      e895feffff      call sym.imp.puts           ; int puts(const char *s)
       ┌──< 0x004011cb      eb0c            jmp 0x4011d9
       │└─> 0x004011cd      488d3d540e..    lea rdi, str.Wrong_password. ; 0x402028 ; "Wrong password."
       │    0x004011d4      e887feffff      call sym.imp.puts           ; int puts(const char *s)
       │    ; CODE XREF from main @ 0x4011cb(x)
       └──> 0x004011d9      90              nop
            0x004011da      488b45f8        mov rax, qword [var_8h]
            0x004011de      6448330425..    xor rax, qword fs:[0x28]
        ┌─< 0x004011e7      7405            je 0x4011ee
        │   0x004011e9      e882feffff      call sym.imp.__stack_chk_fail ; void __stack_chk_fail(void)
        └─> 0x004011ee      c9              leave
            0x004011ef      c3              ret
[0x00401176]>
```

It provides assembly code in **intel flavor**. We can change it in AT&T assembly also.

Ab hum durse visual mode me dekhenge ise. Iske liye hum **V** use karenge.

```
[0x00401176]>
[0x00401176]> V
```

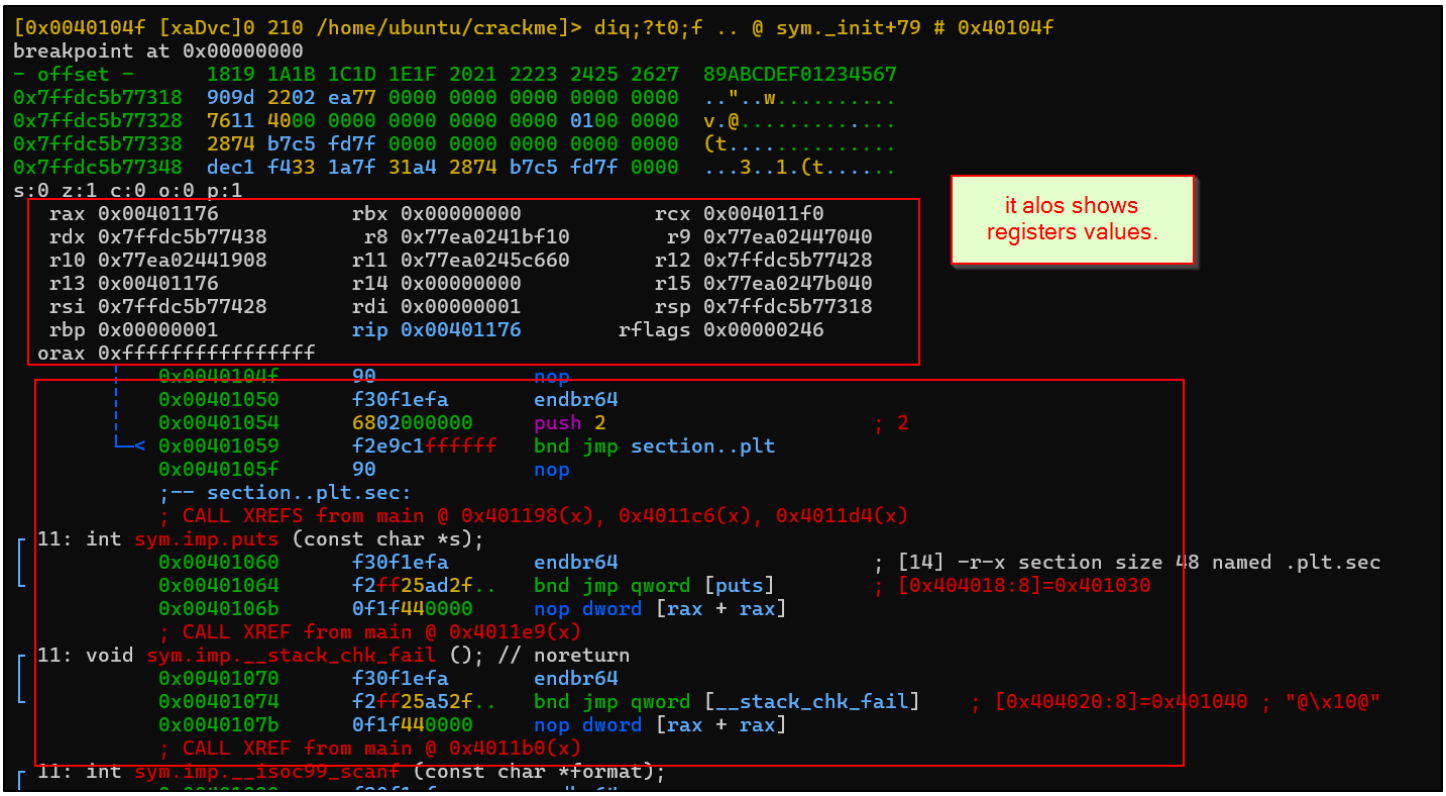
```
[0x00401176 [Xadvc]0 672 /home/ubuntu/crackme]> xc @ main
- offset -  7677 7879 7A7B 7C7D 7E7F 8081 8283 8485  6789ABCDEF012345  comment
0x00401176  f30f 1efa 5548 89e5 4883 ec10 6448 8b04  ....UH..H...dH..  ; rip
0x00401186  2528 0000 0048 8945 f831 c048 8d3d 6c0e  %(...H.E.1.H.=l.
0x00401196  0000 e8c3 feff ff48 8d45 f448 89c6 488d  .......H.E.H..H.
0x004011a6  3d68 0e00 00b8 0000 0000 e8cb feff ff8b  =h..............
0x004011b6  45f4 3d39 0500 0075 0e48 8d3d 500e 0000  E.=9...u.H.=P...
0x004011c6  e895 feff ffeb 0c48 8d3d 540e 0000 e887  .......H.=T.....
0x004011d6  feff ff90 488b 45f8 6448 3304 2528 0000  ....H.E.dH3.%(..
0x004011e6  0074 05e8 82fe ffff c9c3 f30f 1efa 4157  .t............AW  ; rcx
0x004011f6  4c8d 3d13 2c00 0041 5649 89d6 4155 4989  L.=.,..AVI..AUI. ; arg3 ; arg2
0x00401206  f541 5441 89fc 5548 8d2d 042c 0000 534c  .ATA..UH.-.,..SL ; arg1
0x00401216  29fd 4883 ec08 e8df fdff ff48 c1fd 0374  ).H........H...t
0x00401226  1f31 db0f 1f80 0000 0000 4c89 f24c 89ee  .1........L..L..
0x00401236  4489 e741 ff14 df48 83c3 0148 39dd 75ea  D..A...H...H9.u.
0x00401246  4883 c408 5b5d 415c 415d 415e 415f c366  H...[]A\A]A^A_.f
0x00401256  662e 0f1f 8400 0000 0000 f30f 1efa c300  f...............  ; sym.__libc_csu_fini
0x00401266  0000 f30f 1efa 4883 ec08 4883 c408 c300  ......H...H.....  ; sym._fini ; [16] -r-x sect
0x00401276  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x00401286  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x00401296  0000 0000 0000 0000 0000 0000 0000 0000  ................
0x004012a6  0000 0000 0000 0000 0000 0000 0000 0000  ................
```

Here, we can see it is showing hex dump. To see next window press **p**

```
[0x0040104f [xAdvc]0 210 /home/ubuntu/crackme]> afsQ;pd $r.. @ sym._init+79 # 0x40104f
        |   0x0040104f      90              nop
        |   0x00401050      f30f1efa        endbr64
        |   0x00401054      6802000000      push 2                      ; 2
        `=< 0x00401059      f2e9c1ffffff    bnd jmp section..plt
            0x0040105f      90              nop
            ;-- section..plt.sec:
            ; CALL XREFS from main @ 0x401198(x), 0x4011c6(x), 0x4011d4(x)
┌ 11: int sym.imp.puts (const char *s);
│          0x00401060      f30f1efa        endbr64                     ; [14] -r-x section size 48 named .plt.sec
└          0x00401064      f2ff25ad2f..    bnd jmp qword [puts]        ; [0x404018:8]=0x401030
           0x0040106b      0f1f440000      nop dword [rax + rax]
           ; CALL XREF from main @ 0x4011e9(x)
┌ 11: void sym.imp.__stack_chk_fail (); // noreturn
│          0x00401070      f30f1efa        endbr64
└          0x00401074      f2ff25a52f..    bnd jmp qword [__stack_chk_fail]    ; [0x404020:8]=0x401040 ; "@\x10@"
           0x0040107b      0f1f440000      nop dword [rax + rax]
           ; CALL XREF from main @ 0x4011b0(x)
┌ 11: int sym.imp.__isoc99_scanf (const char *format);
│          0x00401080      f30f1efa        endbr64
└          0x00401084      f2ff259d2f..    bnd jmp qword [__isoc99_scanf]    ; [0x404028:8]=0x401050 ; "P\x10@"
           0x0040108b      0f1f440000      nop dword [rax + rax]
           ;-- section..text:
           ;-- _start:
┌ 47: entry0 (int64_t arg3);
│ `- args(rdx)
│          0x00401090      f30f1efa        endbr64                     ; [15] -r-x section size 469 named .text
│          0x00401094      31ed            xor ebp, ebp
│          0x00401096      4989d1          mov r9, rdx                 ; arg3
│          0x00401099      5e              pop rsi
│          0x0040109a      4889e2          mov rdx, rsp
│          0x0040109d      4883e4f0        and rsp, 0xfffffffffffffff0
│          0x004010a1      50              push rax
│          0x004010a2      54              push rsp
│          0x004010a3      49c7c06012..    mov r8, sym.__libc_csu_fini    ; 0x401260
│          0x004010aa      48c7c1f011..    mov rcx, sym.__libc_csu_init    ; 0x4011f0
│          0x004010b1      48c7c77611..    mov rdi, main               ; rip
```

It will showing disassembly.

Press again **p**



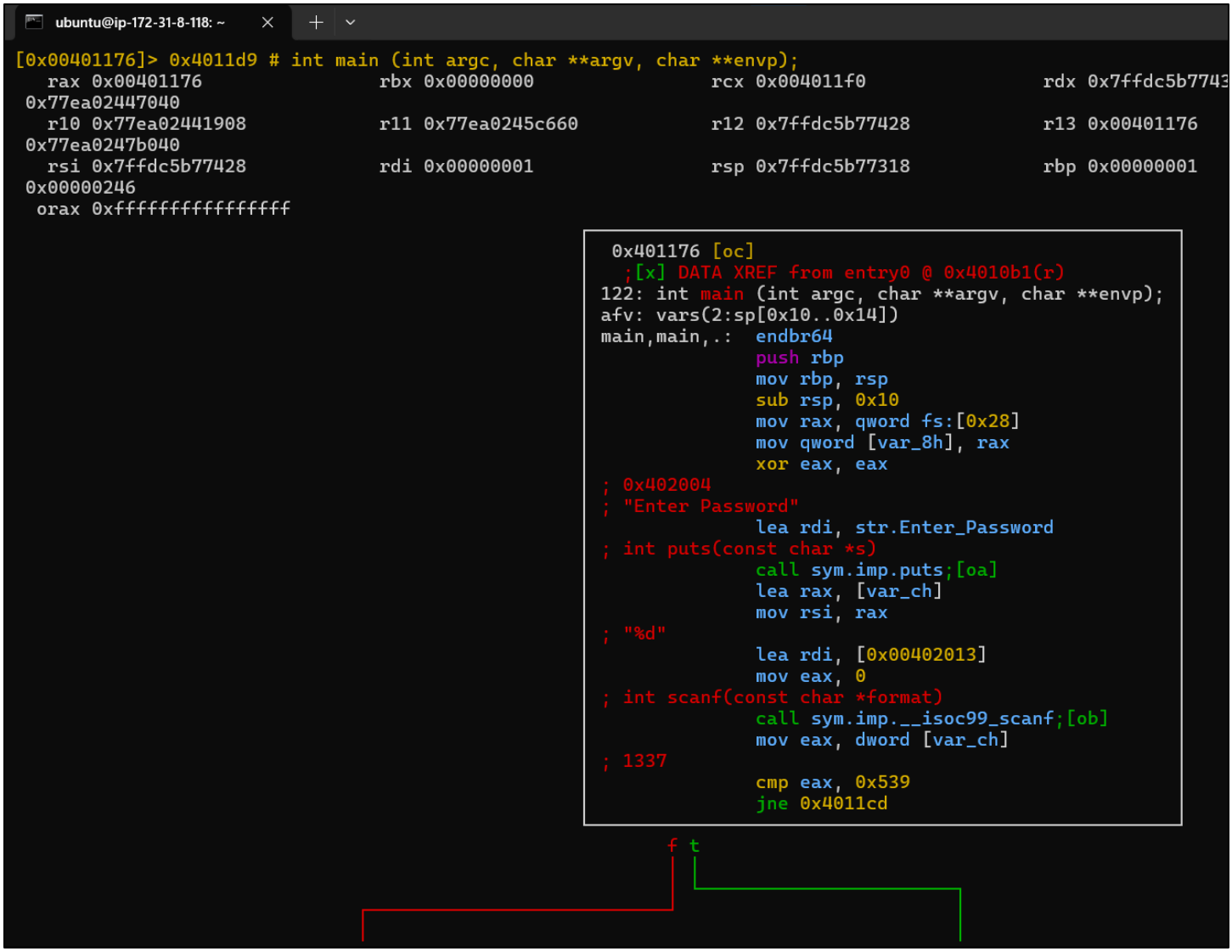
then it will show disassembly as well as registers values.

There are some more modes available press **p** again and again.

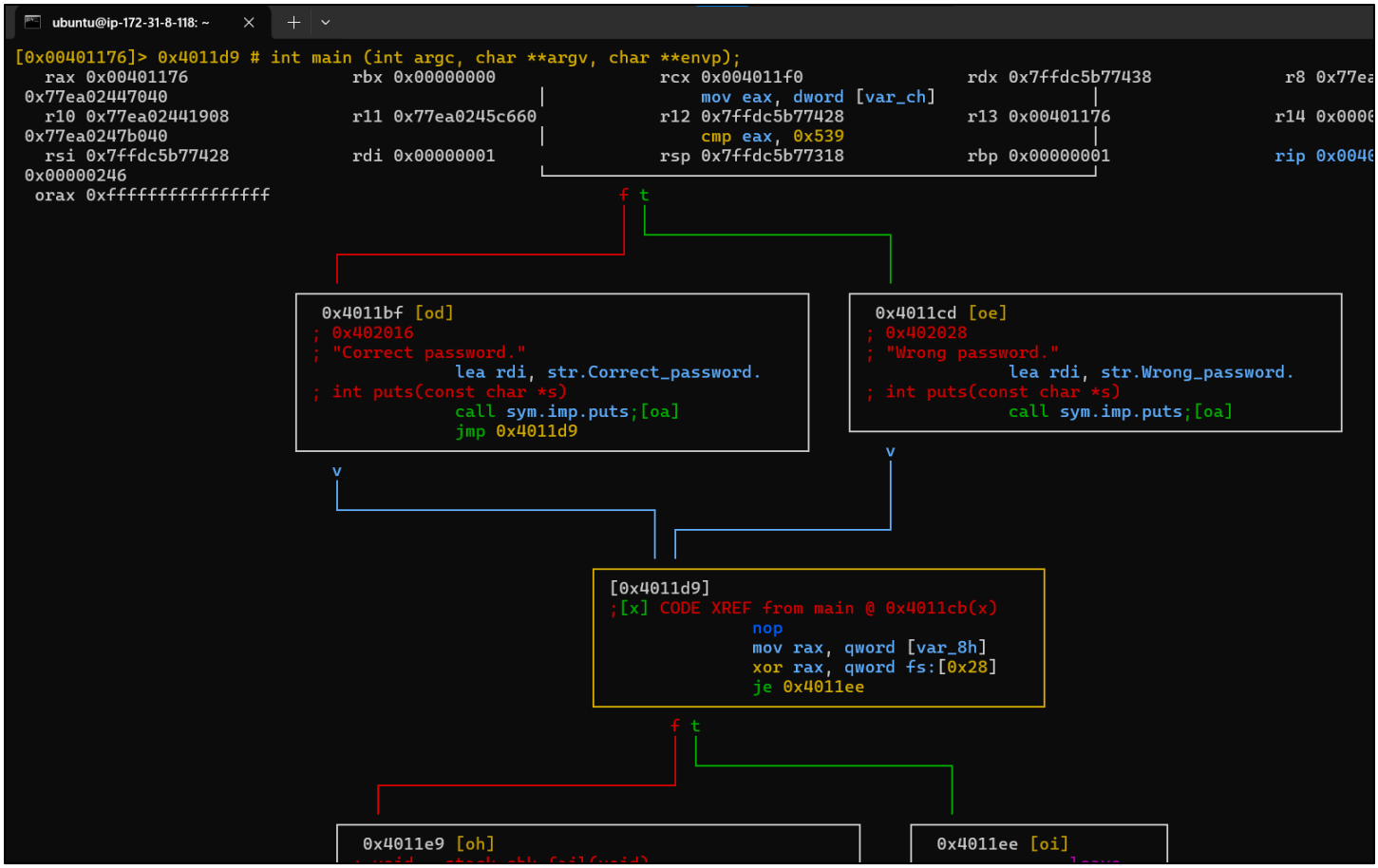
If you want to **exit** it press **q**.

Now, we will show **Visual Graph** mode.

Press **VV** and enter.

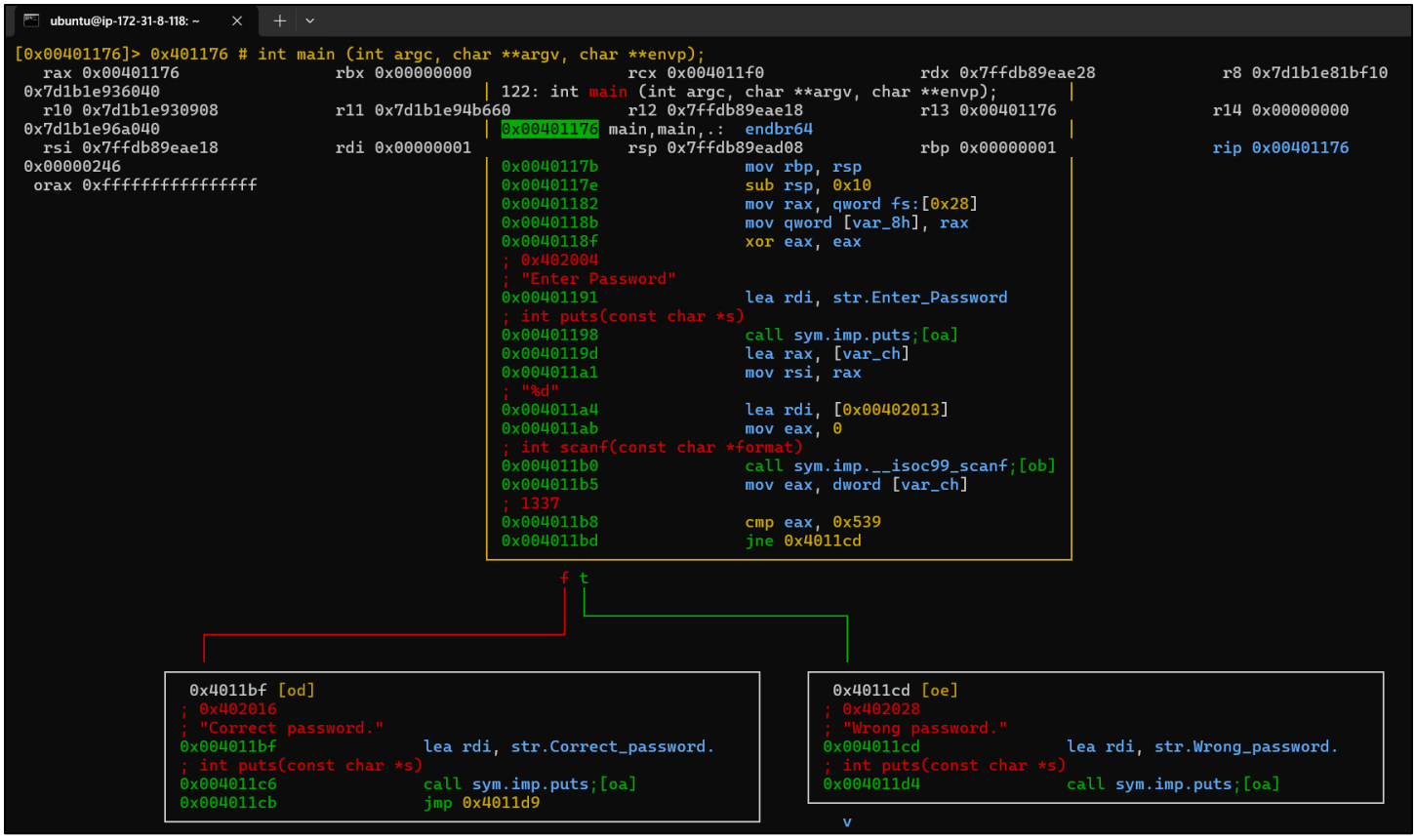


In visual graph mode we can see a jump statement **if false** to kahan jayega **if true** to kahan jayega.



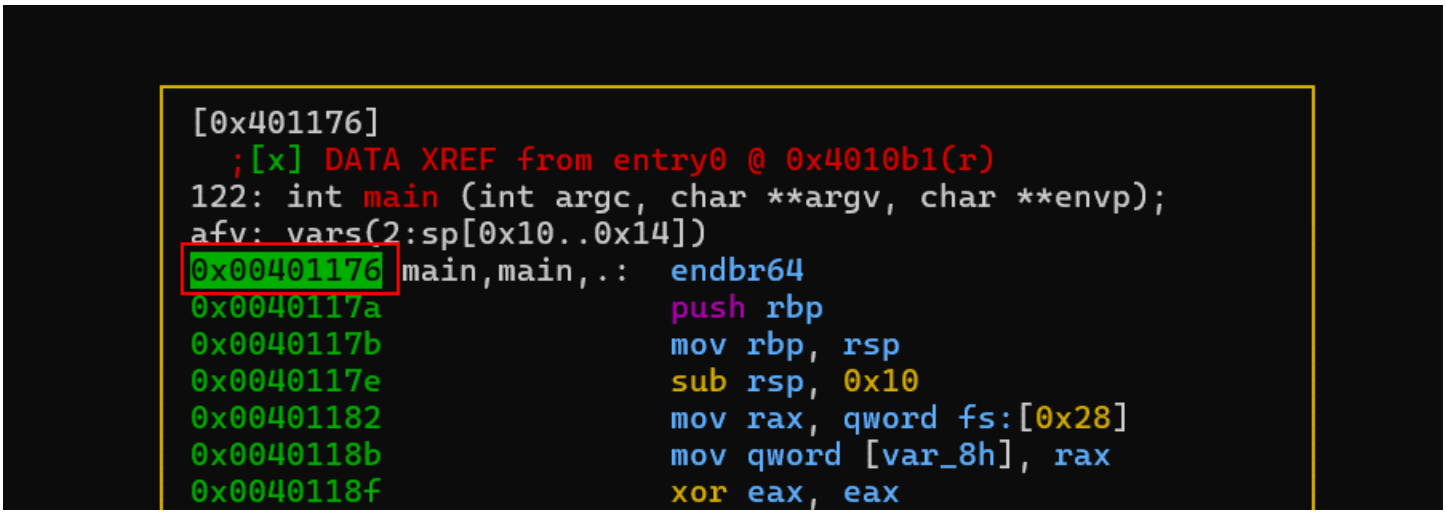
We can move it using **arrow key**. And press **shift + r** to change font color (theme).

Press **p** for next style.



Here, we can see address also with disassembly.

Now, Here, we can see pointer on main function.



If we want to move (go to next intruction) press **shift+s** .

```
[0x401176]
  ;[x] DATA XREF from entry0 @ 0x4010b1(r)
122: int main (int argc, char **argv, char **envp);
afv: vars(2:sp[0x10..0x14])
0x00401176 main,main,.:   endbr64
0x0040117a          rip:  push rbp
0x0040117b                mov rbp, rsp
0x0040117e                sub rsp, 0x10
```

Ok, ab hum cmp instruction pr chalte hai. because compare import thing in reverse engineering.

```
;-- rip:
0x00401206 837dcc01       cmp dword [var_34h], 1
0x0040120a 7f16           jg 0x401222
```

Here, we can see **var_34h** variable **1** se compare ho rha hai.

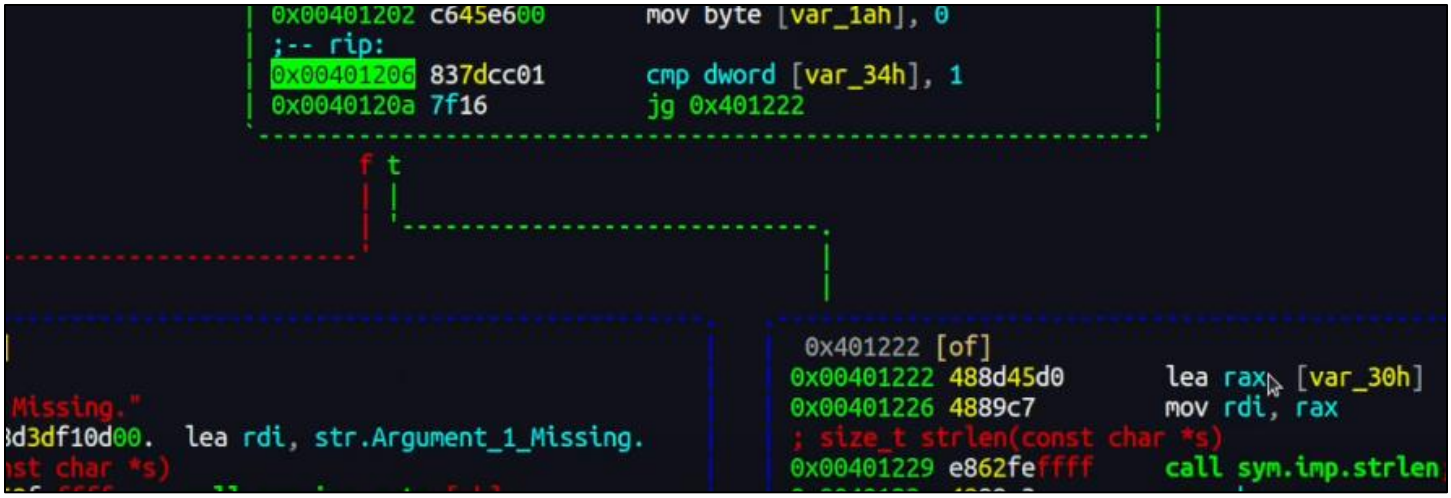
To hum dekhte hai ki var_34h me kaun si value hai.

```
x004011b6]> 0x4011b6 # int main (int argc, char **argv);-0
; var int64_t var_28h @ rbp-0x28
; var int64_t var_20h @ rbp-0x20
; var int64_t var_1ch @ rbp-0x1c
; var int64_t var_1ah @ rbp-0x1a
; var int64_t var_18h @ rbp-0x18
; arg int argc @ rdi
; arg char **argv @ rsi
0x004011b6 f30f1efa       endbr64
0x004011ba 55             push rbp
0x004011bb 4889e5         mov rbp, rsp
0x004011be 53             push rbx
0x004011bf 4883ec38       sub rsp, 0x38
; argc
0x004011c3 897dcc         mov dword [var_34h], edi
; argv
0x004011c6 488975c0       mov qword [var_40h], rsi
0x004011ca 64488b042528.  mov rax, qword fs:[0x28]
0x004011d3 488945e8       mov qword [var_18h], rax
```

Upar hum dekh skte hai ki edi ki jo bhi value thi wo **var_34h** me copy hui hai.

Aur **edi** ki jo bhi value thi **argc** means **argument counter**. Then total number of argument ko hum **argc** khte hai.

To yha pr total humber ko 1 se compare kr rha hai. agar total number of argument 1 se jyada hai to go to **true(t)** otherwise **false(f)**.



It means we have to give atleast two argument. Ek argument jata hi jata hai. filename ko ek argument consider kiya jata hai. uske aage jo bhi argument dete hai wo second, third, forth .. argument consider hota hai.

Yha pr **var_34h** ka memory address **rbp-0x34** hai to iska name **var_34h** rkha gya hai.

Ab hume radare ek command run krna hai. To hum **":"** press karenge. Hume dikh jayega. Hum yha ek memory location pr kya rkha use dekhna hai to **px** command run karenge **@** and **address ka na**m.

```
                                                    | 0x00401d9 48b853337570.  M
:> px@rbp-0x34
- offset -       0 1  2 3  4 5  6 7  8 9  A B  C D  E 0123456789ABCDE
0x7fff17f7cb2c  0100 0000 5333 7570 6572 5f53 3363 72 ....S3uper_S3cr
0x7fff17f7cb3b  3374 5f50 6133 3377 3072 6400 0000 ef 3t_Pa33w0rd....
0x7fff17f7cb4a  dd57 518b a2b2 50cc f717 ff7f 0000 c0 .WQ...P.......
0x7fff17f7cb59  1240 0000 0000 0000 0000 0000 0000 00 .@..............
0x7fff17f7cb68  b360 3239 ef7f 0000 20b6 5339 ef7f 00 .`29.... .S9...
0x7fff17f7cb77  0058 ccf7 17ff 7f00 0000 0000 0001 00 .X..............
0x7fff17f7cb86  0000 b611 4000 0000 0000 c012 4000 00 ....@.......@..
0x7fff17f7cb95  0000 0059 3dc5 2836 e68d 4bd0 1040 00 ...Y=.(6..K..@.
0x7fff17f7cba4  0000 0000 50cc f717 ff7f 0000 0000 00 ....P...........
0x7fff17f7cbb3  0000 0000 0000 0000 0000 0000 0059 3d ..............Y=
0x7fff17f7cbc2  25be d9c9 73b4 593d 0be8 5294 53b4 00 %...s.Y=..R.S..
0x7fff17f7cbd1  0000 0000 0000 0000 0000 0000 0000 00 ................
0x7fff17f7cbe0  0000 0000 0000 0000 0100 0000 0000 00 ................
0x7fff17f7cbef  0058 ccf7 17ff 7f00 0068 ccf7 17ff 7f .X.......h.....
0x7fff17f7cbfe  0000 90d1 5339 ef7f 0000 0000 0000 00 ....S9.........
0x7fff17f7cc0d  0000 0000 0000 0000 0000 00d0 1040 00 ..............@.
0x7fff17f7cc1c  0000 0000 50cc f717 ff7f 0000 0000 00 ....P...........
0x7fff17f7cc2b  00                                    .
:>
```

Yha pr sabse phli value hai wahi **var_34h** variable ki value hai.

Press **Enter** to go to visual mode again.

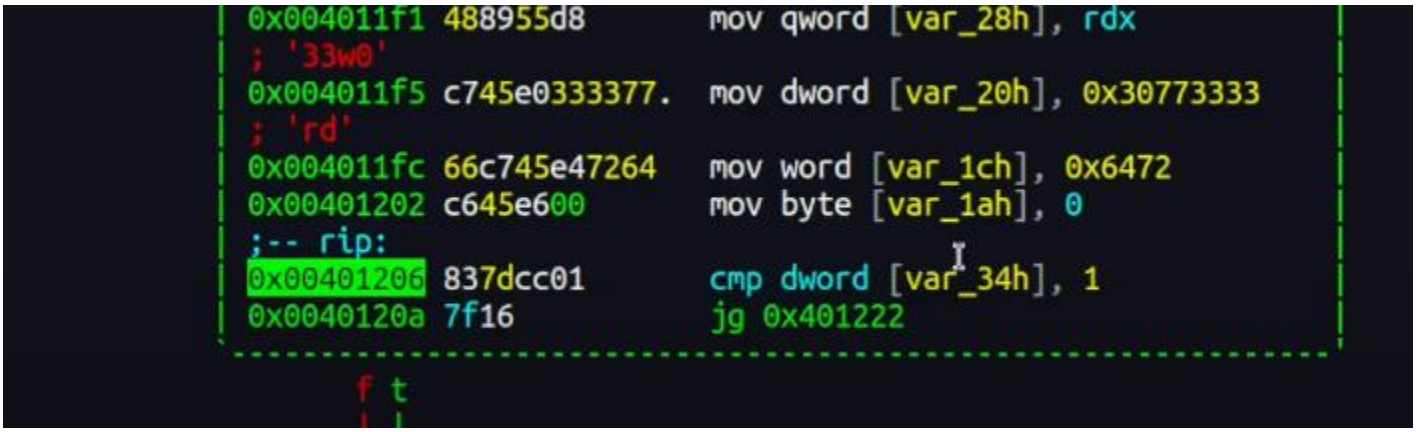
Go to command mode and run further execution. And finish it.

```
:> dc
Argument 1 Missing.
(27610) Process exited with status=0x100
:>
```

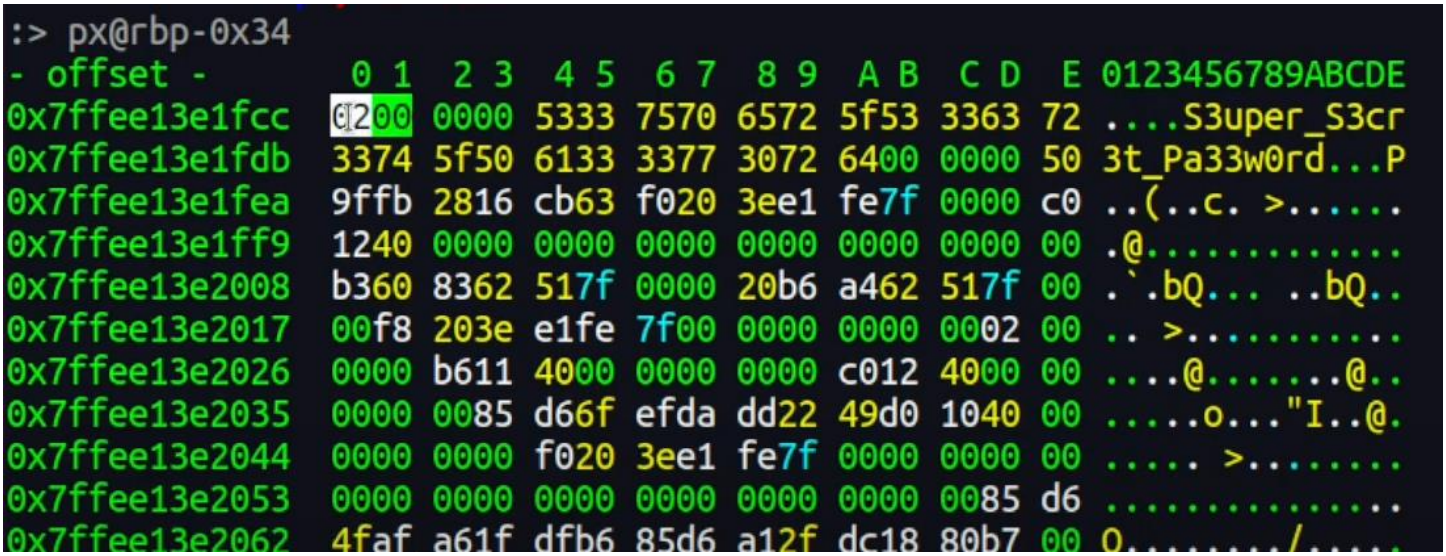
Ab hum program ko restart krte hai ek argument ke sath. We will use **ood** pass any argument

```
> ood 1234567
PTRACE_CONT: No such process
(160035) Process exited with status=0x9
child received signal 9
INFO: File dbg:///home/ubuntu/crackme1 1234567 reopened in read-write mode
> dc
INFO: hit breakpoint at: 0x4011b6
>
```

dc for run .

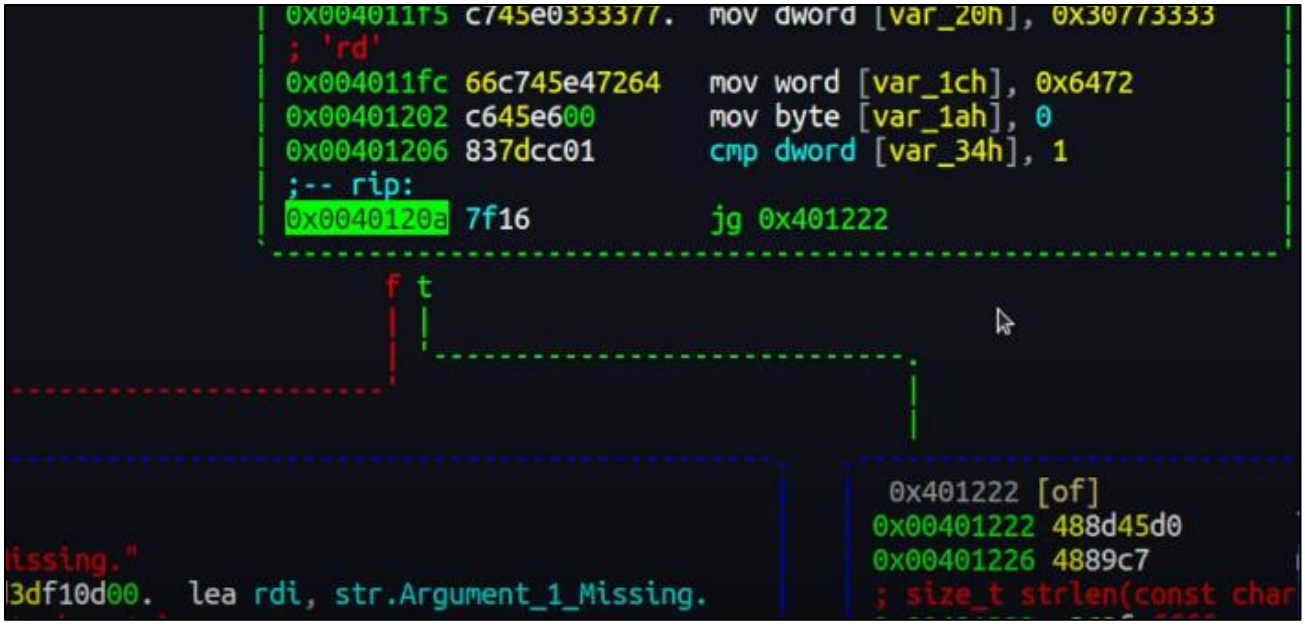


Ab hum fir dekhte hai. usi memory address pr kya stored hai.

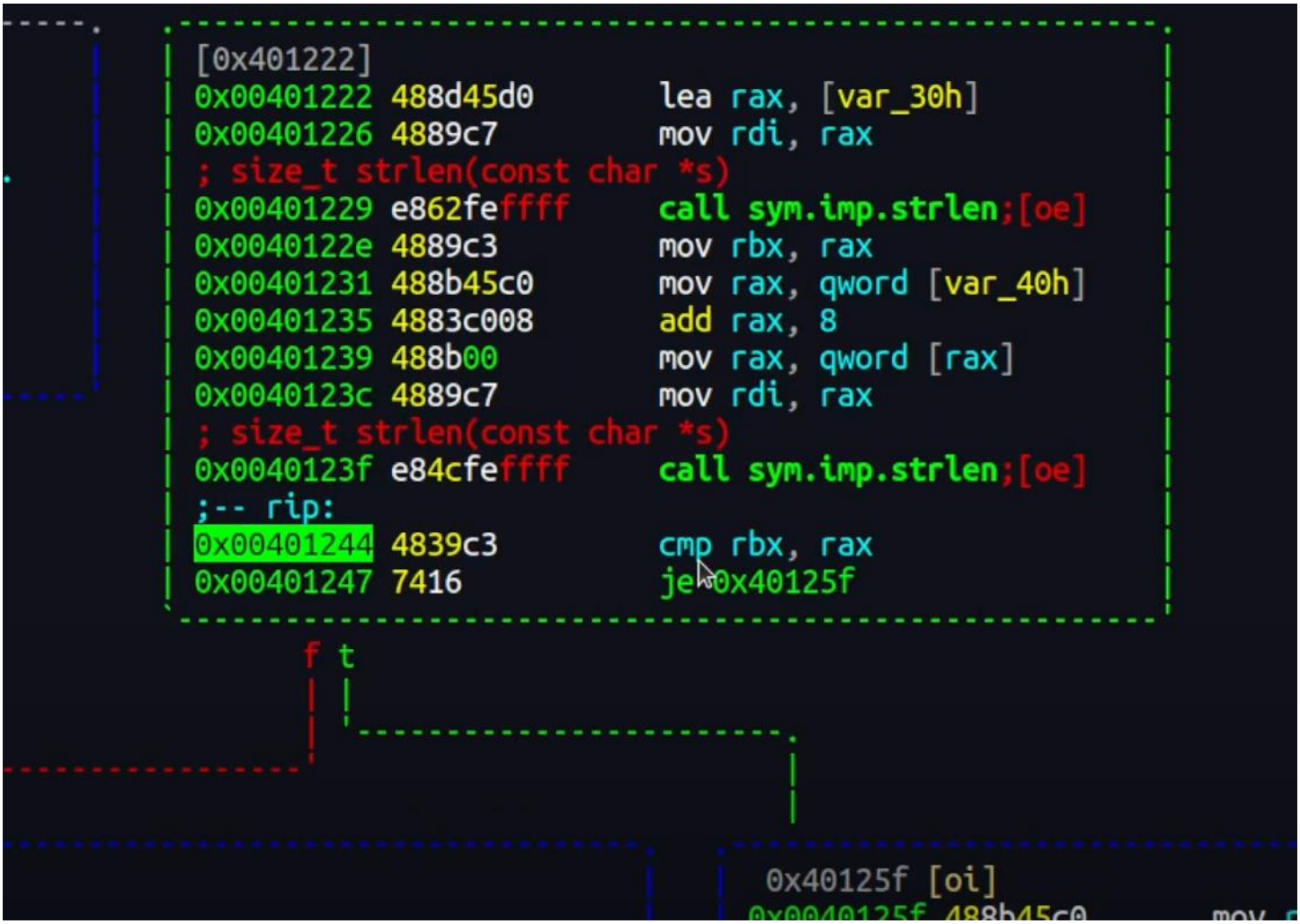


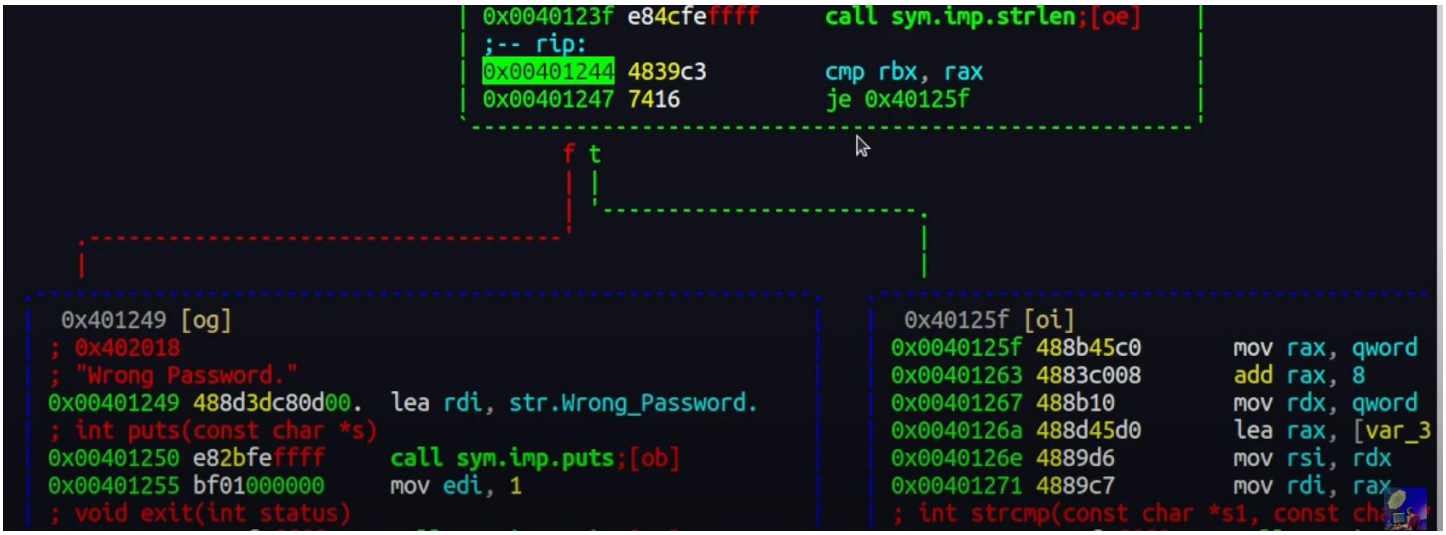
Is bar first value **2** hai.

To ab iski value 2 ho gyi to ye jump lega. Aur t wale section me chla jayega.



Ab hum dusre section me jate hai.





Yha pr **sym.imp.strlen** bs string ki length batate hai.

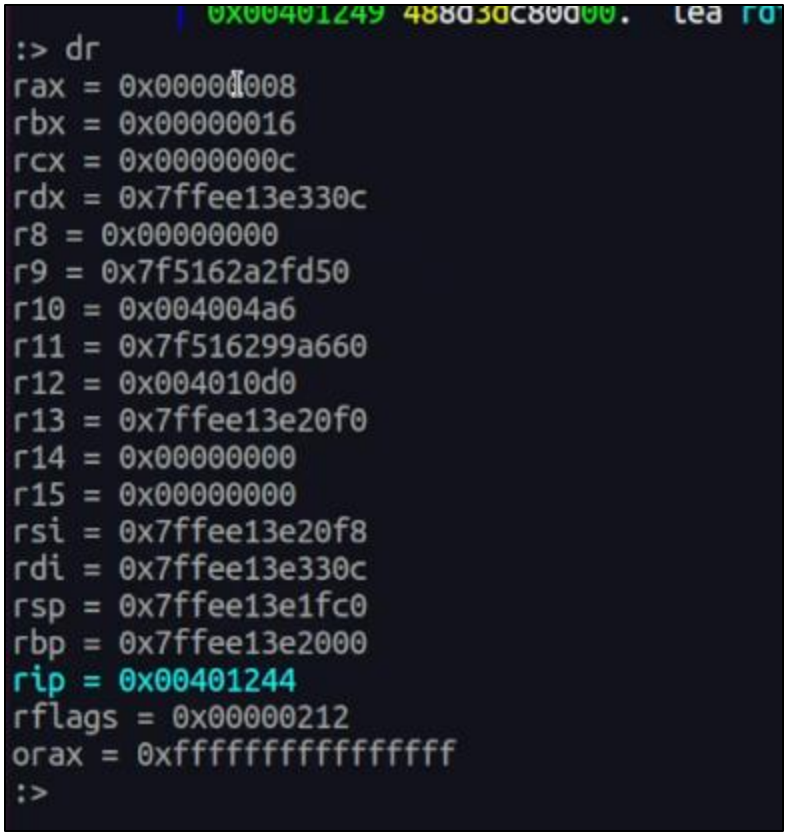
Is pure section me check ho rha hai ki jo bhi humne password diya hai uske length ko compare kiya ja rha hai. agar equal hai to next true section me jayega agar nhi to false section me jayega.

Man lijiye password 8 length ka hai aur humne 10 length diya to kaise match karega. Isliye ye phle hi out kr de rha hai.

To yha pr hume kaise pta chalega ki kitni length hai.

To yha pr humari length aur original length in dono registers me pdi hai.

Registers ki value dekhne ke liye dr command chalate hai.

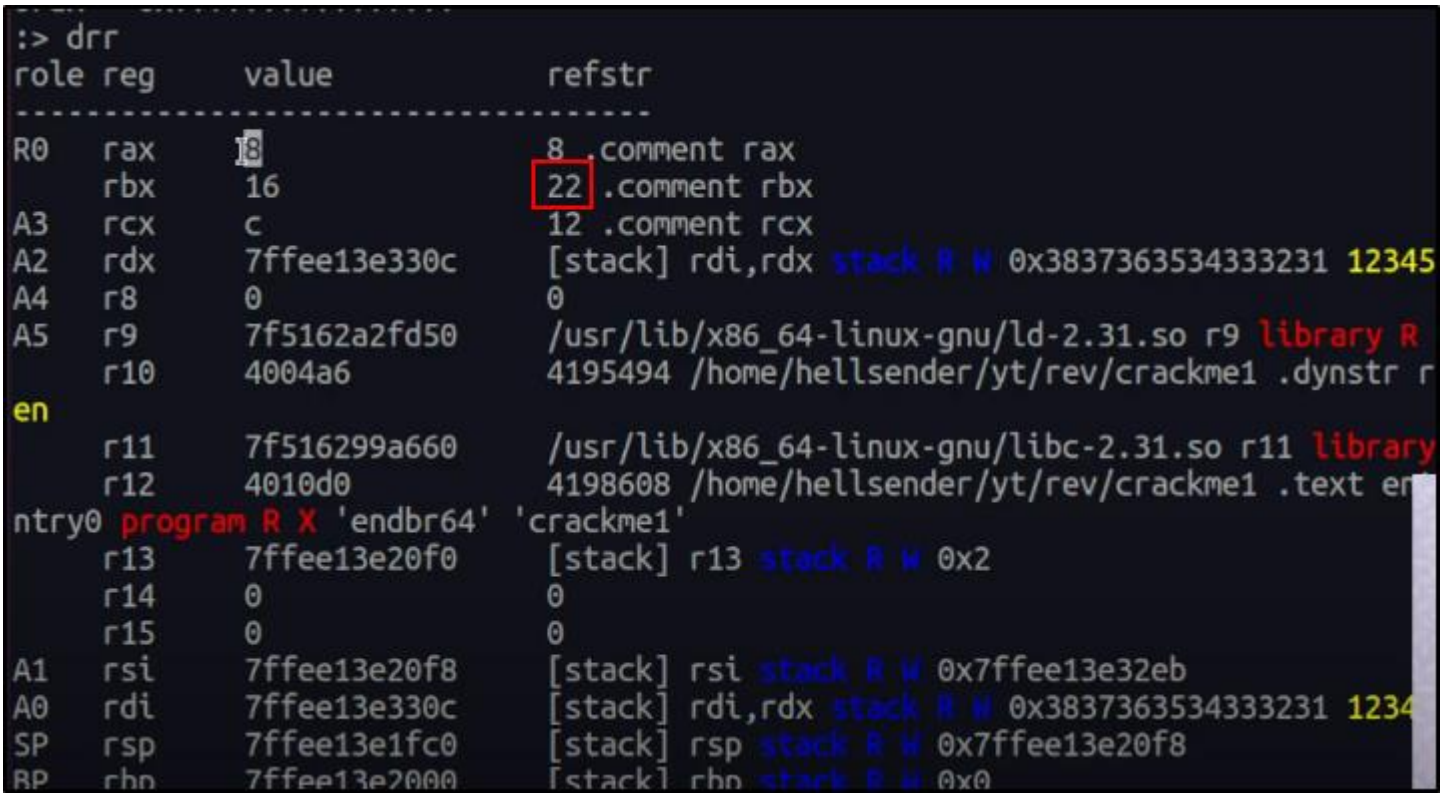


To yha pr **rax** ki value **8** hai. aur **rbx** ki value **16** hai.

So, humne 8 length ka input dala tha 12345678 aur **original length 16** hai.

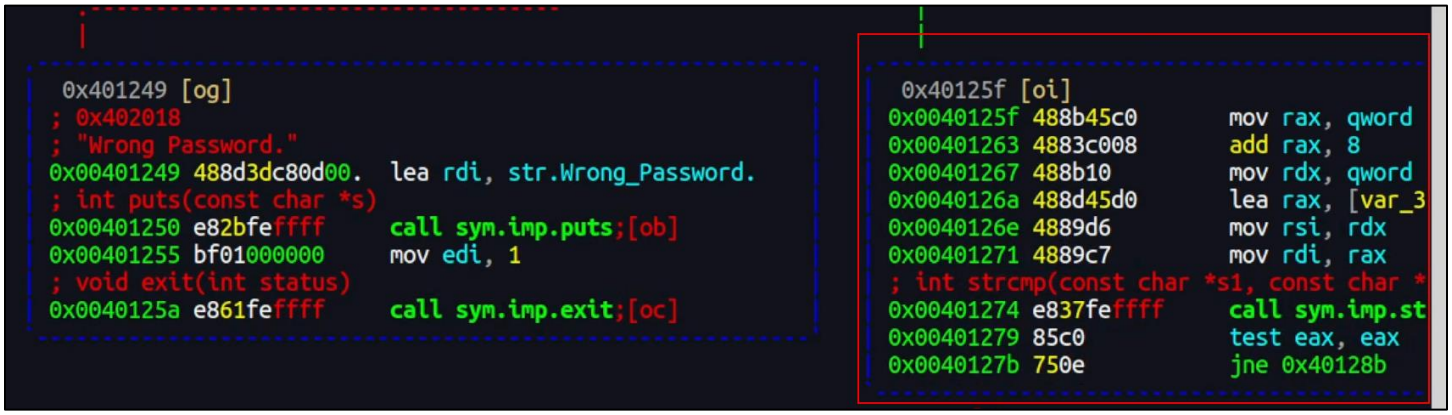
So. **0x00000016** password ki original length hai.

Agar hum apne understanding me dekhna chahe to **drr** command fire karenge.



Hex **0x16** ki value **22** hai.

To hume **22 length** ka input dalna padega tabhi hum is address pr aa payenge.



Ok, ab hum program ko fir se run krte hai.

```
:> ood 123456789012345678901
native-singlestep: No such process
Stepping failed!
child received signal 9
File dbg:///home/hellsender/yt/rev/crackme1 123456789012345678901
29238
:> dc
hit breakpoint at: 0x4011b6
:>
```

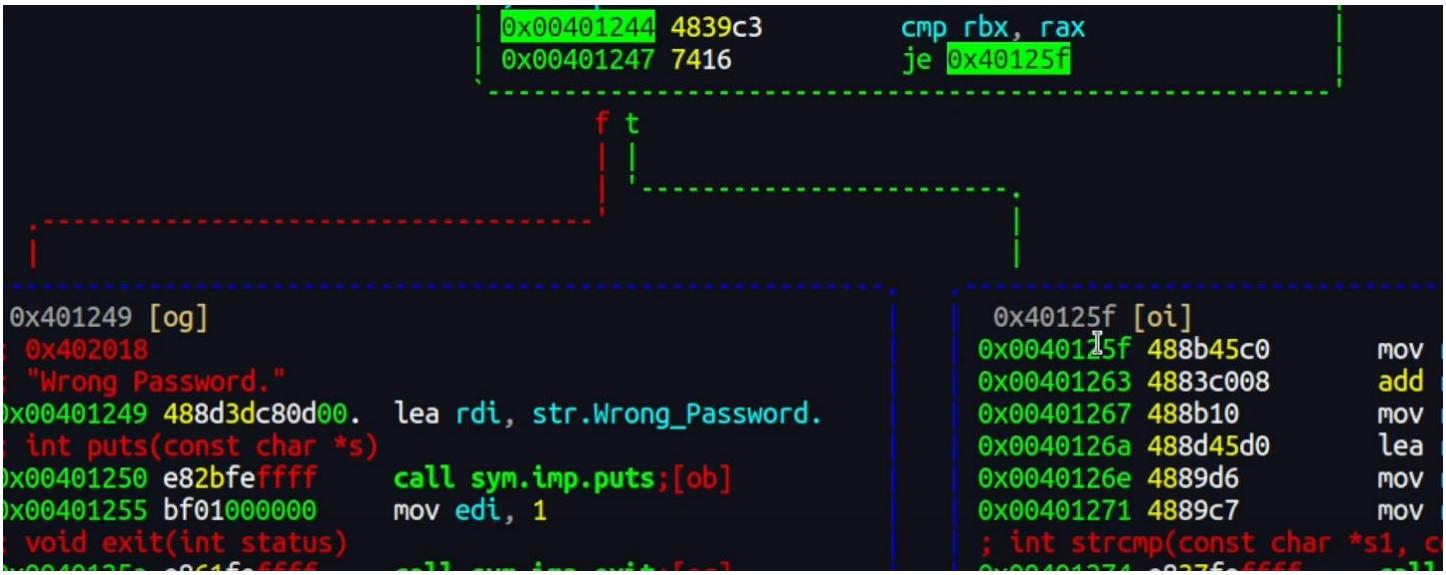
To hum jahan pr string compare ho rha hai wahi pr breakpoint lagate hai.

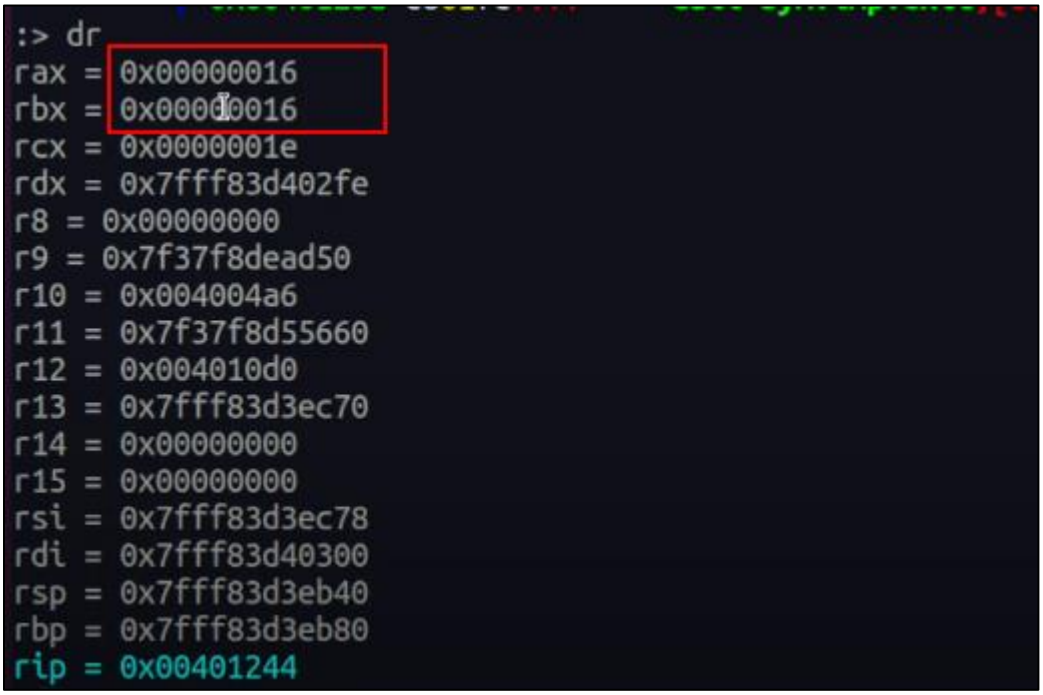
```
    0x00401239      488d00          mov rax, qword [rax]
    0x0040123c      4889c7          mov rdi, rax
    0x0040123f      e84cfeffff      call sym.imp.strlen
    0x00401244      4839c3          cmp rbx, rax
,=< 0x00401247      7416            je 0x40125f
|   0x00401249      488d3dc80d00.   lea rdi, str.Wrong_Password.
|   0x00401250      e82bfeffff      call sym.imp.puts
|   0x00401255      bf01000000      mov edi, 1
|   0x0040125a      e861feffff      call sym.imp.exit
`-> 0x0040125f      488b45c0        mov rax, qword [var_40h]
    0x00401263      4883c008        add rax, 8
    0x00401267      488b10          mov rdx, qword [rax]
    0x0040126a      488d45d0        lea rax, [var_30h]
    0x0040126e      4889d6          mov rsi, rdx
    0x00401271      4889c7          mov rdi, rax
```

Here, we put **breakpoint** and **continue**.

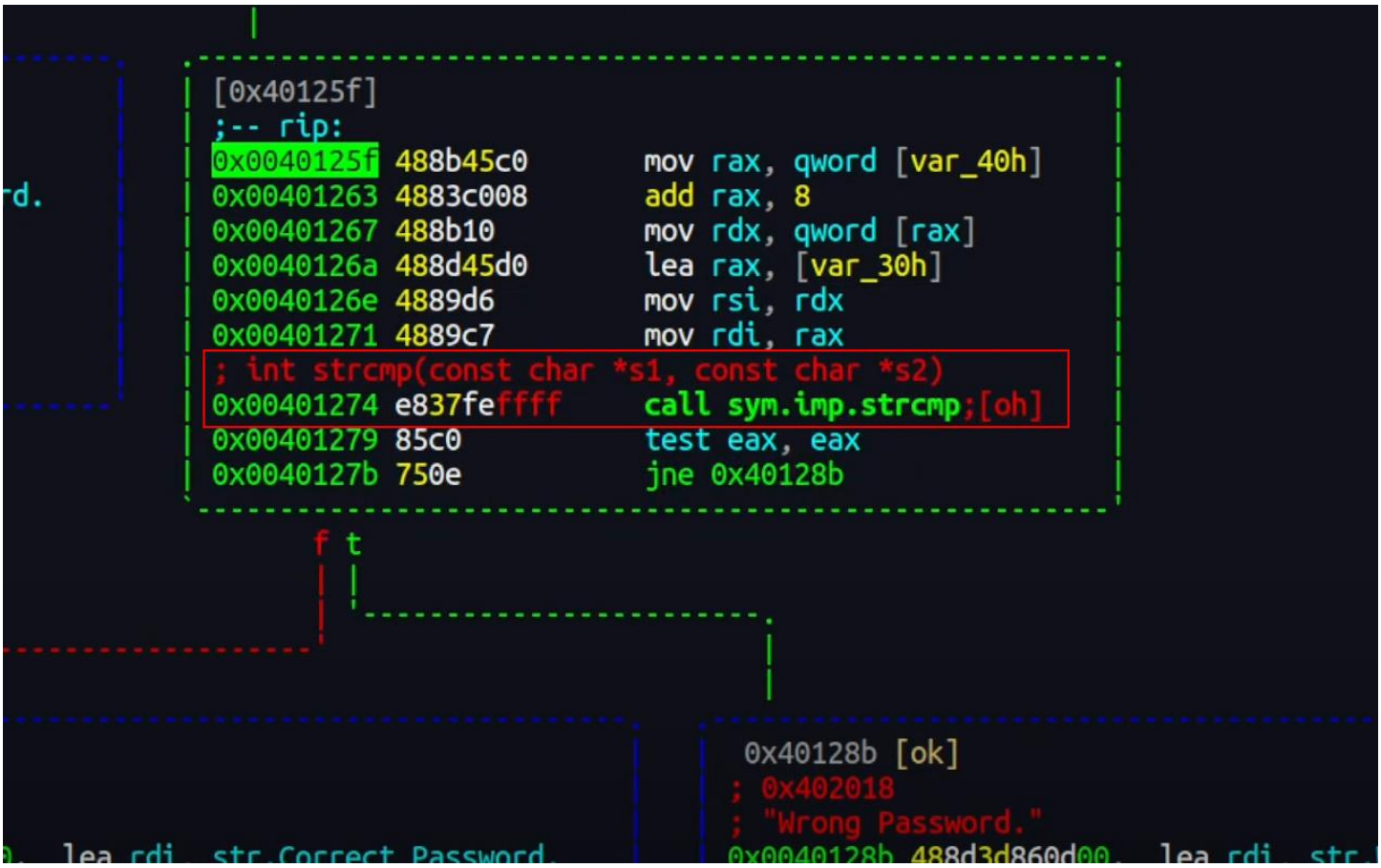
```
|           0x004012b4      5b              pop rbx
|           0x004012b5      5d              pop rbp
\           0x004012b6      c3              ret
:> db 0x00401244
:> dc
hit breakpoint at: 0x401244
:>
```

To ab hum dekhenge ki yha pr **rax and rbx** ki value equal ho gyi hai.





Ab hum yha aa chuke hai.

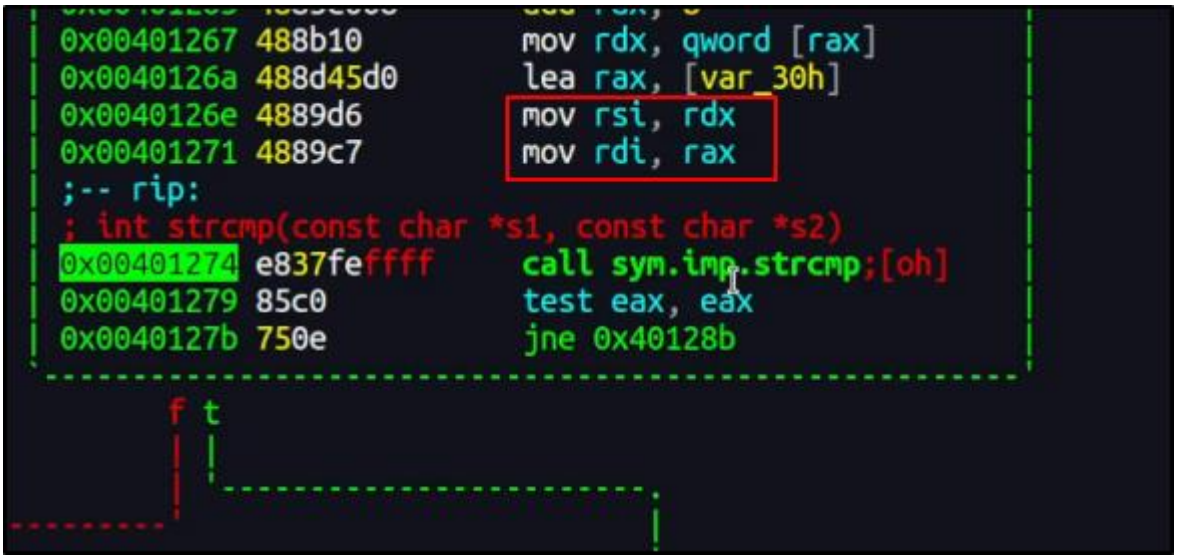


Yha pr **strcmp** string ko compare ke liye use hota hai.

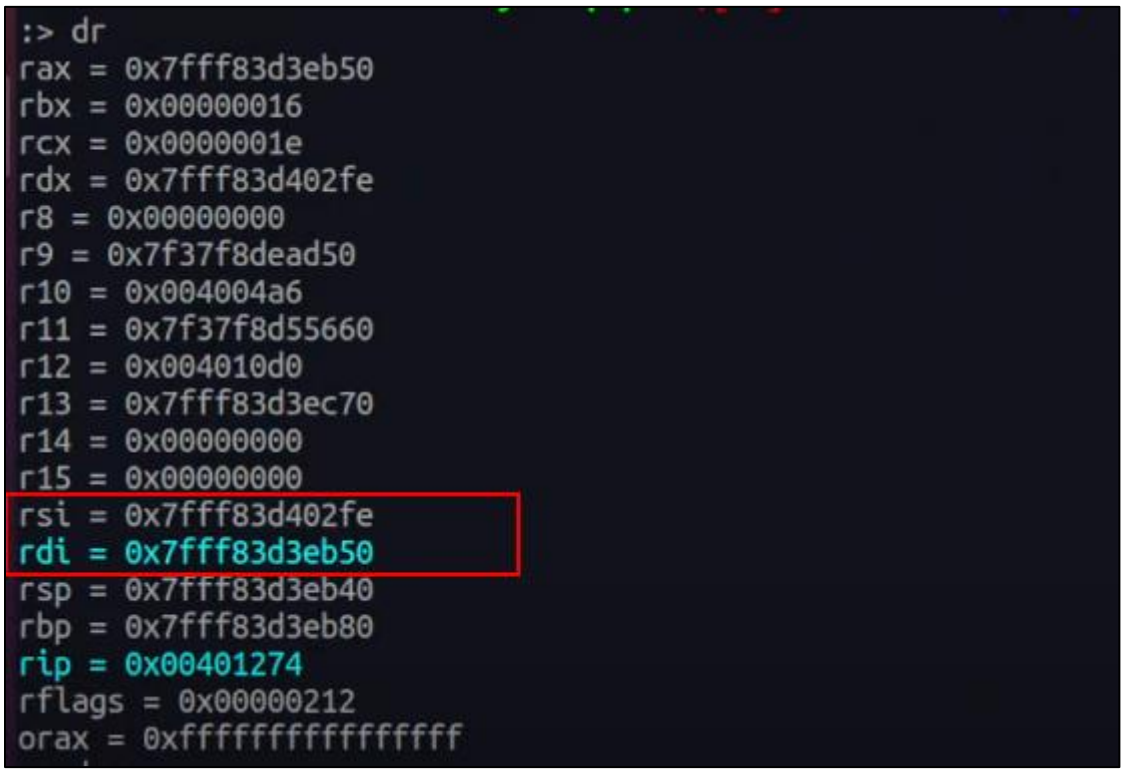
Strcmp take two arguments as pointer of string and compare with each other.

Yha pr ye **humare password** aur **original password** ko check krne ke liye use ho rha hoga. Ki equal hai ki nhi.

Jaisa ki hum upar dekh skte hai ki **original password** and **humare input ka password** dono **rsi and rax** registers me mov ho rhe hai.



Let's check registers values.



Here, we know pointer store values addresses then we use drr to show registers values in readable format.

```
:> drr
role reg     value           refstr
-----------------------------------
R0   rax     7fff83d3eb50    [stack] rax,rdi stack R W 0x535f726570753353 S3uper_S3cr3t_Pa33w0rd
     rbx     16              22 .comment rbx
A3   rcx     1e              30 .comment rcx
A2   rdx     7fff83d402fe    [stack] rdx,rsi stack R W 0x3837363534333231 123456789012345678 90
A4   r8      0               0
A5   r9      7f37f8dead50    /usr/lib/x86_64-linux-gnu/ld-2.31.so r9 library R X 'endbr64' 'ld-2.31
     r10     4004a6          4195494 /home/hellsender/yt/rev/crackme1 .dynstr r10 program R 0x73006
en
```

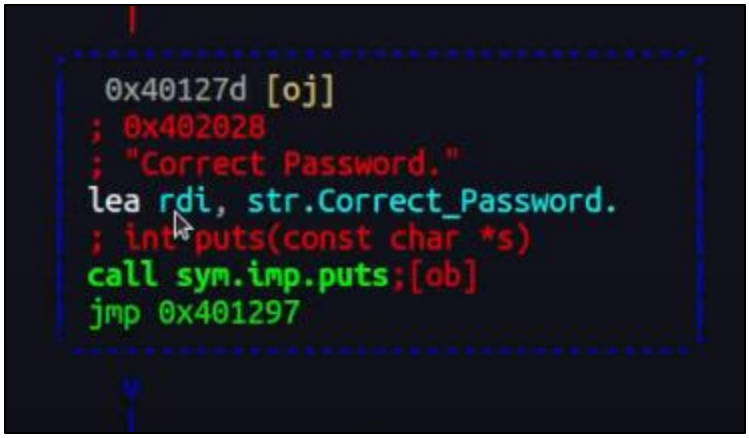
```
A3   rcx     1e              30 .comment rcx
A2   rdx     7fff83d402fe    [stack] rdx,rsi stack R W 0x3837363534333231 123456789012345678 90
A4   r8      0               0
A5   r9      7f37f8dead50    /usr/lib/x86_64-linux-gnu/ld-2.31.so r9 library R X 'endbr64' 'ld-2.31.so'
     r10     4004a6          4195494 /home/hellsender/yt/rev/crackme1 .dynstr r10 program R 0x73006e656c
en
     r11     7f37f8d55660    /usr/lib/x86_64-linux-gnu/libc-2.31.so r11 library R X 'endbr64' 'libc-2.31
     r12     4010d0          4198608 /home/hellsender/yt/rev/crackme1 .text entry0,section..text,.text,_
ntry0 program R X 'endbr64' 'crackme1'
     r13     7fff83d3ec70    [stack] r13 stack R W 0x2
     r14     0               0
     r15     0               0
A1   rsi     7fff83d402fe    [stack] rdx,rsi stack R W 0x3837363534333231 1234567890123456789012
A0   rdi     7fff83d3eb50    [stack] rax,rdi stack R W 0x535f726570753353 S3uper_S3cr3t_Pa33w0rd
SP   rsp     7fff83d3eb40    [stack] rsp stack R W 0x7fff83d3ec78
BP   rbp     7fff83d3eb80    [stack] rbp stack R W 0x0
```

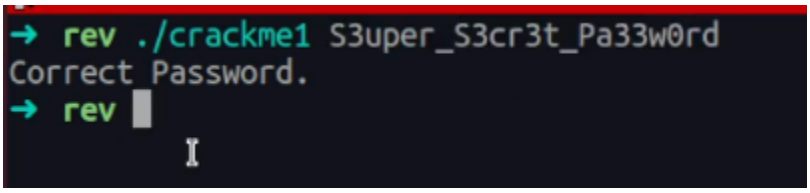
```
0x00401267 488b10          mov rdx, qword [rax]
0x0040126a 488d45d0        lea rax, [var_30h]
0x0040126e 4889d6          mov rsi, rdx
0x00401271 4889c7          mov rdi, rax
;-- rip:
; int strcmp(const char *s1, const char *s2)
0x00401274 e837feffff      call sym.imp.strcmp;[oh]
0x00401279 85c0            test eax, eax
0x0040127b 750e            jne 0x40128b
f t
```

Sym.imp.strcmp return **zero** if both strings are equal.

And test sirf **eax** ki value check karega zero or not.

Ab hum correct password find kr liya hai.





Command	Description
r2 -d crackme1	
aaa	
afl	
db main	
dc	
pdf	
V	
VV	

##

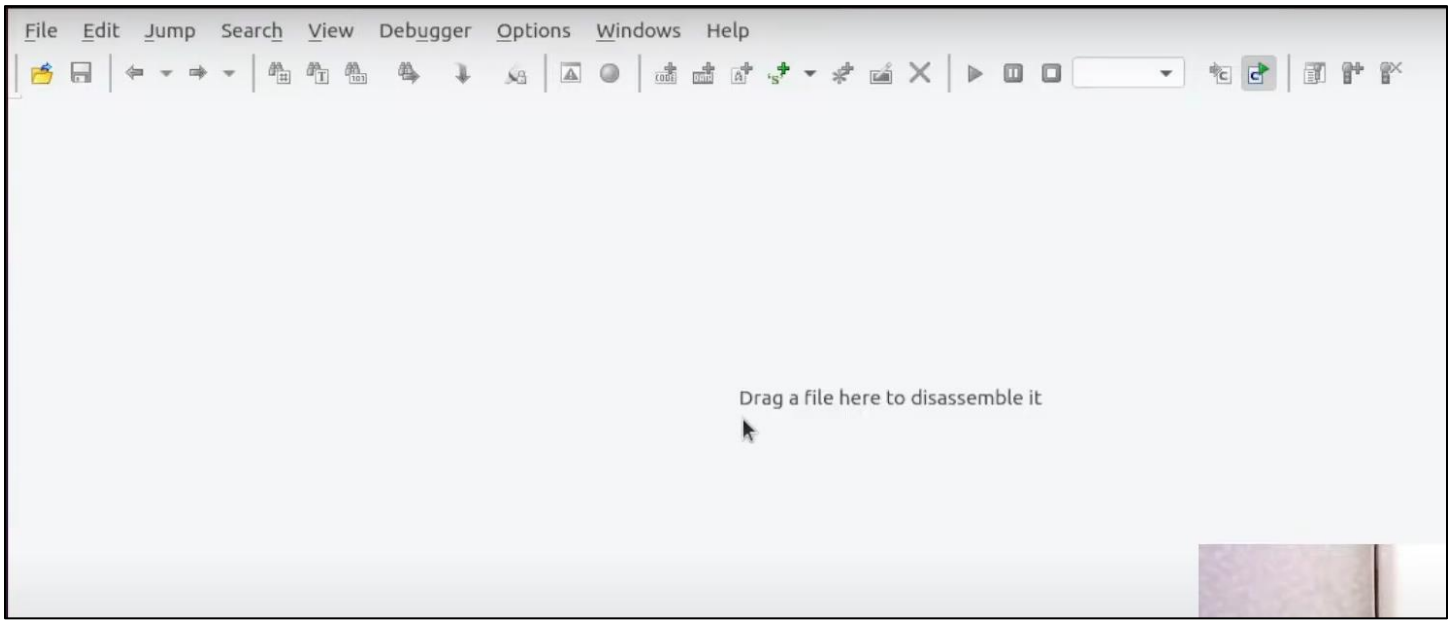
Challenge 3 - Find the correct password of crackme2

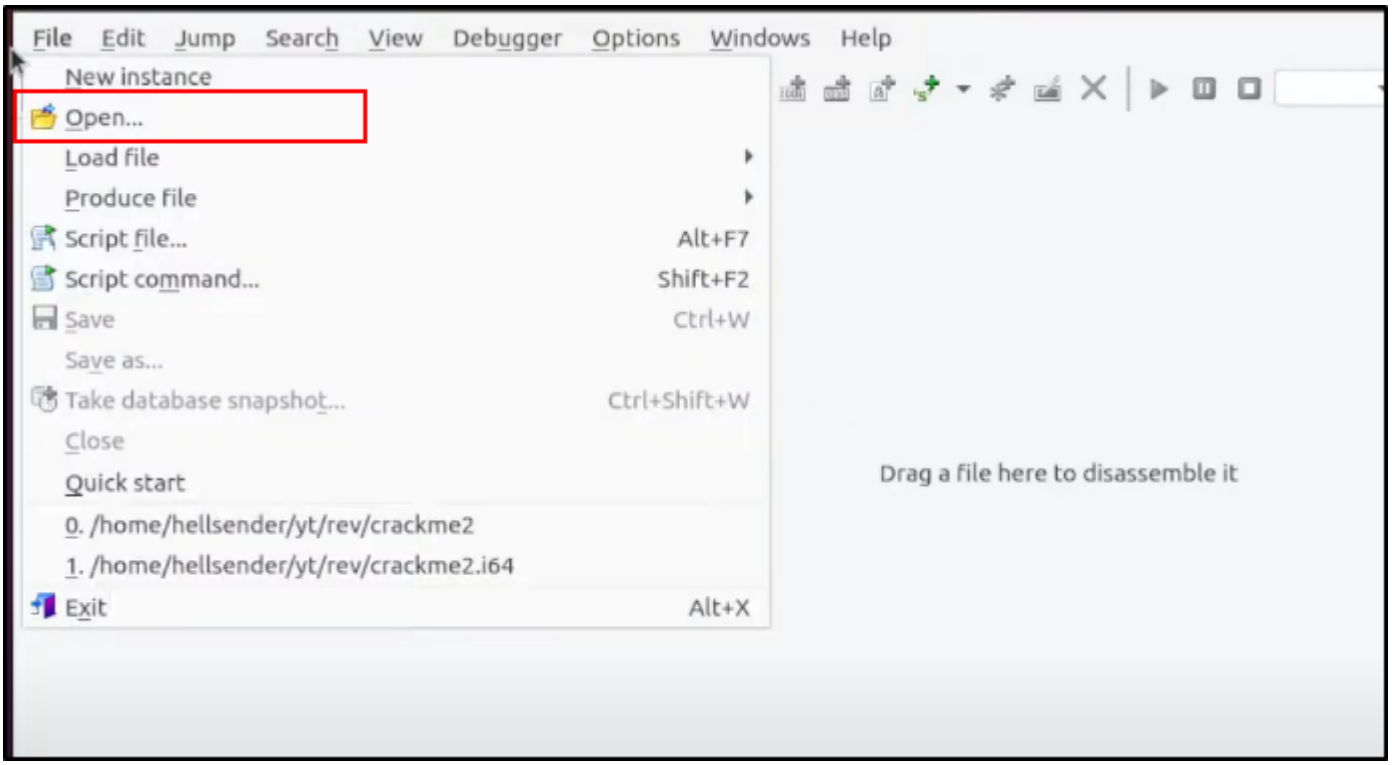
```
→ rev ./crackme2
Enter Password.
12345
Wrong Password.
→ rev
```

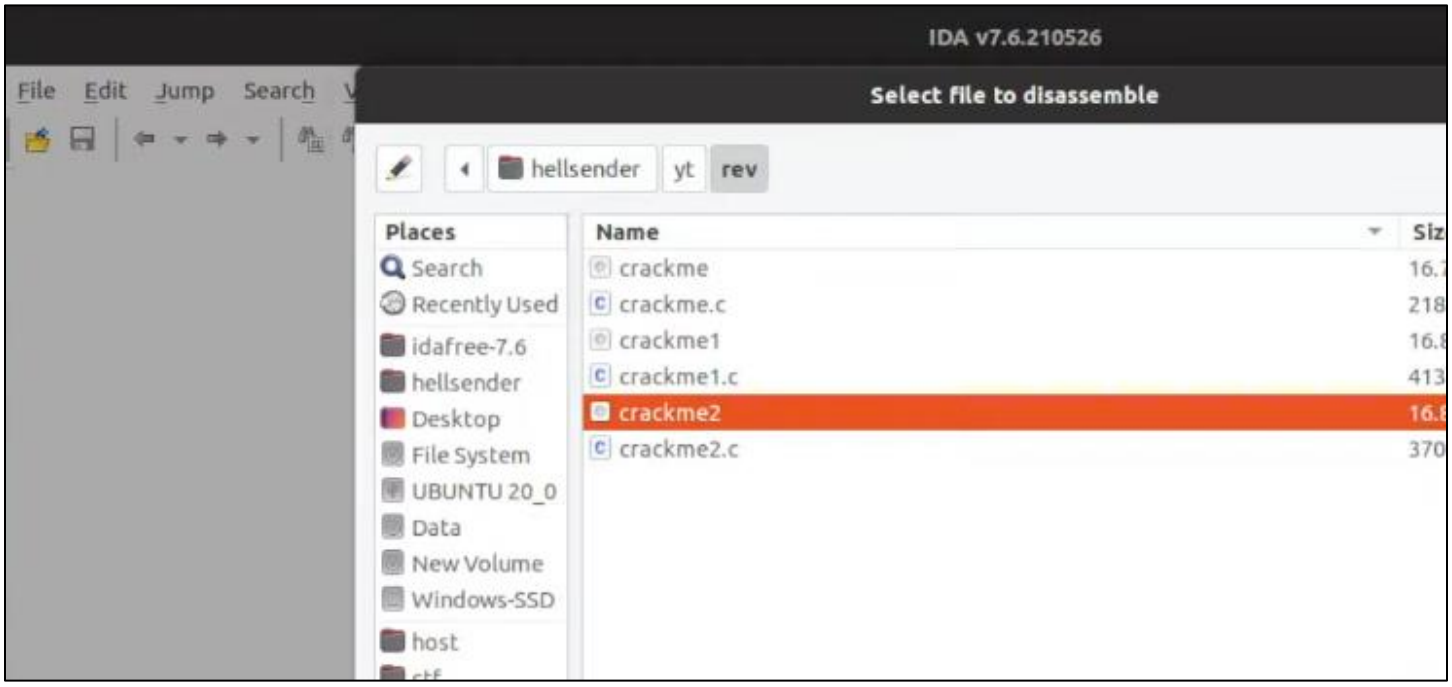
Here, we will use **IDA debugger**.

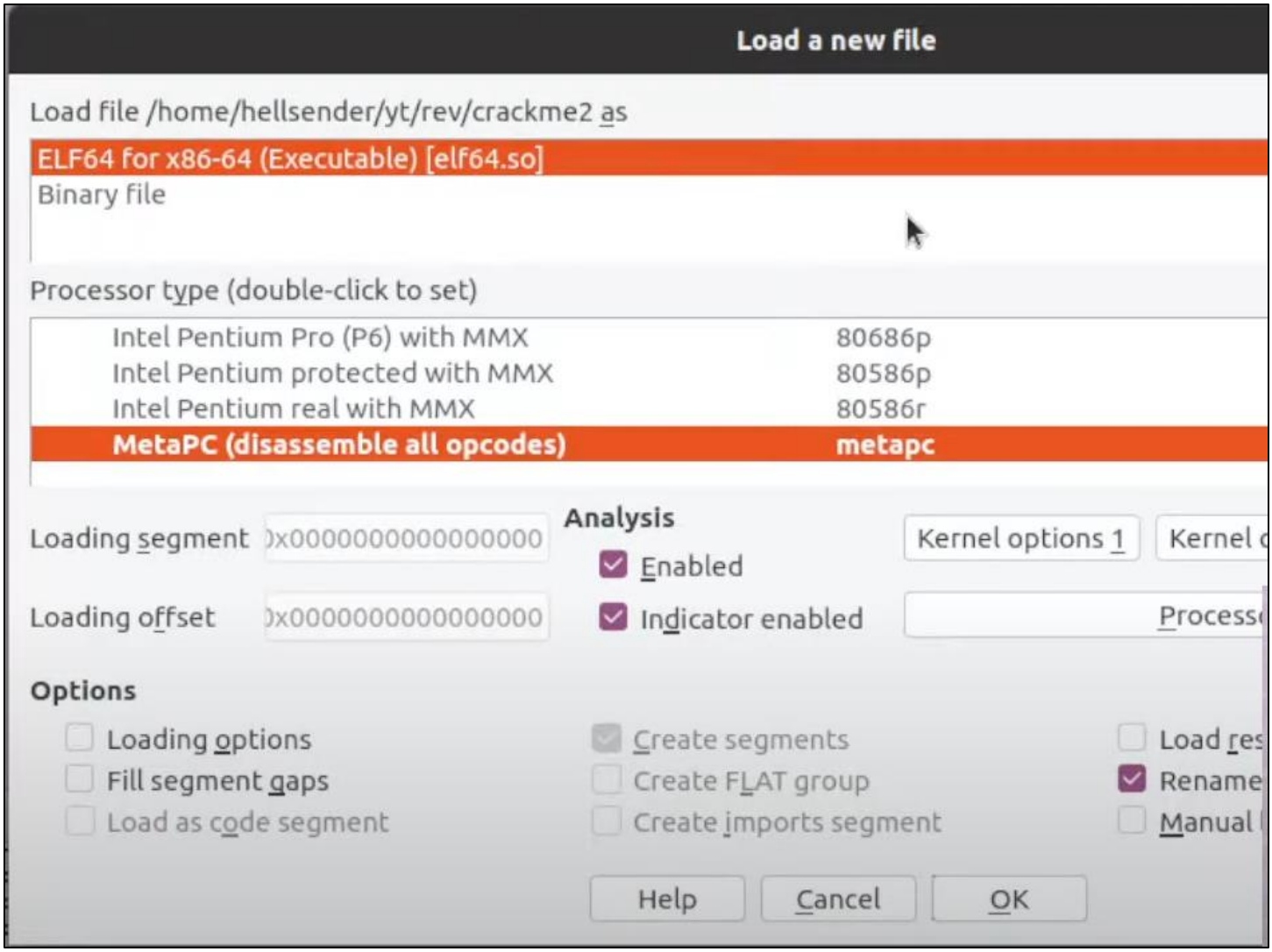
The **IDA Debugger** is a dynamic analysis tool integrated with **IDA Pro**, widely used for **reverse engineering**. It supports **local and remote debugging** across multiple platforms and architectures. By combining **static and dynamic analysis**, it allows users to execute binaries, set breakpoints, inspect memory, analyze control flow, and debug effectively.

So, download and install IDA.

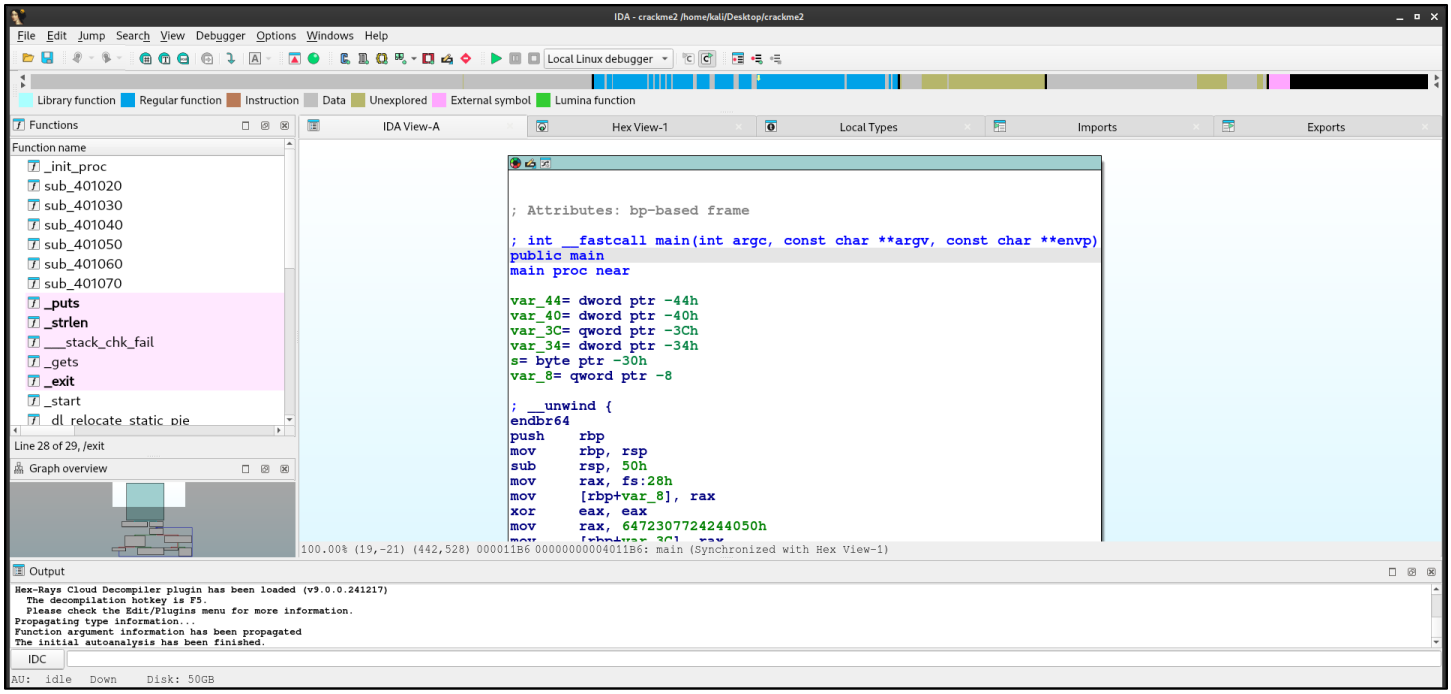


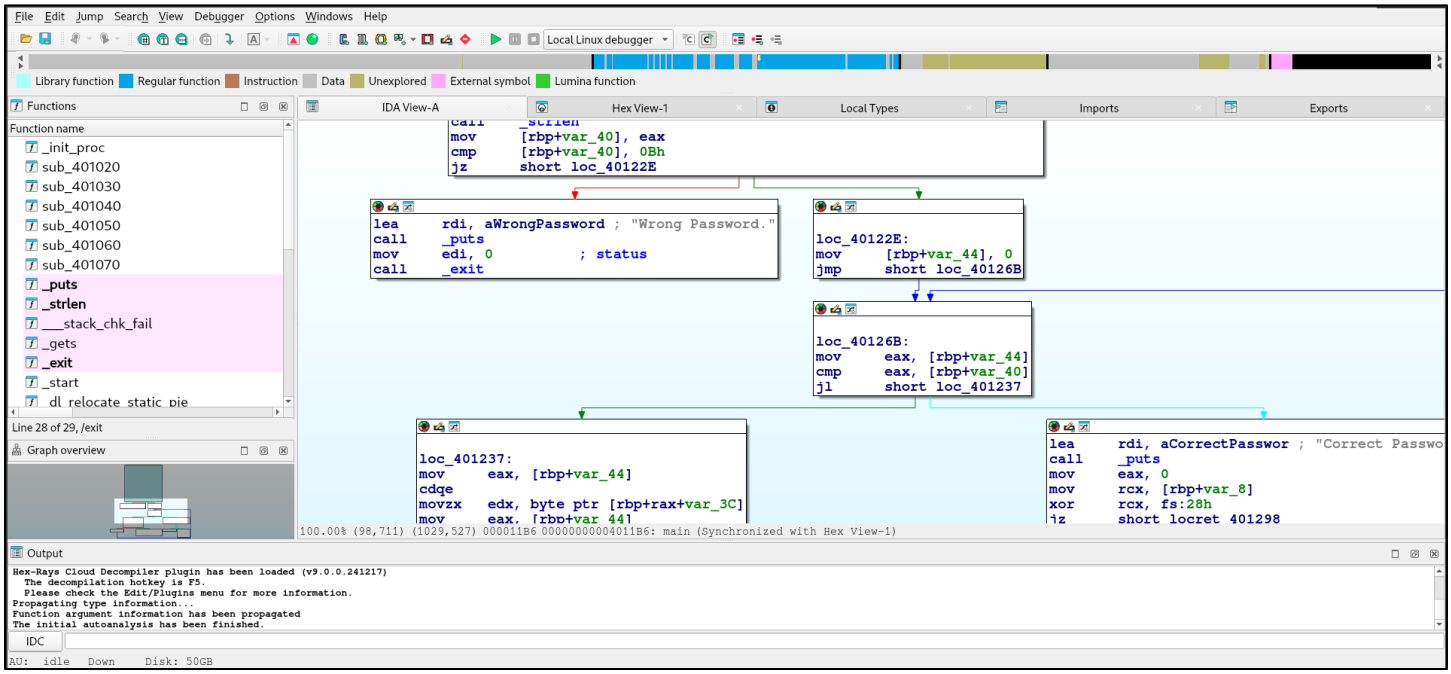

File Edit Jump Search View Debugger Options Windows Help
New instance
Open...
Load file
Produce file
Script file... Alt+F7
Script command... Shift+F2
Save Ctrl+W
Save as...
Take database snapshot... Ctrl+Shift+W
Close
Quick start
0. /home/hellsender/yt/rev/crackme2
1. /home/hellsender/yt/rev/crackme2.i64
Exit Alt+X
Drag a file here to disassemble it


IDA v7.6.210526
File Edit Jump Search
Select file to disassemble
hellsender
yt
rev
Places
Search
Recently Used
idafree-7.6
hellsender
Desktop
File System
UBUNTU 20_0
Data
New Volume
Windows-SSD
host
Name
crackme
crackme.c
crackme1
crackme1.c
crackme2
crackme2.c

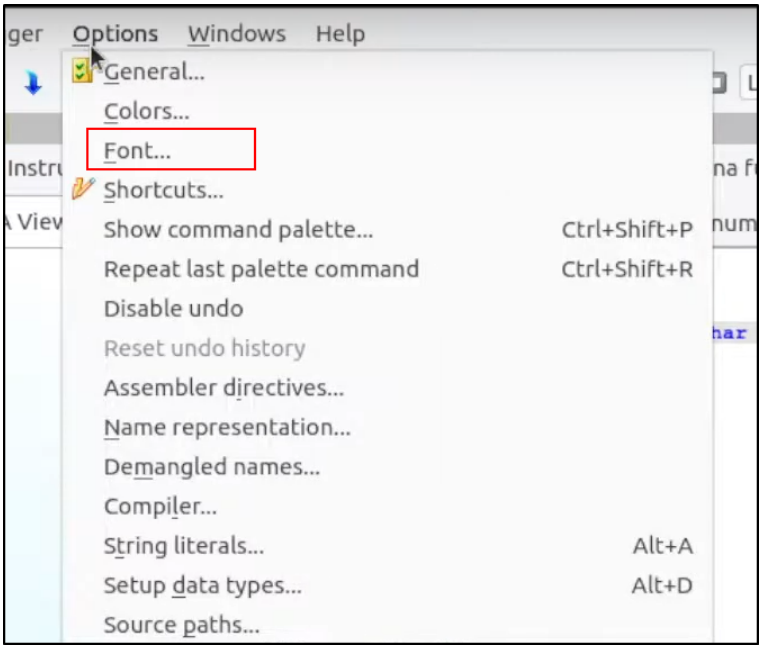

Load a new file
Load file /home/hellsender/yt/rev/crackme2 as
ELF64 for x86-64 (Executable) [elf64.so]
Binary file
Processor type (double-click to set)
Intel Pentium Pro (P6) with MMX 80686p
Intel Pentium protected with MMX 80586p
Intel Pentium real with MMX 80586r
MetaPC (disassemble all opcodes) metapc
Loading segment
Loading offset
Analysis
Enabled
Indicator enabled
Kernel options 1
Options
Loading options
Fill segment gaps
Load as code segment
Create segments
Create FLAT group
Create imports segment
Rename
Help
Cancel
OK

Click on ok.



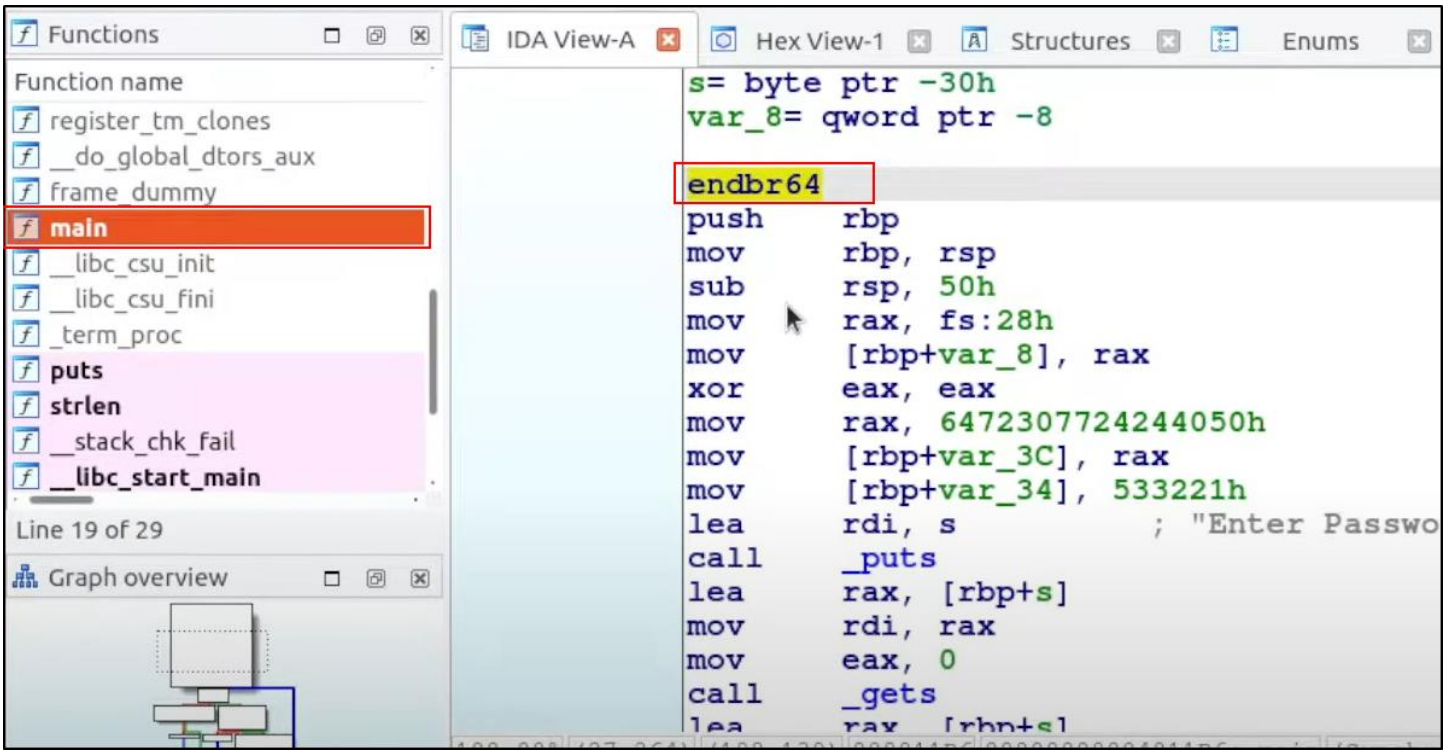


Make font big.



Yha pr abhi ye disassembler ka kam kr rha hai.

Disassembling means convert **machine code** in **assembly code**.



Here, it is showing all function of your program. As we know in high level programming language program is executed from **main** function.

Agar hum kisi bhi function pr double click karenge to ye us function ke portion ko highlight kr dega.

```
→ rev ./crackme2
Enter Password.
12345
Wrong Password.
→ rev
```

Jaisa ki humne program ko run krke dekh liya tha.

```
endbr64
push    rbp
mov     rbp, rsp
sub     rsp, 50h
mov     rax, fs:28h
mov     [rbp+var_8], rax
xor     eax, eax
mov     rax, 6472307724244050h
mov     [rbp+var_3C], rax
mov     [rbp+var_34], 533221h
lea     rdi, s          ; "Enter Password"
call    _puts
lea     rax, [rbp+s]
mov     rdi, rax
mov     eax, 0
call    _gets
lea     rax, [rbp+s]
mov     rdi, rax        ; s
call    _strlen
mov     [rbp+var_40], eax
cmp     [rbp+var_40], 0Bh
jz      short loc_40122E
```

Yha pr lea instruction ek string (s) "enter passsword" ko **rdi** me mov kr rha hai. puts ko call kr rha hai write (print) krne ke liye.

```
lea     rax, [rbp+s]
```

Yha lea instruction use ho rha hai rbp+s ke address ko rax me mov kr rha hai. jaisa ki jante hai mov me [] lagaye to iska mtlb value ko mov kr hai lekin lea me iska biprit hota hai. [] laga ho to address ko mov kr rha hai.

```
lea     rax, [rbp+s]
mov     rdi, rax
mov     eax, 0
call    _gets
```

Yha **_gets** use ho rha hai iska mtlb input liya ja rha hai user se. to **_gets** input leke **[rbp+s]** me store kr dega.

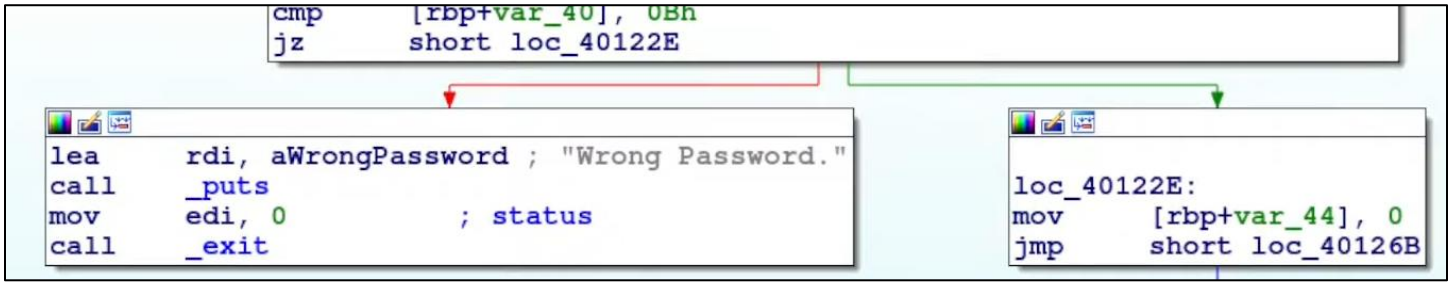
```
lea     rax, [rbp+s]
mov     rdi, rax        ; s
call    _strlen
```

Yha **_strlen** ko call ho rha hai **_strlen** kya krta hai. jo bhi value rdi me hoti hai uska length calculate krke **rax** me reterun krta hai.

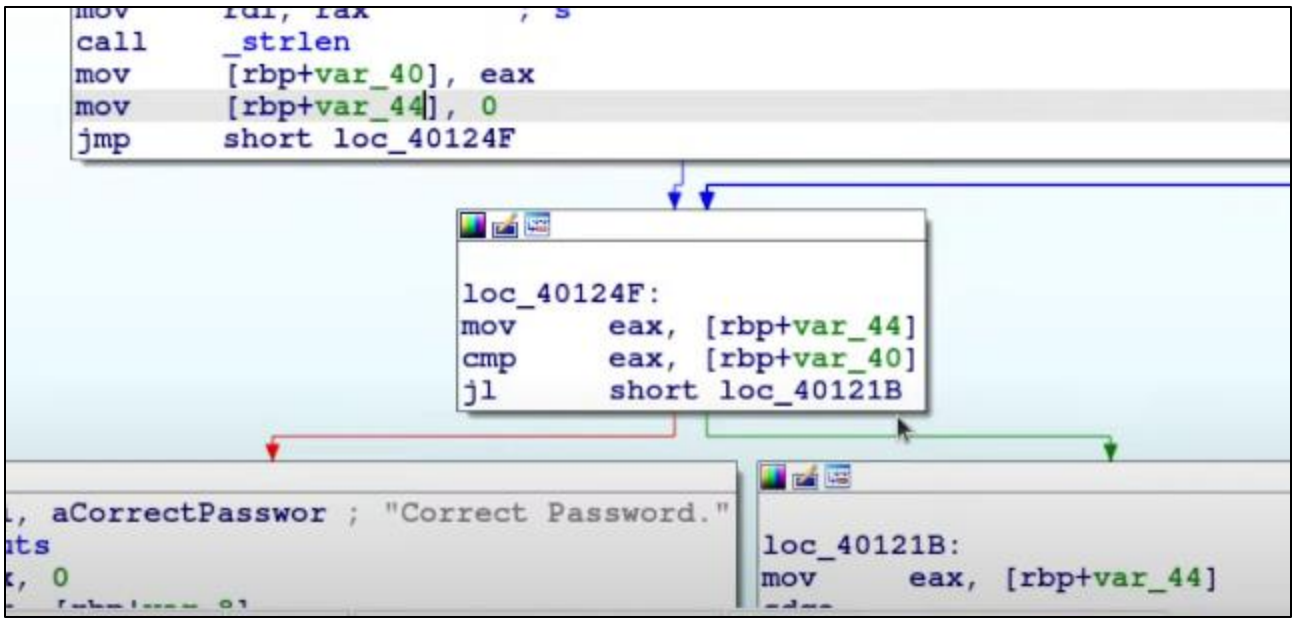
```
mov     [rbp+var_40], eax
cmp     [rbp+var_40], 0Bh
jz      short loc_40122E
```

Yha pr **var_40** me user ke input ka length hai wo ja rha hai. uar hex ke 0B se compare ho rha hai. 0B ka value **11** means **11** se compare ki ja rhi hai.

(Jz means jump if zero / jump if equal) means agar equal hai to aage execute karo otherwise print kr do wrong password.



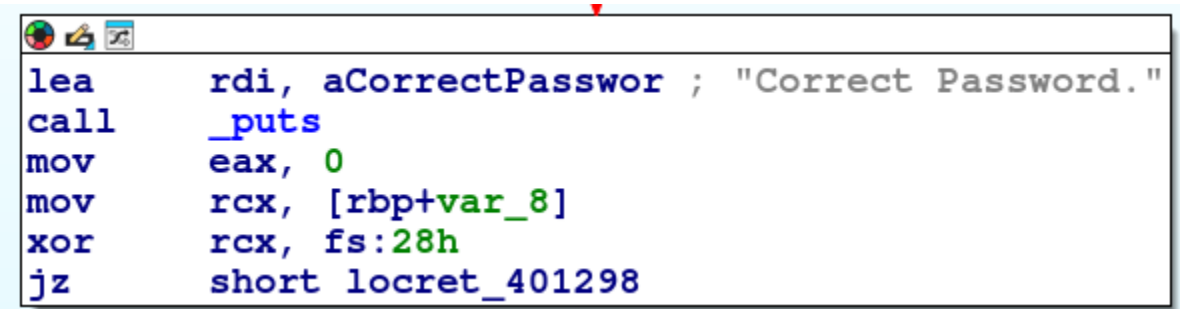
==========



Yha variable **var_44** me **0** ko dala tha. Aur **var_44** ko mov krta hai **eax** ke andar.

Ab ye **cmp** kr rha humare variable ke length **var_40** aur **eax** ko jisme **var_44** mov kiya gya aur usme **0** store hai.

Uske bad hai **jl** means **var_40** less than hai **eax** ke value se to correct password print kr do otherwise location **loc_40121B** pr jump kr jao.

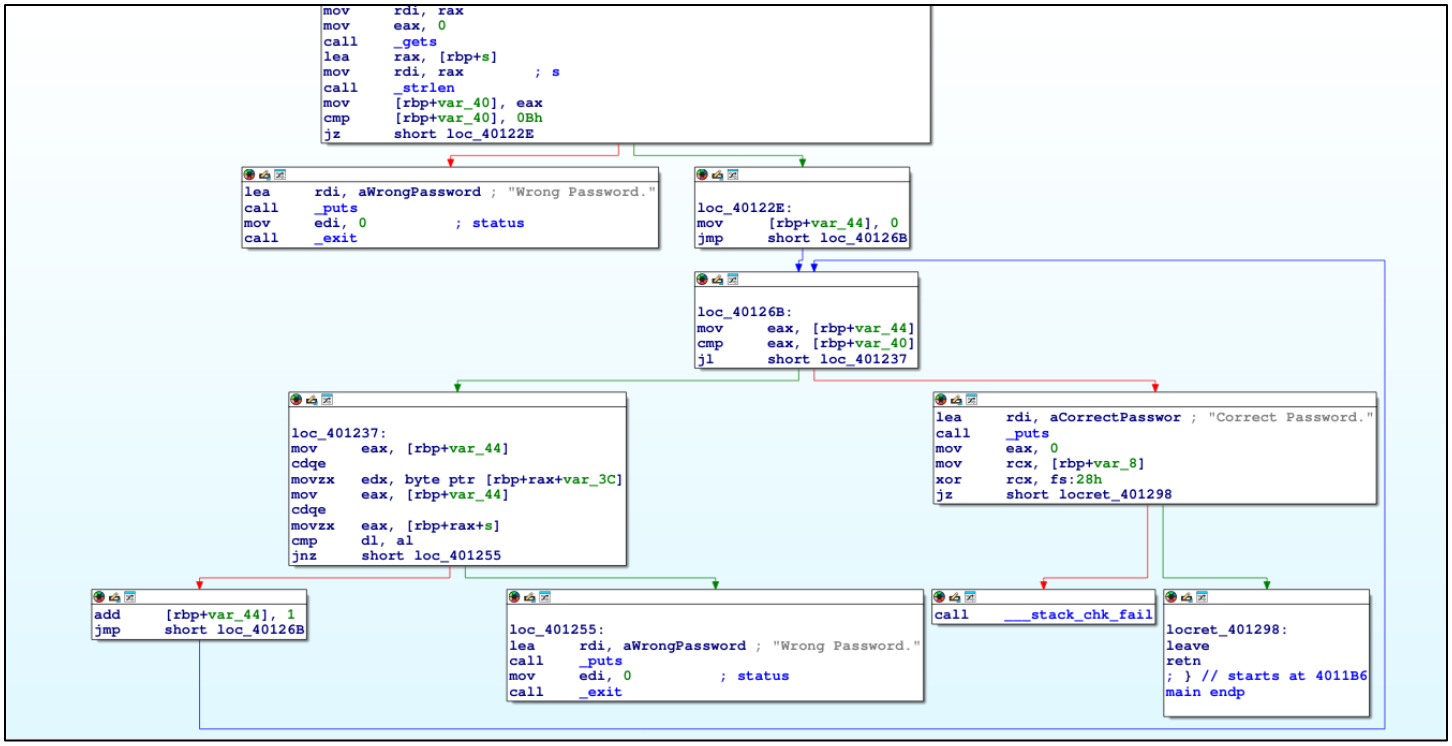


To yha pr humare input ki length kabhi minus me nhi ho sakti. Agar minus me hoti to ye correct password print kr deta.

To ye ab given location pr aa jayega.

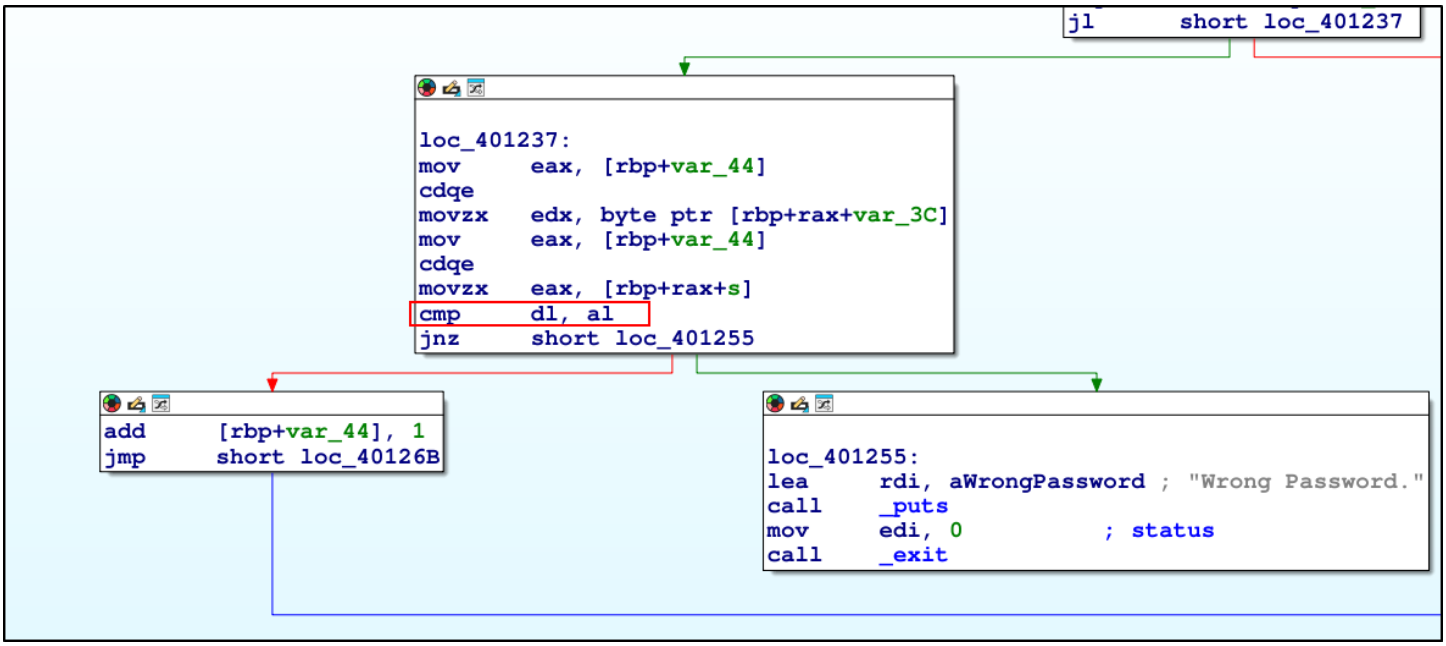
```
loc_40121B:
mov     eax, [rbp+var_44]
cdqe
movzx   edx, byte ptr [rbp+rax+var_3C]
mov     eax, [rbp+var_44]
cdqe
movzx   eax, [rbp+rax+s]
cmp     dl, al
jnz     short loc_401239
```

==========



==========

Jaisa ki hum upar dekh skte hai ki ek loop chal rha hai aur condition ko check kr rha hai.



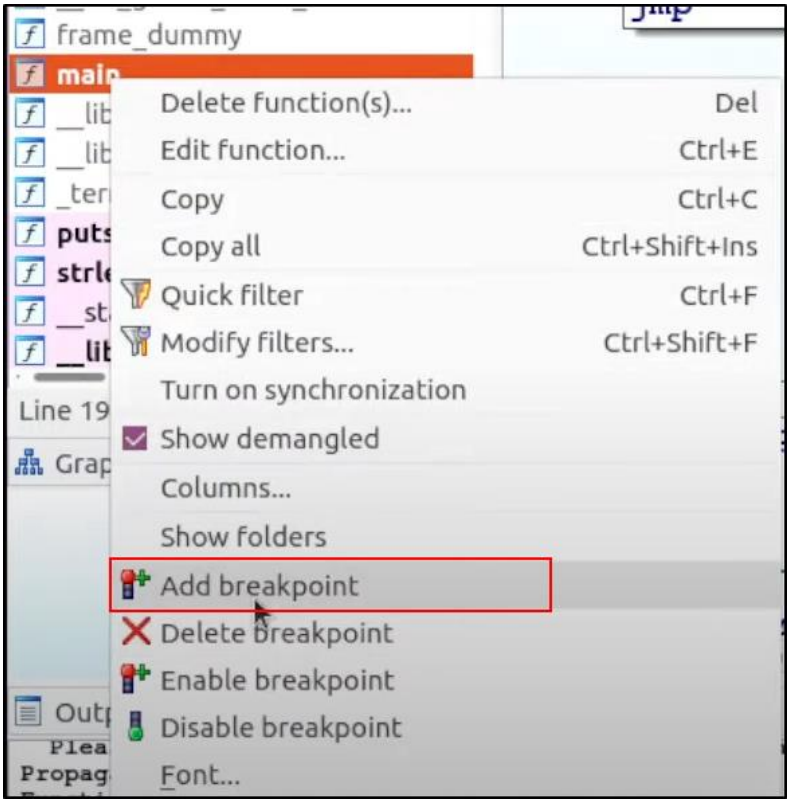
Yha **dl** aur **al** compare ho rha hai. it is very lower part of **rdx** and **rax**.

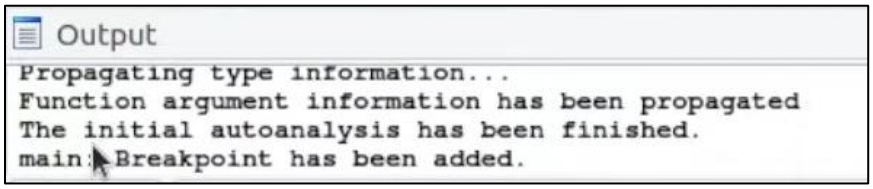
Agar dono equal nhi hue to ye **loc_401255** pr jayega aur **_exit** ko call kr dega.

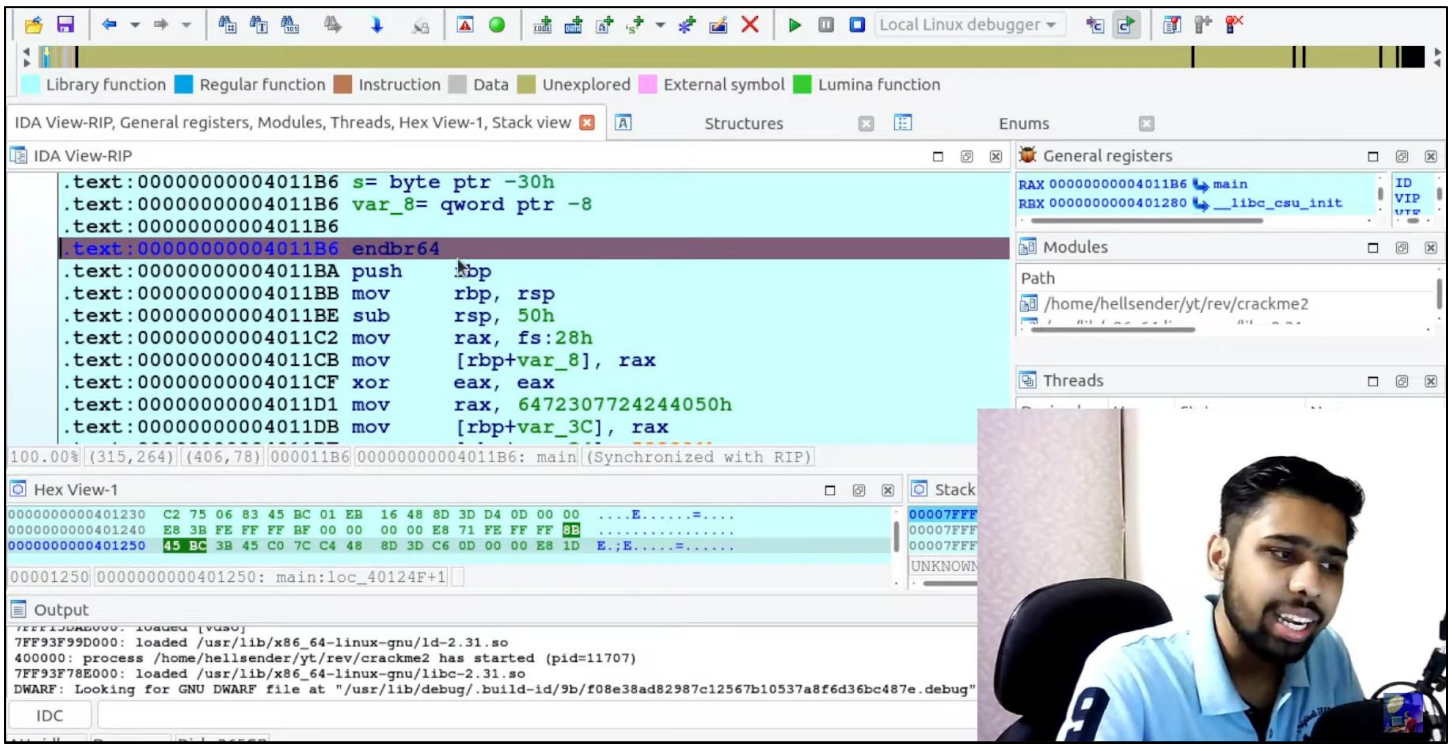
Agar dono equal hue to ye **var_44** me **1** add karega aur loop fir se aayega.

Ab hum debugger ki help se dekhenge ki al aur dl ke andar value kya hai. tabhi hum samjh payenge.

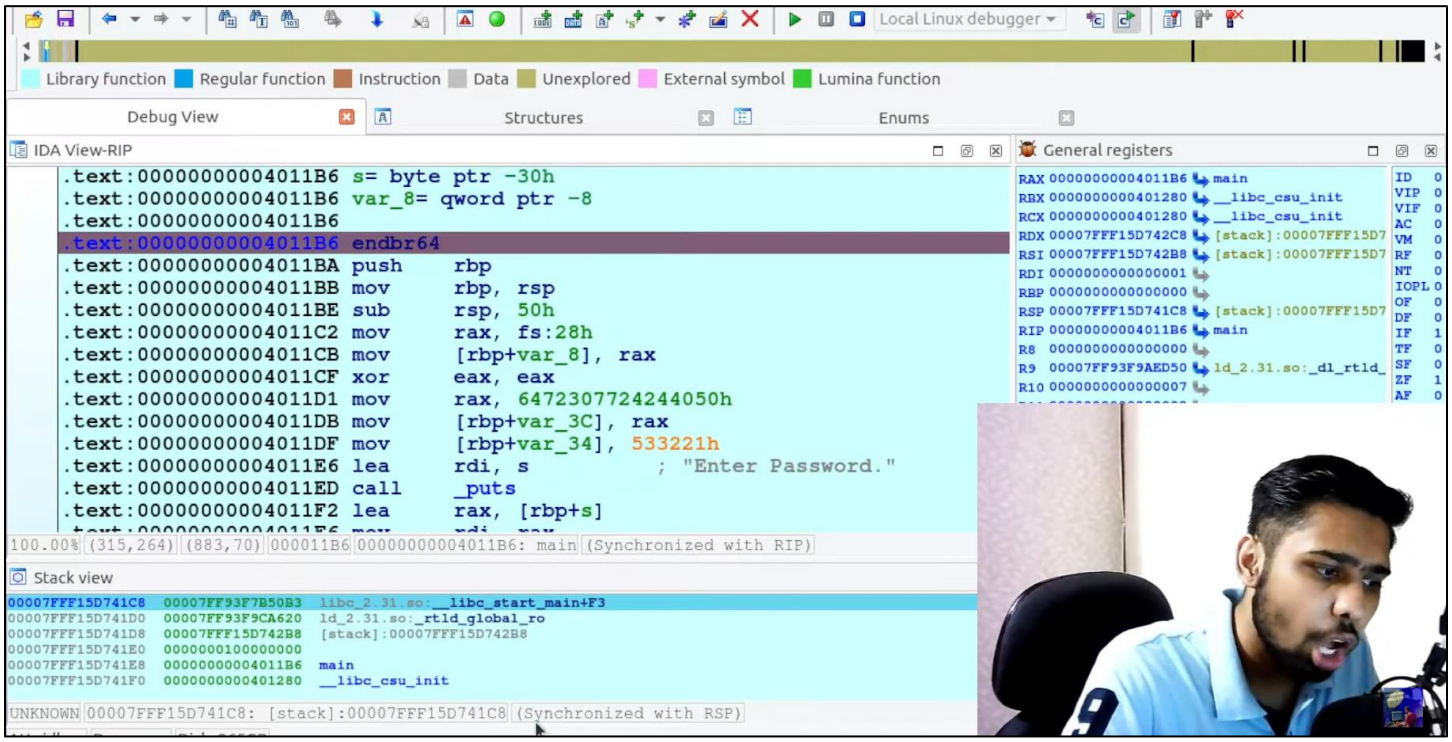
Go to main function and put a breakpoint. Right click on main function. And click on breakpoint.

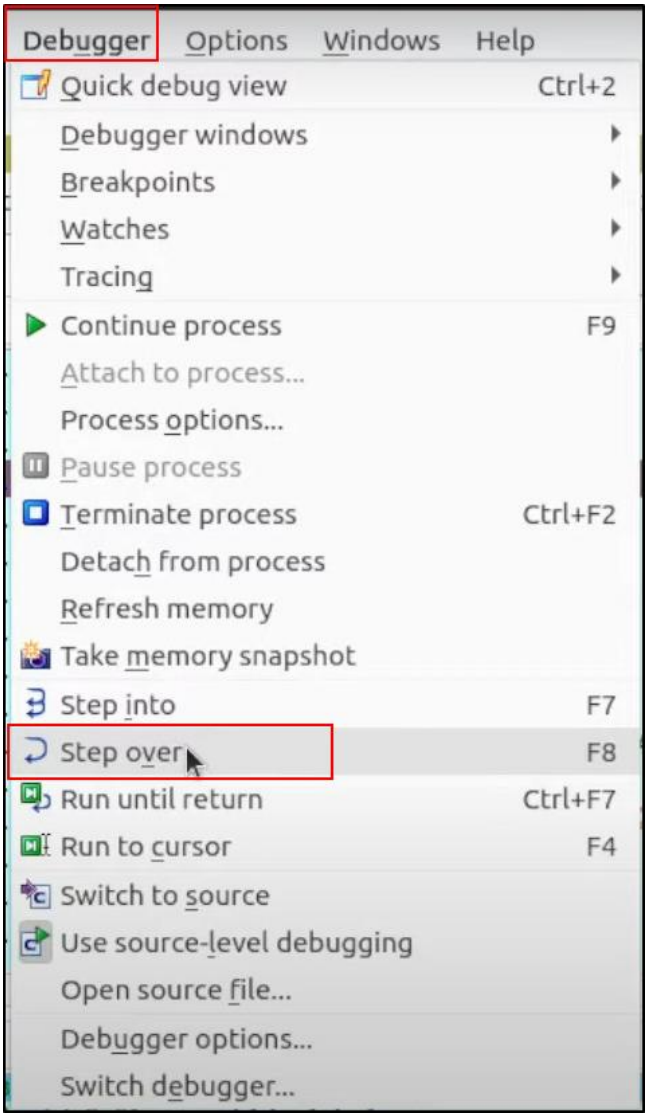

frame_dummy
main
Delete function(s)... Del
Edit function... Ctrl+E
Copy Ctrl+C
Copy all Ctrl+Shift+Ins
Quick filter Ctrl+F
Modify filters... Ctrl+Shift+F
Turn on synchronization
Show demangled
Columns...
Show folders
Add breakpoint
Delete breakpoint
Enable breakpoint
Disable breakpoint
Font...


Output
Propagating type information...
Function argument information has been propagated
The initial autoanalysis has been finished.
main: Breakpoint has been added.

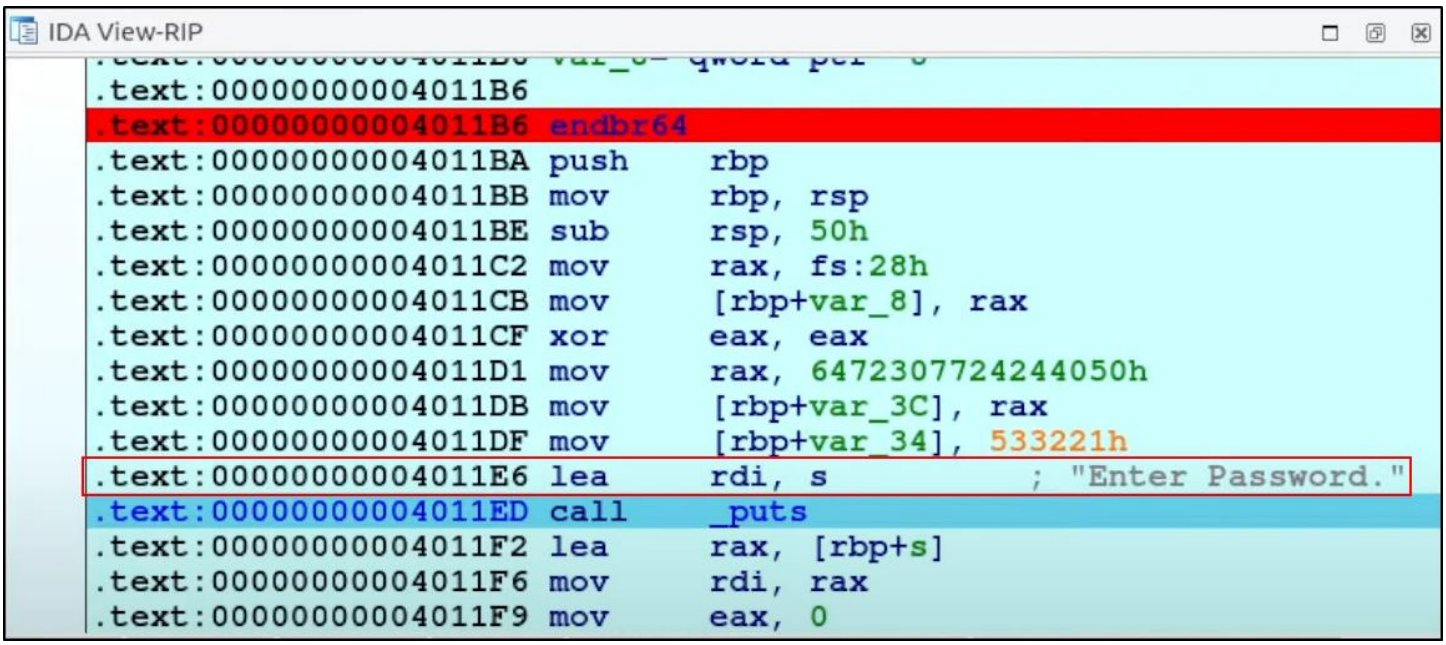

Local Linux debugger
Library function
Regular function
Instruction
Data
Unexplored
External symbol
Lumina function
IDA View-RIP, General registers, Modules, Threads, Hex View-1, Stack view
Structures
Enums
IDA View-RIP
.text:00000000004011B6 s= byte ptr -30h
.text:00000000004011B6 var_8= qword ptr -8
.text:00000000004011B6
.text:00000000004011B6 endbr64
.text:00000000004011BA push rbp
.text:00000000004011BB mov rbp, rsp
.text:00000000004011BE sub rsp, 50h
.text:00000000004011C2 mov rax, fs:28h
.text:00000000004011CB mov [rbp+var_8], rax
.text:00000000004011CF xor eax, eax
.text:00000000004011D1 mov rax, 6472307724244050h
.text:00000000004011DB mov [rbp+var_3C], rax
General registers
RAX 00000000004011B6 main
RBX 0000000000401280 __libc_csu_init
Modules
Path
/home/hellsender/yt/rev/crackme2
Threads
Hex View-1
Stack
Output
7FF93F99D000: loaded /usr/lib/x86_64-linux-gnu/ld-2.31.so
400000: process /home/hellsender/yt/rev/crackme2 has started (pid=11707)
7FF93F78E000: loaded /usr/lib/x86_64-linux-gnu/libc-2.31.so
DWARF: Looking for GNU DWARF file at "/usr/lib/debug/.build-id/9b/f08e38ad82987c12567b10537a8f6d36bc487e.debug"
IDC

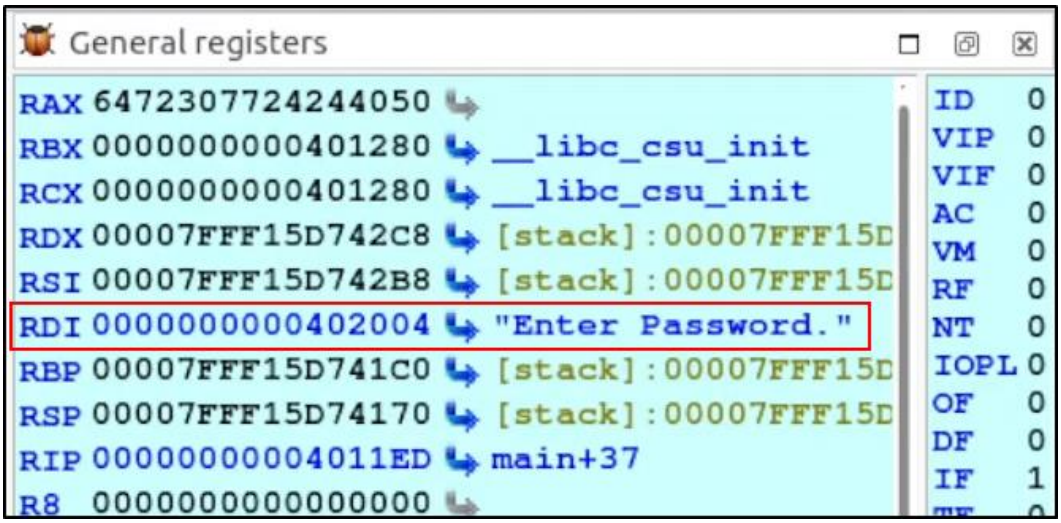
Yha pr bahut messy si screen dikh rhi hogi. To yha hum kuchh windows ko cut kr dete hai.



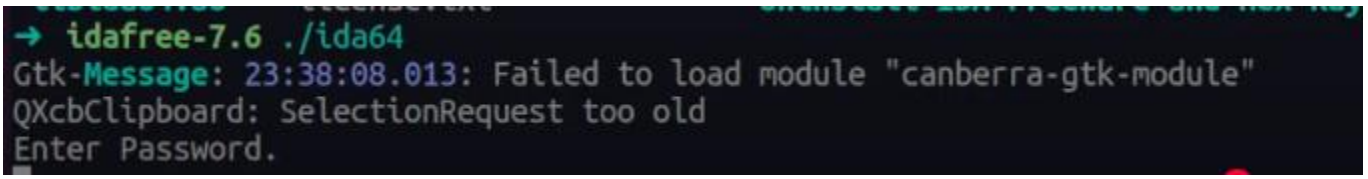


Here, we will press **f8** to step over. Means execute instruction step by step.

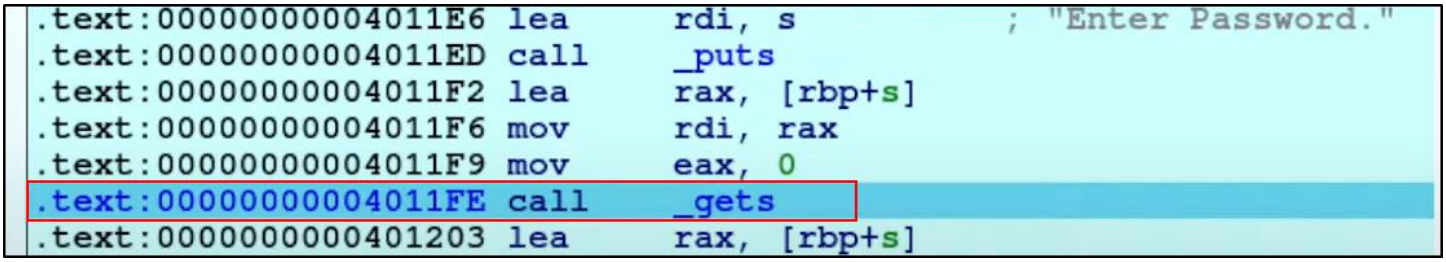




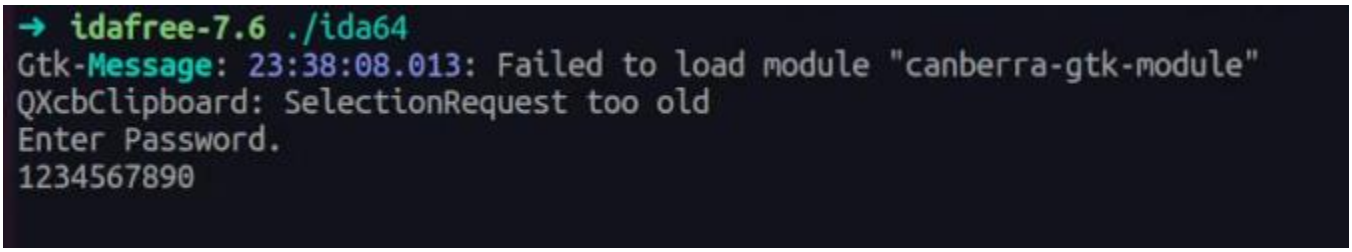
Agar hum terminal pr jakr dekhe to enter password print ho jayega.



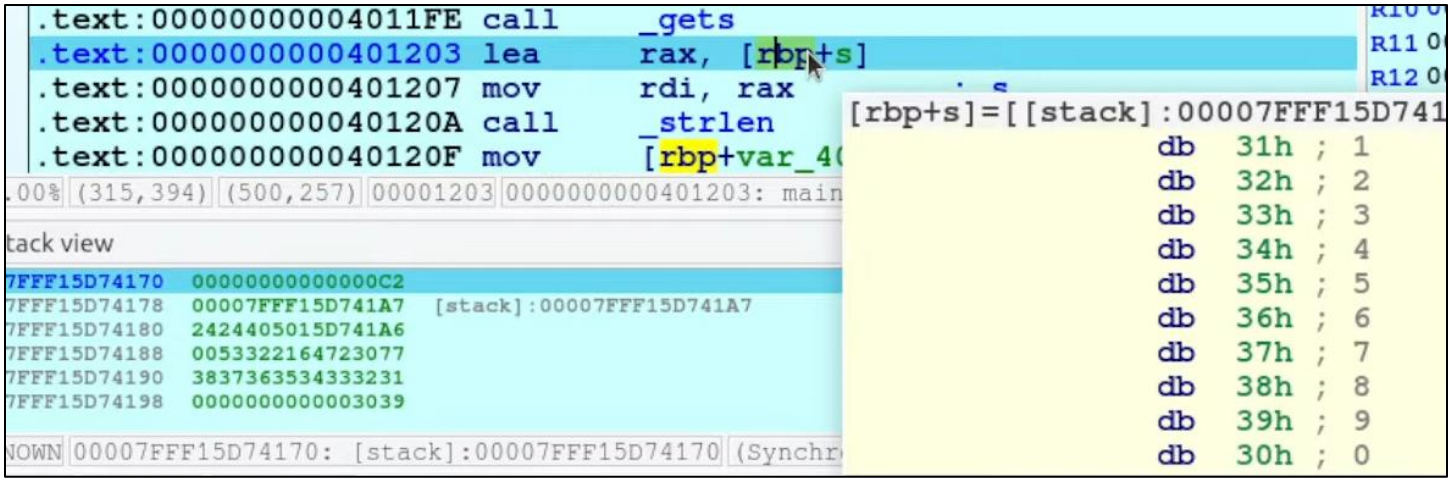
Ok, ab hum aage execute krte hai.



Yha ye input mang rha hai. jb tk input nhi denge ye aage nhi badega.



Yha pr hum input dal ke enter marte hai.



Yha pr hum phle hi assembly ko pd kr samjha tha ki humari values yha pr store hogi.

Jaisa ki hum dekh skte hai.

Ab ye value **rax** ke andar mov hoga.

```
.text:00000000004011FE call     _gets
.text:0000000000401203 lea      rax, [rbp+s]
.text:0000000000401207 mov      rdi, rax        ; s
.text:000000000040120A call     _strlen
.text:000000000040120F mov      [rbp+var_40], eax
.text:0000000000401212 mov      [rbp+var_44], 0
```

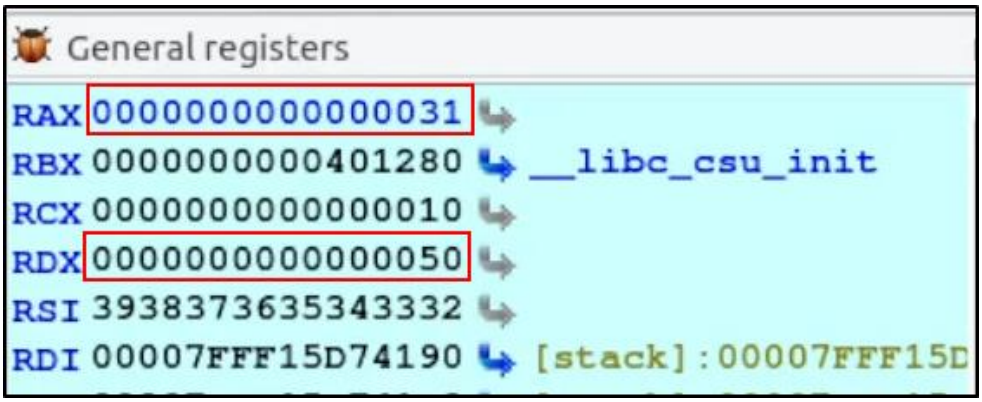
Ab **rbp+s** ki value **rax** me jayega fir **rax** ki value **rdi** me jayega.

Fir iska length nikal ke rax ke andar dal dega.

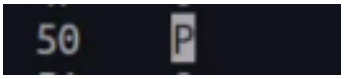
```
.text:0000000000401220 movzx    edx, byte ptr [rbp+rax+var_3C]
.text:0000000000401225 mov      eax, [rbp+var_44]
.text:0000000000401228 cdqe
.text:000000000040122A movzx    eax, [rbp+rax+s]
.text:000000000040122F cmp      dl, al
.text:0000000000401231 jnz      short loc_401239
```

Ab yha pr **dl aur al** compare ho rhe hai.

Inki values dekhte hai. **dl = rdx** and **al = rax**



man ascii

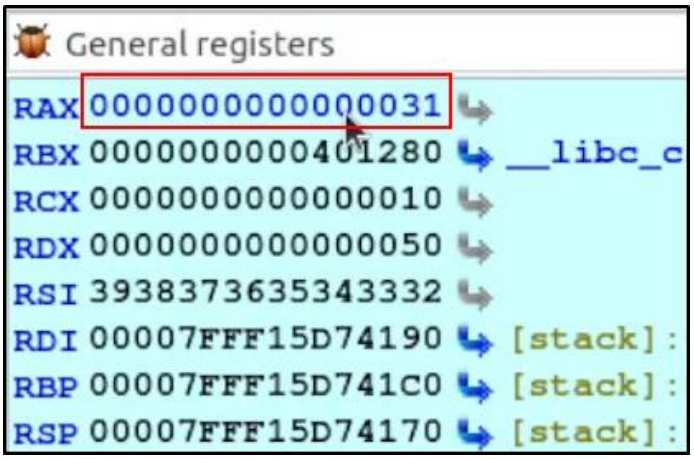


Yha pr ye one by one check kr rha hai ki jo user input ki phli value original password ke phli value se match kr rhi hai.

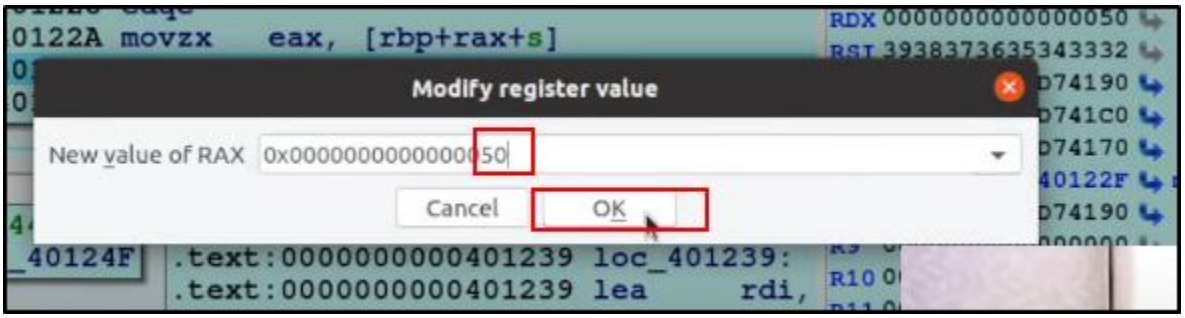
Agar match karegi to agli value ko check karega agar nhi match ki to wrong password print karke exit kr dega.

Yha pr hum inke hex value ko note krenge aur bad me ek password bna denge sbko mila kr.

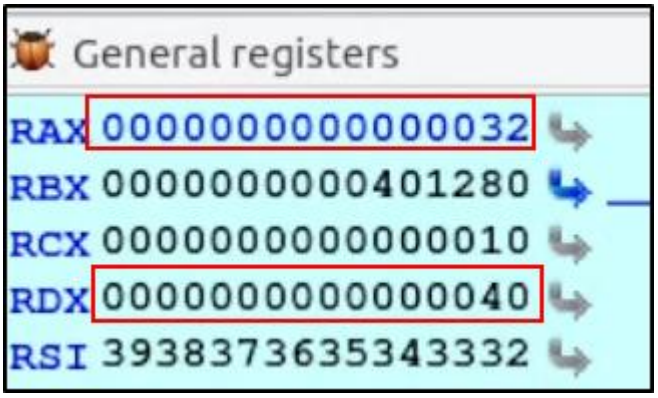
Ab hum al ke value pr double click karenge aur iski value change krke sahi value dal denge.



Aur hum iski value change krke **31** se **50** kr denge. Jo ki sahi password ki value hai.

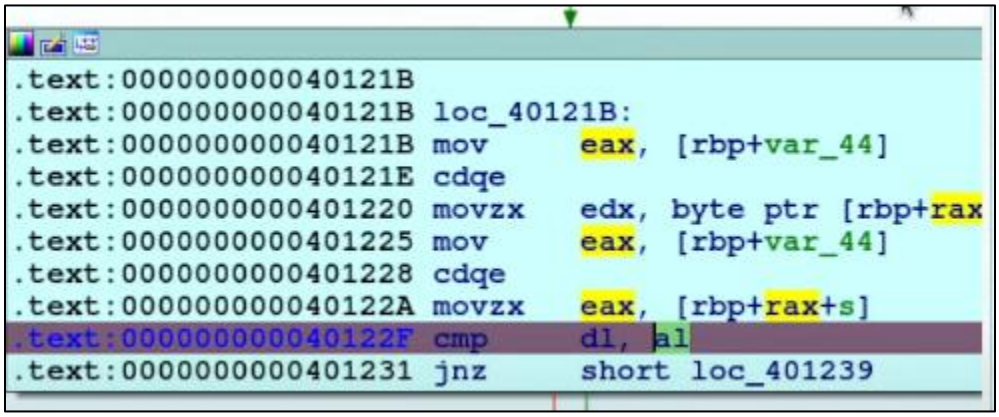


Badte hai new password value ke taraf.

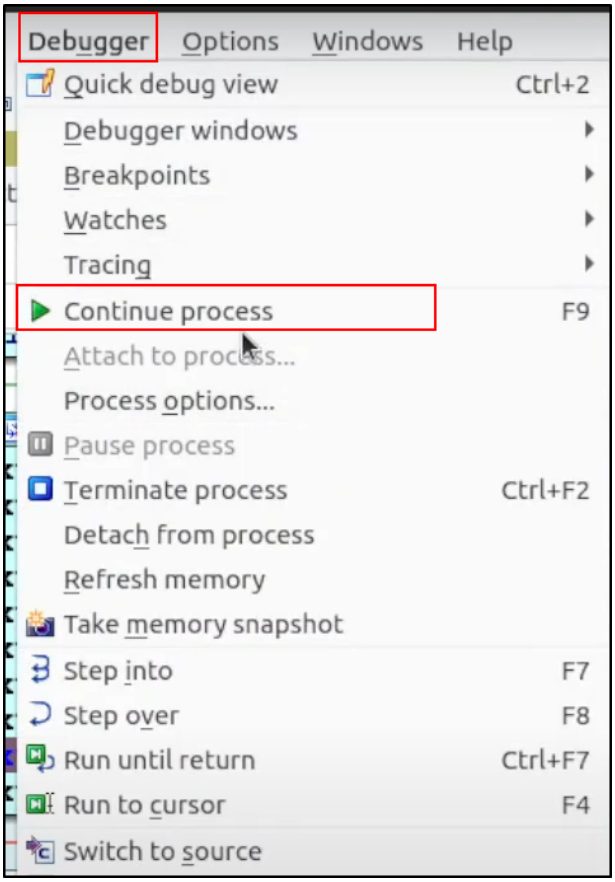


Is bar humari value hai 32 aur original password ki value hai 40. To pichhli bar ki tarah replace kr lenge.

To bar bar krne ke liye hum cmp pr breakpoint lagayenge.

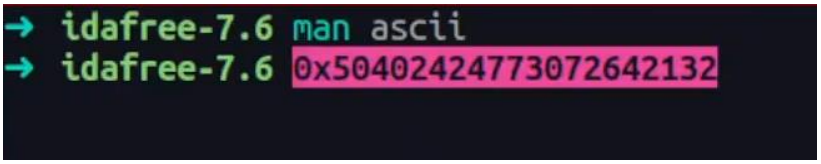


Aur continue process kr denge. Ye cmp ke breakpoint pr ruk jayega aur hum value copy kr lenge.



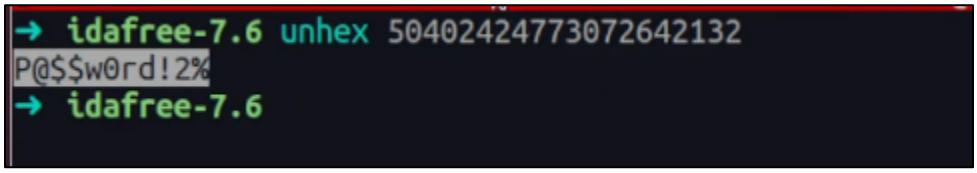
Press **f9** for continue process.

So, here we noted all values.

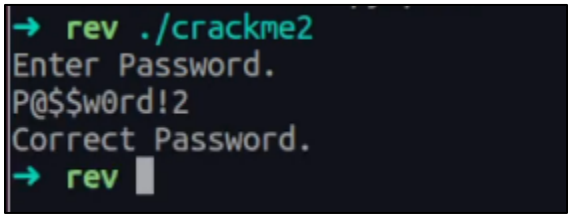


We can decode in using cyberchef tool.

Ya fir pwntool ke unhex tool se bhi kr sekte hai.



Finally we got password.



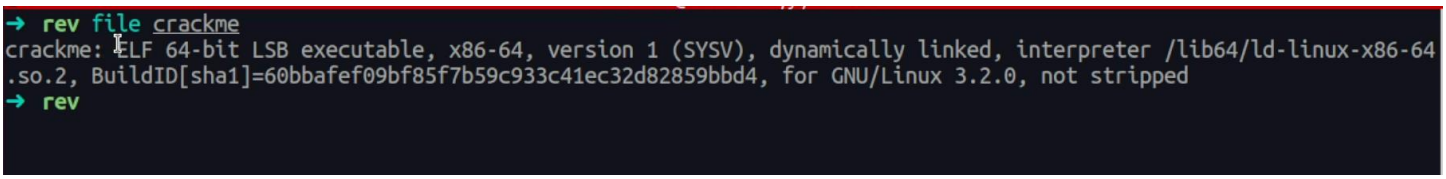
##################################

Static And Dynamic Analysis Tools. Stripped vs Non-Stripped Elf

There are some tools that can help us to make reverse engineering easy.

1) File command

Agar humko koi file milti hai. to kaise pta karenge ki kaun si file hail. Because linux me extension matter nhi krta hai.



Yha pr ye 64bit aur 32 bit bhi batayega jo ki reverse engineering perspective se important hai.

Aur hum dekh skte hai **dynamically linked** hai. jaisa ki hum jante hai bs humare program ka hi code enough nhi hota hai kisi binary ko run krne ke liye bahut sare other code bhi dale jate hai. jaise ki **_puts** function hai isko hum apne program me use krte hai lekin hum iska code khud se nhi likhte hai.

Wo code ek file se aata hai jise hum **libc** khte hai.

To **libc** ke code ko humare code ke sath jodne ke do tarike hote hai. ek hota hai **dynamically linked** aur dusra hota hai **statically link**.

Dynamically linked me ye hota hai ki after compilation jaise ki **_puts** function ka code libc me hi rhta hai bs uska reference se hum access krte hai. means humara program jata hai aur whi pdkr wahi execute kr deta hai. dynamically link me file ka size chota hota hai.

Aur **statically linked** me ye hota hai ki **_puts** ka code humare code me uth kr chala aayega. Wahi se pdkr use execute kr deta hi. Statically me file ka size bda hota hai.

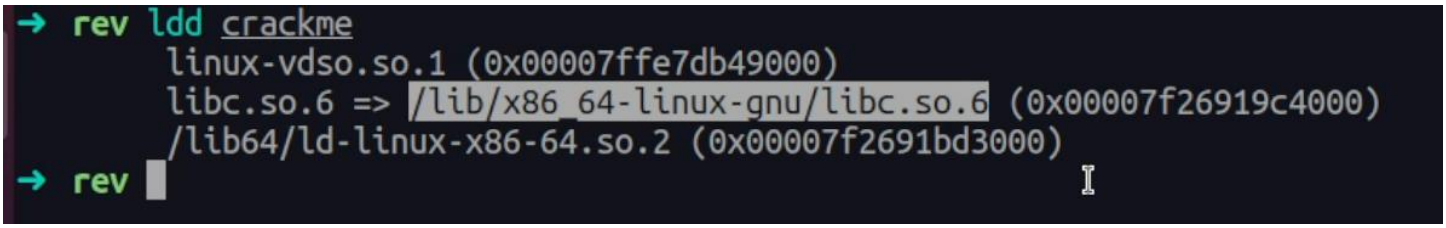
Ab humare pass do tarike ki binary hota hai. ek hoti hai **stripped** aur dusri hota hai, **not stripped.**

Stripped binary ka purpose ye hota hai ki aap jitne km se km english ke word use kr sako. Jisse file ka size chota hota hai aur reverse engineering dificult hoti hai. jaise ki reverse engineer ko pta chal jaye ki **main** function yha se start ho rha hai. to uska kam aasan ho jayega.

Jaisa ki hum jante hai ki **main** function ka jo word main hai wo program ko execute krne ke liye jaruri nhi hai. hum uske address se bhi execute kr skte hai. ye reverse engineer ka kam aasan kr deta hai.

Aur **not stripped** theek iske biprit hota hai usme english words bahut jyada use hota hai. aur wo debugging purpose ke liye banaya jata hai.

Jb **dynamically linked** hota hai to ye **libc** ka code use kr rha hota hai. to **libc** file kahan hoti hai.

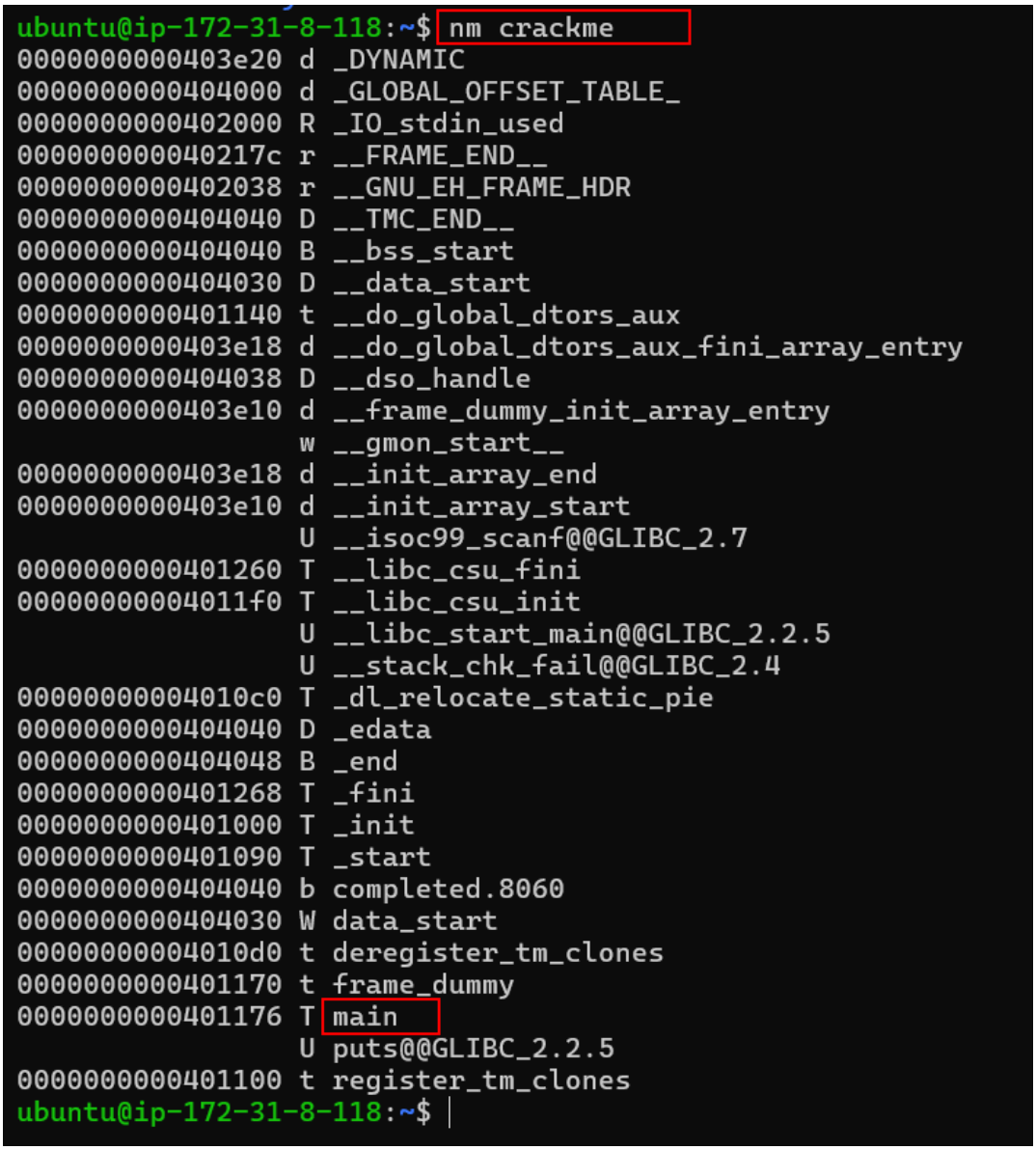


.so means shared object file. Jaisa ki hum assembly me object file banate the fir link krte the yha pr bhi ye object file hai. shared object hai.

Aur ye bahut important file agar hum ise delete kr de to system chalna band kr de ya next time boot hi na ho paye. Jaisa ki hum jante hai linux pura C se bna hai aur backend me libc ka use krta hai.

Iska use lete hai c program jo hum built-in function likhte ho wo yha stored rhte hai.

To un symbols ko hum kaise pd skte hai uske liye ek tool aata hai **nm**.



To yha pr kuchh symbols ki jarurat hoti hai. unke bina program nhi chal payega. Aur **symbols** jaise main iske bina bhi program chal jayega.

Yha symbols aur machine code me difference hai. symbols upar jo likhe hai wo hai aur english word jaisa ki humne password likha.

Agar hum is binary ko **stripped** bna dunga to bahut sare symbols rhege. Because wo jaruri hai binary ko run krne ke liye. Aur bahut sare ht jayenge. Because wo jaruri nhi hai binary ko run krne ke liye.

Kya ek binary ke andar sirf symbols aate hai. nhi aate balki unke sath english ke words bhi aate hai.

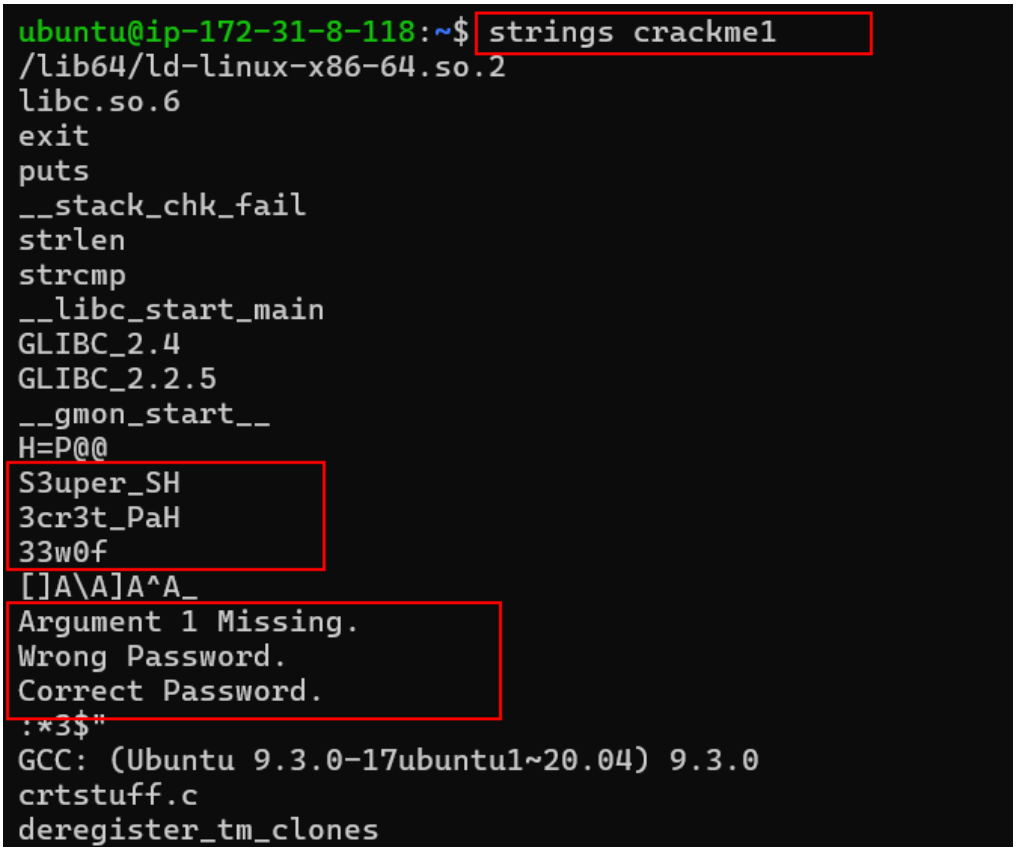
Jaise ki hum password likh diye to machine code me convert nhi hoga. Kyoki use execute nhi krna hota hai. use to bs match krna hota hai.

Yha pr humne jo code likha wo to machine code me convert ho gya. Jaise kuch chije hoti hai jo machine code me convert nhi hoti. Jaise humne password check ka program banaya. Sb kuchh machine code me convert ho gya lekin jo password hai wo machine code me convert nhi hoga.

Usko to execute nhi krna processor ko wo to bs ek string hai english word hai.

To un string ko print krne ke liye hum **strings** command ka use krte hai.

Strings command(ya humara terminal) sirf un hi character(english words) ko print kr pata hai jo **ascii table** me milta hai. uske alawa kisi chij ko nhi print kr pata hai.



Aur hum niche dekhe to

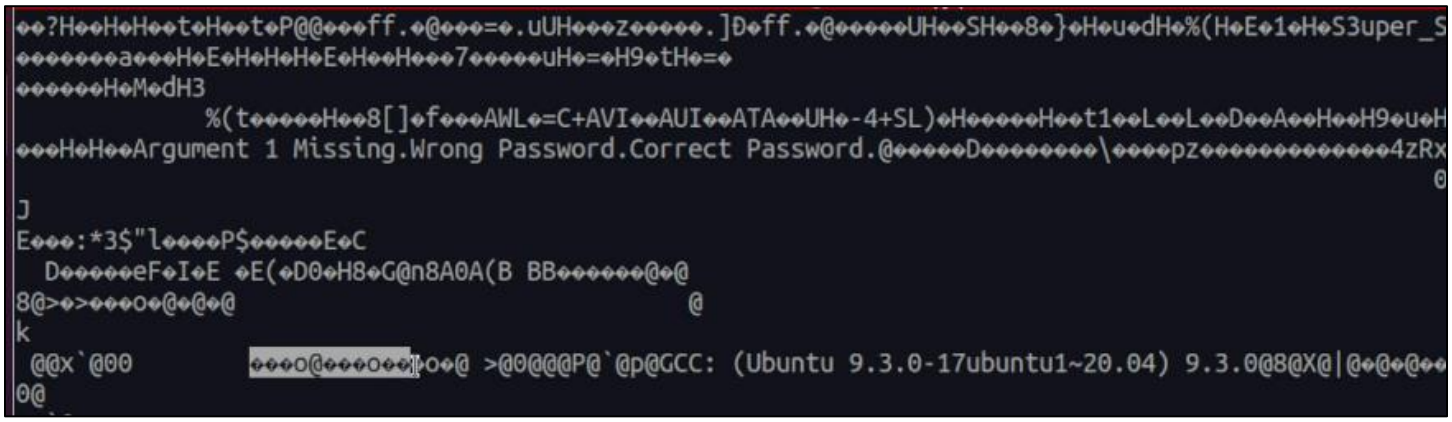
```
.plt.sec
.text
.fini
.rodata
.eh_frame_hdr
.eh_frame
.init_array
.fini_array
.dynamic
.got
.got.plt
.data
.bss
.comment
ubuntu@ip-172-31-8-118:~$
```

Yha pr **.bss aur .data** section show ho rha hai.

To ye symbols aur sath hi sath user defined jo english ke word hai use bhi dikhaye.

Ye bahut important tool hai kyoki ye bahut sari information leak kr deta hai.

Agar hum ise cat kare to ye kuchh is tarah se show karega.



Ye kuchh english ke words bhi print kr rha hai aur jo ascii table ke bahar ke word hai. to ye print nhi kr pa rha hai.

Ab hum stripped aur not stripped ka example dekhte hai.

```
➜ rev strings crackme1.c
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
int main(int argc, char const *argv[])
        char password[] = "S3uper_S3cr3t_Pa33w0rd";
        if (argc < 2) {
                puts("Argument 1 Missing.");
                exit(1);
        if (strlen(password) != strlen(argv[1])) {
                puts("Wrong Password.");
                exit(1);
        if (!(strcmp(password,argv[1]))) {
                puts("Correct Password.");
        else {
                puts("Wrong Password.");
        return 0;
➜ rev
```

Ab hum is code ka non stripped binary banayenge **gcc** ke help se.

```
➜ rev gcc crackme1.c -o crackme1
```

Ab hum stripped binary banayenge.

```
➜ rev gcc -s crackme1.c -o crackme1_stripped
```

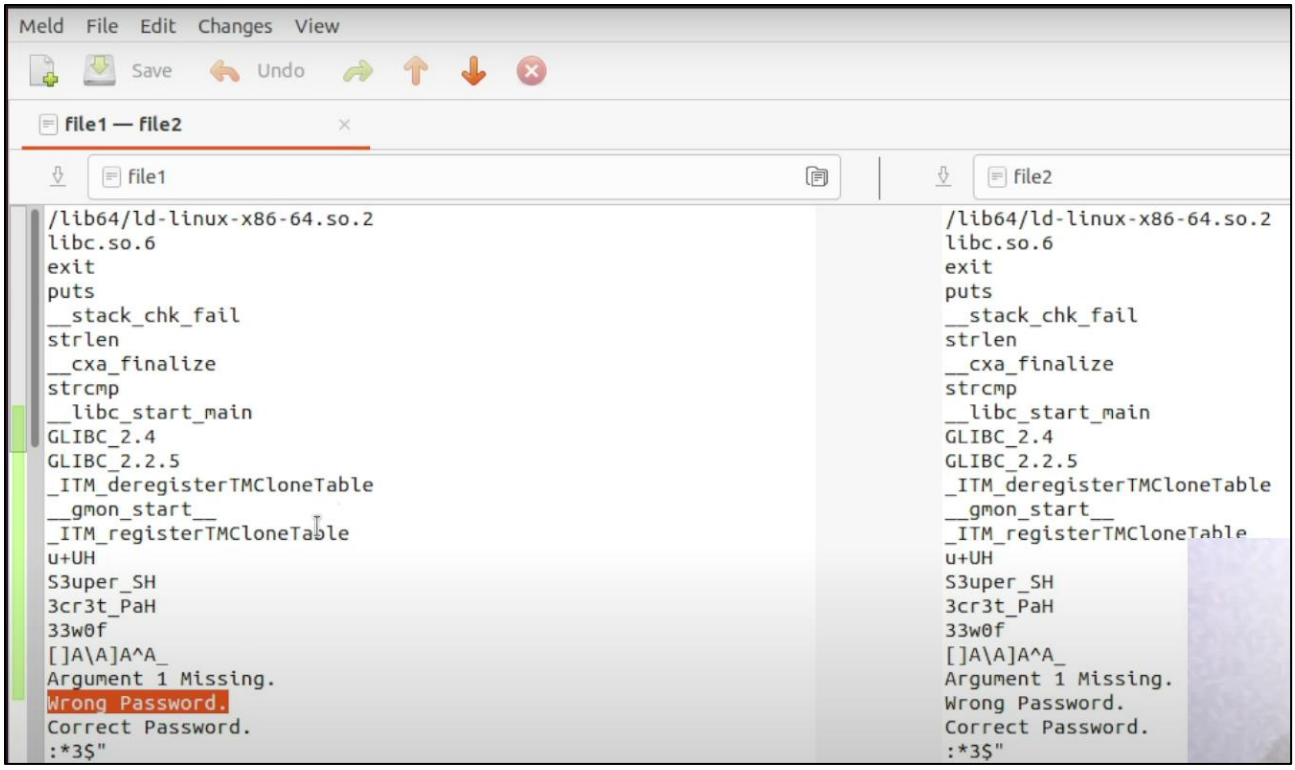
Yha pr **-s** lagane se stripped binary banegi.

Dono ka strings krke dekhenge stripped aur not stripped binary ka.

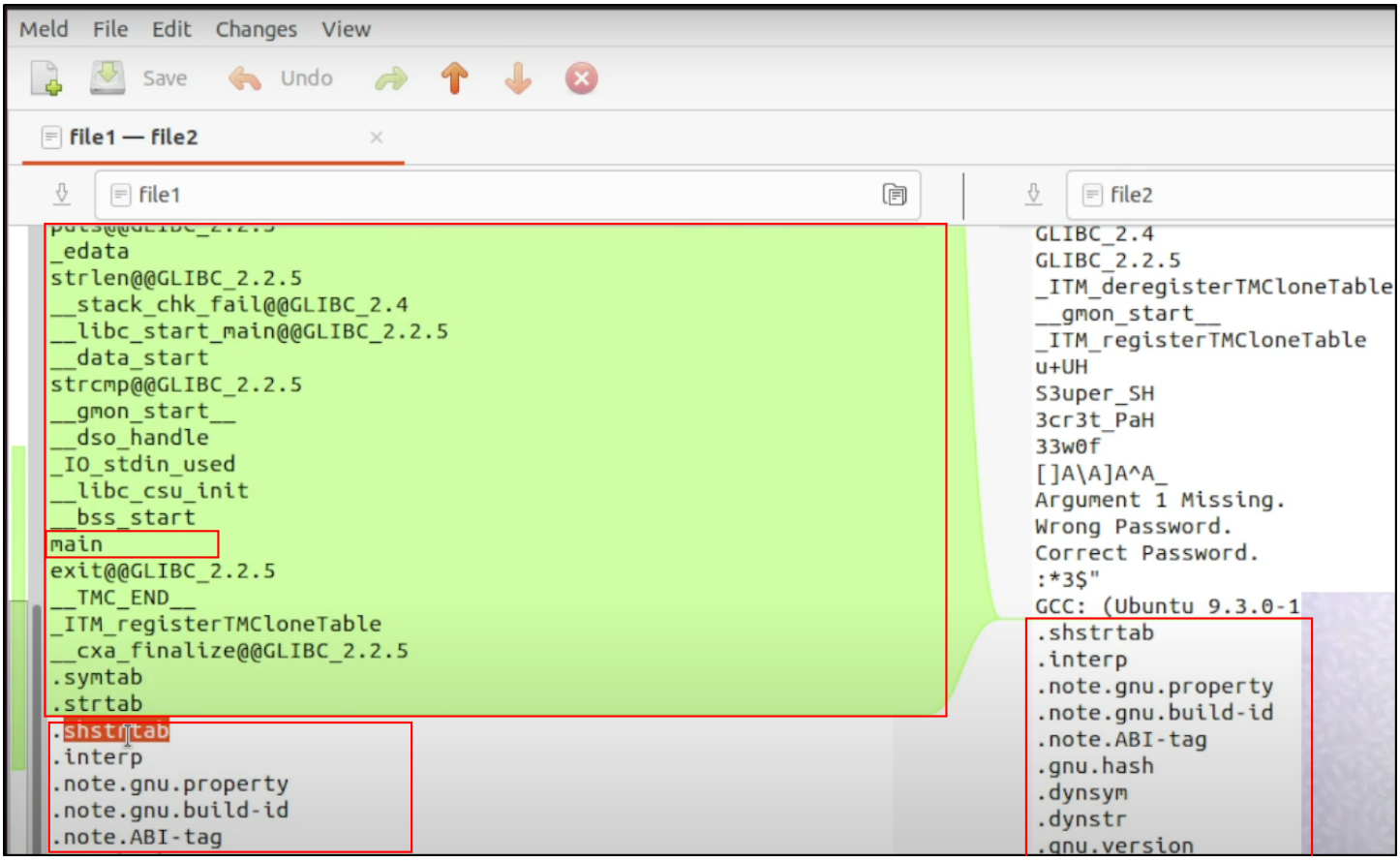
```
➜ rev strings crackme1 > file1
➜ rev strings crackme1_stripped > file2
```

Ab hum iska difference nikalenge meld tool ki help se.

```
➜ rev meld file1 file2
```



Yha pr abhi tk to same hai.



Ab hum yha dekh skte hai green box me jo bhi content hai wo extra hai. **stripped** me bahut sare symbols hta diye usi me ek symbol tha **main**. Use bhi hta diya gya.

Yha pr hum **not stripped** binary ko **gdb** ke andar function ko dekhte hai.

```
Non-debugging symbols:
0x0000000000001000  _init
0x0000000000001080  __cxa_finalize@plt
0x0000000000001090  puts@plt
0x00000000000010a0  strlen@plt
0x00000000000010b0  __stack_chk_fail@plt
0x00000000000010c0  strcmp@plt
0x00000000000010d0  exit@plt
0x00000000000010e0  _start
0x0000000000001110  deregister_tm_clones
0x0000000000001140  register_tm_clones
0x0000000000001180  __do_global_dtors_aux
0x00000000000011c0  frame_dummy
0x00000000000011c9  main
0x00000000000012d0  __libc_csu_init
0x0000000000001340  __libc_csu_fini
0x0000000000001348  _fini
(gdb) q
```

In stripped binary:

```
Non-debugging symbols:
0x0000000000001080  __cxa_finalize@plt
0x0000000000001090  puts@plt
0x00000000000010a0  strlen@plt
0x00000000000010b0  __stack_chk_fail@plt
0x00000000000010c0  strcmp@plt
0x00000000000010d0  exit@plt
(gdb)
```

==========

Jb hum binary ko analysis krte hai. to ye do types se hota hai.

1. Static analysis

2. Dynamic analysis

Static analysis me hum binary ko bina run kiye analysis krte hai. ab kisi binary ki hum assembly pd rhe hai wo static analysis hai bina run kiye bhi hum assembly ko pd skte hai.

Aur **dynamic analysis** me hum binary ko run krke analysis krte hai. debugging dynamic analysis me aata hai.

Ab tk humne jitna bhi analysis kiya wo static analysis kiya usme ek bhi bar binary ko run hi kiya.

Ab hum tool use karenge **ltrace**. Ye hume batayega ki hum libc ke kaun-2 se function ko use kr rhe hai. **Ye libc ke function ko with argument dikhata hai**.

```
→ rev ltrace ./crackme2
```

Yha pr hume **full path** dena pdta hai.

```
→ rev ltrace ./crackme2
puts("Enter Password"Enter Password
)                                                    = 15
gets(0x7ffe177d9180, 0x1d012a0, 0, 0x7f11ba82a1e7
```

To ye yha wait kr rha hai humare input ka to hum ise input dete hai.

```
→ rev ltrace ./crackme2
puts("Enter Password"Enter Password
)                                                    = 15
gets(0x7ffe177d9180, 0x1d012a0, 0, 0x7f11ba82a1e7abcdef
)                    = 0x7ffe177d9180
strlen("abcdef")
Wrong Password.
exit(0 <no return ...>
+++ exited (status 0) +++
→ rev
```

User Input

Ek aur example with crackme1

```
ubuntu@ip-172-31-8-118:~$ ltrace ./crackme1 abc123
strlen("S3uper_S3cr3t_Pa33w0rd")
strlen("abc123")
puts("Wrong Password."Wrong Password.
)
exit(1 <no return ...>
+++ exited (status 1) +++
ubuntu@ip-172-31-8-118:~$
```

Yha pr hum dekh skte hai isne password leak kr diya. **Strlen** function ke sath.

==========

strace tool hume ye batata hai ki kaun-2 se system call ko ye call kr rha hai.

jaisa ki hum jante hai ki **_puts** function bs fancy sa function hai. backend me ye **write syscall** ko call krta hai.

```
→ rev strace ./crackme2
execve("./crackme2", ["./crackme2"], 0x7fffcefa4e40 /* 56 vars */) = 0
brk(NULL)                               = 0x1140000
arch_prctl(0x3001 /* ARCH_??? */, 0x7ffffd5a7180) = -1 EINVAL (Invalid argument)
access("/etc/ld.so.preload", R_OK)      = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=107558, ...}) = 0
mmap(NULL, 107558, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7f9e0bb44000
close(3)                                = 0
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\0\0\360q\2\0\0\0\0"..., 83
pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 7
pread64(3, "\4\0\0\0\20\0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0\0", 3
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\t\233\222%\274\260\320\31\331\326\10\
fstat(3, {st_mode=S_IFREG|0755, st_size=2029224, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7f9
pread64(3, "\6\0\0\0\4\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0@\0\0\0\0\0\0\0"..., 7
pread64(3, "\4\0\0\0\20\0\0\0\5\0\0\0GNU\0\2\0\0\300\4\0\0\0\3\0\0\0\0\0\0\0", 3
pread64(3, "\4\0\0\0\24\0\0\0\3\0\0\0GNU\0\t\233\222%\274\260\320\31\331\326\10\
mmap(NULL, 2036952, PROT_READ, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7f9e0b950000
mprotect(0x7f9e0b975000, 1847296, PROT_NONE) = 0
mmap(0x7f9e0b975000, 1540096, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED|MAP_DEN
```

Niche dekhte hai.

```
fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x1), ...}) = 0
brk(NULL)                               = 0x1140000
brk(0x1161000)                          = 0x1161000
write(1, "Enter Password\n", 15Enter Password
)       = 15
fstat(0, {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x1), ...}) = 0
read(0, 1234567890                      Our input
"1234567890\n", 1024)           = 11
write(1, "Wrong Password.\n", 16Wrong Password.
)       = 16
exit_group(0)                           = ?
+++ exited with 0 +++
```

Yha pr sabhi syscall ko show kr rha hai. aadhe se jyada humare kam ke nhi hote hai.

Ye dynamic analysis kr rha hai.

Yha ek tool hota hai jo sb kuchh dikha deta hai. ltrace aur strace chhodkr aur ye static analysis me help krta hai.

```
ubuntu@ip-172-31-8-118:~$ readelf -a crackme1
ELF Header:
  Magic:   7f 45 4c 46 02 01 01 00 00 00 00 00 00 00 00 00
  Class:                             ELF64
  Data:                              2's complement, little endian
  Version:                           1 (current)
  OS/ABI:                            UNIX - System V
  ABI Version:                       0
  Type:                              EXEC (Executable file)
  Machine:                           Advanced Micro Devices X86-64
  Version:                           0x1
  Entry point address:               0x4010d0
  Start of program headers:          64 (bytes into file)
  Start of section headers:          14864 (bytes into file)
  Flags:                             0x0
  Size of this header:               64 (bytes)
  Size of program headers:           56 (bytes)
  Number of program headers:         13
  Size of section headers:           64 (bytes)
  Number of section headers:         31
  Section header string table index: 30

Section Headers:
  [Nr] Name              Type             Address           Offset
       Size              EntSize          Flags  Link  Info  Align
  [ 0]                   NULL             0000000000000000  00000000
       0000000000000000  0000000000000000           0     0     0
  [ 1] .interp           PROGBITS         0000000000400318  00000318
       000000000000001c  0000000000000000   A       0     0     1
```

Magic address se linux indentify krta hai ki kaun si type ki file hai.

Section headers me kaun sa section hai uska information hai.

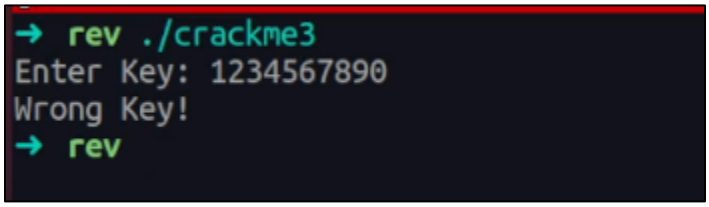
Jaise **.text section**

.bss section etc.

Aur bhi bahut kuchh.

##

Most Used Debugger. Crackme – 3



Ye binary **keygen** category ki hai.

Jaisa ki hum jante hai ki **keygen** program ke bahut sare **key** combination bn sakte hai.

Yha pr hum sare key dal skte hai jo ki sahi hai.

To yha pr hume program ke algorithm ko samjhna pdega to hume pta chaleg ki iski bahut sare key ban skti hai.

Is binary ko crack karne ke liye hum **ghidra** ka use karenge.

Hum **gdb** me apna binary load krte hai. aur function dekhne ki koshish krte hai.

```
Non-debugging symbols:
0x0000000000401000  _init
0x0000000000401070  puts@plt
0x0000000000401080  __stack_chk_fail@plt
0x0000000000401090  printf@plt
0x00000000004010a0  __isoc99_scanf@plt
0x00000000004010b0  _start
0x00000000004010e0  _dl_relocate_static_pie
0x00000000004010f0  deregister_tm_clones
0x0000000000401120  register_tm_clones
0x0000000000401160  __do_global_dtors_aux
0x0000000000401190  frame_dummy
0x0000000000401196  check_key
0x00000000004011da  main
0x0000000000401270  __libc_csu_init
0x00000000004012e0  __libc_csu_fini
0x00000000004012e8  _fini
(gdb)
```

Yha pr do functions kam ke dikh rhe hai. **check key** aur **main** function.

Ab hum **main** ko disassemble krte hai.

```
(gdb) disassemble main
Dump of assembler code for function main:
   0x00000000004011da <+0>:     endbr64
   0x00000000004011de <+4>:     push   rbp
   0x00000000004011df <+5>:     mov    rbp,rsp
   0x00000000004011e2 <+8>:     sub    rsp,0x10
   0x00000000004011e6 <+12>:    mov    rax,QWORD PTR fs:0x28
   0x00000000004011ef <+21>:    mov    QWORD PTR [rbp-0x8],rax
   0x00000000004011f3 <+25>:    xor    eax,eax
   0x00000000004011f5 <+27>:    lea    rdi,[rip+0xe08]        # 0x402004
   0x00000000004011fc <+34>:    mov    eax,0x0
   0x0000000000401201 <+39>:    call   0x401090 <printf@plt>
   0x0000000000401206 <+44>:    lea    rax,[rbp-0x10]
   0x000000000040120a <+48>:    mov    rsi,rax
   0x000000000040120d <+51>:    lea    rdi,[rip+0xdfc]        # 0x402010
   0x0000000000401214 <+58>:    mov    eax,0x0
   0x0000000000401219 <+63>:    call   0x4010a0 <__isoc99_scanf@plt>
   0x000000000040121e <+68>:    mov    eax,DWORD PTR [rbp-0x10]
   0x0000000000401221 <+71>:    mov    edi,eax
```

Yha ye comment krke dikha deta hai ki kaun si chij kisme mov ho rhi hai.

Jaise ki **rdi** me **0x402004** mov ho rha hai.

To hum is value ko dekh lete hai kya hai.

```
End of assembler dump.
(gdb) x/s 0x402004
0x402004:       "Enter Key: "
```

Hex value ko human readable format me covert krne ke liye **x/s** use karenge. **x/s** means examine string.

Ab hum aage chale to ek _**scanf** function hai. jo ki do argument leta hai.

```
0x0000000000401206 <+44>:    lea    rax,[rbp-0x10]
0x000000000040120a <+48>:    mov    rsi,rax
0x000000000040120d <+51>:    lea    rdi,[rip+0xdfc]        # 0x402010
0x0000000000401214 <+58>:    mov    eax,0x0
0x0000000000401219 <+63>:    call   0x4010a0 <__isoc99_scanf@plt>
0x000000000040121e <+68>:    mov    eax,DWORD PTR [rbp-0x10]
0x0000000000401221 <+71>:    mov    edi,eax
0x0000000000401223 <+73>:    call   0x401196 <check_key>
0x0000000000401228 <+78>:    mov    DWORD PTR [rbp-0xc],eax
```

Jaisa ki hum jante hai, _**scanf** do argument leta hai. phla argument **rdi** aur dusra **rsi**. phla argument batayega ki **kis type** ka argument lena hai int, float,char etc. dusra argument ye batayega ki kahan pr store krna hai.

```
(gdb) x/s 0x402010
0x402010:       "%d"
(gdb)
```

Yha pr value **%d** type ka le rha hai.

```
0x00000000004011fc <+34>:    mov    eax,0x0
0x0000000000401201 <+39>:    call   0x401090 <printf@plt>
0x0000000000401206 <+44>:    lea    rax,[rbp-0x10]
0x000000000040120a <+48>:    mov    rsi,rax
0x000000000040120d <+51>:    lea    rdi,[rip+0xdfc]        # 0x402010
0x0000000000401214 <+58>:    mov    eax,0x0
0x0000000000401219 <+63>:    call   0x4010a0 <__isoc99_scanf@plt>
0x000000000040121e <+68>:    mov    eax,DWORD PTR [rbp-0x10]
0x0000000000401221 <+71>:    mov    edi,eax
```

Aur hum **rsi** ki value dekhte hai. to usme **rax** ko mov kiya ja rha hai. **rax** me **[rbp-0x10]** ki value plus, minus krke dala ja rha hai.

Jaisa ki hum jante hai ki koi bhi **syscall** koi bhi value **rax** ke andar return krta hai.

```
End of assembler dump.
(gdb) x/s 0x402004
0x402004:       "Enter Key: "
(gdb) x/s 0x402010
0x402010:       "%d"
(gdb) x/s 0x40202f
0x40202f:       "Wrong Key!"
(gdb) x/s 0x402013
0x402013:       "Correct Key! Now Keygen Me."
(gdb)
```

Ab hum **check_key** function ko disassemble krte hai. aur dekhte hai ki ye kya kr rha hai.

```
(gdb) disassemble check_key
Dump of assembler code for function check_key:
   0x0000000000401196 <+0>:     endbr64
   0x000000000040119a <+4>:     push   rbp
   0x000000000040119b <+5>:     mov    rbp,rsp
   0x000000000040119e <+8>:     mov    DWORD PTR [rbp-0x4],edi
   0x00000000004011a1 <+11>:    mov    eax,DWORD PTR [rbp-0x4]
   0x00000000004011a4 <+14>:    sub    eax,0x64
   0x00000000004011a7 <+17>:    lea    edx,[rax+rax*1]
   0x00000000004011aa <+20>:    movsxd rax,edx
   0x00000000004011ad <+23>:    imul   rax,rax,0x51eb851f
   0x00000000004011b4 <+30>:    shr    rax,0x20
   0x00000000004011b8 <+34>:    mov    ecx,eax
   0x00000000004011ba <+36>:    sar    ecx,0x5
   0x00000000004011bd <+39>:    mov    eax,edx
   0x00000000004011bf <+41>:    sar    eax,0x1f
   0x00000000004011c2 <+44>:    sub    ecx,eax
   0x00000000004011c4 <+46>:    mov    eax,ecx
   0x00000000004011c6 <+48>:    imul   eax,eax,0x64
   0x00000000004011c9 <+51>:    sub    edx,eax
   0x00000000004011cb <+53>:    mov    eax,edx
   0x00000000004011cd <+55>:    test   eax,eax
   0x00000000004011cf <+57>:    jne    0x4011d8 <check_key+66>
   0x00000000004011d1 <+59>:    mov    eax,0x1
   0x00000000004011d6 <+64>:    jmp    0x4011d8 <check_key+66>
   0x00000000004011d8 <+66>:    pop    rbp
   0x00000000004011d9 <+67>:    ret
End of assembler dump.
(gdb)
```

Yha pr hum assembly ko samjhne ki koshish krte hai.

```
0x000000000040119b <+5>:     mov    rbp,rsp
0x000000000040119e <+8>:     mov    DWORD PTR [rbp-0x4],edi
0x00000000004011a1 <+11>:    mov    eax,DWORD PTR [rbp-0x4]
0x00000000004011a4 <+14>:    sub    eax,0x64
0x00000000004011a7 <+17>:    lea    edx,[rax+rax*1]
0x00000000004011aa <+20>:    movsxd rax,edx
0x00000000004011ad <+23>:    imul   rax,rax,0x51eb851f
0x00000000004011b4 <+30>:    shr    rax,0x20
```

Yha pr **eax** me **0x64** value mov kr rha hai.

To hum yha pr **"p"** or **"print"** command ka use karenge pta krenge ki **0x64** ki value kya hai.

```
End of assembler dump.
(gdb) p 0x64
$1 = 100
(gdb)
```

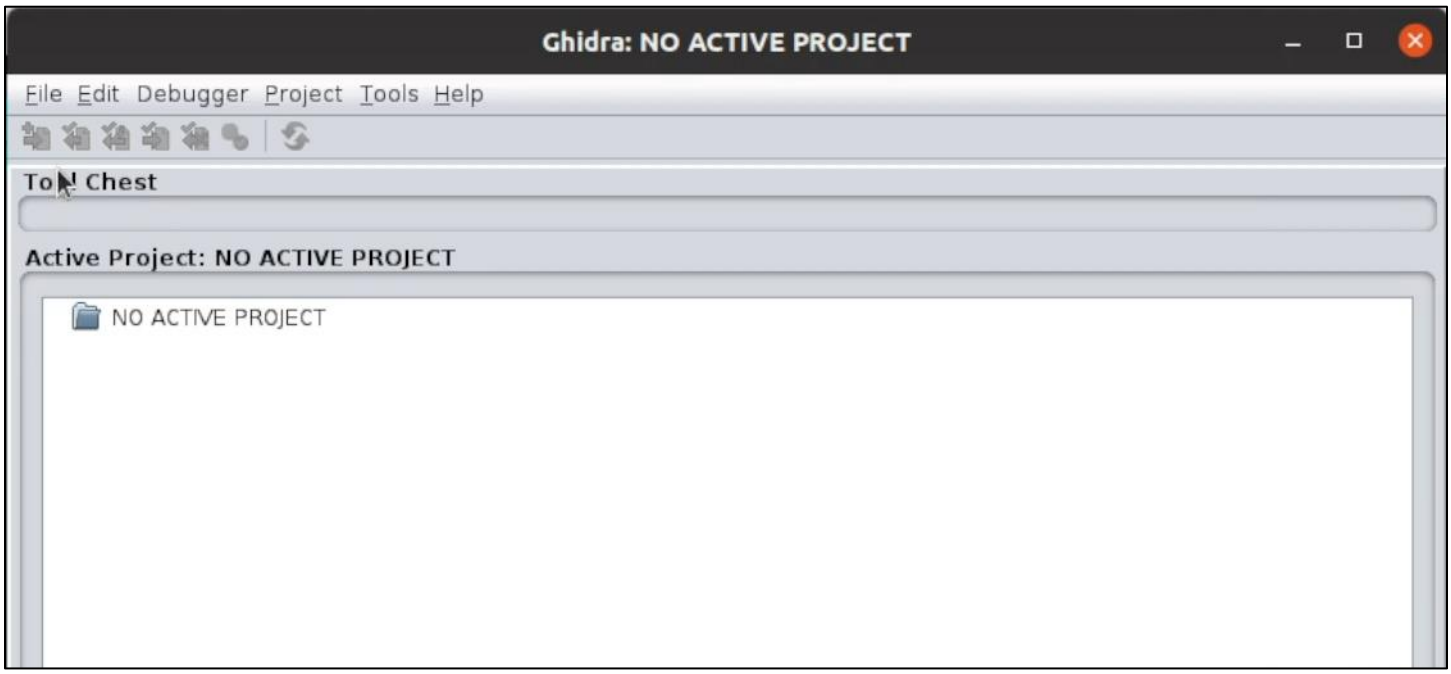
But hume yha samjhne me difficulty hoti hai to aise me kam aata hai **decompiler**.

Jaisa ki hum jante hai **compiler** humare high level programming language ke code ko machine level code (low level code) me covert krta hai.

Whi **decompiler** iske biprit kam krta hai. ye low level code ko high level code me convert krta hai.

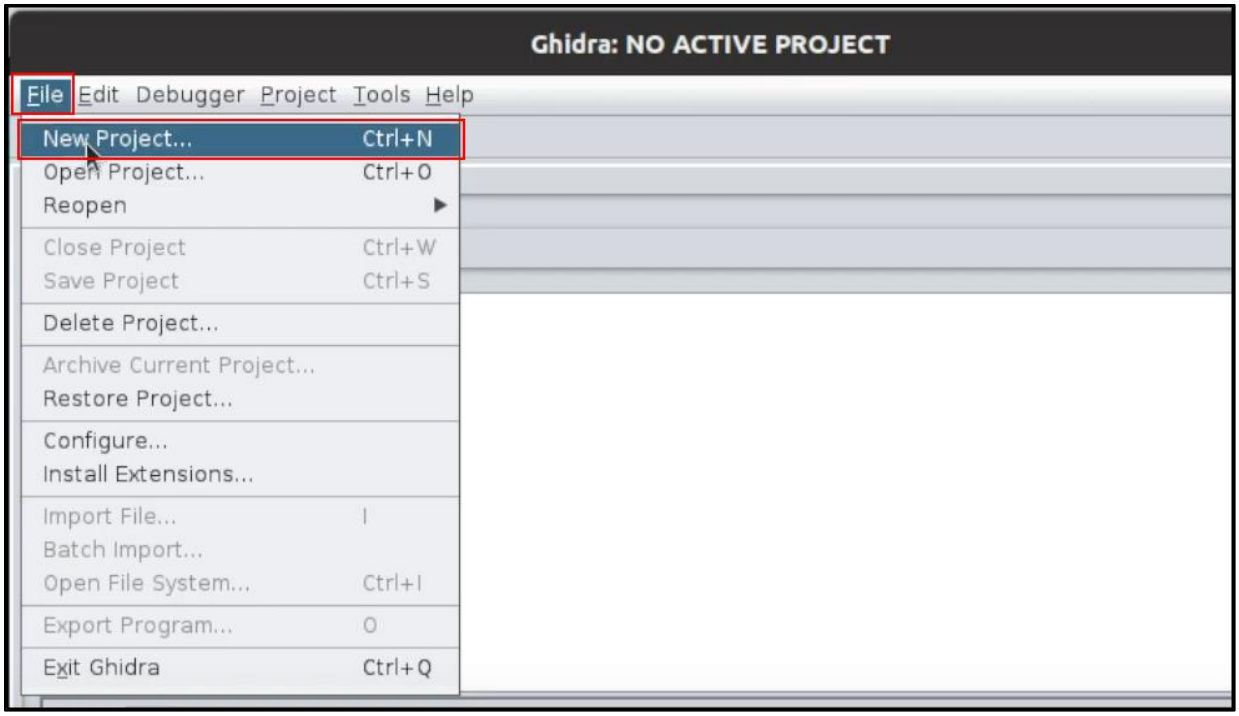
Hum ise jo bhi **elf** (**binary file**) denge use ye high level me convert krne ka power rkhta hai.

Yha hum **ghidra** decompiler ka use karenge.

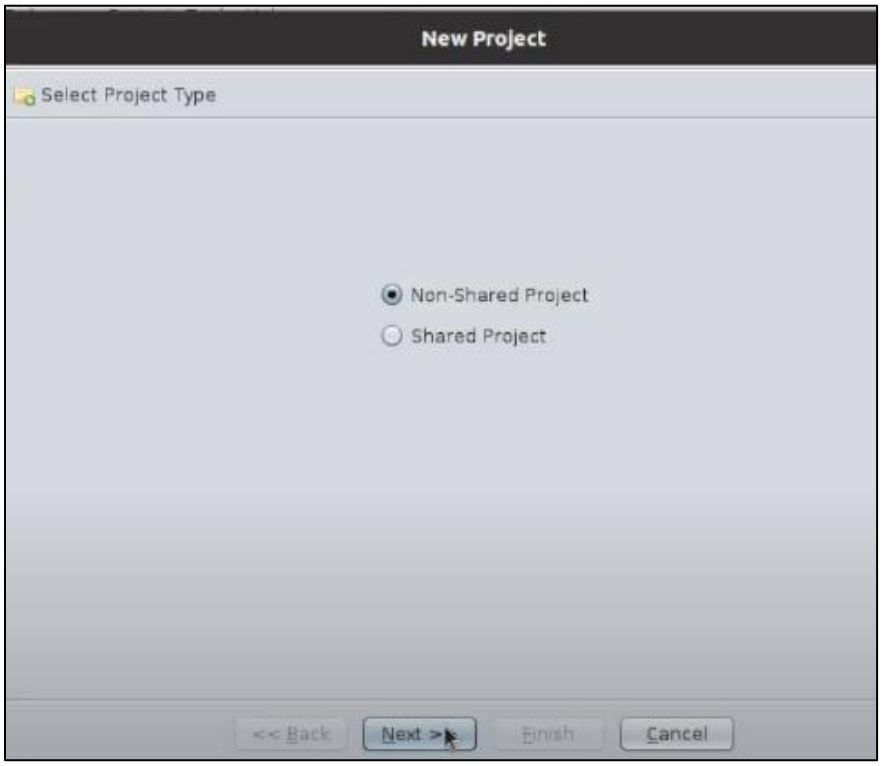


Jaisa ki hum ghidra ko first time open krte hai to ye kuchh is tarah se dikhta hai.

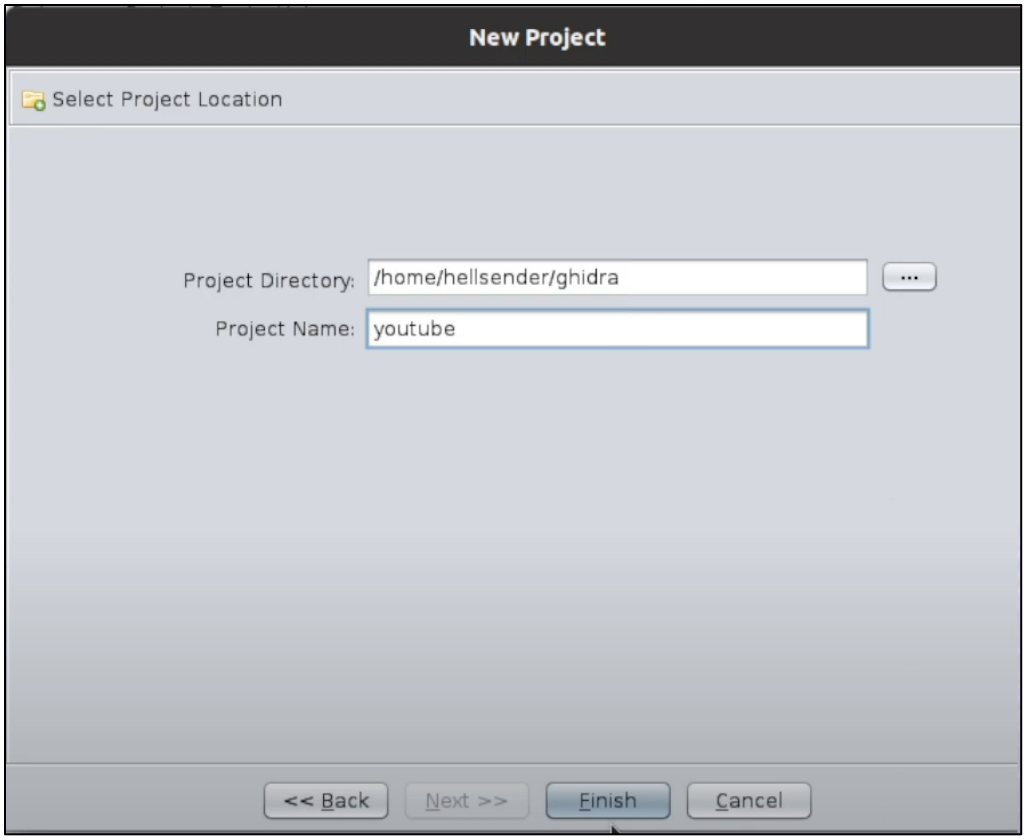
To sbse phle hume **project** create krna pdta hai, uske andar hum apne binary ko open krte hai.

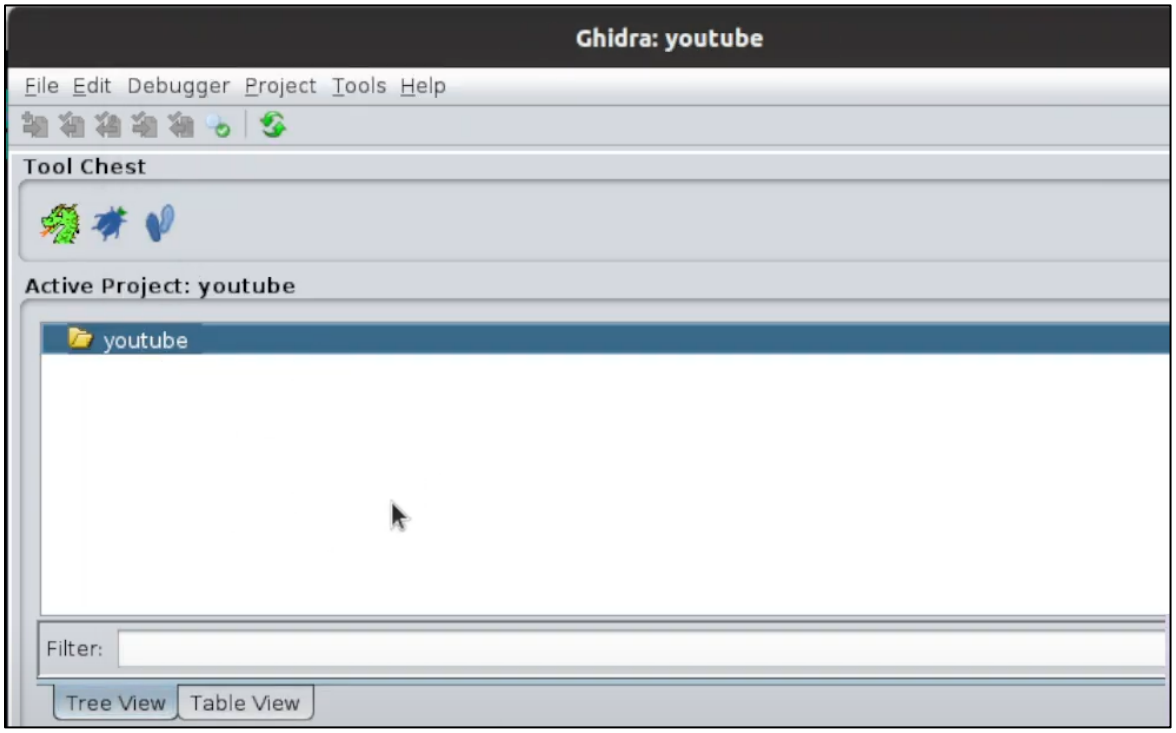


Go to file > New project.



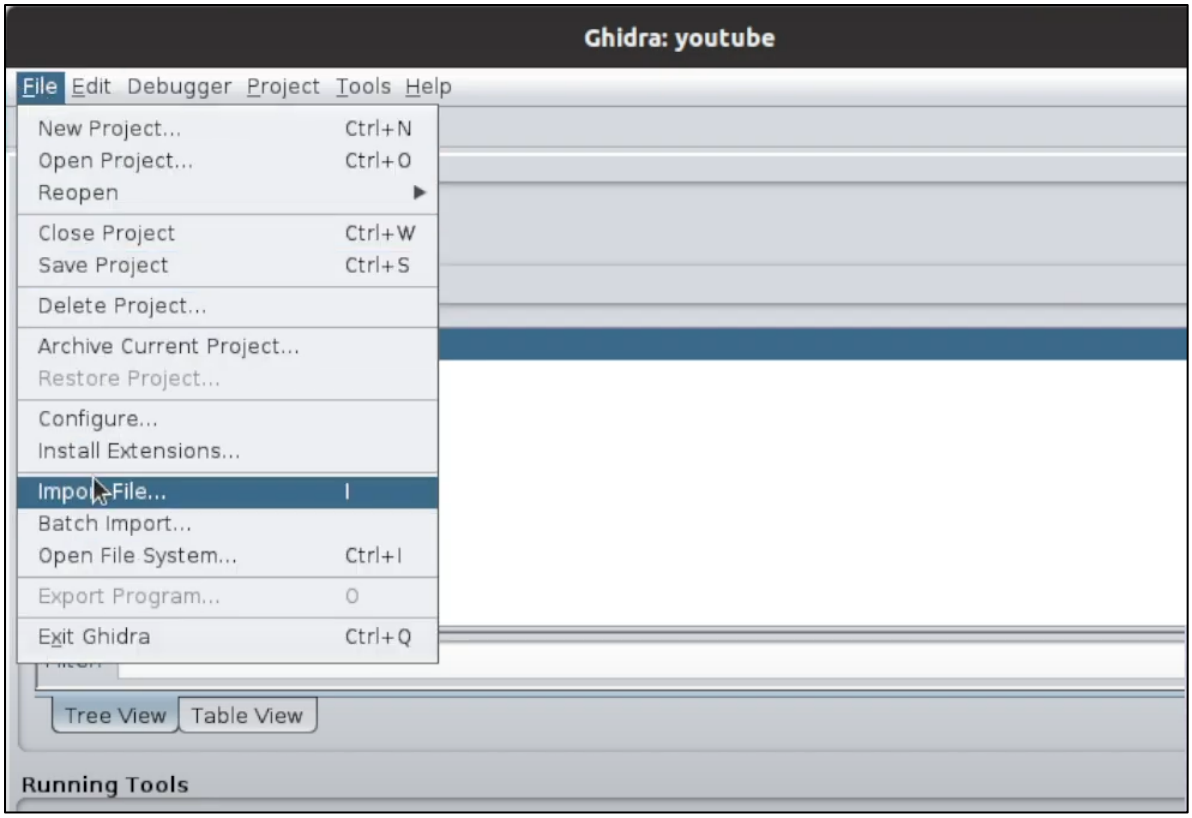
Click on **Non-shared** project click on Next.

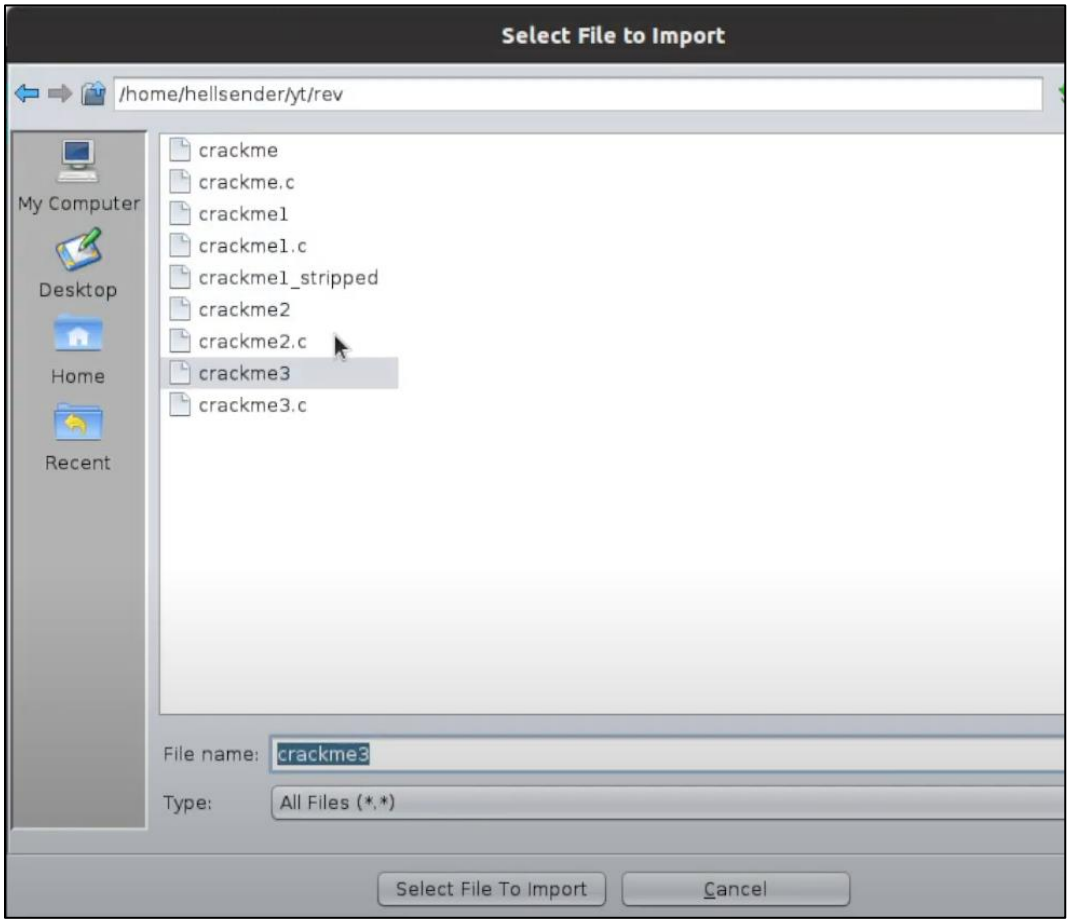


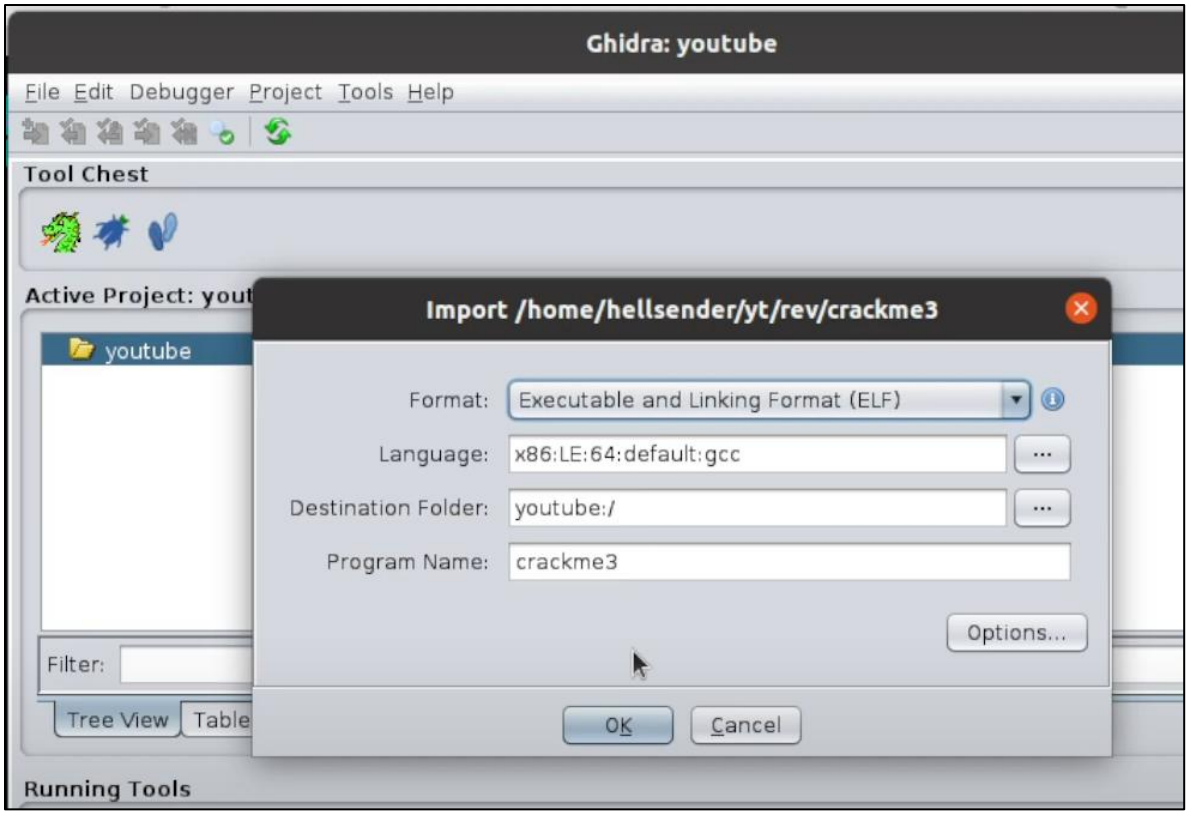


Yha hum dekh skte hai. ki project create ho chuka hai.

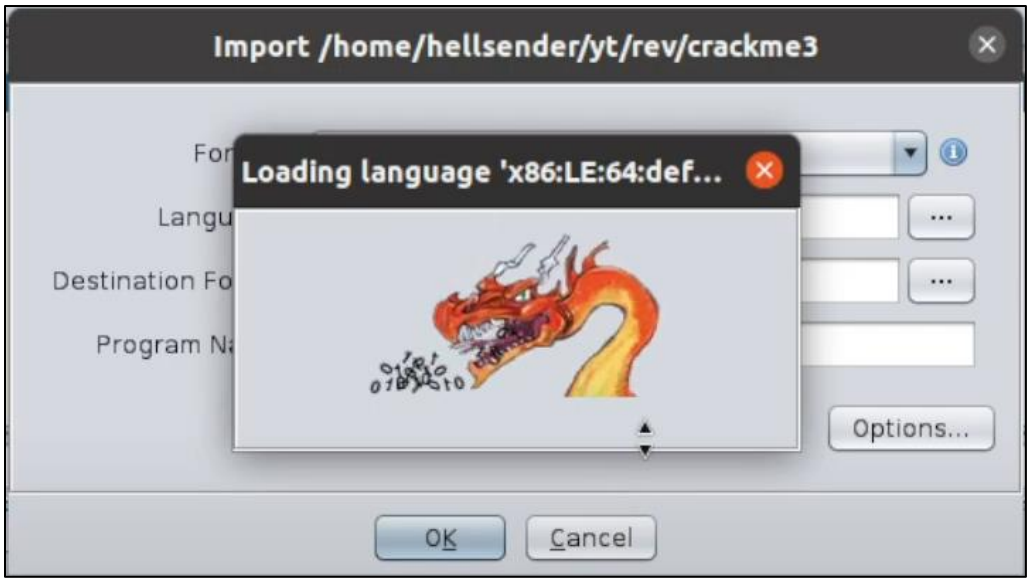
Ab hum isme apna binary file dalenge.


Ghidra: youtube
File Edit Debugger Project Tools Help
New Project... Ctrl+N
Open Project... Ctrl+O
Reopen
Close Project Ctrl+W
Save Project Ctrl+S
Delete Project...
Archive Current Project...
Restore Project...
Configure...
Install Extensions...
Batch Import...
Open File System... Ctrl+I
Export Program...
Exit Ghidra Ctrl+Q
Tree View
Table View
Running Tools


Select File to Import
/home/hellsender/yt/rev
My Computer
Desktop
Home
Recent
crackme
crackme.c
crackme1
crackme1.c
crackme1_stripped
crackme2
crackme2.c
crackme3
crackme3.c
File name: crackme3
Type: All Files (*.*)
Select File To Import
Cancel

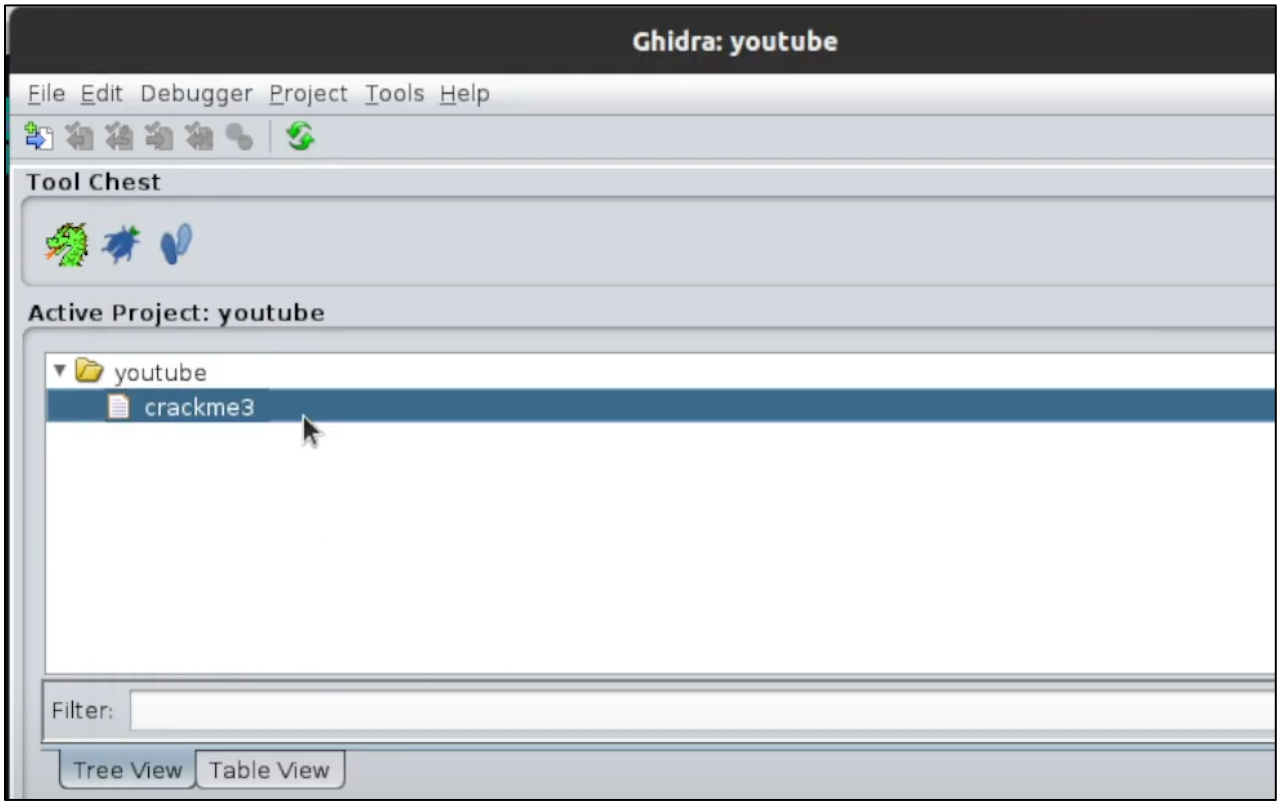


Yha pr ye kuchh information show karega. Jaise hi ok pr click karenge ye analysis karega aur binary ko open kr dega.



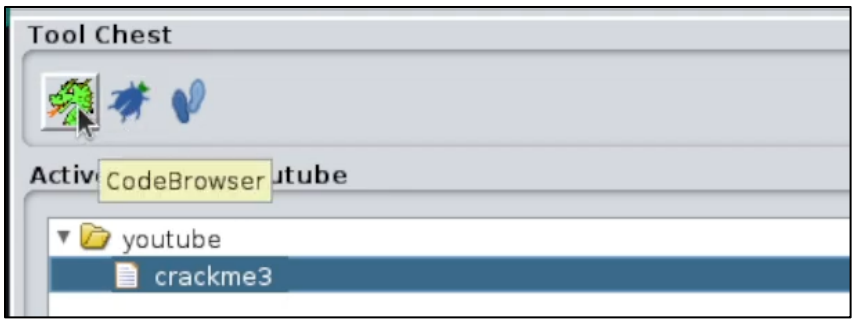
Yha pr ye some info show karega ok pr click krna hai.

```
Project File Name:          crackme3
Last Modified:              Wed Aug 04 01:00:10 IST 2021
Readonly:                   false
Program Name:               crackme3
Language ID:                x86:LE:64:default (2.10)
Compiler ID:                gcc
Processor:                  x86
Endian:                     Little
Address Size:               64
Minimum Address:            00400000
Maximum Address:            _elfSectionHeaders::000007bf
# of Bytes:                 7718
# of Memory Blocks:         33
# of Instructions:          16
# of Defined Data:          106
# of Functions:             22
# of Symbols:               54
# of Data Types:            30
# of Data Type Categories:  2
Created With Ghidra Version:10.0
Date Created:               Wed Aug 04 01:00:08 IST 2021
ELF File Type:              executable
ELF Original Image Base:    0x400000
ELF Prelinked:              false
ELF Required Library [   0]:libc.so.6
ELF Source File [   0]:     crtstuff.c
```



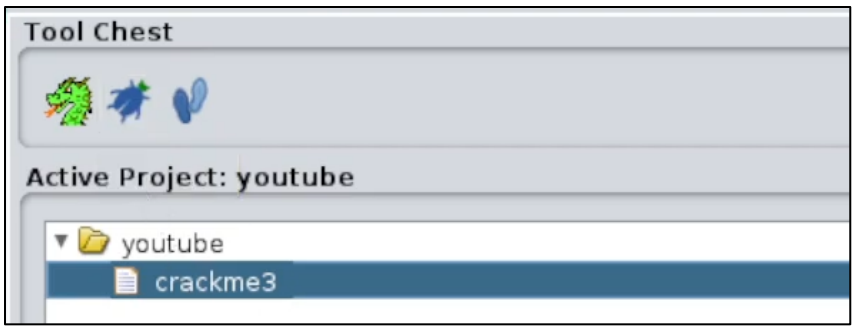
Yha pr humari binary file aa gyi.

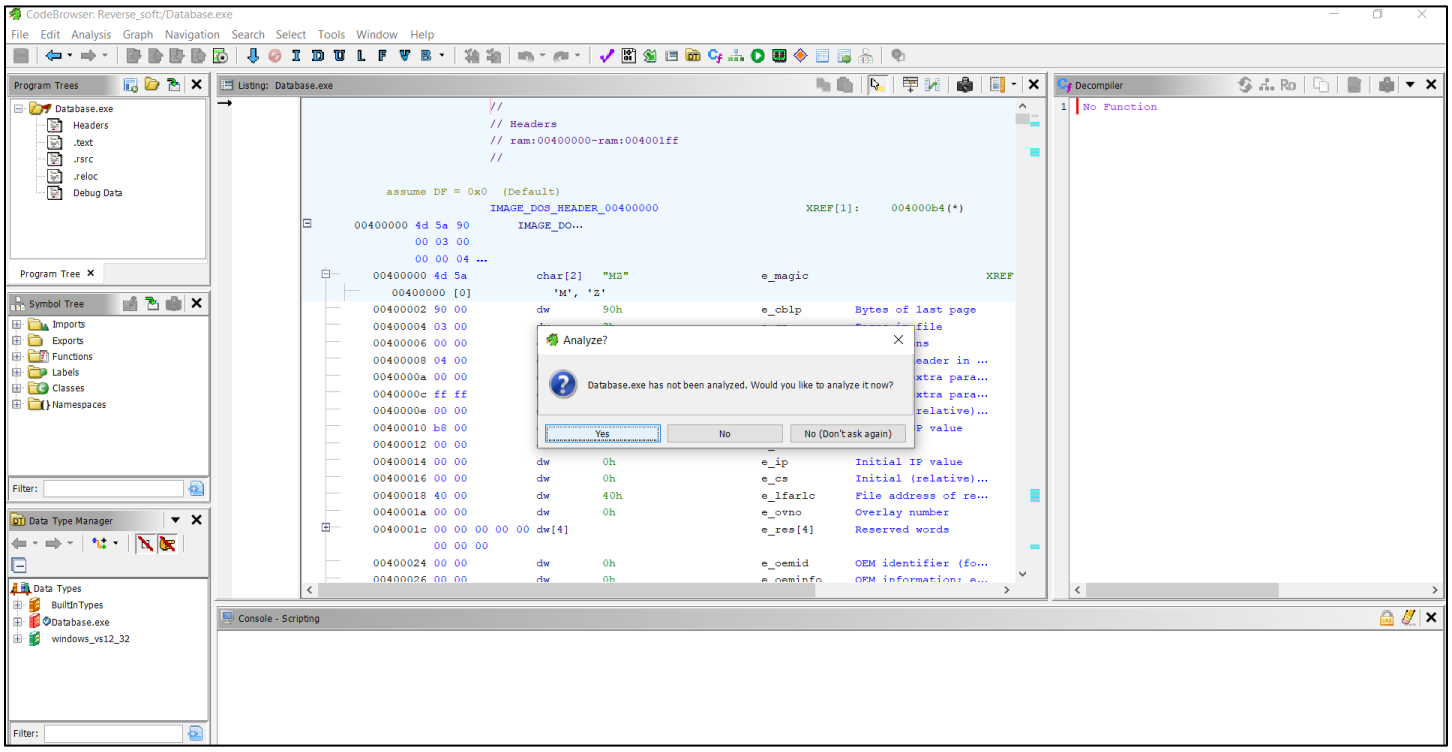
Yha pr jitni chahe utni file import kr skte hai.



Yha pr do option hai. Ek **codebrowser** jo code ko **decompile** aur **disassemble** karega. Aur dusra **debugger** ka option hai.

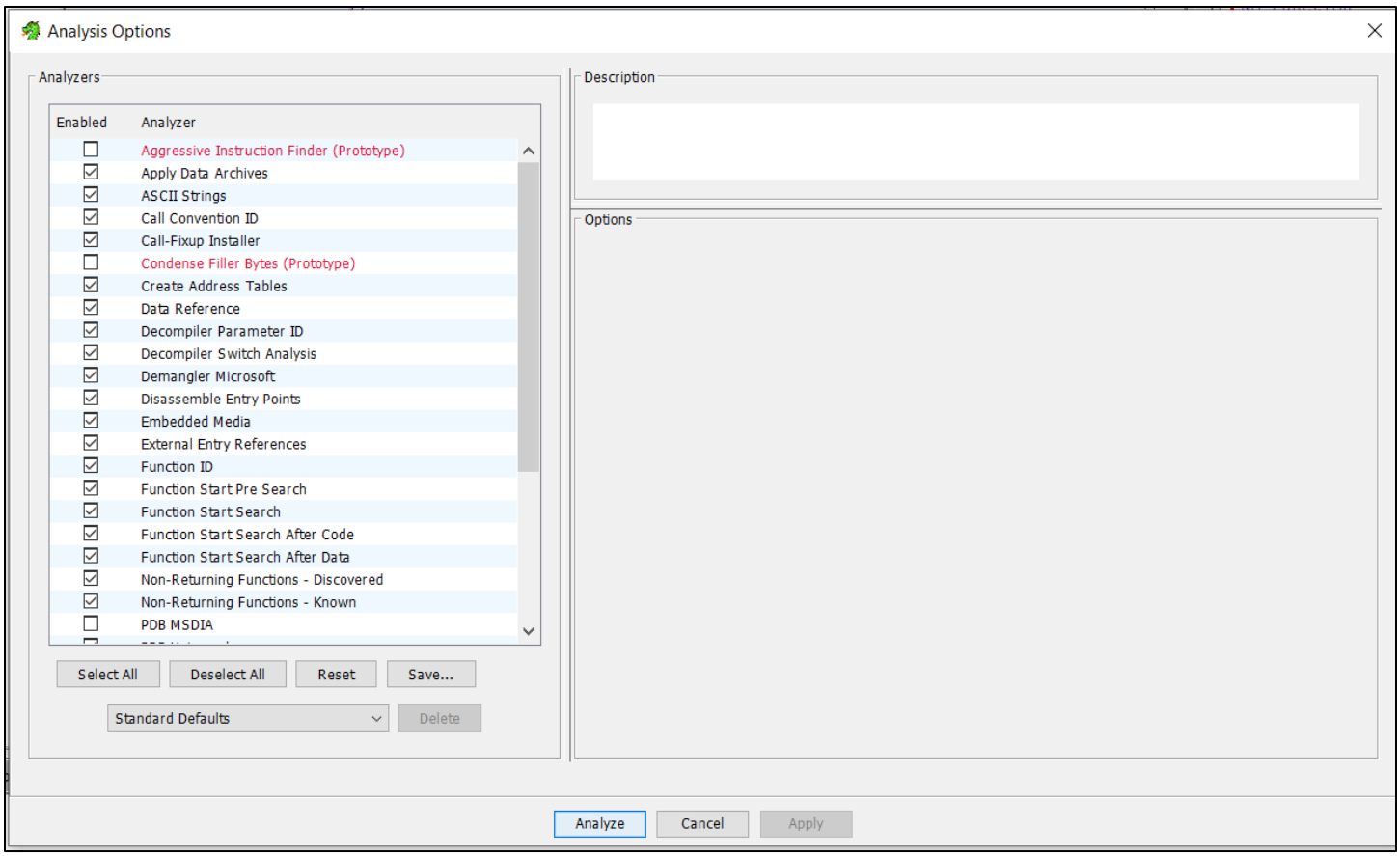
Ab hum **crackme3** pr double click karenge to ye codebrowser me open ho jayega.



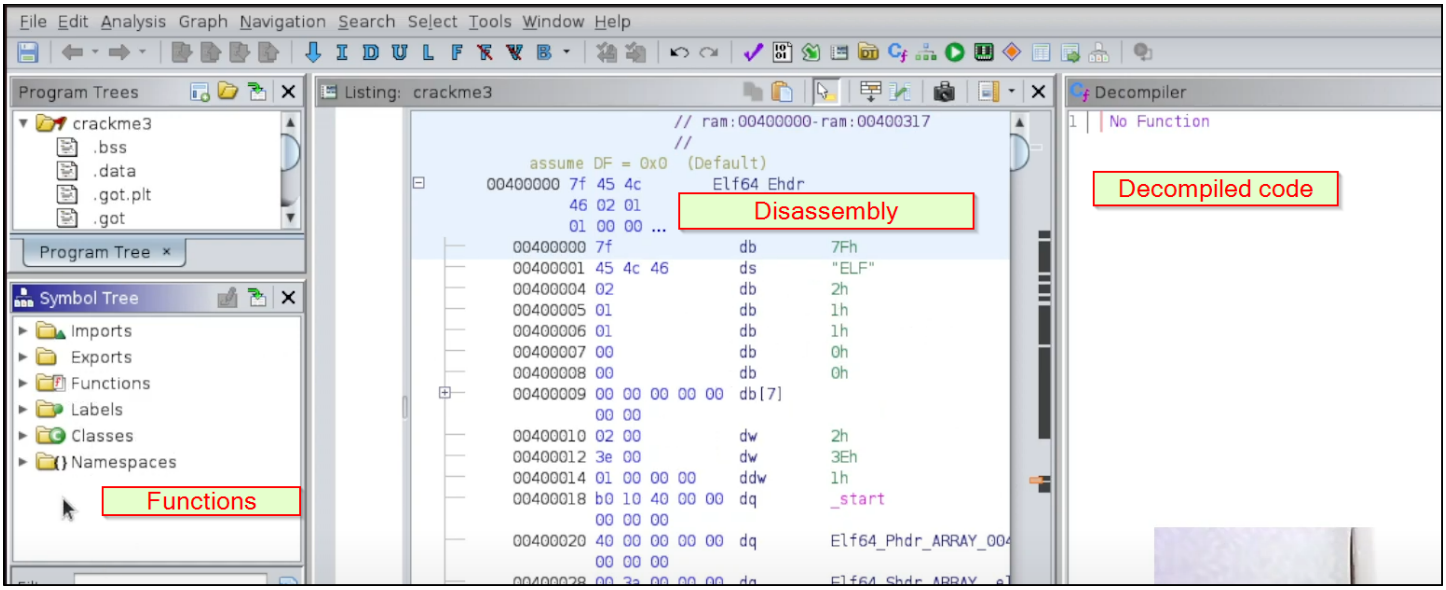


Yha pr ise yes kr dena hai.

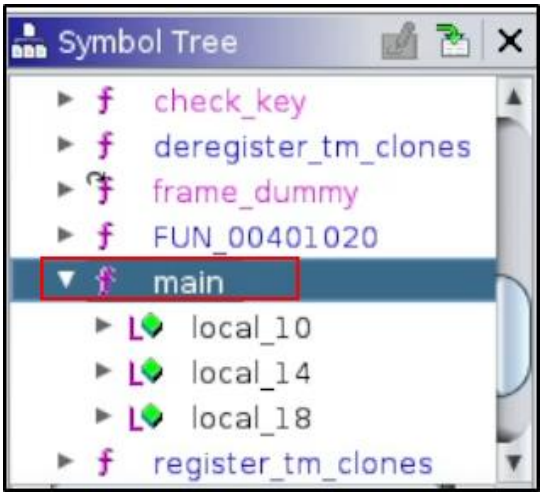
Fir ek aur popup show karega. Analyze pr click kr dena hai.



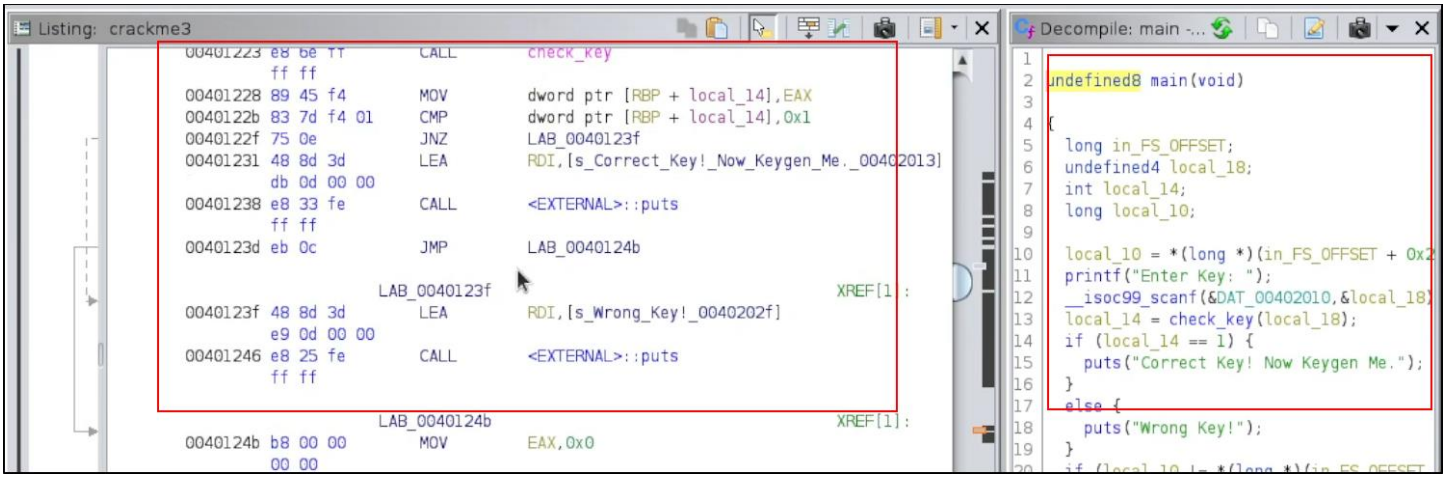
Fir yha anlyze pr click kr dega.



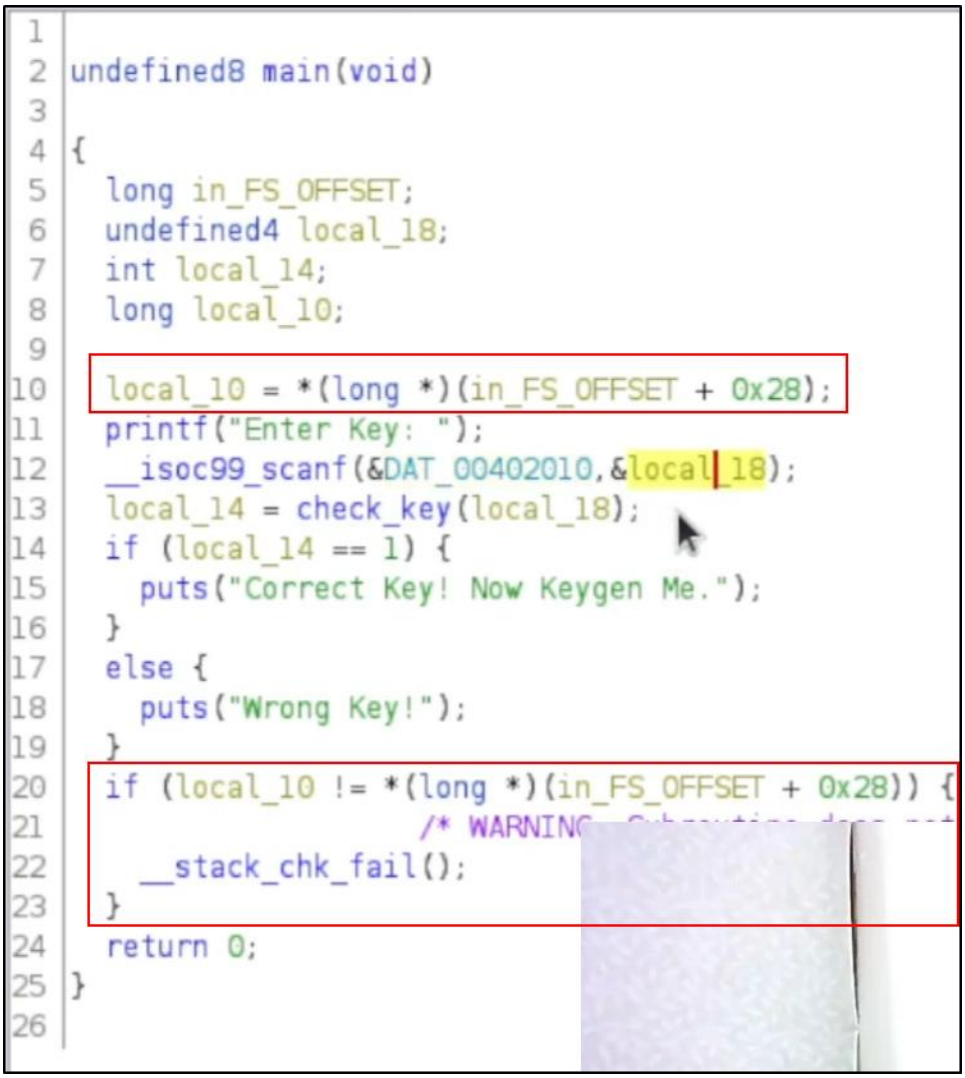
Yha sbse phle hume **main function** find krna hota hai.



Yha pr hum main pr double click karenge.



Yha pr ye disassembly aur decompile code dono code load ho jayega.

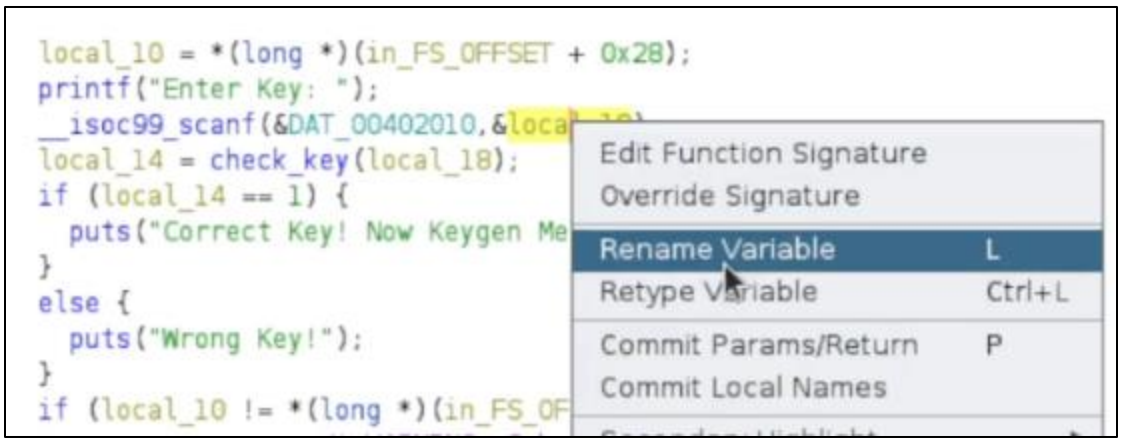


```
undefined8 main(void)

{
  long in_FS_OFFSET;
  undefined4 local_18;
  int local_14;
  long local_10;

  local_10 = *(long *)(in_FS_OFFSET + 0x28);
  printf("Enter Key: ");
  __isoc99_scanf(&DAT_00402010,&local_18);
  local_14 = check_key(local_18);
  if (local_14 == 1) {
    puts("Correct Key! Now Keygen Me.");
  }
  else {
    puts("Wrong Key!");
  }
  if (local_10 != *(long *)(in_FS_OFFSET + 0x28)) {
                    /* WARNING
    __stack_chk_fail();
  }
  return 0;
}
```

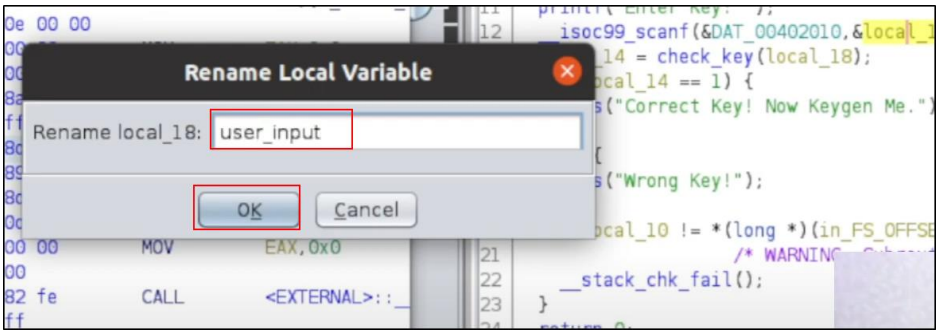
Ye underlined things humare kam ki nhi hai. ye canaries hai.

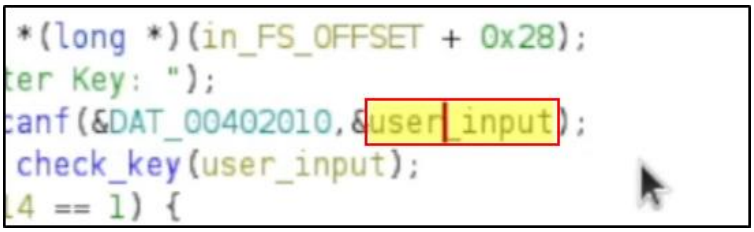
Baki ka code humare liye aasan hai as comparatively **assembly code**.

Yha pr variables ke name humare hisab se nhi milta **decompiler** ko samjh me aata hai usi hisab se rkh deta hai.



Yha pr hum variables ka nam apne hisab se rename kr lete hai.





==========

Yha pr **check_key** function **user_input** (humare input ke value) ke sath call karega.

Aur ye jo bhi value return karega use **local_14** store kr dega.

local_14 ko rename kr denge return_value se

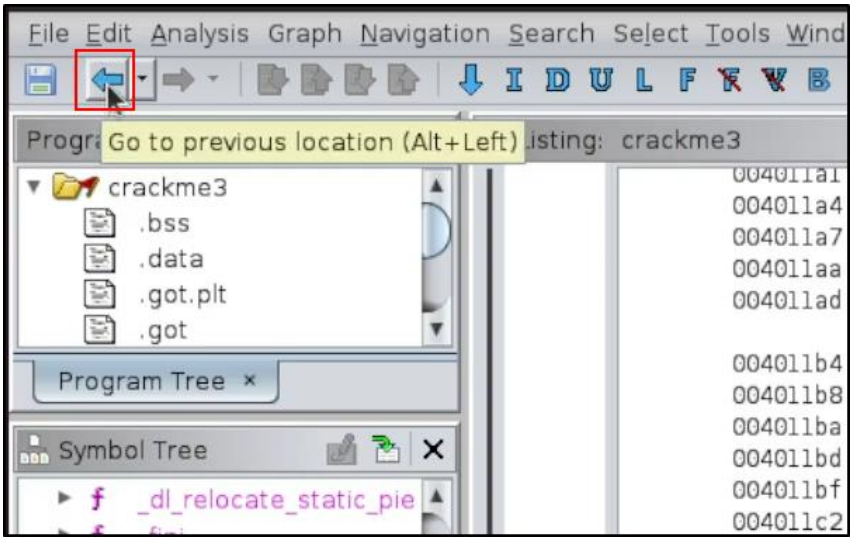
```
undefined8 main(void)

{
  long in_FS_OFFSET;
  undefined4 user_input;
  int return_value;
  long local_10;

  local_10 = *(long *)(in_FS_OFFSET + 0x28);
  printf("Enter Key: ");
  __isoc99_scanf(&DAT_00402010,&user_input);
  return_value = check_key(user_input);
  if (return_value == 1) {
    puts("Correct Key! Now Keygen Me.");
  }
  else {
    puts("Wrong Key!");
  }
  if (local_10 != *(long *)(in_FS_OFFSET + 0x28)) {
                    /* WARNING
    __stack_chk_fail();
  }
  return 0;
}
```

aur hum **check_key()** function me jate hai aur dekhte hai ki usme kya logic hai.

```
int check_key(int param_1)

{
  int iVar1;

  iVar1 = ((param_1 + -100) * 2) % 100;
  if (iVar1 == 0) {
    iVar1 = 1;
  }
  return iVar1;
}
```

Iske variables ko hum rename kr lete hai.

```
1
2  int check_key(int user_input)
3
4  {
5    int result;
6
7    result = ((user_input + -100) * 2) % 100;
8    if (result == 0) {
9      result = 1;
10   }
11   return result;
12 }
```



Ab is arrow pr click karenge to wapas **main** function pr aa jayenge.

```
printf("Enter Key: ");
__isoc99_scanf(&DAT_00402010,&user_input);
return_value = check_key(user_input);
if (return_value == 1) {
  puts("Correct Key! Now Keygen Me.");
}
else {
  puts("Wrong Key!");
}
```

Yha hum dekh skte hai ki **return_value** ki value agar **1** hogi tabhi correct key print karega.

Return 1 kb karega jb

```
1
2  int check_key(int user_input)
3
4  {
5    int result;
6
7    result = ((user_input + -100) * 2) % 100;
8    if (result == 0) {
9      result = 1;
10   }
11   return result;
12 }
```

Jb is pure calculation ki value **0** hogi to ye return **1** karega.

To hume apni value kuchh aisa dalna padega ki calculation **0** aaye.

To yha **user_input** ki value 200 man lete hai. agar calculate kare to reminder 0 aa jayega.

```
➜ rev ./crackme3
Enter Key: 200
Correct Key! Now Keygen Me.
➜ rev
```

To 200 correct key hai.
yha humne 1 posible key find kr liya.

Ab aur bhi posible key find krte hai.

Ab hum python ki script ki help se **1000** tk key generate krte hai.

```
➜ rev python3
Python 3.8.10 (default, Jun  2 2021, 10:49:15)
[GCC 9.4.0] on linux
Type "help", "copyright", "credits" or "license"
>>> for i in range(1000):
...     result = ((i-100)*2)%100
...     if result == 0:
...             print(i)
```

Output

```
>>> for i in range(1000):
...     result = ((i-100)*2)%100
...     if result == 0:
...             print(i)
...
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
>>>
```

These are correct key between **0** to **1000.**

```
➜ rev ./crackme3
Enter Key: 50
Correct Key! Now Keygen Me.
➜ rev ./crackme3
Enter Key: 350
Correct Key! Now Keygen Me.
➜ rev
```

##

Patching in reverse engineering:

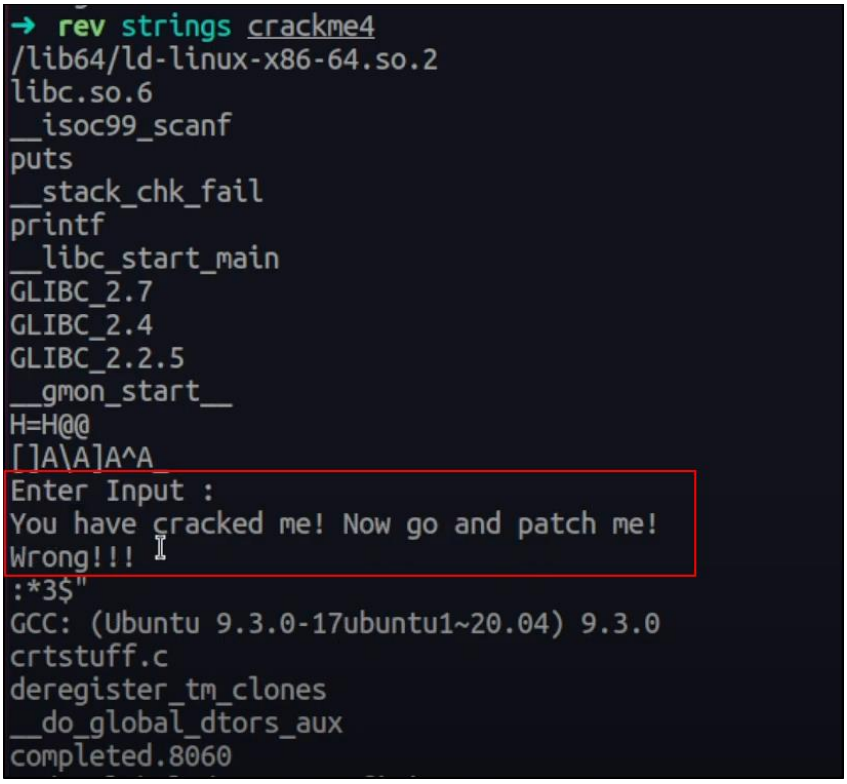
Challenge – crackme4

```
➜ rev ./crackme4
Enter Input : 123456
Wrong!!!
```

Yha hum is kam ko krne ke liye **Binary Ninja** ka use karenge.

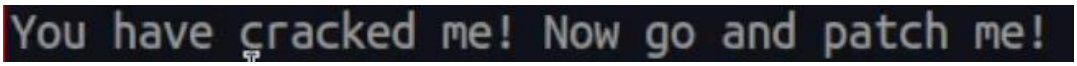
==========

Agar hum ise strings kare to.



To hume yha pr sahi password nikalna hai. agar galat password dalenge to ye wrong!!!

Agar sahi password dalenge to



Print karega.

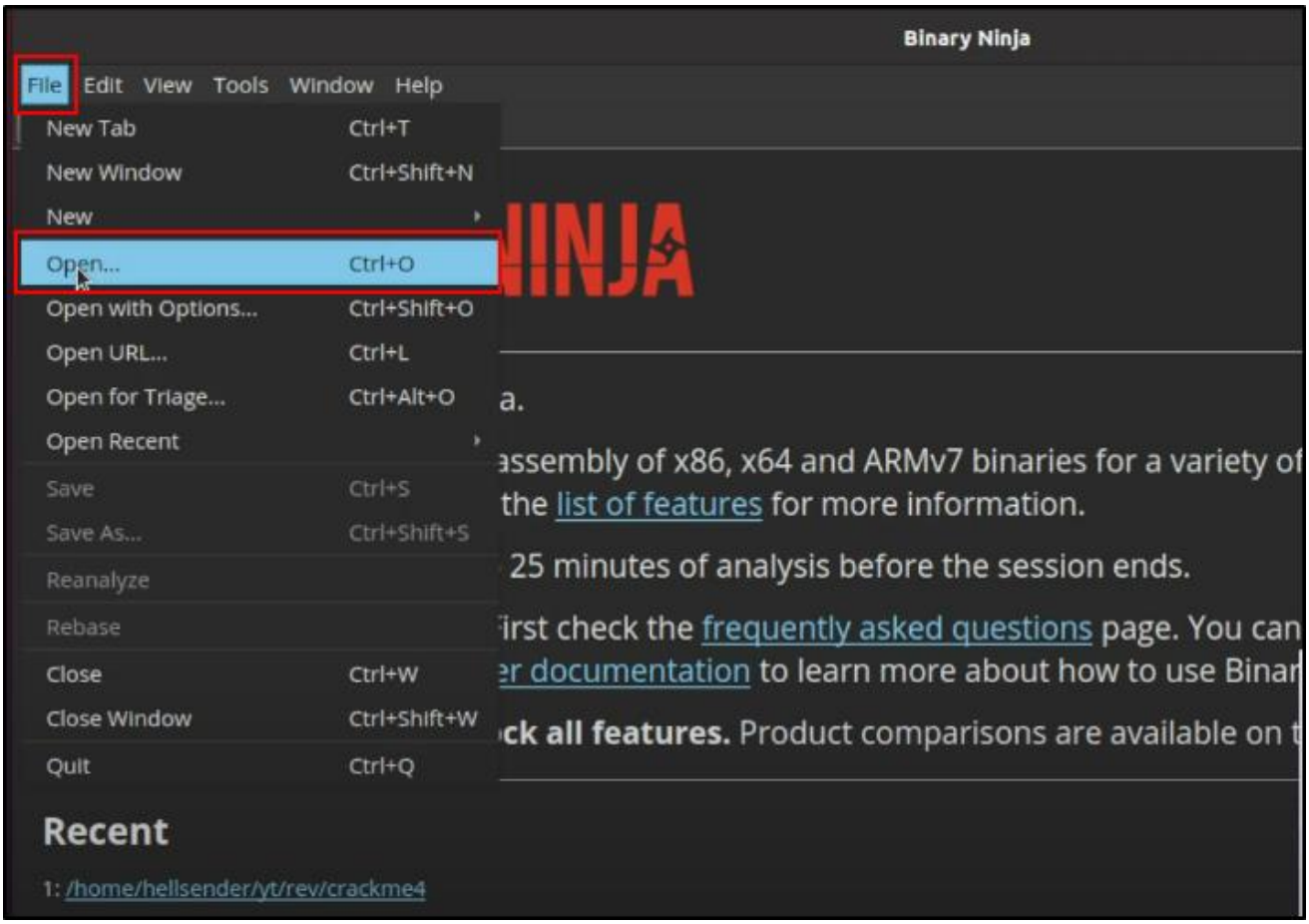
To hum yha binary ninja ka install karenge. Agar hume free use karna hai to cloud pr kr skte hai.

Agar hum offline free version use krna hai to isse bs disassembly aur decompilation pd skte hai aur debugging nhi kr skte hai.

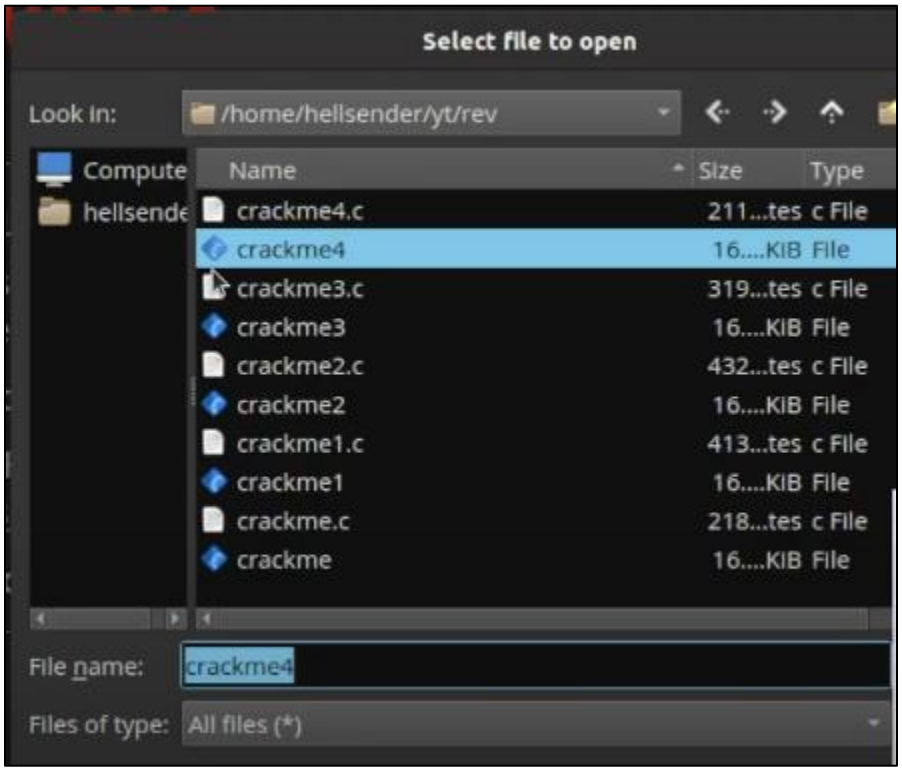
Iska free version sift 30 minute ke liye hi hota hai.

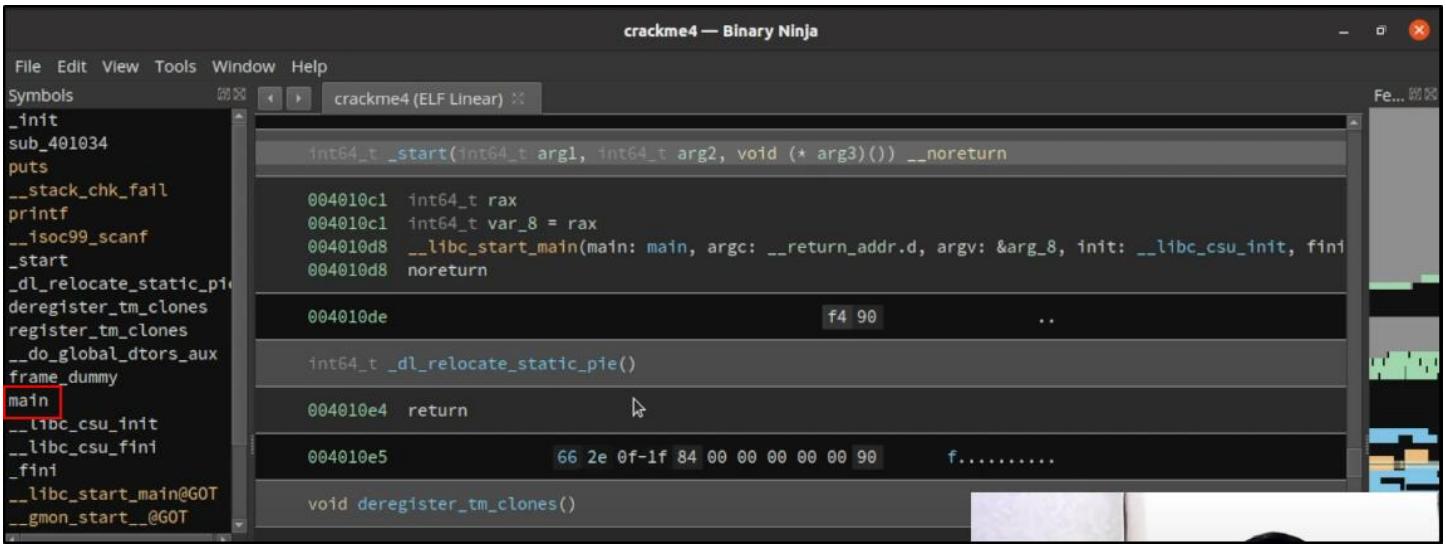
Let’s move on binary ninja.

Sbse phle hum file pr jayenge aur open pr click karenge.

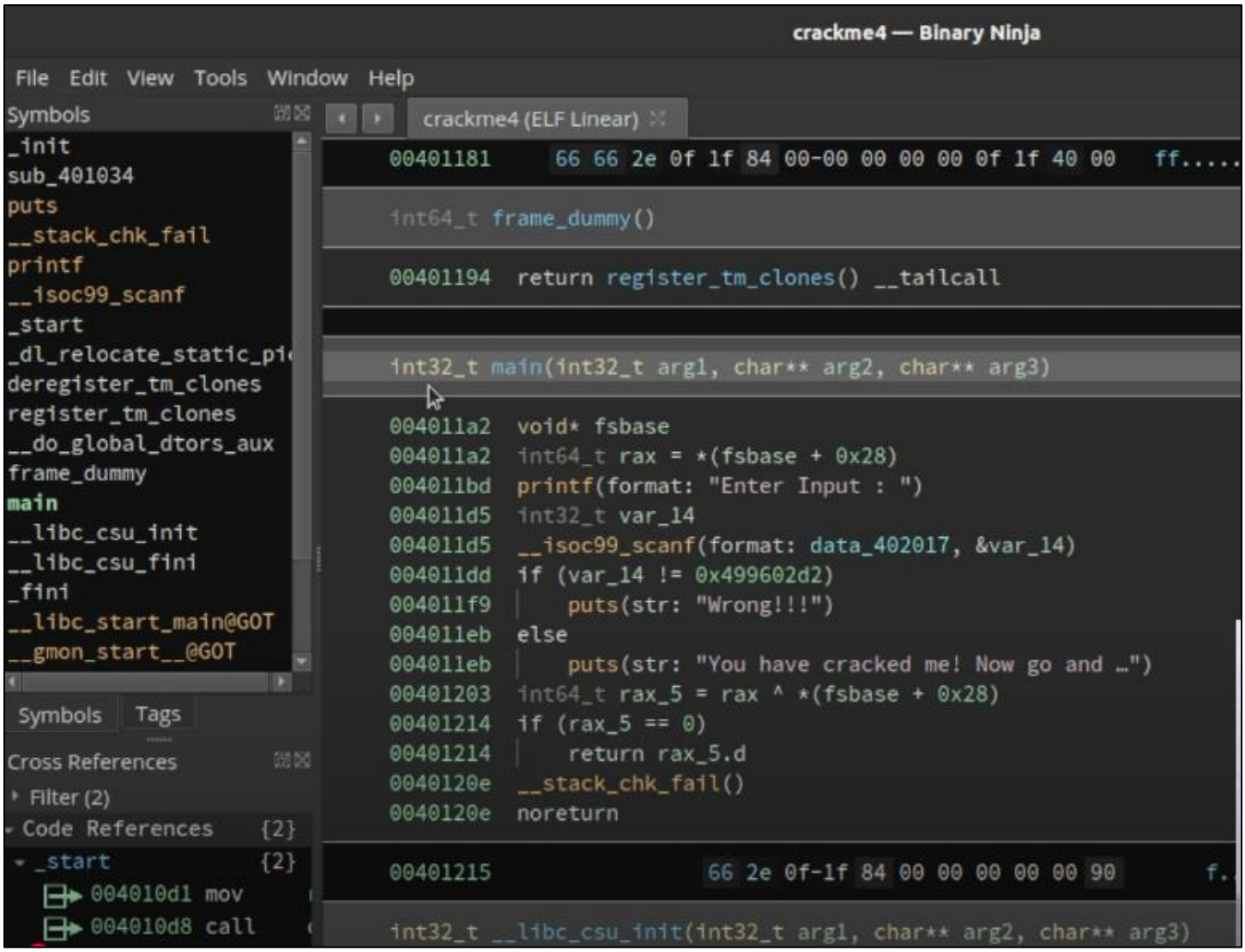


Yha hum crackme4 select karenge aur open pr click kr denge.



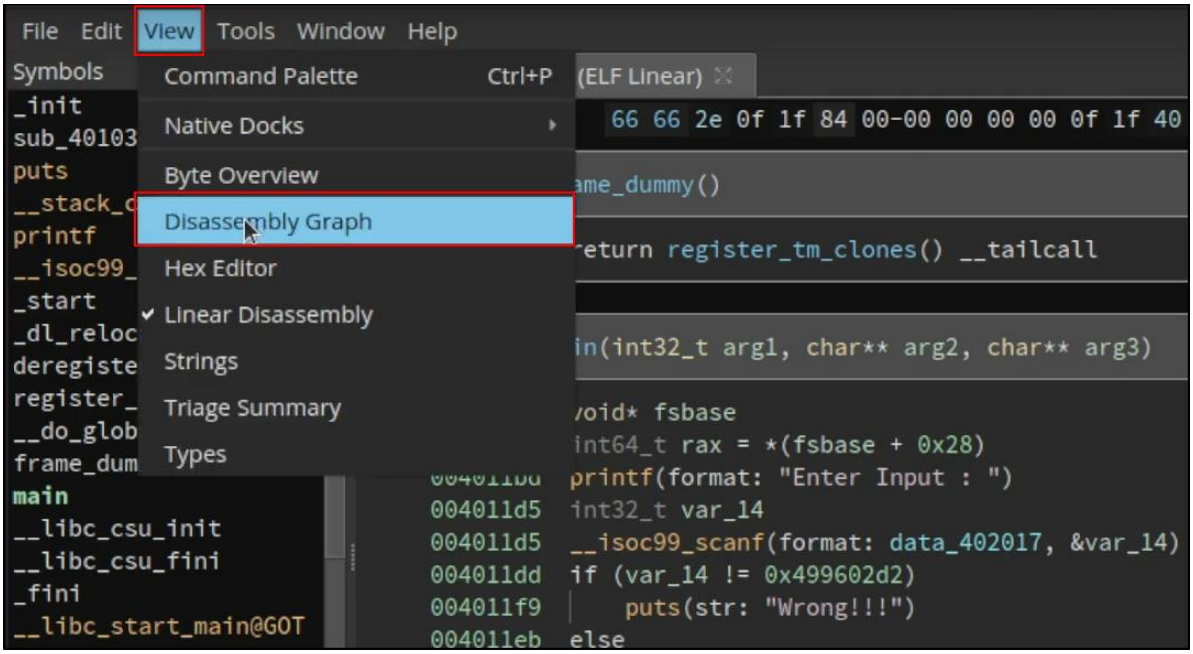


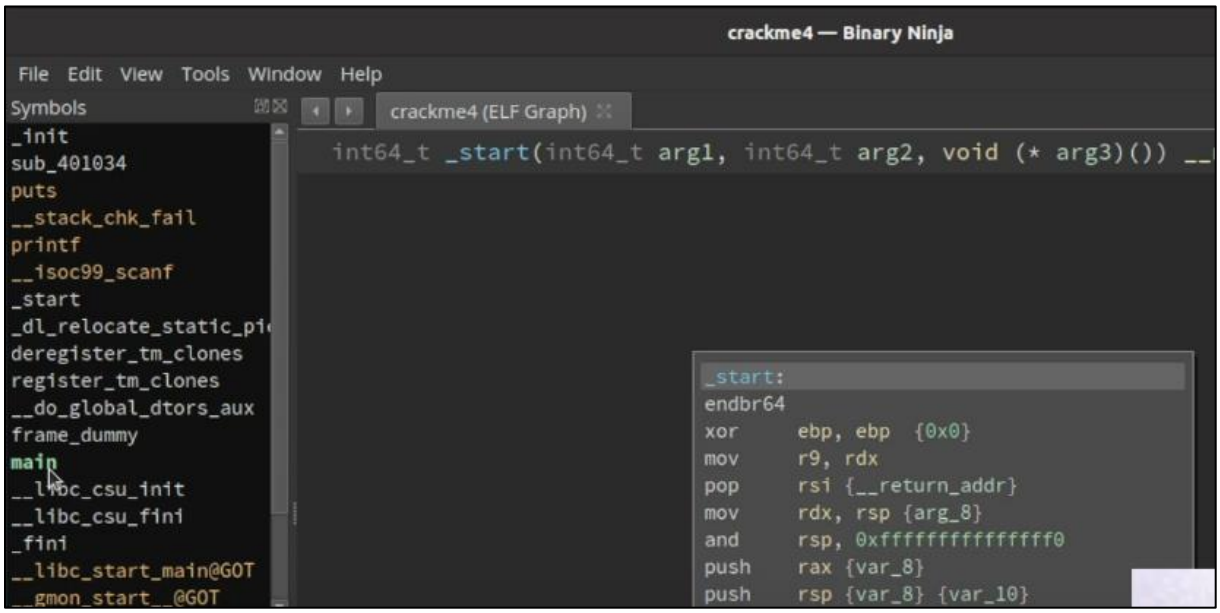
To ye yha pr load ho jayega. Aur hum dekh skte hai main function ko uspr double click karenge. To main function khul jayega.



Yha main khul chuka hai.

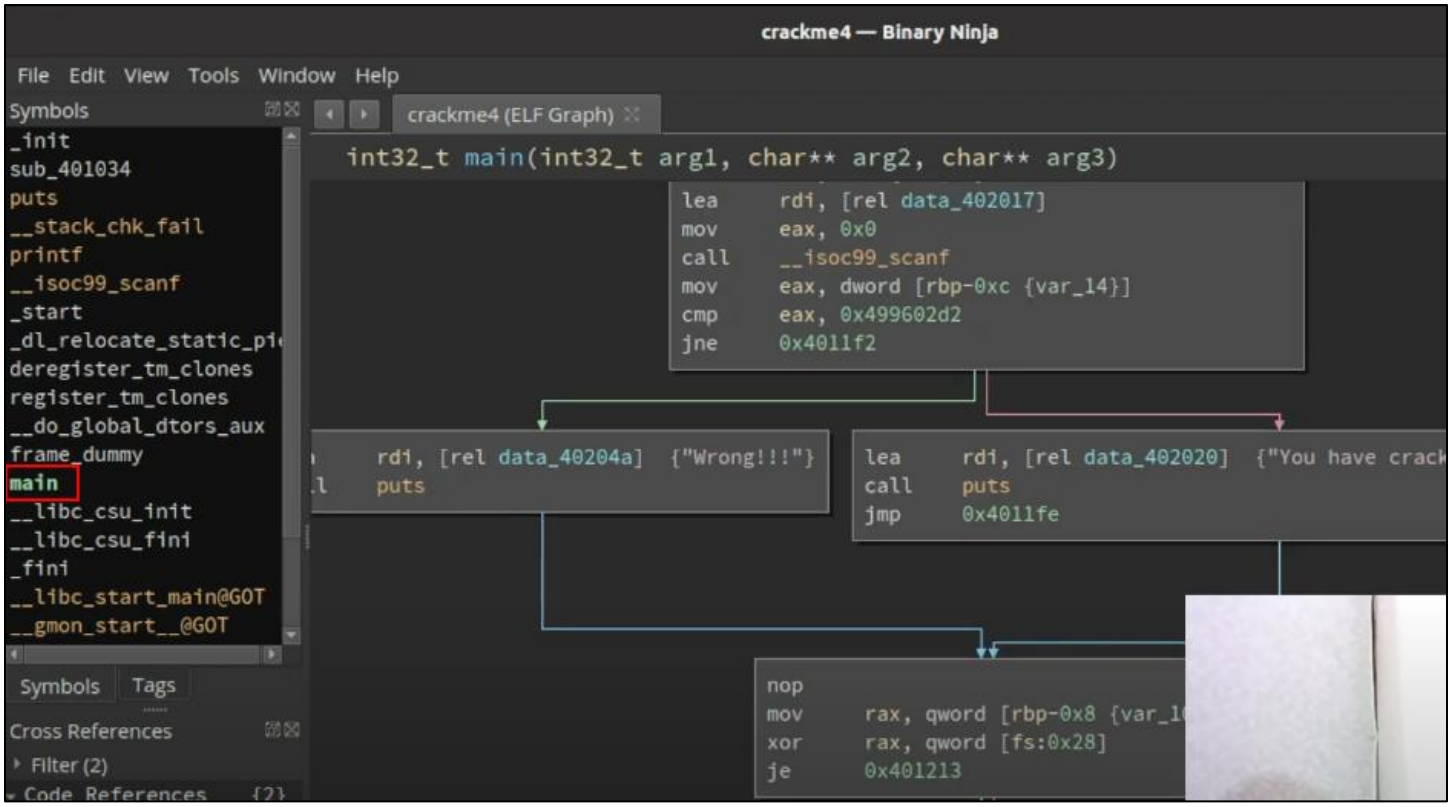
Abhi ye **list view** me show ho rha hai. to view pr jate hai aur **graph view** pr click krte hai.





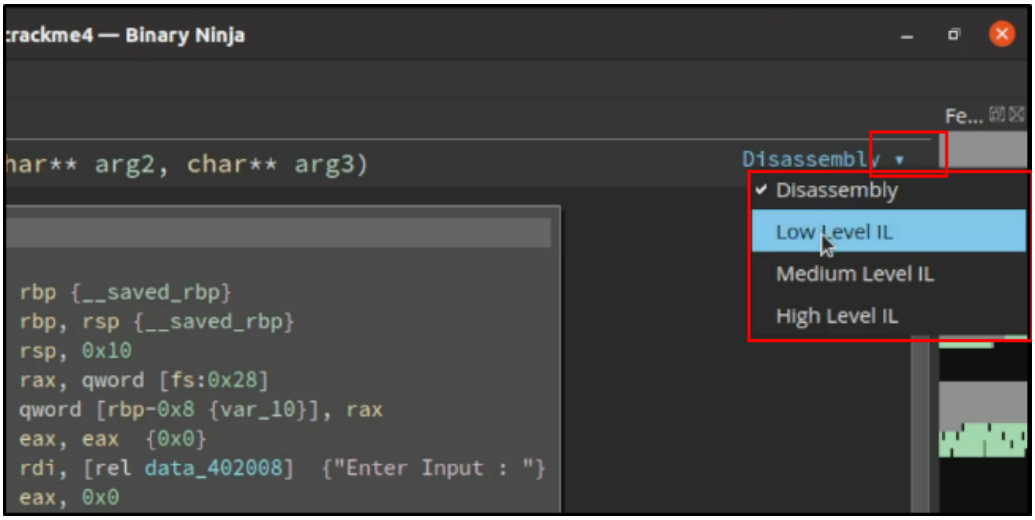
To ye **graph view** me show krne laga.

Hum fir se **main** pr double click karenge.



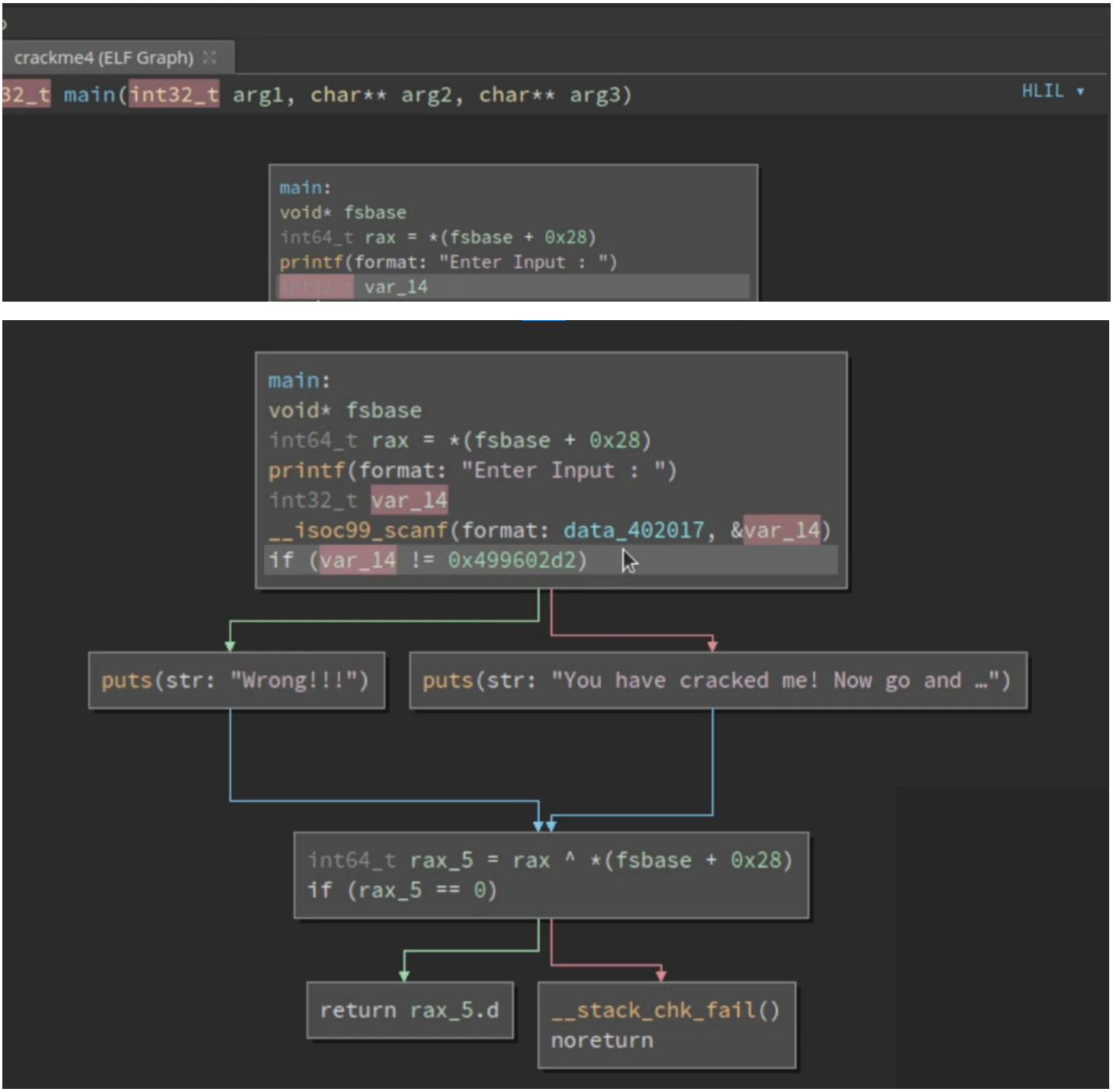
Yha pr main load ho gya. Aur kafi achha view show ho rha hai.

Ye yha pr char tarike se code ko pdne ka option deta hai.

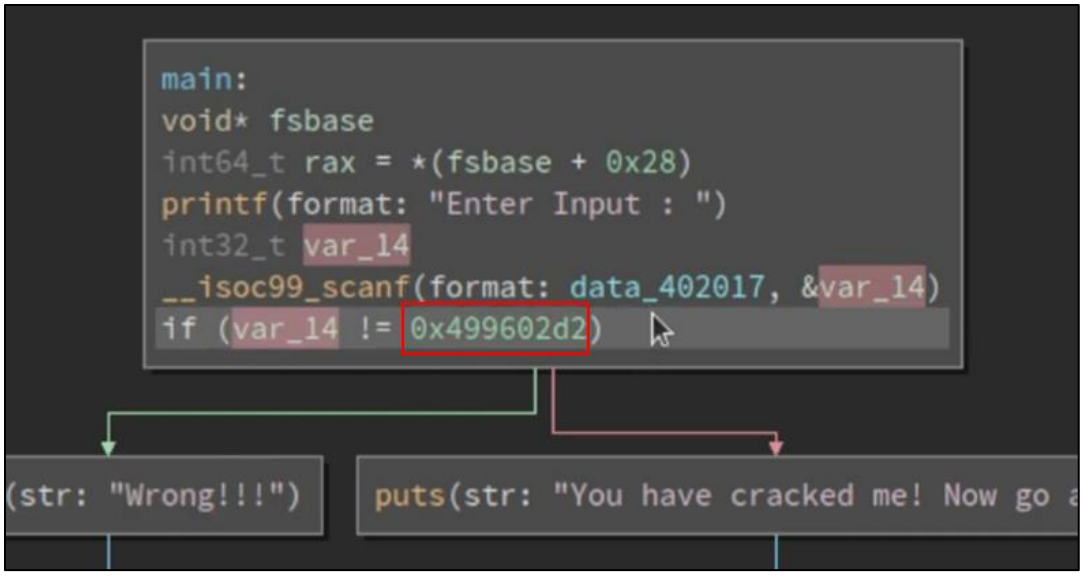


Yha pr **low level** me ye thoda aur human readable bna deta hai. **medium level** thoda aur human readable banata hai. aur **High level** me ye bilkul high level jaisa code banane ki koshish krta hai.

Agar hum high level pr set kare to

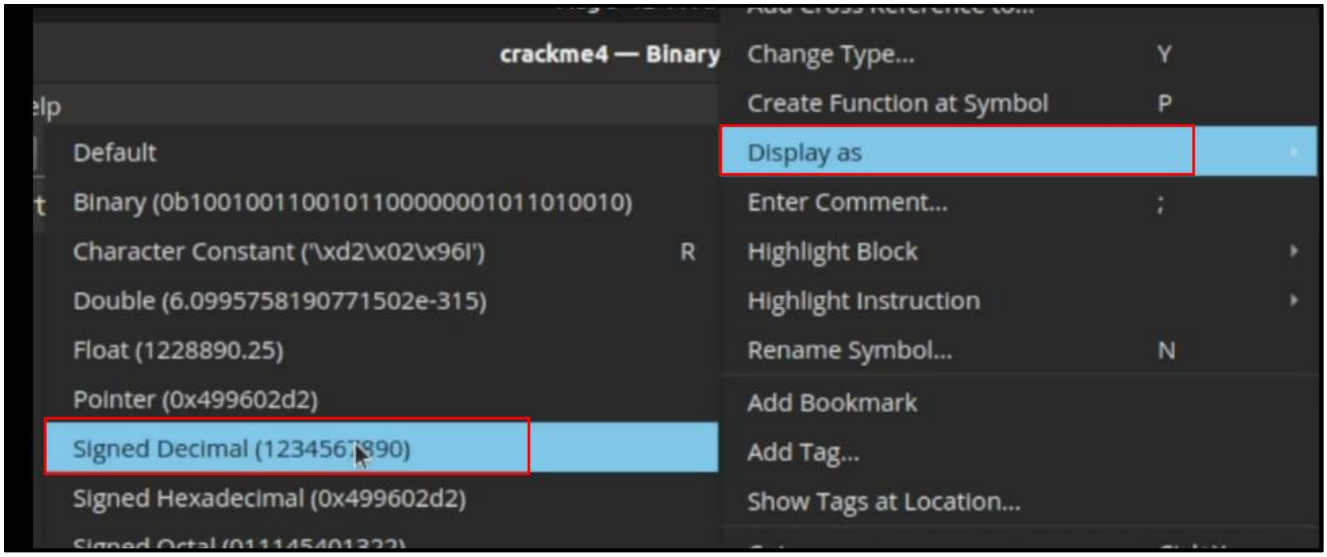


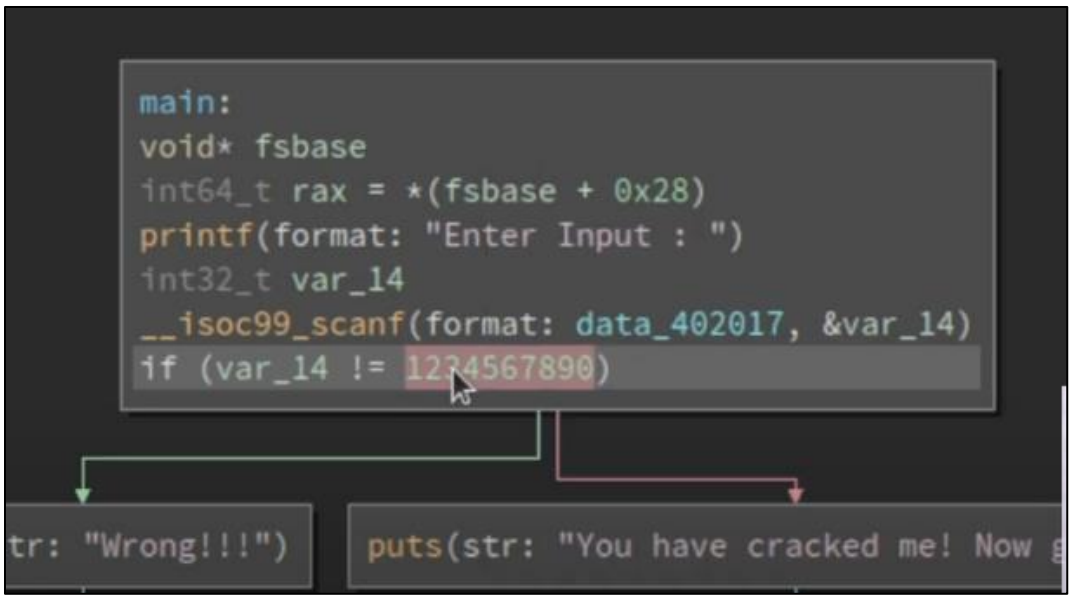
Hum value pr click krke right click karenge.



Aur ise display as **signed Decimal** karenge.

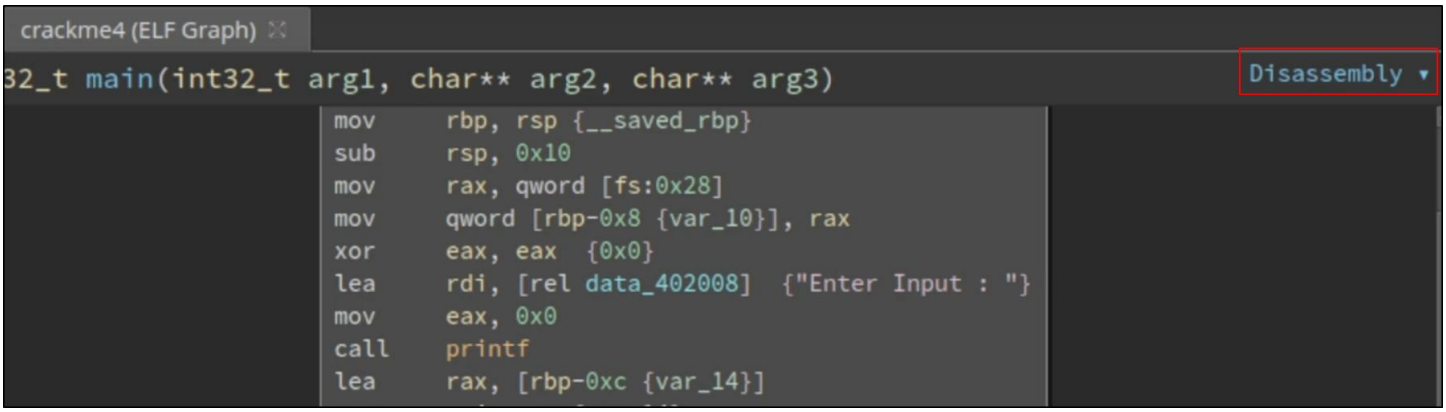
Upar hum dekh skte hai. ki **var_14 int32** type ka hai isliye humne ise integer me covert kiya.

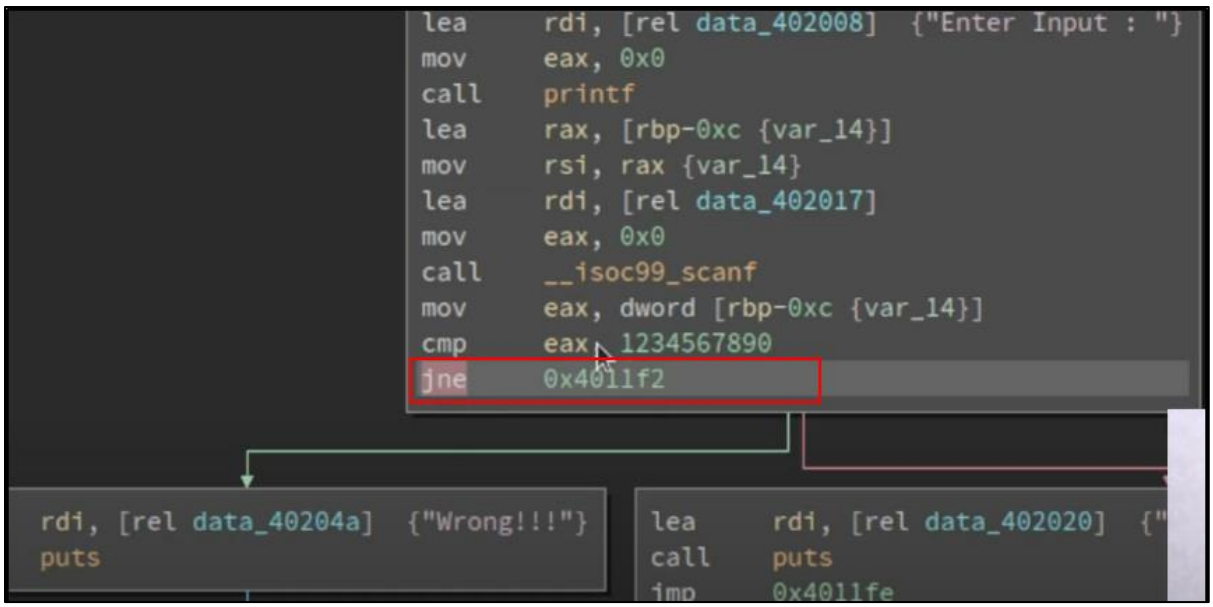




To yha pr hume patch banana hai to yha **!=** ko hum **==** bna ke patch kr denge ki koi bhi chalaye wo correct password print kare even password galat bhi ho.

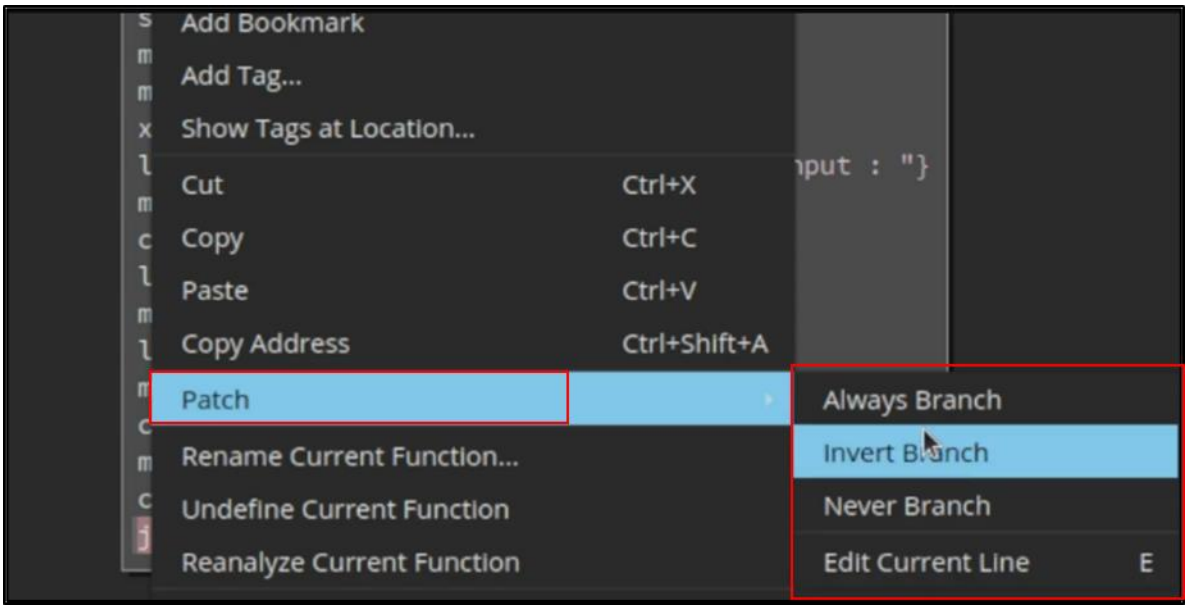
Hum wapas se chalenge disassembly code me.



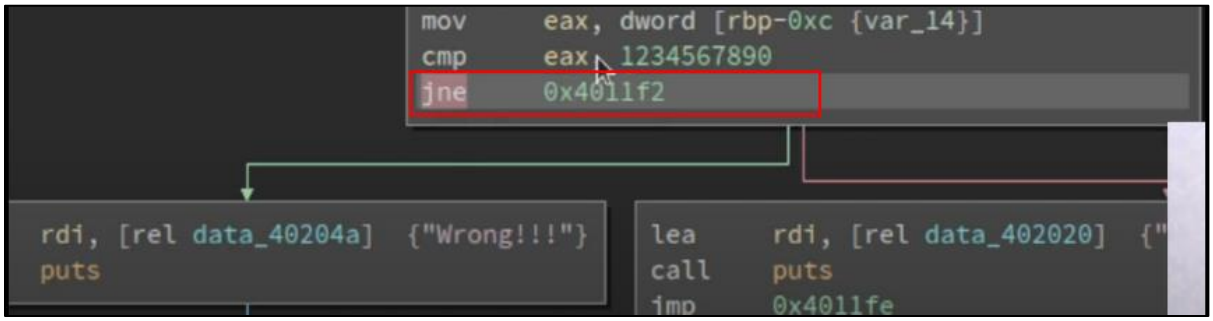


Jne ko change kr denge **je** me.

Agar hum patch pr right click kare to.

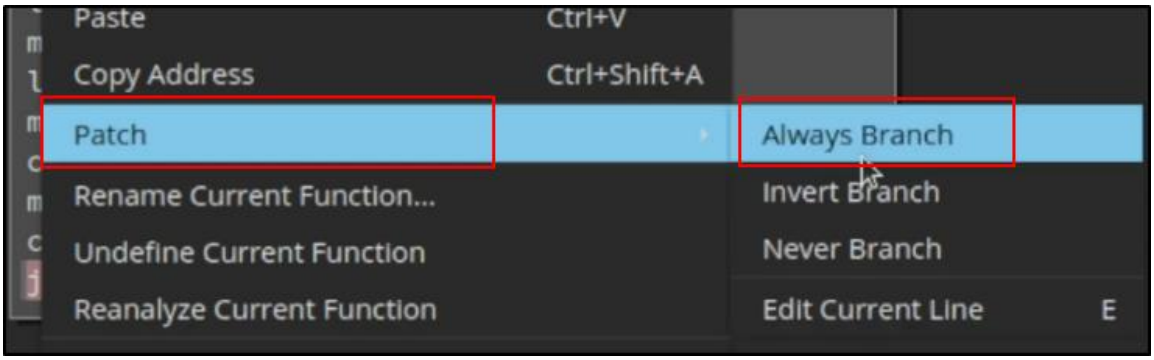


Yha pr humare pass char options hai.

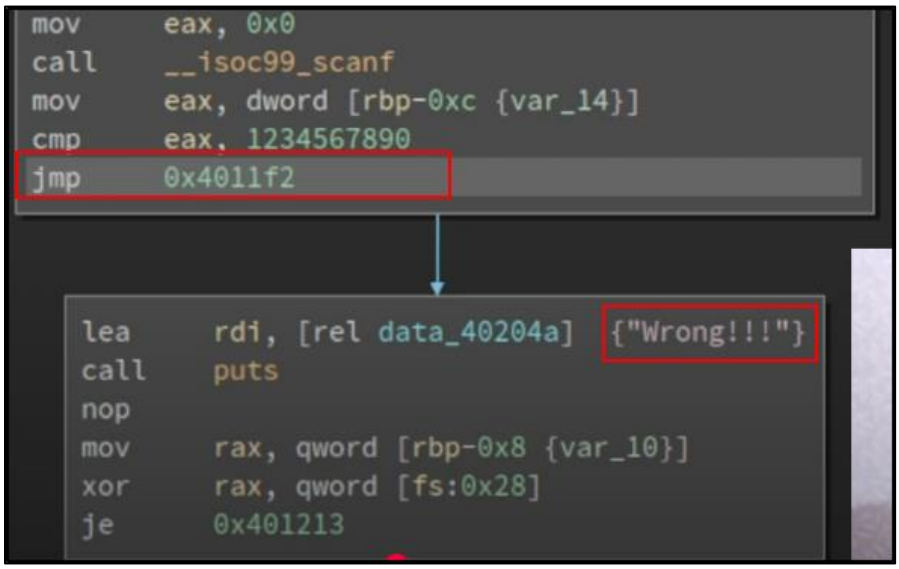


Ye waise **"wrong!!!"** branch jayega kyoki humne galat password diya. hume password nhi pta tha.

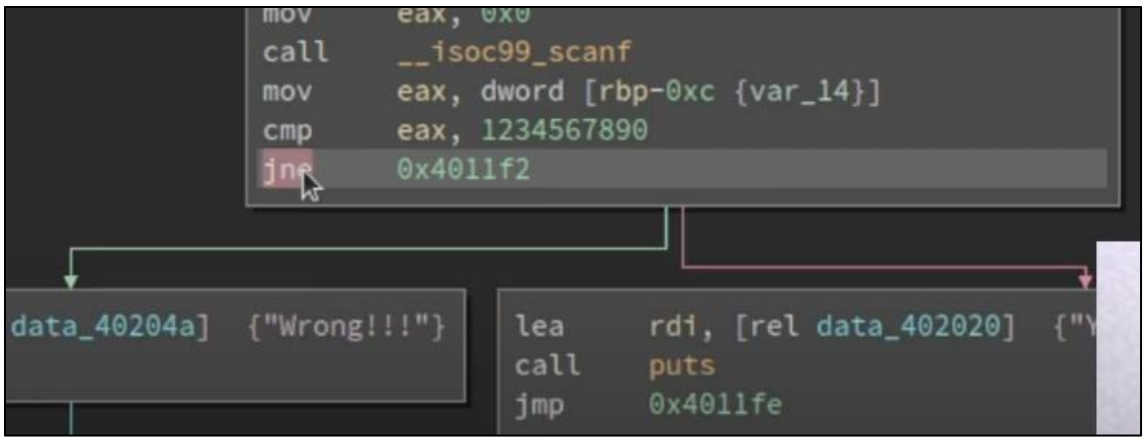
Yha hum always branch krke dekhte hai.



Agar hum always branch karenge to ye correct branch remove kr dega aur hamesa "wrong!!" branch pr le jayega. **Jne** ko **jmp** kr dega.

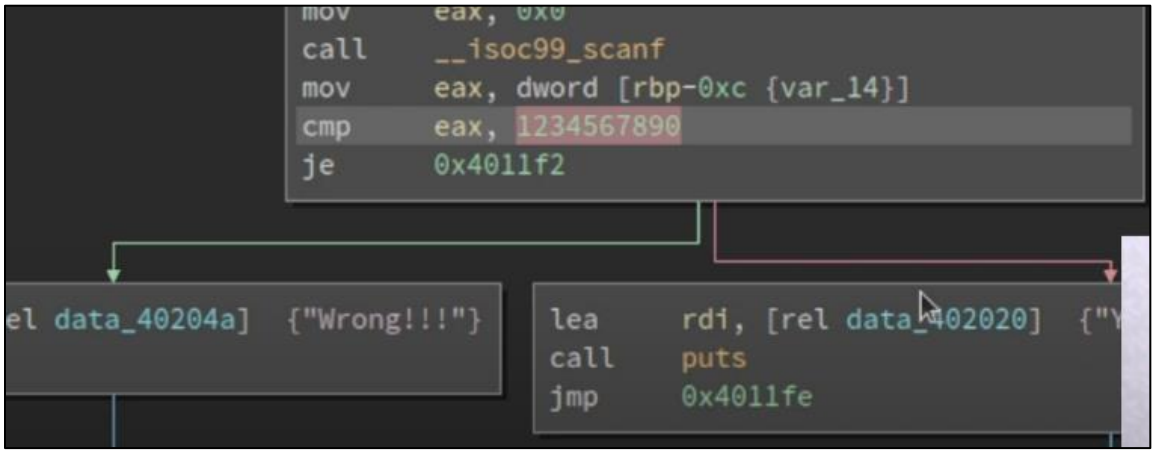


To hum **ctrl+z** krke wapas aate hai hume ye nhi krna.

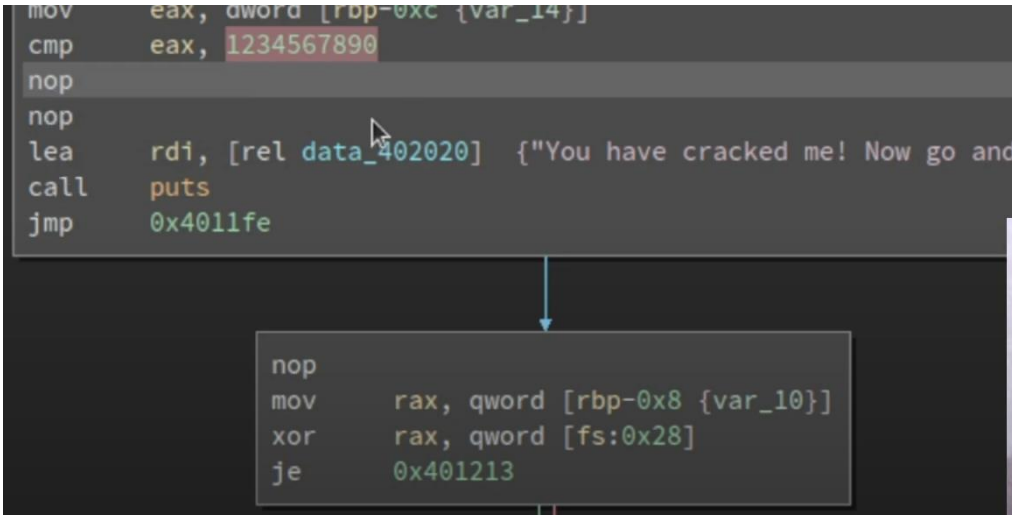


Ab hum invert branch karenge.

Yha humne invert branch kr diya mtlb **1234567890** dale to **wrong** print kr do other **correct password** pr le chalo.

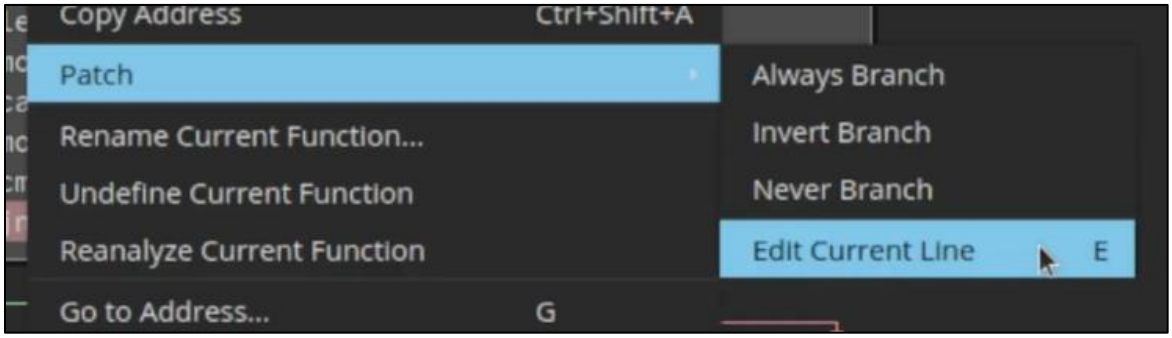


Agar hum never kare to..

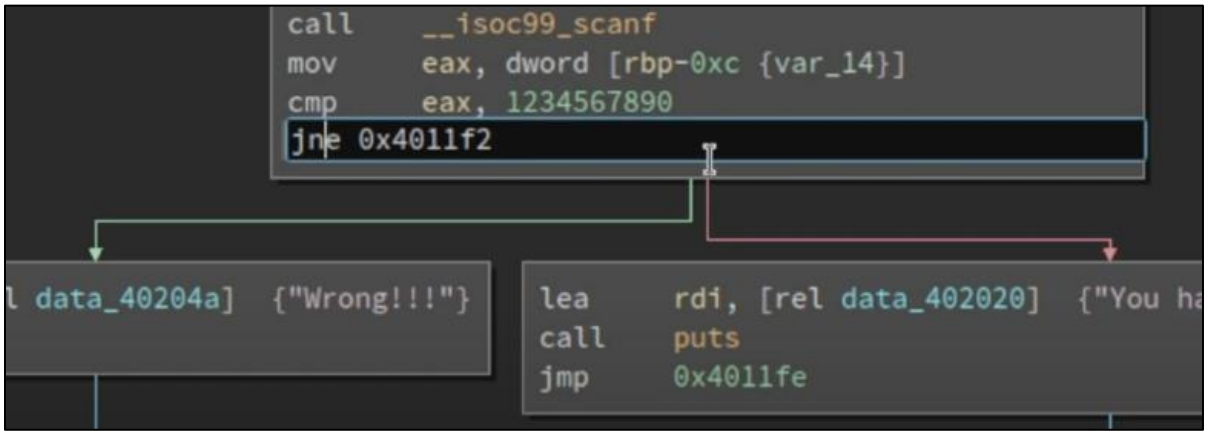


To ye **"wrong!!"** pr jayega hi nhi use nop kr dega. Aur hamesa correct password pr le jayega.

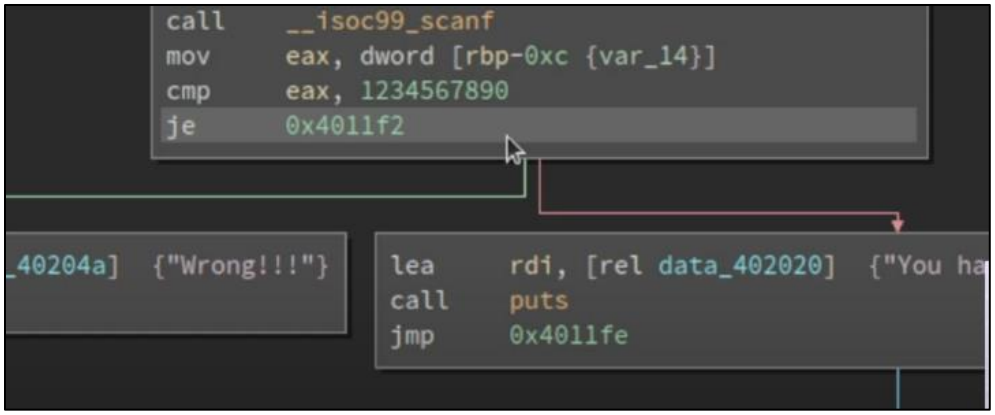
Aur last option.



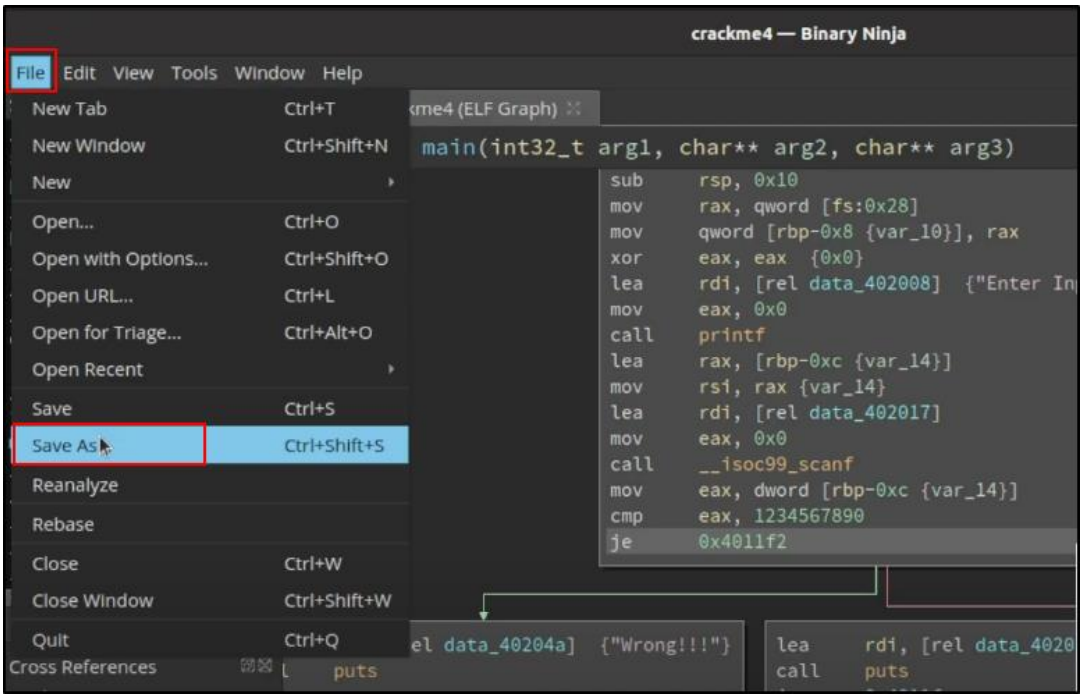
Agar aap khud se krna chahte ho to wo bhi kr skte ho edit krke.

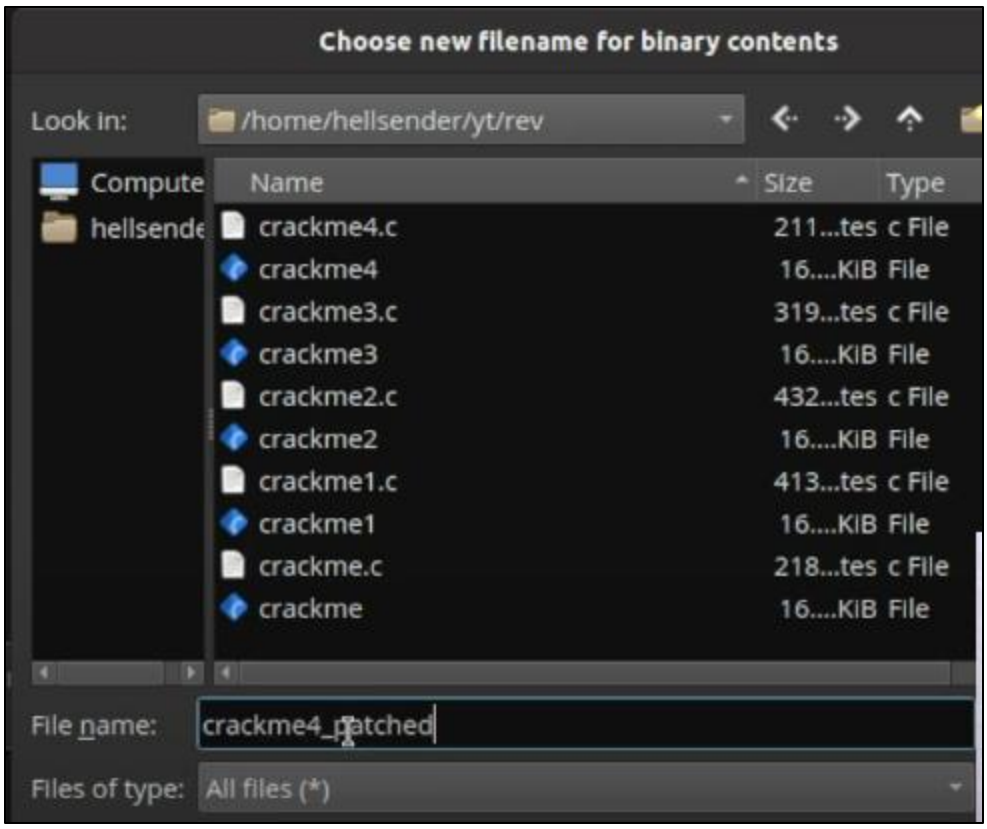


To yha pr hum invert branch kr lete hai.



Aur hum ise **save as** kr lete hai.





Ise run krke dekhte hai.

```
➜ rev chmod +x crackme4_patched
➜ rev ./crackme4_patched
Enter Input : 63327636237
You have cracked me! Now go and patch me!
➜ rev
```

Yha kuch bhi password dalenge to wrong aayega.

```
➜ rev ./crackme4_patched
Enter Input : aasasas
You have cracked me! Now go and patch me!
```

Agar hum sahi password dalenge to wrong aayega.

```
➜ rev ./crackme4_patched
Enter Input : 1234567890
Wrong!!!
➜ rev
```

Ab hum ise kisi ko bhi share kr skte hai. wo ise use kr skta hai.

==========

Yha pr ek aur **disassembler** ki hum bat kr lete hai. **objdump** jo commad line pr disassemble krke dikha deta hai.

```
➜ rev objdump -D crackme4 -M intel --disassemble=main
```

-D for disassemble file

-M intel for intel flavor

--disassembler=main for disassemble only main function otherwise it will disassemble all functions.

```
hellsender@hellsender:~/yt/rev 116x28

Disassembly of section .init:

Disassembly of section .plt:

Disassembly of section .plt.sec:

Disassembly of section .text:

0000000000401196 <main>:
  401196:       f3 0f 1e fa             endbr64
  40119a:       55                      push   rbp
  40119b:       48 89 e5                mov    rbp,rsp
  40119e:       48 83 ec 10             sub    rsp,0x10
  4011a2:       64 48 8b 04 25 28 00    mov    rax,QWORD PTR fs:0x28
  4011a9:       00 00
  4011ab:       48 89 45 f8             mov    QWORD PTR [rbp-0x8],rax
  4011af:       31 c0                   xor    eax,eax
  4011b1:       48 8d 3d 50 0e 00 00    lea    rdi,[rip+0xe50]        # 402008
  4011b8:       b8 00 00 00 00          mov    eax,0x0
  4011bd:       e8 ce fe ff ff          call   401090 <printf@plt>
  4011c2:       48 8d 45 f4             lea    rax,[rbp-0xc]
  4011c6:       48 89 c6                mov    rsi,rax
  4011c9:       48 8d 3d 47 0e 00 00    lea    rdi,[rip+0xe47]        # 402017
```

Yha pr ye **opcodes (Operation Codes)** hai.

Jaisa ki jante hai humara processor **call, mov, sub, add instructions** ko pdkar nhi samajh pata ki use kya krna hai. wo inhi **opcode** ko pdkr samajhta hai ki use kya krna hai.

```
0000000000401196 <main>:
  401196:       f3 0f 1e fa             endbr64
  40119a:       55                      push   rbp
  40119b:       48 89 e5                mov    rbp,rsp
  40119e:       48 83 ec 10             sub    rsp,0x10
  4011a2:       64 48 8b 04 25 28 00    mov    rax,QWORD PTR fs:0x28
  4011a9:       00 00
  4011ab:       48 89 45 f8             mov    QWORD PTR [rbp-0x8],rax
  4011af:       31 c0                   xor    eax,eax
  4011b1:       48 8d 3d 50 0e 00 00    lea    rdi,[rip+0xe50]        # 402008
```

To yha pr do opcodes hai. **75 0e** to isme ka **First opcode (75)** hume batata hai ki kaun sa instruction use ho rha hai. Aur **Second opcode(oe)** hume **offset** batata hai ki hume kitna dur jump krni hai.

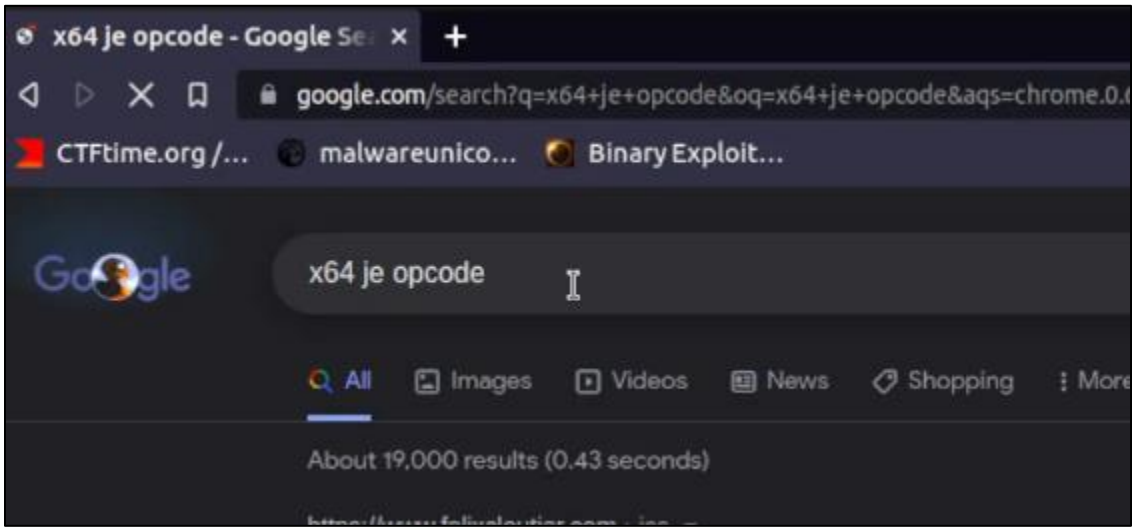
```
4011d5:      e8 c6 fe ff ff          call   4010a0 <__isoc99_scanf@plt>
4011da:      8b 45 f4                mov    eax,DWORD PTR [rbp-0xc]
4011dd:      3d d2 02 96 49          cmp    eax,0x499602d2
4011e2:      75 0e                   jne    4011f2 <main+0x5c>
4011e4:      48 8d 3d 35 0e 00 00    lea    rdi,[rip+0xe35]        # 402020 <_IO
4011eb:      e8 80 fe ff ff          call   401070 <puts@plt>
4011f0:      eb 0c                   jmp    4011fe <main+0x68>
4011f2:      48 8d 3d 51 0e 00 00    lea    rdi,[rip+0xe51]        # 40204a <_IO
```

Kitni line bad hai. **4011e4**se **4011f2** ki duri kitni hai. use second opcode batata hai.

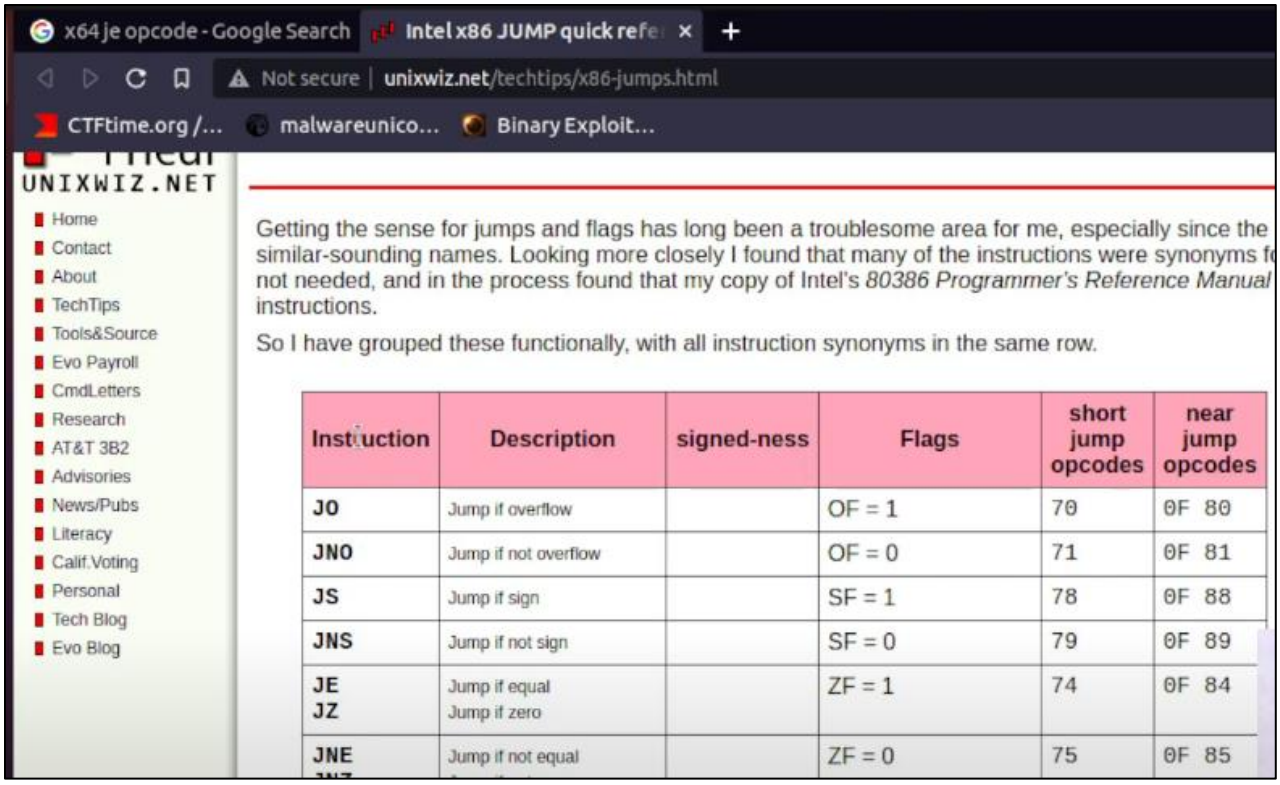
```
4011dd:      3d d2 02 96 49          cmp    eax,0x499602d2
4011e2:      75 0e                   jne    4011f2 <main+0x5c>
4011e4:      48 8d 3d 35 0e 00 00    lea    rdi,[rip+0xe35]
4011eb:      e8 80 fe ff ff          call   401070 <puts@plt>
4011f0:      eb 0c                   jmp    4011fe <main+0x68>
4011f2:      48 8d 3d 51 0e 00 00    lea    rdi,[rip+0xe51]
4011f9:      e8 72 fe ff ff          call   401070 <puts@plt>
4011fe:      90                      nop
```

To yha pr hum **jne** ke opcode ko **je** ke opcode se replace kr denge.

Agar hum **je** ka **opcode** pta krna ho to isi disassembly me dekh skte hai ya fir google kr skte hai.



Uske bad hum kisi bhi website se dekh skte hai.



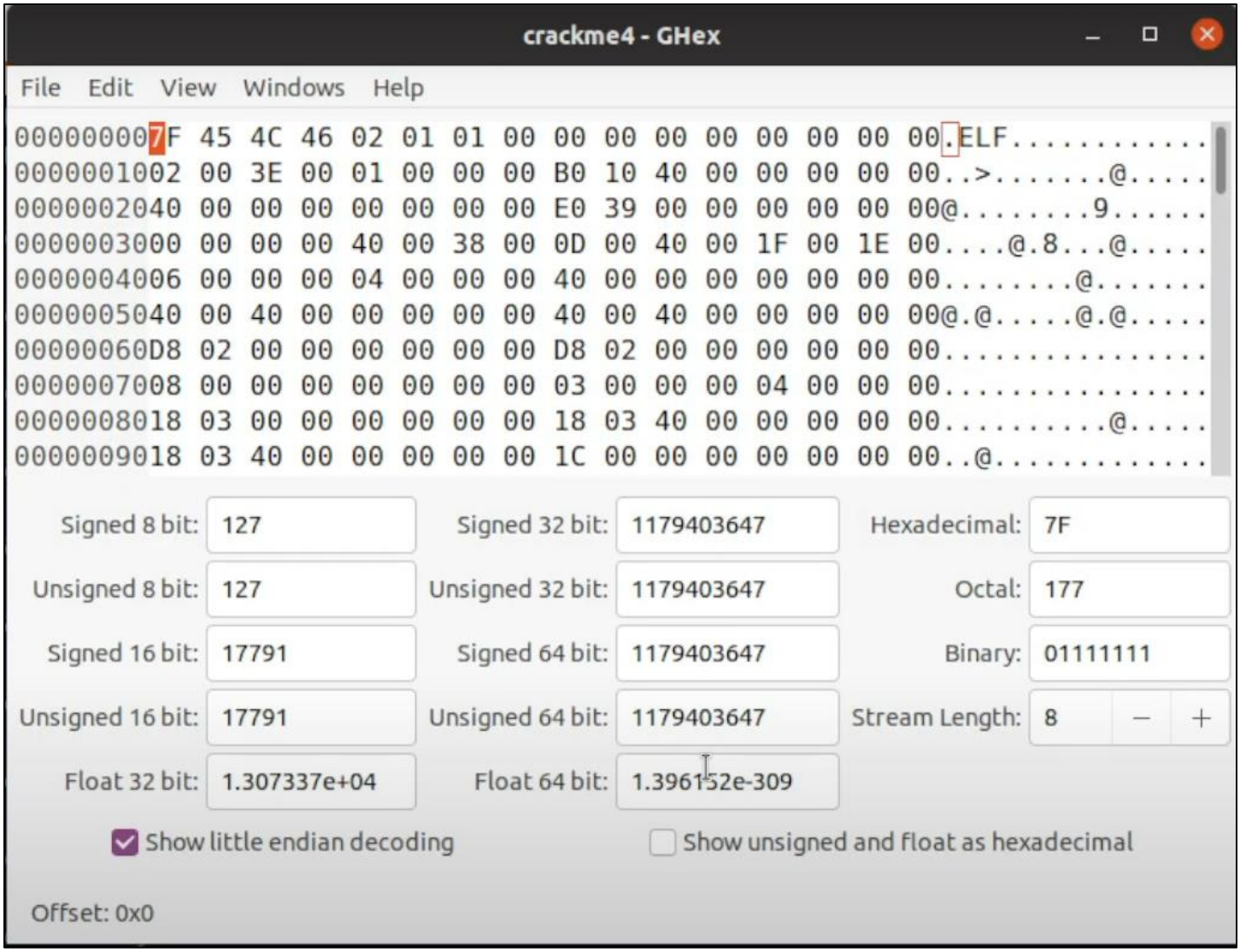
JE **JZ**	Jump if equal Jump if zero		ZF = 1	74	0F 84
JNE **JNZ**	Jump if not equal Jump if not zero		ZF = 0	75	0F 85

Ab ise edit krne ke liye hum **hexeditor** ka use karenge. Yha pr koi bhi hex **editor** use kr skte hai.

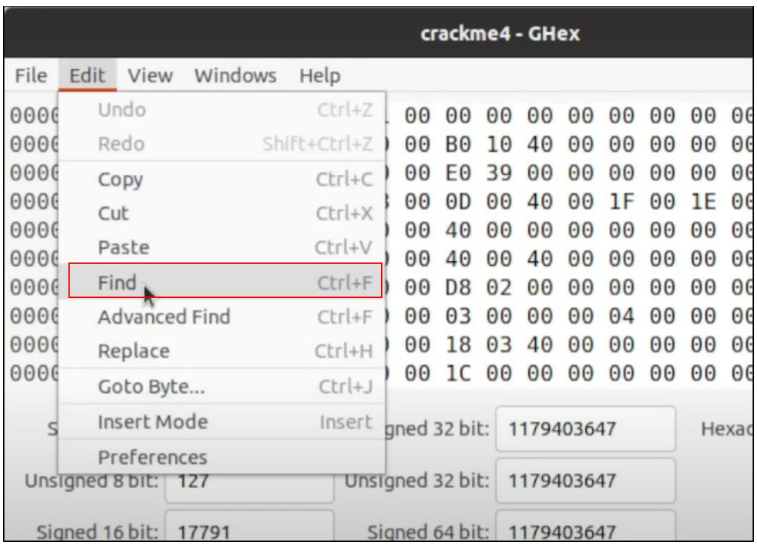
As we know **hexeditor** kisi binary ke **opcodes** ko show krta hai.

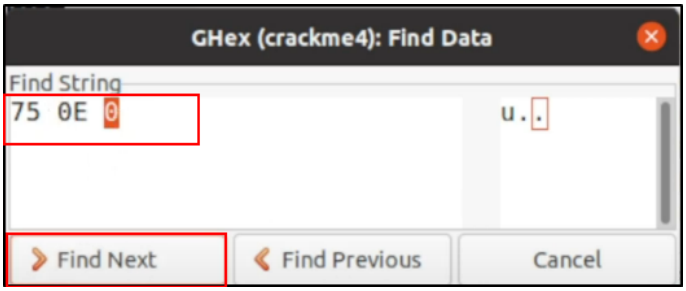
Agar aap **cli hexeditor** chahiye to **hexedit** use kr skte hai.

Yha pr hum **ghex** use karenge isko krne ke liye.

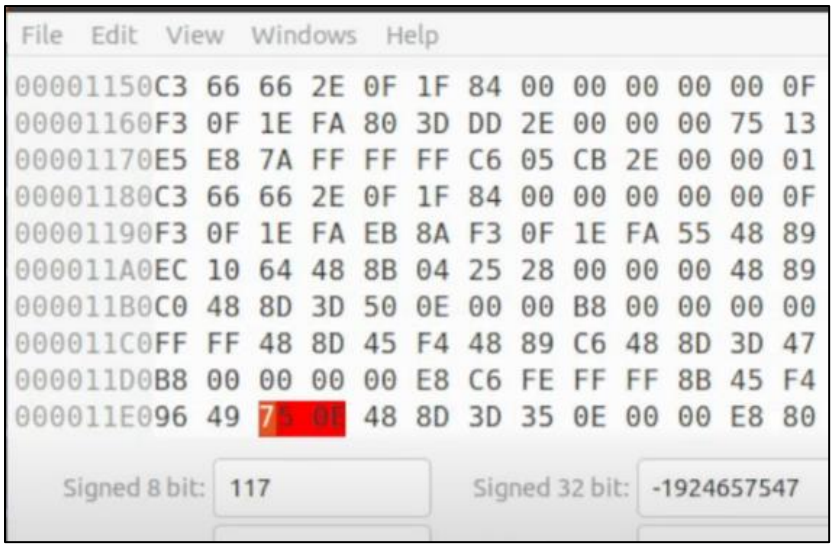


Ab yha pr apna **opcode** find karenge. Jo ki 75 0e tha. Hume uske aas pas ka 5-6 opcodes ko find krna chahiye tabhi hum apna wala sahi opcode find kr payenge.

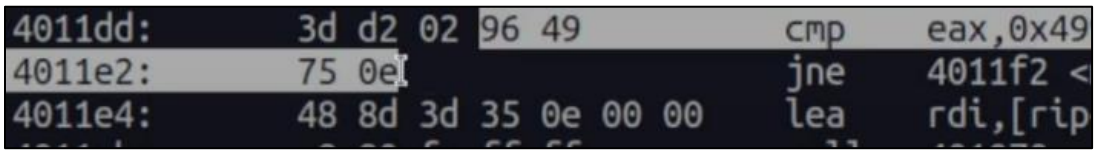




To ise mil gya ki yha pr ye wala opcode hai.



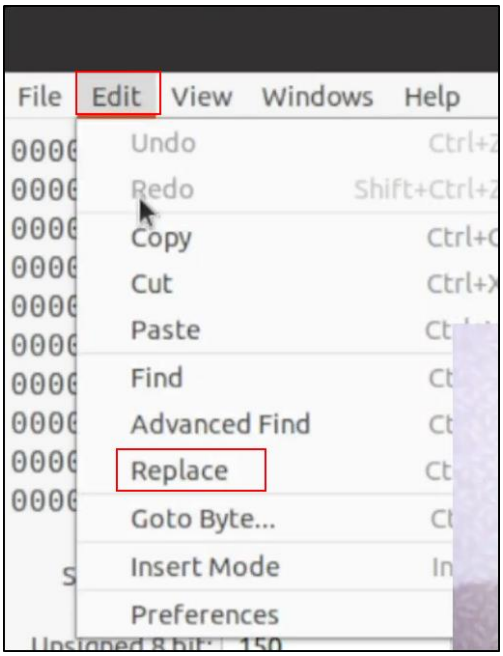
Iske aage aur piche ke opecodes jarur match kr le.

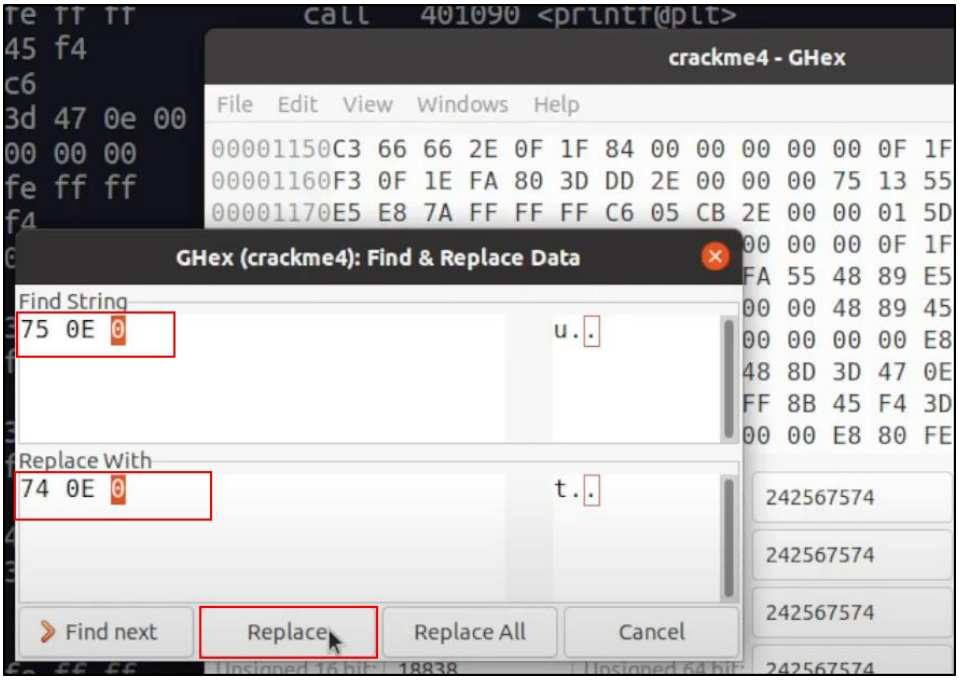


Jaisa ki dono me hai 96 49 **75 0e** 48 8d 3d jo ki sahi hai. yha capital aur small matter nhi krta hai.

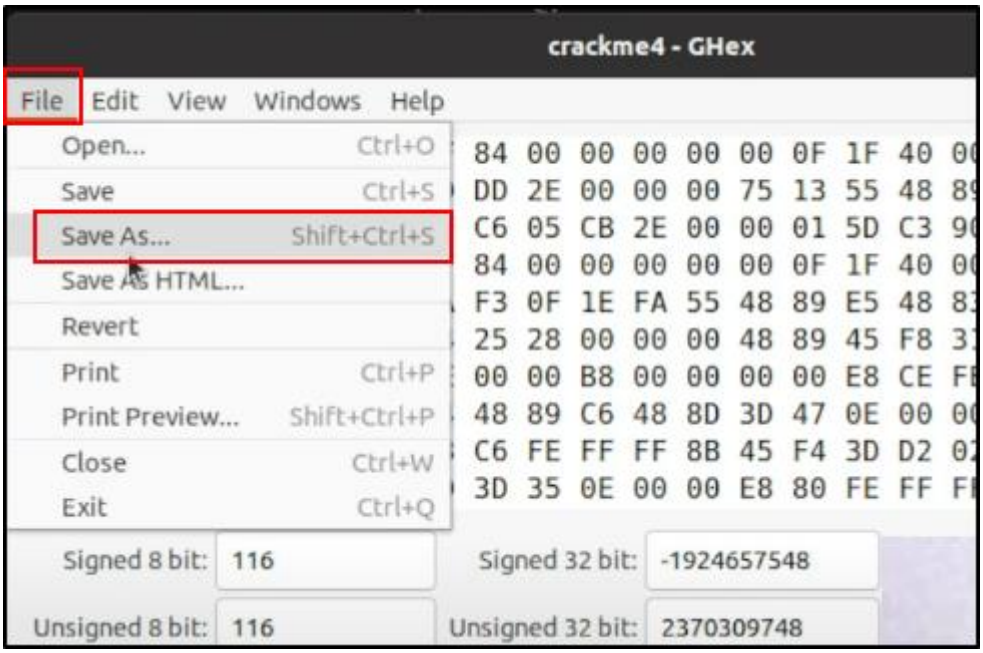
Yha achhe se match jarur ke le otherwise ek hi byte pure binary ko corrupt kr skti hai.

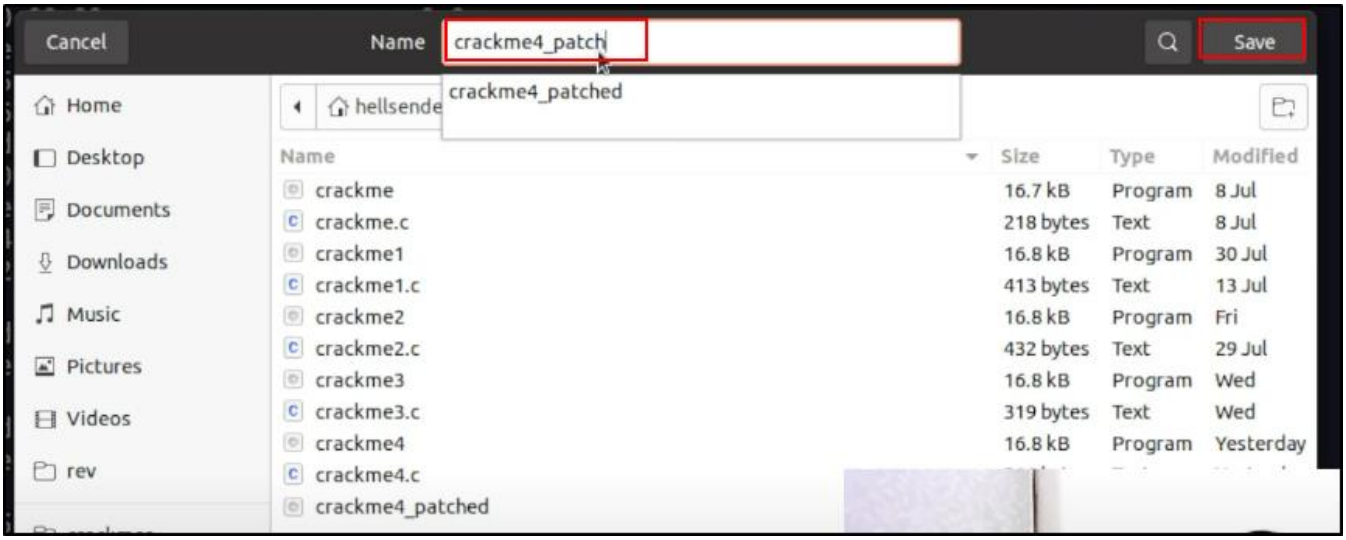
Ab hum replace karenge.





Ab hum ise **save as** kr denge.





Run and test.

```
→ rev chmod +x crackme4_patch
→ rev ./crackme4_patch
Enter Input : 1234567
You have cracked me! Now go and patch me!
→ rev
```

Agar hum disassembly me dekhe to.

```
→ rev objdump -D crackme4_patch -M intel --disassemble=main
```

```
4011da:       8b 45 f4                mov    eax,DWORD PTR [rbp-0xc]
4011dd:       3d d2 02 96 49          cmp    eax,0x499602d2
4011e2:       74 0e                   je     4011f2 <main+0x5c>
4011e4:       48 8d 3d 35 0e 00 00    lea    rdi,[rip+0xe35]
4011eb:       e8 80 fe ff ff          call   401070 <puts@plt>
```

Is tarah ki software ko hum generally **cracked** software but ye **patched** software hote hai.

##

Anti-Reversing Techniques, How To Deal With Stripped Binaries

```
→ rev ./crackme5
[BINARY] [KEY]
→ rev ./crackme5 12345678
Bad Serial
→ rev
```

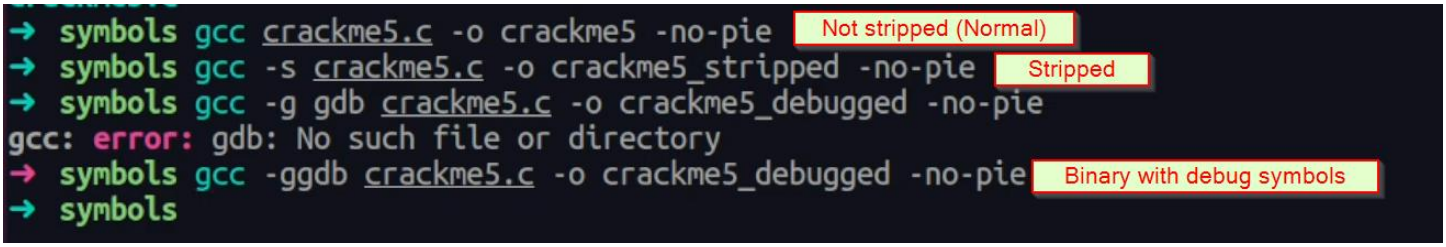
```
→ rev strings crackme5
/lib64/ld-linux-x86-64.so.2
;vB\
libc.so.6
exit
puts
strlen
__libc_start_main
GLIBC_2.2.5
__gmon_start__
H=@@@
[]A\A]A^A_
[BINARY] [KEY]
Bad Serial
Good Serial
:*3$"
GCC: (Ubuntu 9.3.0-17ubuntu1~20.04) 9.3.0
.shstrtab
.interp
```

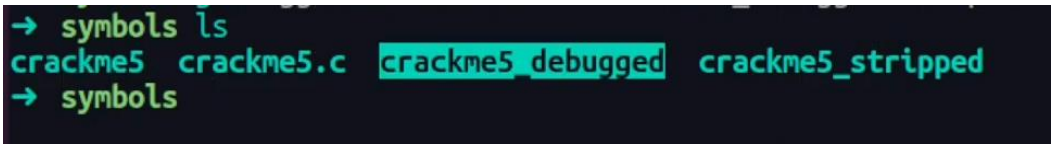
Jaisa ki hum jante hai. binary 2 type ki hoti hai **stripped** and **not stripped**.

Ek aur type hota hai. **binary with debug symbols**

Binary with debug symbols – Isme pura source code chala jata hai jo debugger ko bahut help krta hai. ye debug purpose ke liye hi taiyar kiya jata hai.

Let's create these all.





Yha hum pwndbg ka use karenge. Jiske liye hum iska official github profile visite kr skte hai.

How to install it.

https://github.com/pwndbg/pwndbg

Let's open these files in **gdb**.

Sabse phle hum **stripped** binary ko open krte hai.

```
➜ symbols gdb crackme5_stripped
GNU gdb (Ubuntu 9.2-0ubuntu1~20.04) 9.2
Copyright (C) 2020 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
    <http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
pwndbg: loaded 195 commands. Type pwndbg [filter] for a list.
pwndbg: created $rebase, $ida gdb functions (can be used with print/break)
Reading symbols from crackme5_stripped...
(No debugging symbols found in crackme5_stripped)
pwndbg>
```

Yha isko koi bhi debugging symbols nhi mile.

Ab isme functions dekhte hai.

```
pwndbg> info functions
All defined functions:

Non-debugging symbols:
0x0000000000401060  puts@plt
0x0000000000401070  strlen@plt
0x0000000000401080  exit@plt
pwndbg>
```

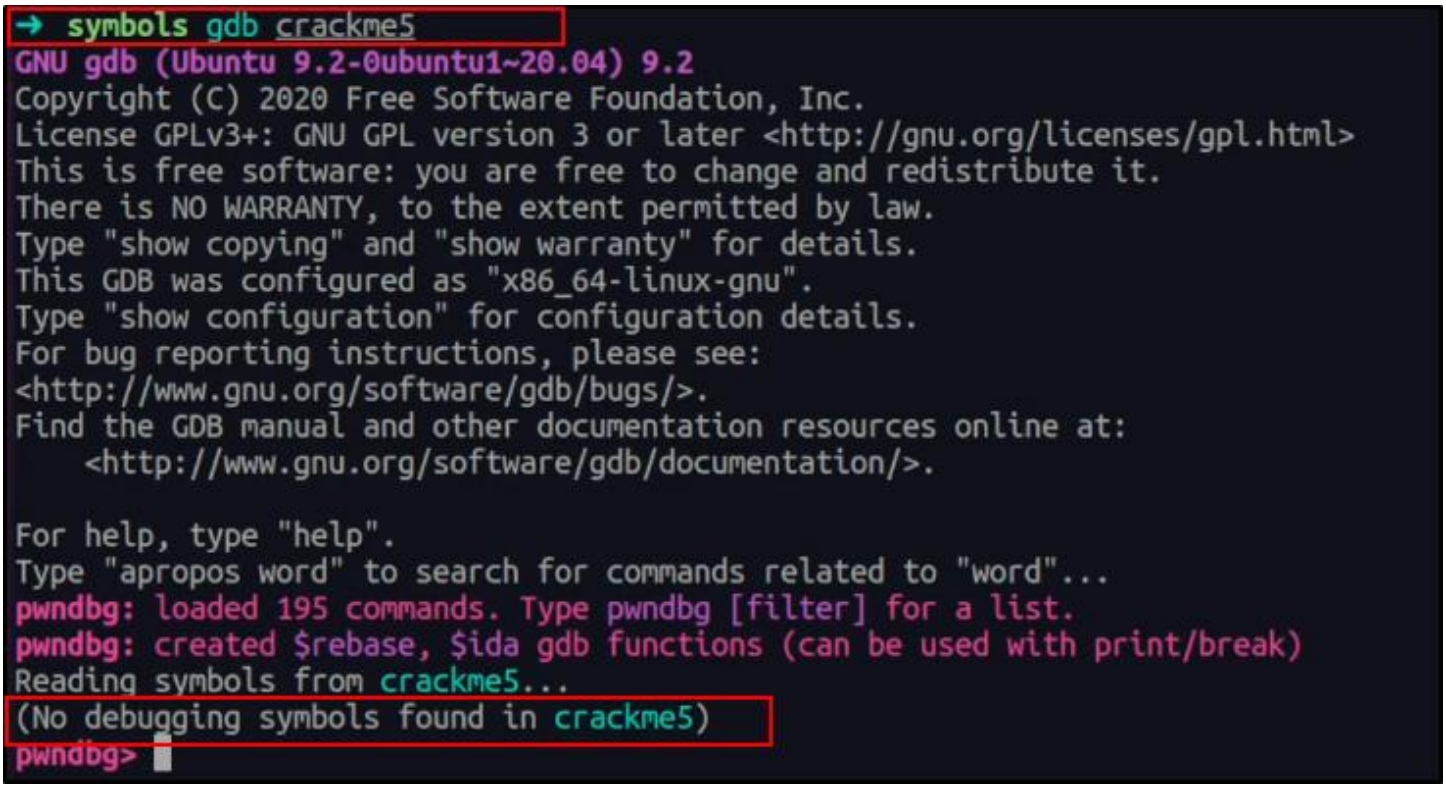
Yha pr sirf teen functions hi dikhe yh bhi nhi pta chala ki main function hai ki nhi.

Agar hum main ko disassemble kare to.

```
pwndbg> disassemble main
No symbol table is loaded.  Use the "file" command.
pwndbg>
```

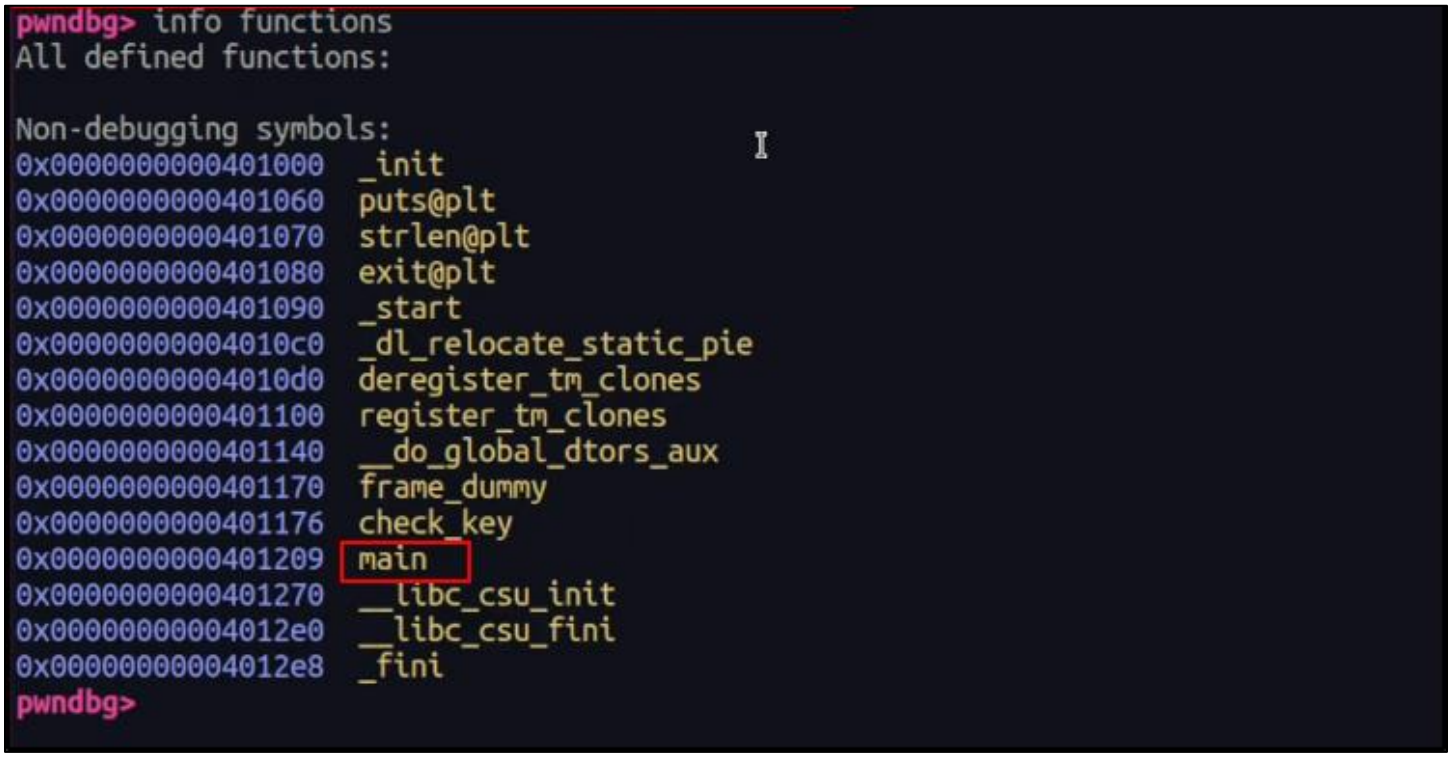
To iske pas symble table nhi hai. ki yh pta kr paye main ke bare me.

Ab hum **not stripped** ko gdb me load krte hai.



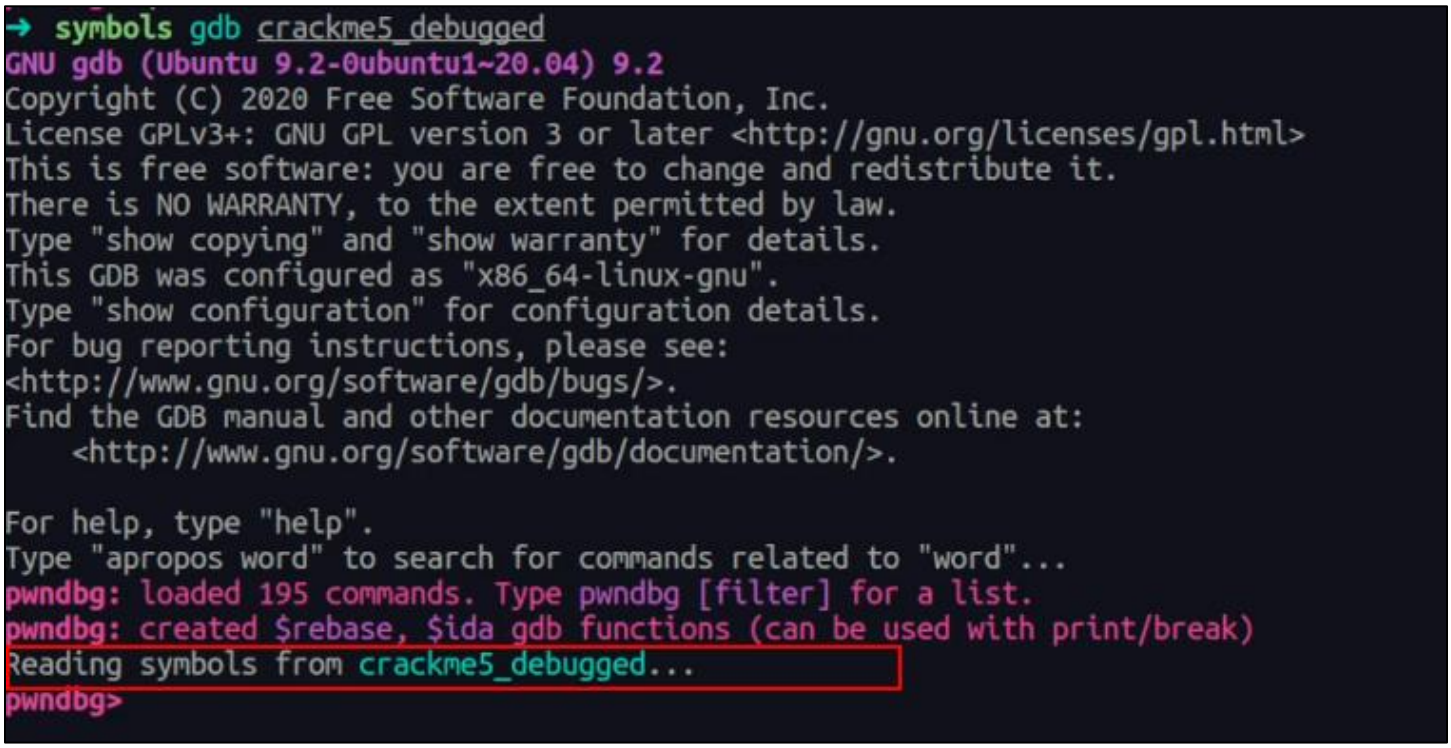
Yha hum dekh skte hai ki yha pr bhi debugging symbols nhi mile.

Aur functions dekhe to.



Yha **pr main** function hai.

Ab hum debugged binary ko load krte hai.



Yha hum dekh skte hai ki ise debugging symble mile aur ye use read kr rha hai.

Agar hum show functions kare to.

```
pwndbg> info functions
All defined functions:

File crackme5.c:
5:      int check_key(const char *);
18:     int main(int, char **);

Non-debugging symbols:
0x0000000000401000  _init
0x0000000000401060  puts@plt
0x0000000000401070  strlen@plt
0x0000000000401080  exit@plt
0x0000000000401090  _start
0x00000000004010c0  _dl_relocate_static_pie
0x00000000004010d0  deregister_tm_clones
0x0000000000401100  register_tm_clones
0x0000000000401140  __do_global_dtors_aux
0x0000000000401170  frame_dummy
0x0000000000401270  __libc_csu_init
0x00000000004012e0  __libc_csu_fini
0x00000000004012e8  _fini
pwndbg>
```

Yha ise do functions mile c program ke jise ye sbse upar diya hai. aur uska data type bhi bta rha hai.

Agar hum list command run kare to ye source code bhi dikha deta hai.

```
pwndbg> list
5       int check_key(const char *key) {
6         int i;
7
8         if ( strlen(key) != 16 )
9           return 1;
10        for ( i = 0; i < strlen(key); i += 2 )
11        {
12          if ( key[i] - key[i + 1] != -1 )
13          return 1;
14        }
pwndbg>
```

Agar hume main function ka source code dekhna hai to.

```
pwndbg> list main
14        }
15        return 0;
16      }
17
18      int main(int argc, char *argv[])
19      {
20              if ( argc != 2 ) {
21                      puts("[BINARY] [KEY]");
22                      exit(0);
23              }
pwndbg>
```

==========

Ab problem ye hai ki hum stripped binary ki reverse engineering kaise karenge.

```
➜ symbols ls
crackme5  crackme5.c  crackme5_debugged  crackme5_stripped
➜ symbols
```

Jisme hume **entry point** ya **main function** kaise pta karenge.

Yha pr humne ek stripped binary ready ki hai. use pwndbg load kr lete hai.

```
→ rev gdb crackme5
GNU gdb (Ubuntu 9.2-0ubuntu1~20.04) 9.2
Copyright (C) 2020 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
    <http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
pwndbg: loaded 195 commands. Type pwndbg [filter] for a list.
pwndbg: created $rebase, $ida gdb functions (can be used with print/break)
Reading symbols from crackme5...
(No debugging symbols found in crackme5)
pwndbg>
```

Yha pr debugging symbles nhi milenge.

Aur agar hum functions dekhne ki koshish kare to.

```
pwndbg> info functions
All defined functions:

Non-debugging symbols:
0x0000000000401060  puts@plt
0x0000000000401070  strlen@plt
0x0000000000401080  exit@plt
pwndbg> disassemble main
No symbol table is loaded.  Use the "file" command.
pwndbg>
```

Yha koi main function nhi mila.

To kya hota hai jb bhi hum **C program** ko gcc ki help compile krte hai. to wo uske sath bahut sare functions apne side se add krta hai. jinme se do function hote hai. ek hota hai **_start** aur dusra hota hai **__libc_start_main**

To humara **main** function directly call nhi hota. Sabse phle ek function hota hai. jo **_start** ko call krta hai.

Binary jaise hi run hoti hai to sbse phle **_start** function call hota hai. to ye function call krta hai **__libc_start_main** function ko. Aur **__libc_start_main** function **main** function ko call krta hai.

To hum unhi do functions ko follow karenge wahi functions aage jake hume main function tk pahuchayenge.

Aap likh diya main break **main** to **main** function nhi nikalega.

Main function run hone se phle bahut kuchh ho rha hota hai aur uske bad bahut kuchh ho rha hota hai binary ke andar abhi ke liye use hum nhi samjhenge.

Sabse phle hume **_start** ka address nikalna hoga to usko nikalne ke do tarike hai.

First way:

Yha **info file** karenge to sare sections open ho jayenge.

```
pwndbg> info file
Symbols from "/home/ubuntu/crackme5".
Local exec file:
        `/home/ubuntu/crackme5', file type elf64-x86-64.
        Entry point: 0x401090
        0x0000000000400318 - 0x0000000000400334 is .interp
        0x0000000000400338 - 0x0000000000400358 is .note.gnu.property
        0x0000000000400358 - 0x000000000040037c is .note.gnu.build-id
        0x000000000040037c - 0x000000000040039c is .note.ABI-tag
        0x00000000004003a0 - 0x00000000004003bc is .gnu.hash
        0x00000000004003c0 - 0x0000000000400450 is .dynsym
        0x0000000000400450 - 0x0000000000400499 is .dynstr
        0x000000000040049a - 0x00000000004004a6 is .gnu.version
        0x00000000004004a8 - 0x00000000004004c8 is .gnu.version_r
        0x00000000004004c8 - 0x00000000004004f8 is .rela.dyn
        0x00000000004004f8 - 0x0000000000400540 is .rela.plt
        0x0000000000401000 - 0x000000000040101b is .init
        0x0000000000401020 - 0x0000000000401060 is .plt
        0x0000000000401060 - 0x0000000000401090 is .plt.sec
        0x0000000000401090 - 0x00000000004012e5 is .text
        0x00000000004012e8 - 0x00000000004012f5 is .fini
        0x0000000000402000 - 0x000000000040202a is .rodata
        0x000000000040202c - 0x0000000000402078 is .eh_frame_hdr
        0x0000000000402078 - 0x00000000004021a0 is .eh_frame
        0x0000000000403e10 - 0x0000000000403e18 is .init_array
        0x0000000000403e18 - 0x0000000000403e20 is .fini_array
        0x0000000000403e20 - 0x0000000000403ff0 is .dynamic
        0x0000000000403ff0 - 0x0000000000404000 is .got
        0x0000000000404000 - 0x0000000000404030 is .got.plt
        0x0000000000404030 - 0x0000000000404040 is .data
        0x0000000000404040 - 0x0000000000404048 is .bss
pwndbg>
```

Jaisa ki hum assembly pdi hai. to **_start** kis section me aayega.

Wo **.text** section me aata hai.

Yha execution start **.text** section ek address se hoga.

```
pwndbg> info file
Symbols from "/home/ubuntu/crackme5".
Local exec file:
        `/home/ubuntu/crackme5', file type elf64-x86-64.
        Entry point: 0x401090
        0x0000000000400318 - 0x0000000000400334 is .interp
        0x0000000000400338 - 0x0000000000400358 is .note.gnu.property
        0x0000000000400358 - 0x000000000040037c is .note.gnu.build-id
```

```
  0x0000000000401020 - 0x0000000000401060 is .plt
  0x0000000000401060 - 0x0000000000401090 is .plt.sec
  0x0000000000401090 - 0x00000000004012e5 is .text
  0x00000000004012e8 - 0x00000000004012f5 is .fini
```

Jaisa ki hum upar dekh pa rha hai **Entry point** pr likha address aur **.text** section ka address same hai.

Second way:

Agar hum **gdb** pr jaye aur **start** command run kare to automatic start function pr le jayega jo humne abhi dekha.

```
pwndbg>  start

Program stopped.
0x00007ffff7fe3290 in _start () from /lib64/ld-linux-x86-64.so.2
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
Disabling the emulation via Unicorn Engine that is used for computing branches as there isn't enough memory (
e also:
* https://github.com/pwndbg/pwndbg/issues/1534
* https://github.com/unicorn-engine/unicorn/pull/1743
Either free your memory or explicitly set `set emulate off` in your Pwndbg config
LEGEND: STACK | HEAP | CODE | DATA | WX | RODATA
─────────────────────────────────────────────────[ REGISTERS / show-flags off / show-compact-regs off ]─────
 RAX  0x1c
 RBX  0
 RCX  0x7fffffffe448 —▸ 0x7fffffffe6cf ◂— 'SHELL=/bin/bash'
 RDX  0x7ffff7fc9040 (_dl_fini) ◂— endbr64
 RDI  0x7ffff7ffe2e0 ◂— 0
 RSI  0x7ffff7ffe888 ◂— 0
 R8   0x7fff
 R9   0xf
 R10  0x7ffff7fc3860 ◂— 0xd0012000000c1
 R11  0x206
 R12  0x401090 ◂— endbr64
 R13  0x7fffffffe430 ◂— 1
 R14  0
 R15  0
 RBP  0
 RSP  0x7fffffffe430 ◂— 1
 RIP  0x401090 ◂— endbr64
```

```
 RBP  0
 RSP  0x7fffffffe430 ◂— 1
 RIP  0x401090 ◂— endbr64
──────────────────────────────────────────────────[ DISASM / x86-64 / set emulate off ]──────────
► 0x401090     endbr64
  0x401094     xor    ebp, ebp                    EBP => 0
  0x401096     mov    r9, rdx
  0x401099     pop    rsi
  0x40109a     mov    rdx, rsp
  0x40109d     and    rsp, 0xfffffffffffffff0
  0x4010a1     push   rax
  0x4010a2     push   rsp
  0x4010a3     mov    r8, 0x4012e0                R8 => 0x4012e0 ◂— endbr64
  0x4010aa     mov    rcx, 0x401270               RCX => 0x401270 ◂— endbr64
  0x4010b1     mov    rdi, 0x401209               RDI => 0x401209 ◂— endbr64
──────────────────────────────────────────────────────────────────[ STACK ]──────────────────────────
00:0000│ r13 rsp 0x7fffffffe430 ◂— 1
01:0008│         0x7fffffffe438 —▸ 0x7fffffffe6b9 ◂— '/home/ubuntu/crackme5'
02:0010│         0x7fffffffe440 ◂— 0
03:0018│ rcx     0x7fffffffe448 —▸ 0x7fffffffe6cf ◂— 'SHELL=/bin/bash'
04:0020│         0x7fffffffe450 —▸ 0x7fffffffe6df ◂— 'PWD=/home/ubuntu'
05:0028│         0x7fffffffe458 —▸ 0x7fffffffe6f0 ◂— 'LOGNAME=ubuntu'
06:0030│         0x7fffffffe460 —▸ 0x7fffffffe6ff ◂— 'XDG_SESSION_TYPE=tty'
07:0038│         0x7fffffffe468 —▸ 0x7fffffffe714 ◂— '_=/usr/bin/gdb'
──────────────────────────────────────────────────────────────[ BACKTRACE ]──────────────────────────
 ► 0         0x401090 None
   1              0x1 None
   2   0x7fffffffe6b9 None
   3              0x0 None
──────────────────────────────────────────────────────────────────────────────────────────────────
pwndbg>
```

Ab agar hum disassemble run kare to.

```
pwndbg> disassemble
No function contains program counter for selected frame.
pwndbg>
```

Ise koi function nhi mila. gdb symbles hote hai usi se batata hai.

To gdb ye nhi kr payega kyoki iske pass koi symble nhi hai. ise samjh nhi aayega. Pta nhi chalega.

disassemble command ek function ko disaasemble krta hai.

==========

pwndbg me hum **registers, disaasembly, stack aur backtrace** dekh skte hai.

backtrace hume ye batata hai ki kaun-2 se functions ko humne call kiya hai.

ye note krta hai ki hum kis-2 functions me jate ja rhe hai.

Agar hume **gdb** me kisi chij ko dekhna hai to use krte hai.

To yah pr dete hai. phle hum likhenge **x/** (exmine) fir hume kitni value dekhni hai. jaise 30 fir hume kya dekhna hai hex, string, intruction ya address.

Hex → **x**

String → **s**

Address → **a**

Instruction → **i**

man lo hume 30 instructions dekhne hai ek function ka.

x/30i <address_of_entry_point>

```
pwndbg> x/30i 0x401090
```

Yha pr hum **rip** ka bhi use kr skte hai. kyoki execution pointer entery point pr hai aur next execution rip me hota hai. aur kisi bhi **register** ko use krne se phle **$** likhna pdta hai.

```
pwndbg> x/30i $rip
=> 0x401090:    endbr64
   0x401094:    xor    ebp,ebp
   0x401096:    mov    r9,rdx
   0x401099:    pop    rsi
   0x40109a:    mov    rdx,rsp
   0x40109d:    and    rsp,0xfffffffffffffff0
   0x4010a1:    push   rax
   0x4010a2:    push   rsp
   0x4010a3:    mov    r8,0x4012e0
   0x4010aa:    mov    rcx,0x401270
   0x4010b1:    mov    rdi,0x401209
   0x4010b8:    call   QWORD PTR [rip+0x2f32]        # 0x403ff0
```

Yha pr assembly pd skte hai lekin humare kam ka nhi hai.

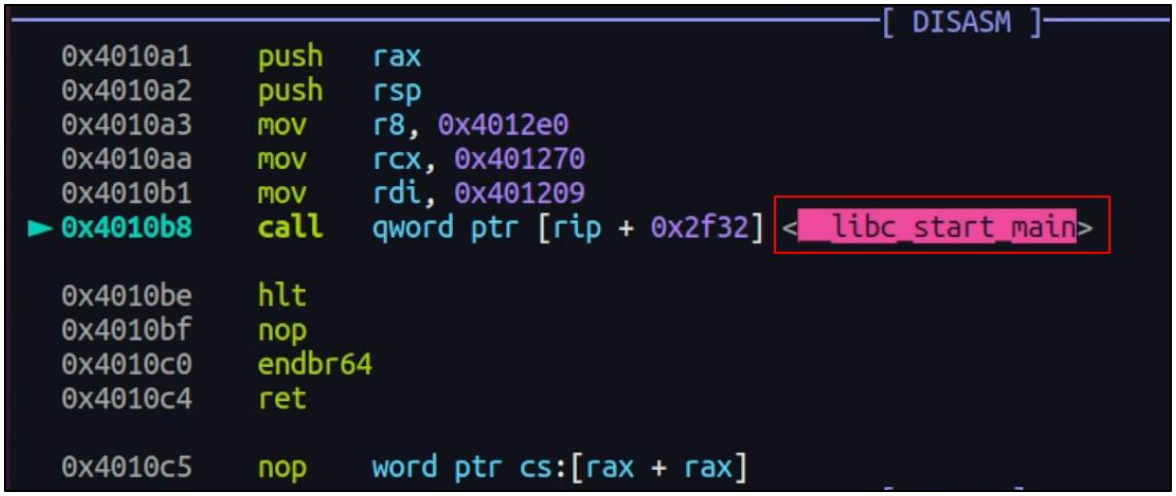
To hum **ni** krke instructions ko pdne ki koshish krte hai.

```
pwndbg> ni
```

Yha next intruction pr pahuch gye.

```
──────────────────────────────────────────────────────────[ DISASM ]──
   0x401090    endbr64
 ► 0x401094    xor    ebp, ebp
   0x401096    mov    r9, rdx
   0x401099    pop    rsi
   0x40109a    mov    rdx, rsp
   0x40109d    and    rsp, 0xfffffffffffffff0
   0x4010a1    push   rax
   0x4010a2    push   rsp
   0x4010a3    mov    r8, 0x4012e0
   0x4010aa    mov    rcx, 0x401270
   0x4010b1    mov    rdi, 0x401209
──────────────────────────────────────────────────────────[ STACK ]──
```

Yha pr hum ni krke call syscall pr pahuch jayenge.



Yhi function bad me fir **main** ko call krta hai.

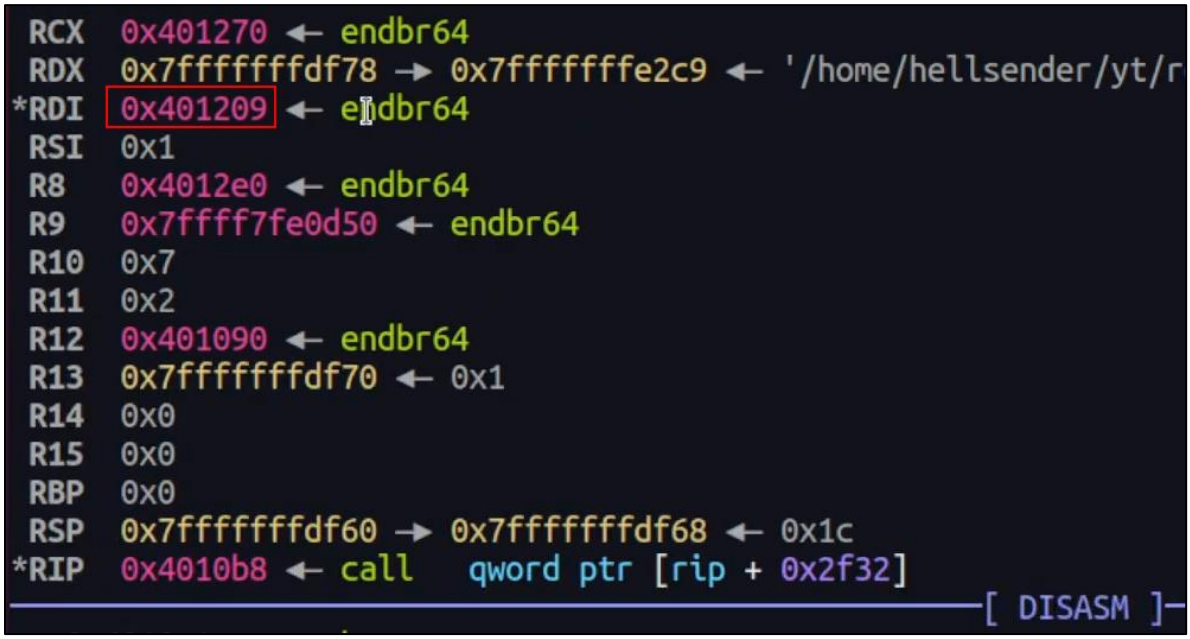
2nd Trick to find main function ka address:

_start function jb **__libc_start_main** ko **call** krta hai to ise kuchh **argument**s pass krne pdte hai. to ye alag-2 argument pass krta hai. lekin humare liye ek argument jaruri hota hai.**rdi** ke andar ka argument.

jaisa ki hum jante hai **rdi** ke andar sbse phla **argument** jata hai kisi bhi function ka.

Ye phle argument me binary ke **main** address ka address mangta hai **_start** fucntion se.

Agar hum **rdi** ka value dekhe to



Humne phle hi **main** function ka address find kr liya hai.

Yha pr humne main function ka address aise hi nikal liye **__libc_start_main** pr jane ki jarurat hi nhi hui.

```
pwndbg> b *0x401209
```

Ab yha pr breakpoint lagakr continue kr denge to hum main function me pahuch jaenge.

Lekin agar hum **__libc_start_main** me pahuch gye ho to kaise main me pahuchna hai. wo bhi dekh lete hai.

To hum **si (step into)** krte hai.

```
pwndbg> si
```

```
 R15  0x0
 RBP  0x0
*RSP  0x7fffffffdf58 → 0x4010be ← hlt
*RIP  0x7ffff7ddffc0 (__libc_start_main) ← endbr64
[ DISASM ]
► 0x7ffff7ddffc0 <__libc_start_main>       endbr64
  0x7ffff7ddffc4 <__libc_start_main+4>     push   r15
  0x7ffff7ddffc6 <__libc_start_main+6>     xor    eax, eax
  0x7ffff7ddffc8 <__libc_start_main+8>     push   r14
  0x7ffff7ddffca <__libc_start_main+10>    push   r13
  0x7ffff7ddffcc <__libc_start_main+12>    push   r12
  0x7ffff7ddffce <__libc_start_main+14>    push   rbp
  0x7ffff7ddffcf <__libc_start_main+15>    push   rbx
  0x7ffff7ddffd0 <__libc_start_main+16>    mov    rbx, rcx
  0x7ffff7ddffd3 <__libc_start_main+19>    sub    rsp, 0x98
  0x7ffff7ddffda <__libc_start_main+26>    mov    qword ptr [rsp + 8], rdx
[ STACK ]
00:0000| rsp 0x7fffffffdf58 → 0x4010be ← hlt
01:0008|     0x7fffffffdf60 → 0x7fffffffdf68 ← 0x1c
02:0010|     0x7fffffffdf68 ← 0x1c
03:0018| r13 0x7fffffffdf70 ← 0x1
04:0020| rdx 0x7fffffffdf78 → 0x7fffffffe2c9 ← '/home/hellsender/yt/rev/crackr
05:0028|     0x7fffffffdf80 ← 0x0
06:0030|     0x7fffffffdf88 → 0x7fffffffe2ea ← 'GJS_DEBUG_TOPICS=JS ERROR;JS L
```

Ab hum **ni(next instruction)** krte jate hai aur ek hi jahan hume **call rax** milega. Wahan pahuchte hai. aur **rax** me humare **main** address ka value hoga.

```
                                                    [ DISASM ]
  0x7ffff7de0099 <__libc_start_main+217>    mov    rax, qword ptr [rip + 0x1c3e10]
  0x7ffff7de00a0 <__libc_start_main+224>    mov    rsi, qword ptr [rsp + 8]
  0x7ffff7de00a5 <__libc_start_main+229>    mov    edi, dword ptr [rsp + 0x14]
  0x7ffff7de00a9 <__libc_start_main+233>    mov    rdx, qword ptr [rax]
  0x7ffff7de00ac <__libc_start_main+236>    mov    rax, qword ptr [rsp + 0x18]
► 0x7ffff7de00b1 <__libc_start_main+241>    call   rax <0x401209>

  0x7ffff7de00b3 <__libc_start_main+243>    mov    edi, eax
  0x7ffff7de00b5 <__libc_start_main+245>    call   exit <exit>

  0x7ffff7de00ba <__libc_start_main+250>    mov    rax, qword ptr [rsp + 8]
  0x7ffff7de00bf <__libc_start_main+255>    lea    rdi, [rip + 0x18fda2]
  0x7ffff7de00c6 <__libc_start_main+262>    mov    rsi, qword ptr [rax]
                                                    [ STACK ]
```

Yha hum dekh skte hai **rax** ke sath ek **address** hai. ye **main** function ka address hai.

Aur ye same **address** hai jo humne **rdi** ke andar ka **address** copy kiya tha.

Ab hum step into kr skte hai main function me.

```
pwndbg> si
```

```
                                                    [ DISASM ]
► 0x401209    endbr64
  0x40120d    push   rbp
  0x40120e    mov    rbp, rsp
  0x401211    sub    rsp, 0x10
  0x401215    mov    dword ptr [rbp - 4], edi
  0x401218    mov    qword ptr [rbp - 0x10], rsi
  0x40121c    cmp    dword ptr [rbp - 4], 2
  0x401220    je     0x401238 <0x401238>

  0x401222    lea    rdi, [rip + 0xddb]
  0x401229    call   puts@plt <puts@plt>

  0x40122e    mov    edi, 0
                                                    [ STACK ]
```

Ab hum **main** function ke andar padhar chuke hai.

To hum yha pr breakpoint laga dete hai. ki jb bhi hum program run kare to ye main function pr jakr run jaye.

```
pwndbg> b *0x401209
```

Agar aap pwndbg ke tarike se lagana chahte ho to…

```
pwndbg> bp 0x401209
```

To yha pr hum dekhna chahte hai ki main function me kya hai.

Yha hum **x/ (examine)** command use karenge.

```
pwndbg> x/20i $rip
=> 0x401209:    endbr64
   0x40120d:    push   rbp
   0x40120e:    mov    rbp,rsp
   0x401211:    sub    rsp,0x10
   0x401215:    mov    DWORD PTR [rbp-0x4],edi
   0x401218:    mov    QWORD PTR [rbp-0x10],rsi
   0x40121c:    cmp    DWORD PTR [rbp-0x4],0x2
   0x401220:    je     0x401238
   0x401222:    lea    rdi,[rip+0xddb]        # 0x402004
   0x401229:    call   0x401060 <puts@plt>
   0x40122e:    mov    edi,0x0
   0x401233:    call   0x401080 <exit@plt>
   0x401238:    mov    rax,QWORD PTR [rbp-0x10]
   0x40123c:    add    rax,0x8
   0x401240:    mov    rax,QWORD PTR [rax]
   0x401243:    mov    rdi,rax
   0x401246:    call   0x401176
   0x40124b:    test   eax,eax
   0x40124d:    je     0x40125d
   0x40124f:    lea    rdi,[rip+0xdbd]        # 0x402013
pwndbg>
```

Jaisa ki hum dekh skte hai ki yha pr **ret** nhi aaya. To hum instruction ke value bda lete hai.

Yha **23** instruction pr bhi nhi aaya to hum instruction ki value bda lete hai.

```
pwndbg> x/30i $rip
=> 0x401209:    endbr64
   0x40120d:    push   rbp
   0x40120e:    mov    rbp,rsp
   0x401211:    sub    rsp,0x10
   0x401215:    mov    DWORD PTR [rbp-0x4],edi
   0x401218:    mov    QWORD PTR [rbp-0x10],rsi
   0x40121c:    cmp    DWORD PTR [rbp-0x4],0x2
   0x401220:    je     0x401238
   0x401222:    lea    rdi,[rip+0xddb]        # 0x402004
   0x401229:    call   0x401060 <puts@plt>
   0x40122e:    mov    edi,0x0
   0x401233:    call   0x401080 <exit@plt>
   0x401238:    mov    rax,QWORD PTR [rbp-0x10]
   0x40123c:    add    rax,0x8
   0x401240:    mov    rax,QWORD PTR [rax]
   0x401243:    mov    rdi,rax
   0x401246:    call   0x401176
   0x40124b:    test   eax,eax
   0x40124d:    je     0x40125d
   0x40124f:    lea    rdi,[rip+0xdbd]        # 0x402013
   0x401256:    call   0x401060 <puts@plt>
   0x40125b:    jmp    0x401269
   0x40125d:    lea    rdi,[rip+0xdba]        # 0x40201e
   0x401264:    call   0x401060 <puts@plt>
   0x401269:    mov    eax,0x0
   0x40126e:    leave
   0x40126f:    ret
   0x401270:    endbr64
```

```
   0x401269:    mov    eax,0x0
   0x40126e:    leave
   0x40126f:    ret
   0x401270:    endbr64
   0x401274:    push   r15
   0x401276:    lea    r15,[rip+0x2b93]        # 0x403e10
pwndbg> nearpc
```

To yha ye **30** pr mil chuka hai. aur agla function **endbr64** se suru ho rha hai.

Agar aap **pwndbg** use kr rhe ho to **nearpc** command use kr skte hai. **rip** ko **pc (program counter)** bhi khte hai.

```
pwndbg> nearpc
 ► 0x401209    endbr64
   0x40120d    push   rbp
   0x40120e    mov    rbp, rsp
   0x401211    sub    rsp, 0x10
   0x401215    mov    dword ptr [rbp - 4], edi
   0x401218    mov    qword ptr [rbp - 0x10], rsi
   0x40121c    cmp    dword ptr [rbp - 4], 2
   0x401220    je     0x401238 <0x401238>

   0x401222    lea    rdi, [rip + 0xddb]
   0x401229    call   puts@plt <puts@plt>

   0x40122e    mov    edi, 0
pwndbg>
```

Yha pr rip ke aas paas ke instruction dikh jayenge.

Man lo hume **27** instructions dekhne hai.

```
pwndbg> nearpc 27
 ► 0x401209    endbr64
   0x40120d    push   rbp
   0x40120e    mov    rbp, rsp
   0x401211    sub    rsp, 0x10
   0x401215    mov    dword ptr [rbp - 4], edi
   0x401218    mov    qword ptr [rbp - 0x10], rsi
   0x40121c    cmp    dword ptr [rbp - 4], 2
   0x401220    je     0x401238 <0x401238>

   0x401222    lea    rdi, [rip + 0xddb]
   0x401229    call   puts@plt <puts@plt>

   0x40122e    mov    edi, 0
   0x401233    call   exit@plt <exit@plt>

   0x401238    mov    rax, qword ptr [rbp - 0x10]
   0x40123c    add    rax, 8
   0x401240    mov    rax, qword ptr [rax]
   0x401243    mov    rdi, rax
   0x401246    call   0x401176 <0x401176>

   0x40124b    test   eax, eax
   0x40124d    je     0x40125d <0x40125d>
```

To yha pr **27** instructions dikh jayenge.

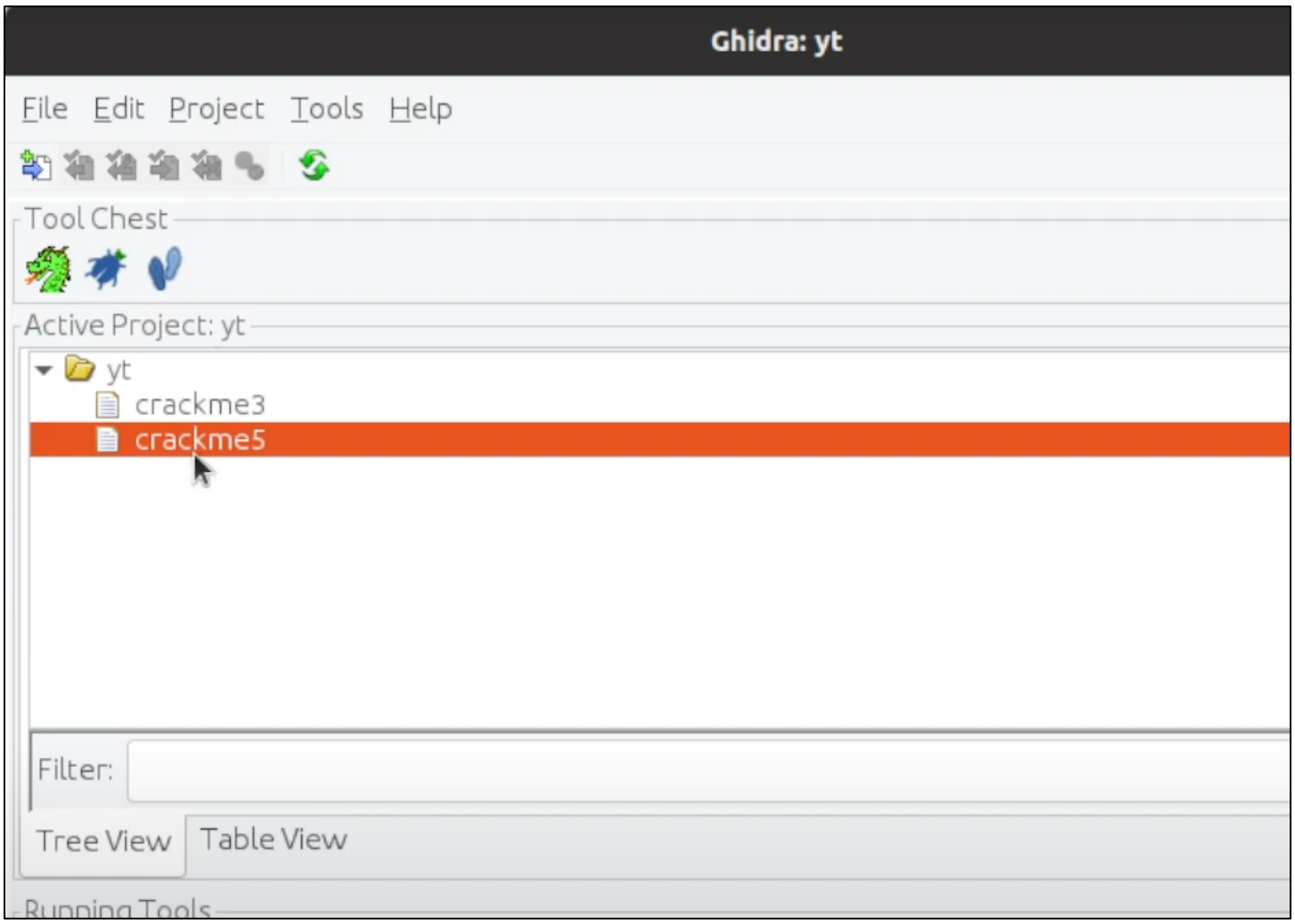
Lekin yha pr dono me difference hai.

```
0x40124d:    je     0x40125d
0x40124f:    lea    rdi,[rip+0xdbd]        # 0x402013
0x401256:    call   0x401060 <puts@plt>
0x40125b:    jmp    0x401269
0x40125d:    lea    rdi,[rip+0xdba]        # 0x40201e
0x401264:    call   0x401060 <puts@plt>
0x401269:    mov    eax,0x0
0x40126e:    leave
```

gdb commect krke registers ki hone wali value bta deta hai lekin **pwndbg** nhi batata.

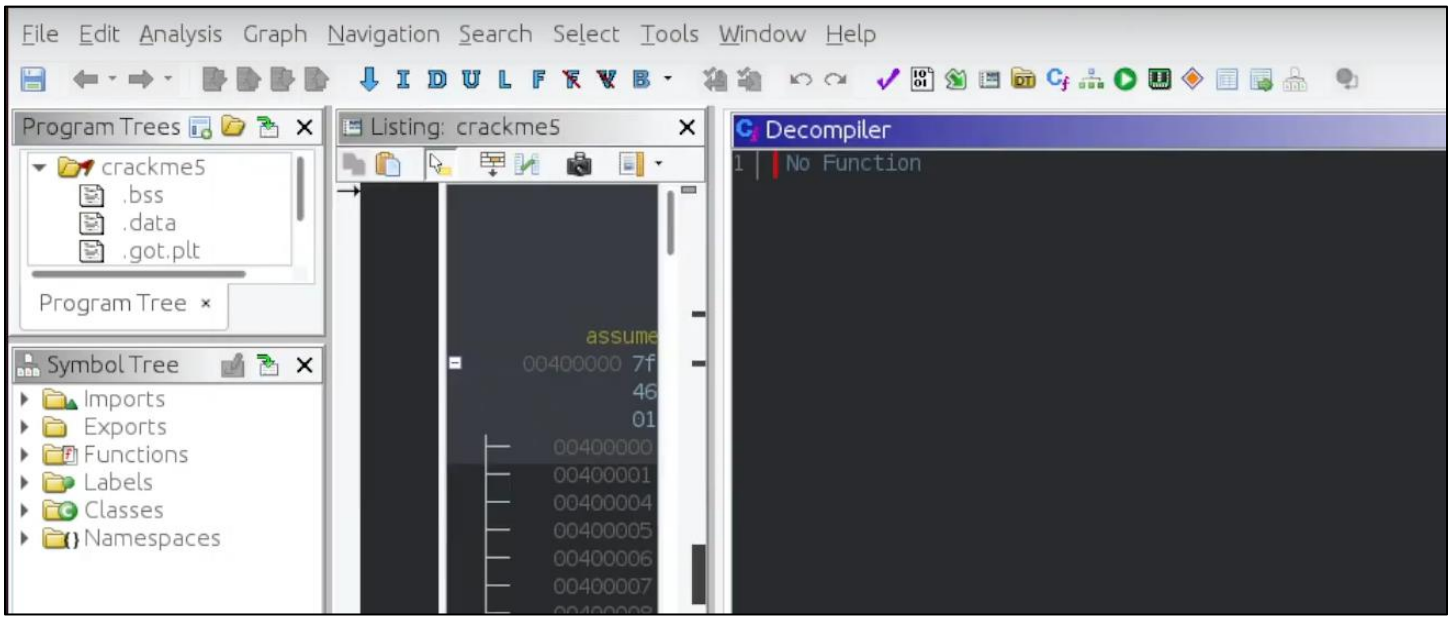
To yha pr hum assembly smajhne me bahut time lagega. To hum deconpiler ka help lenge.

Ab hum apna **ghidra** open krte hai.

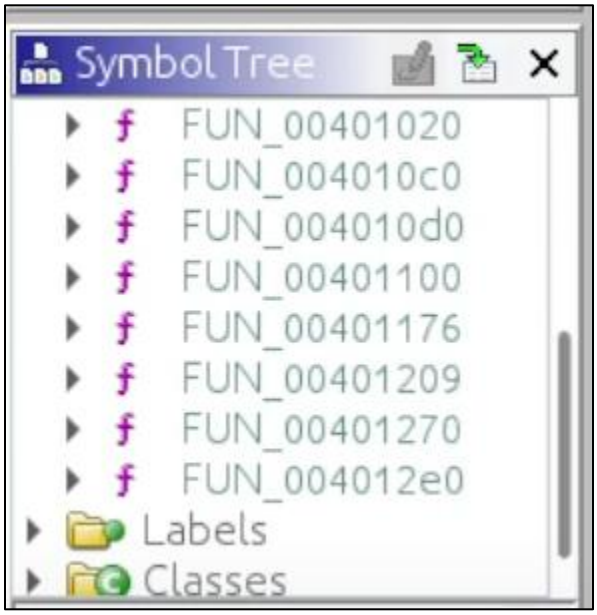


Ise hum **decompiler** pr drag kr dete hai. ya fir double click krke **decompile** kr dete hai.

Iske bad ye analyze ke liye puchega.



Yha pr hum functions ko expend krte hai.



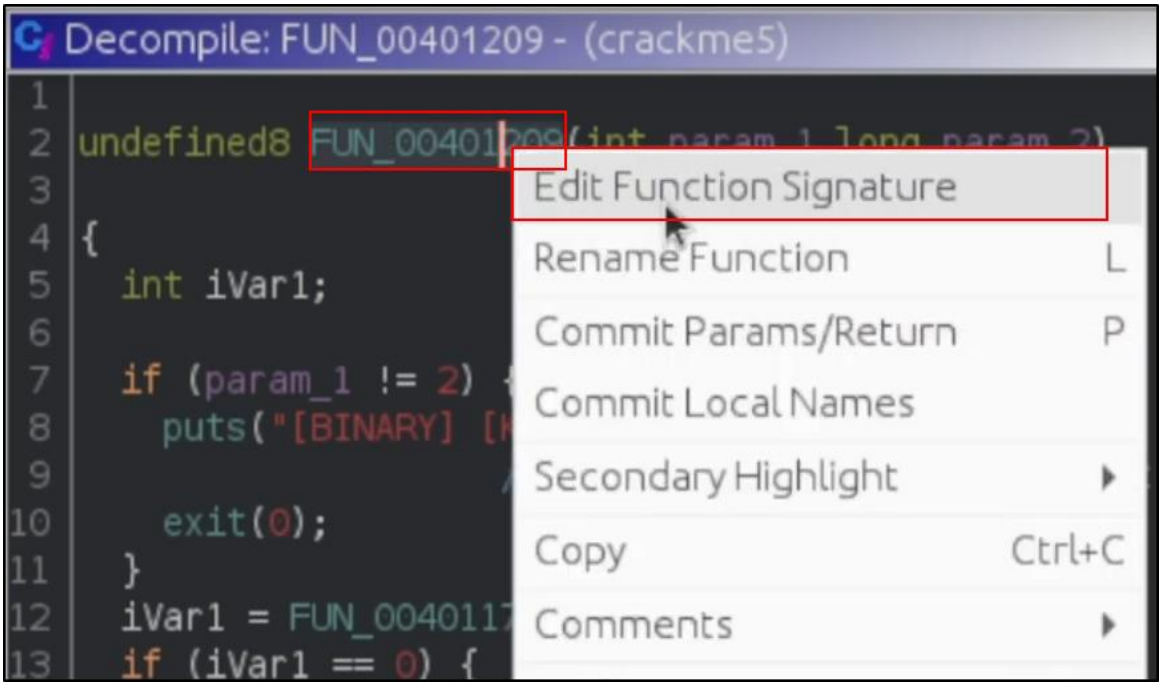
To koi **main** functions nhi dikhega. Kyoki ye **stripped** binary hai. to hum sb pr click krke dekh le **main** function hume alag hi dikh jayega.

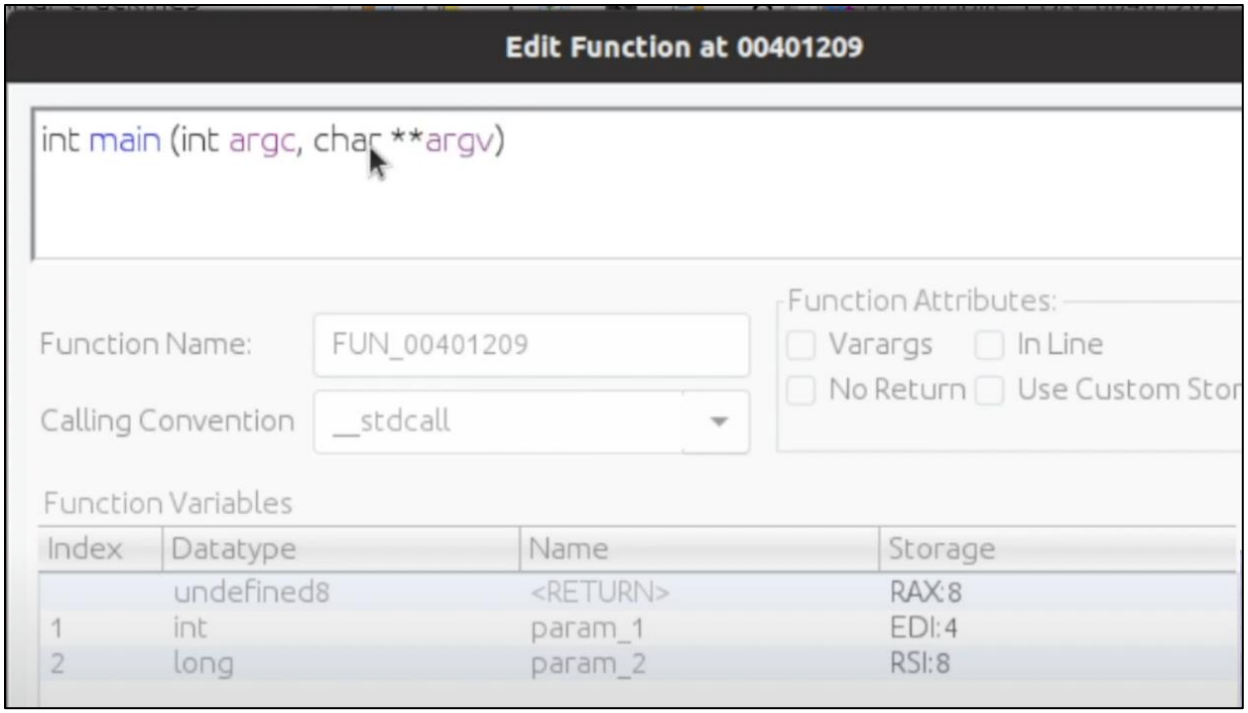
Yha pr hume **main** function mil gya dekhne se hi lg rha hai.

```
undefined8 FUN_00401209(int param_1,long param_2)

{
  int iVar1;

  if (param_1 != 2) {
    puts("[BINARY] [KEY]");
                    /* WARNING: Subroutine does not return */
    exit(0);
  }
  iVar1 = FUN_00401176(*(undefined8 *)(param_2 + 8));
  if (iVar1 == 0) {
    puts("Good Serial");
  }
  else {
    puts("Bad Serial");
  }
  return 0;
}
```

Yha pr hum functions ke nam change kr lete hai.

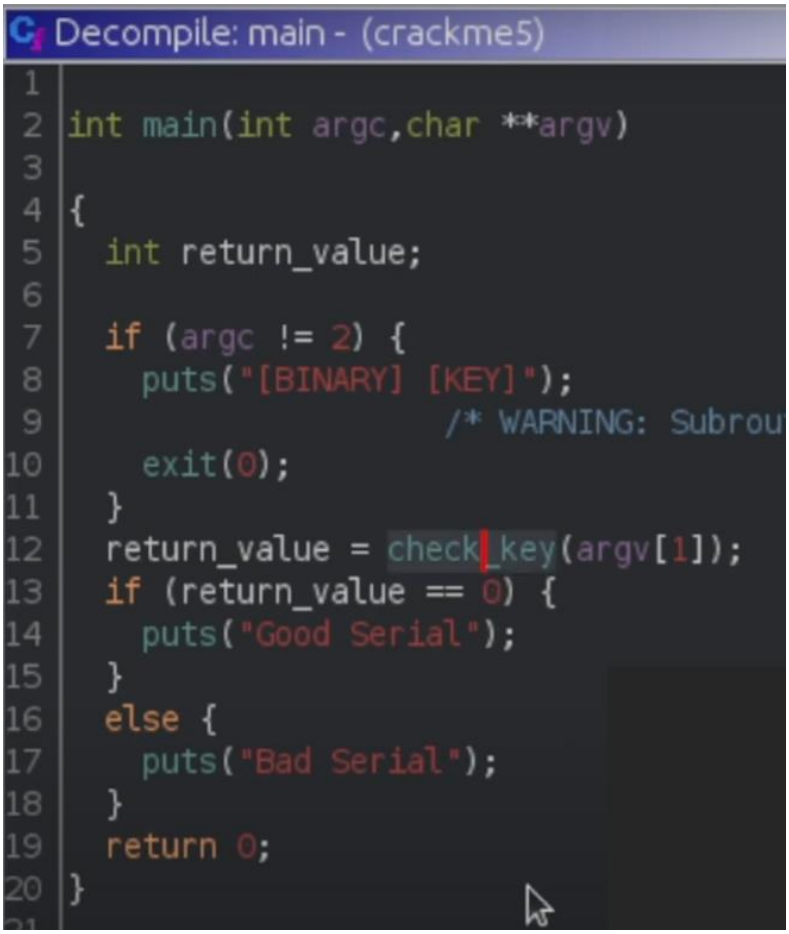
Function pr click krte hai aur **> edit function signature** pr click krte hai.





Yha first argument **int argc** means **argument counter** (total number of argument) that is abviously int hi hoga.

And second argument character type ka hoga. Jaisa ki hum jante hai jitne bhi argument aate hai wo **char**argv** ke andar aate hai. ye C ++ ke main function me lagana hi pdta hai.



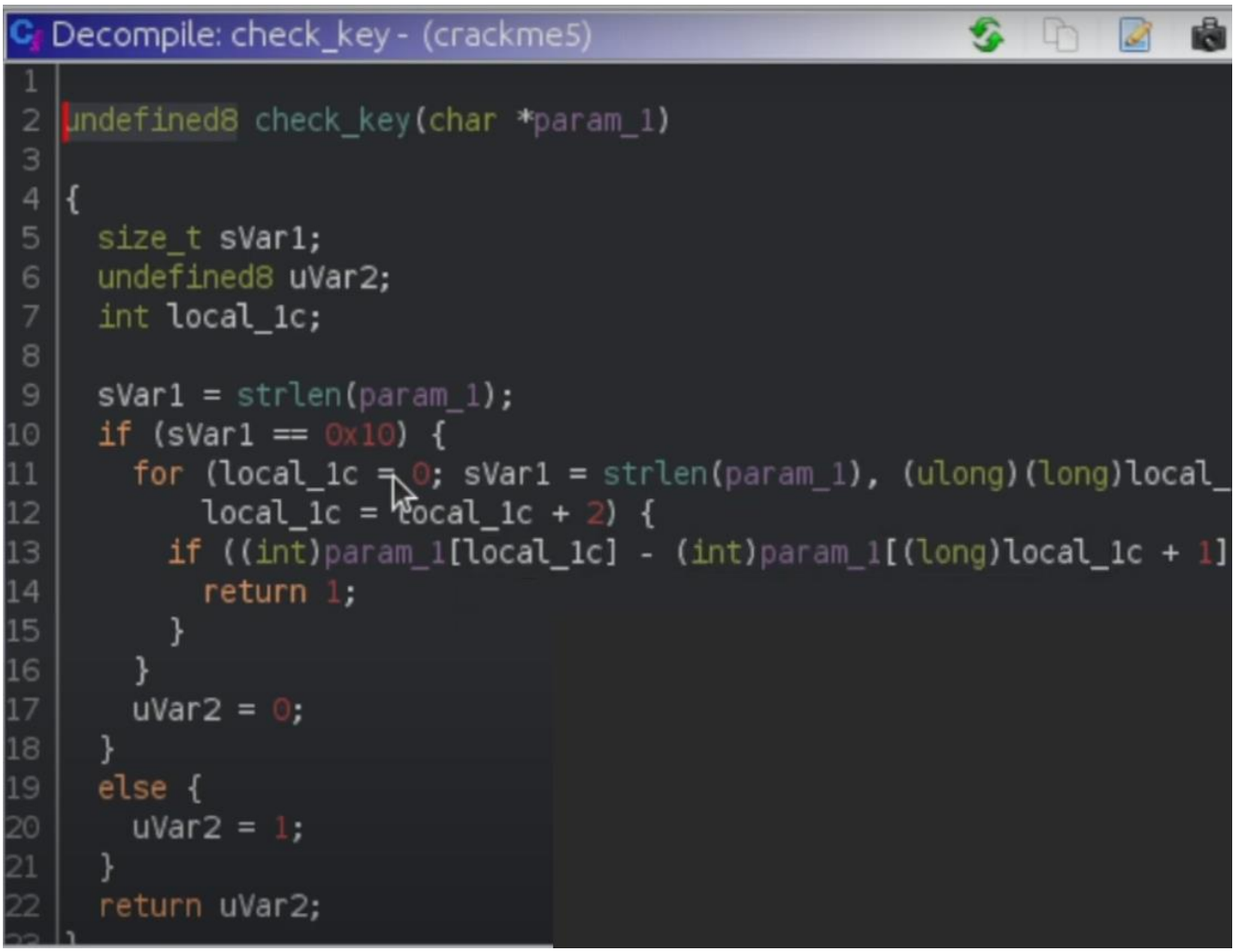
Ab ye program phle se jyada easy ho gya. Ghidra automatic jo code generate krta hai. wo dekhne me hard lgta hai.

To ye program sabse check krta hai ki do argument pass hua hai ki nhi. Agar nhi to ye **[Binary] [key]** print krke program ko **exit** kr dega.

Agar key pass ho rhi hai to **check_key** function uske **2nd** argument means key ko check krke **return_value** me store kr dega. Yha **[1]** ka mtlb second argument agar zero diya hota to humara **binary file** ho jata.

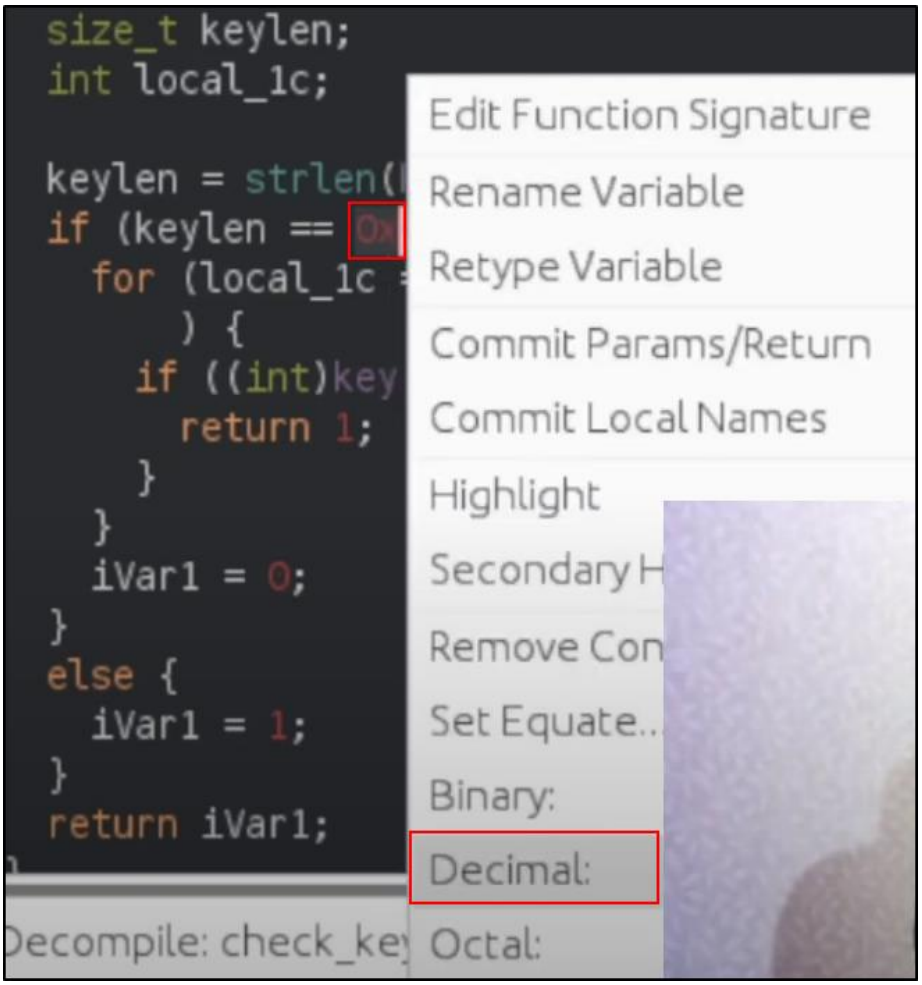
Uske bad agar **return_value** ki value **0** hoti hai to **"good serial"** otherwise **"bad serial"**

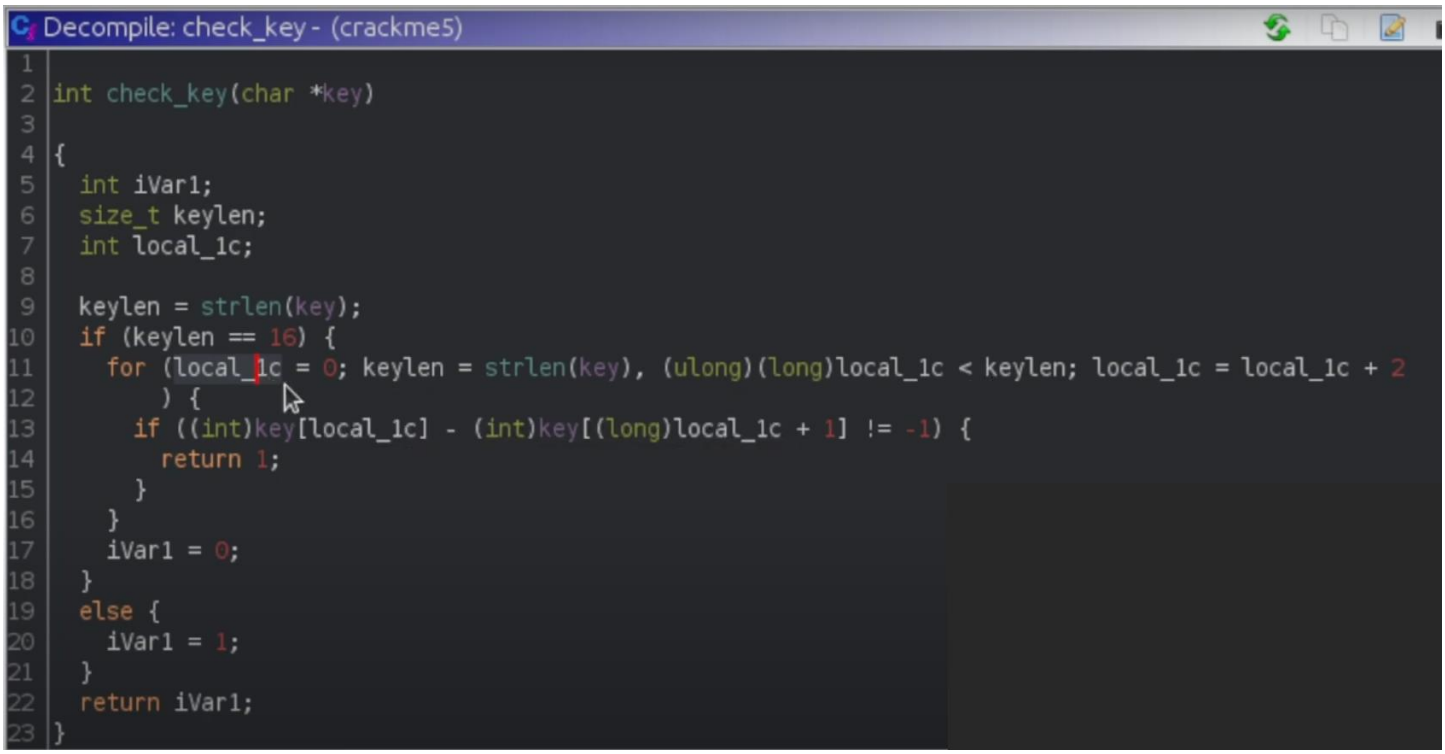
Ab hum **check_key()** function pr double click karenge to ye hume **check_key()** function me enter kr dega.



Ab hume easy kr lete hai.

0x10 pr right click krke ise decimal me convert ke lenge.





Let’s try to understand.

Decompile: check_key - (crackme5)

```
1
2  int check_key(char *key)
3
4  {
5    int iVar1;
6    size_t keylen;
7    int i;
8
9    keylen = strlen(key);
10   if (keylen == 16) {
11     for (i = 0; keylen = strlen(key), (ulong)(long)i < keylen; i = i + 2) {
12       if ((int)key[i] - (int)key[(long)i + 1] != -1) {
13         return 1;
14       }
15     }
16     iVar1 = 0;
17   }
18   else {
19     iVar1 = 1;
20   }
21   return iVar1;
22 }
```

Let's try to make posible password.

```
➜ rev ./crackme5 1212121212121212
Good Serial
➜ rev
```

Ek aur try krte hai.

```
➜ rev ./crackme5 3434343434343434
Good Serial
➜ rev
```

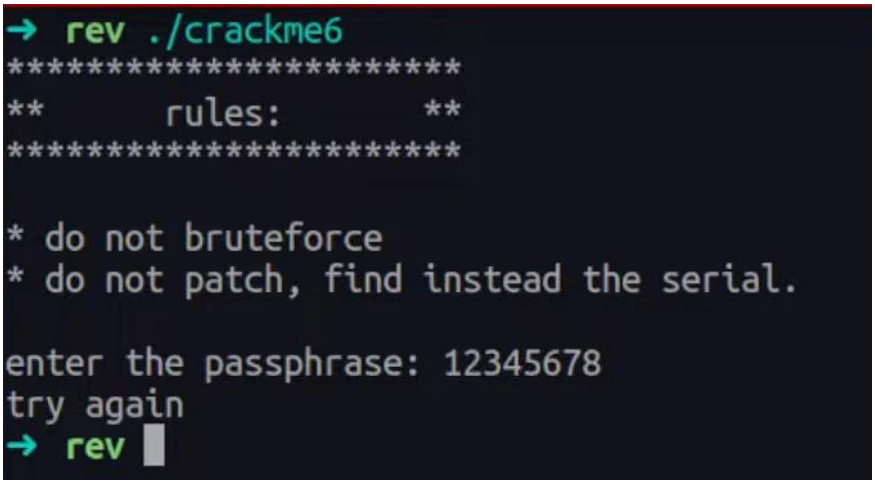
Aise hi bahut sare combination ho skte hai.

```
➜ rev ./crackme5 1234567812345678
Good Serial
➜ rev
```

##

How To Deal With Anti-Debug and Anti-VM Technique:

Challenge – crackme6

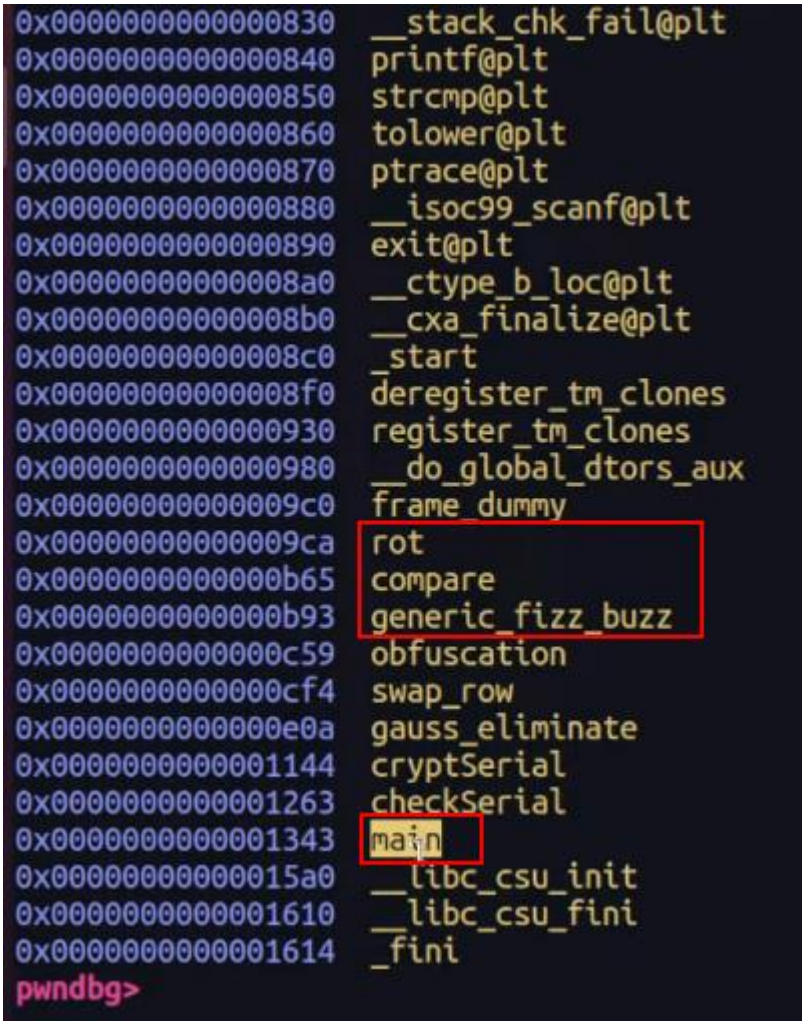


Ise hum gdb me load kr lete hai.

```
→ rev gdb ./crackme6
GNU gdb (Ubuntu 9.2-0ubuntu1~20.04) 9.2
Copyright (C) 2020 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
    <http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
pwndbg: loaded 195 commands. Type pwndbg [filter] for a list.
pwndbg: created $rebase, $ida gdb functions (can be used with print/break)
Reading symbols from ./crackme6...
(No debugging symbols found in ./crackme6)
pwndbg>
```

info function krte hai.

```
pwndbg> info functions
All defined functions:

Non-debugging symbols:
0x00000000000007c8  _init
0x00000000000007f0  putchar@plt
0x0000000000000800  puts@plt
0x0000000000000810  qsort@plt
0x0000000000000820  strlen@plt
0x0000000000000830  __stack_chk_fail@plt
0x0000000000000840  printf@plt
0x0000000000000850  strcmp@plt
0x0000000000000860  tolower@plt
```



disassemble main krte hai.

```
pwndbg> disassemble main
Dump of assembler code for function main:
   0x0000000000001343 <+0>:     push   rbp
   0x0000000000001344 <+1>:     mov    rbp,rsp
   0x0000000000001347 <+4>:     sub    rsp,0xb0
   0x000000000000134e <+11>:    mov    DWORD PTR [rbp-0xa4],edi
   0x0000000000001354 <+17>:    mov    QWORD PTR [rbp-0xb0],rsi
   0x000000000000135b <+24>:    mov    rax,QWORD PTR fs:0x28
   0x0000000000001364 <+33>:    mov    QWORD PTR [rbp-0x8],rax
   0x0000000000001368 <+37>:    xor    eax,eax
   0x000000000000136a <+39>:    lea    rdi,[rip+0x46c]        # 0x17dd
   0x0000000000001371 <+46>:    call   0x800 <puts@plt>
   0x0000000000001376 <+51>:    lea    rdi,[rip+0x478]        # 0x17f5
   0x000000000000137d <+58>:    call   0x800 <puts@plt>
   0x0000000000001382 <+63>:    lea    rdi,[rip+0x454]        # 0x17dd
   0x0000000000001389 <+70>:    call   0x800 <puts@plt>
   0x000000000000138e <+75>:    mov    edi,0xa
   0x0000000000001393 <+80>:    call   0x7f0 <putchar@plt>
   0x0000000000001398 <+85>:    lea    rdi,[rip+0x46e]        # 0x180d
   0x000000000000139f <+92>:    call   0x800 <puts@plt>
   0x00000000000013a4 <+97>:    lea    rdi,[rip+0x47d]        # 0x1828
   0x00000000000013ab <+104>:   call   0x800 <puts@plt>
   0x00000000000013b0 <+109>:   mov    edi,0xa
   0x00000000000013b5 <+114>:   call   0x7f0 <putchar@plt>
   0x00000000000013ba <+119>:   movabs rax,0x2073692073696854
   0x00000000000013c4 <+129>:   movabs rdx,0x657320706f742061
   0x00000000000013ce <+139>:   mov    QWORD PTR [rbp-0x30],rax
   0x00000000000013d2 <+143>:   mov    QWORD PTR [rbp-0x28],rdx
   0x00000000000013d6 <+147>:   movabs rax,0x7865742074657263
   0x00000000000013e0 <+157>:   movabs rdx,0x676173736d2074
   0x00000000000013ea <+167>:   mov    QWORD PTR [rbp-0x20],rax
   0x00000000000013ee <+171>:   mov    QWORD PTR [rbp-0x18],rdx
```

To yha pr main kafi bda hai.

Ab hum **main** pr **breakpoint** lga lete hai.

```
pwndbg>  b main
Breakpoint 1 at 0x1347
pwndbg>
```

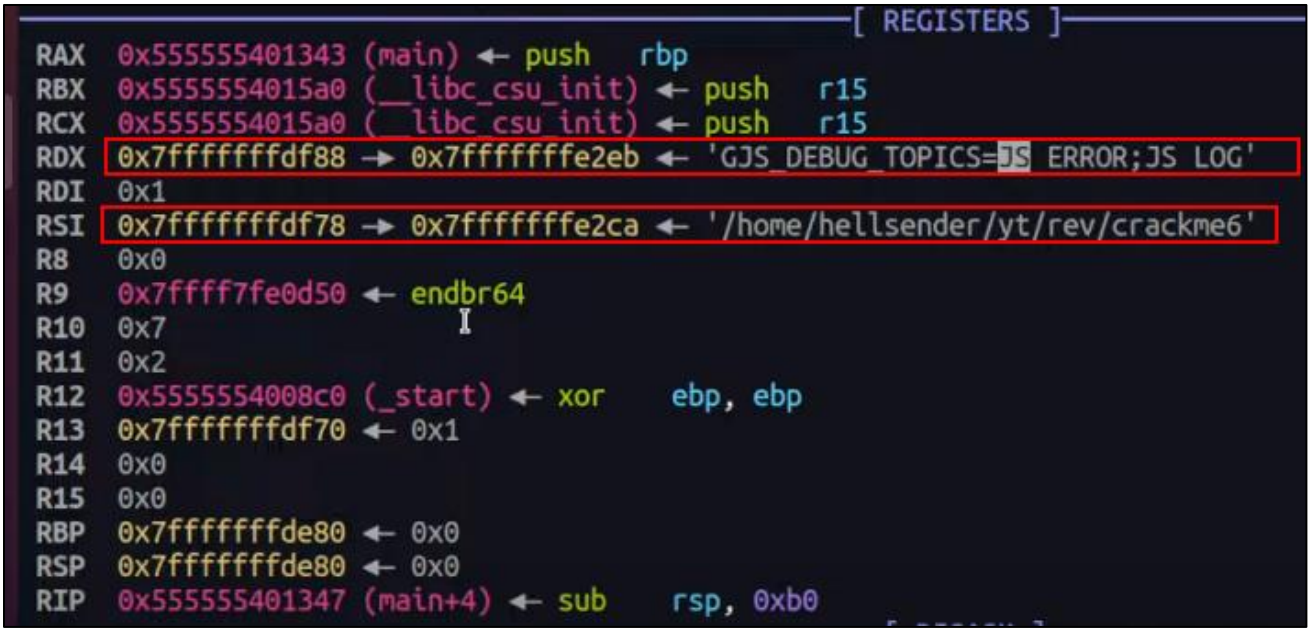
Aur ise **run** krte hai.

```
pwndbg> run
Starting program: /home/ubuntu/crackme6
[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".

Breakpoint 1, 0x0000555555401347 in main ()
Disabling the emulation via Unicorn Engine that is used for computing branches as there isn't enough memory
e also:
* https://github.com/pwndbg/pwndbg/issues/1534
* https://github.com/unicorn-engine/unicorn/pull/1743
Either free your memory or explicitly set `set emulate off` in your Pwndbg config
LEGEND: STACK | HEAP | CODE | DATA | WX | RODATA
──────────────────────────────────────[ REGISTERS / show-flags off / show-compact-regs off ]──
 RAX  0x555555401343 (main) ◂— push rbp
 RBX  0
 RCX  0x5555554015a0 (__libc_csu_init) ◂— push r15
 RDX  0x7fffffffe478 —▸ 0x7fffffffe6fd ◂— 'SHELL=/bin/bash'
 RDI  1
 RSI  0x7fffffffe468 —▸ 0x7fffffffe6e7 ◂— '/home/ubuntu/crackme6'
 R8   0x7ffff7e1bf10 (initial+16) ◂— 4
 R9   0x7ffff7fc9040 (_dl_fini) ◂— endbr64
 R10  0x7ffff7fc3908 ◂— 0xd00120000000e
 R11  0x7ffff7fde660 (_dl_audit_preinit) ◂— endbr64
 R12  0x7fffffffe468 —▸ 0x7fffffffe6e7 ◂— '/home/ubuntu/crackme6'
 R13  0x555555401343 (main) ◂— push rbp
 R14  0
 R15  0x7ffff7ffd040 (_rtld_global) —▸ 0x7ffff7ffe2e0 —▸ 0x555555400000 ◂— jg 0x555555400047
 RBP  0x7fffffffe350 ◂— 1
 RSP  0x7fffffffe350 ◂— 1
 RIP  0x555555401347 (main+4) ◂— sub rsp, 0xb0
──────────────────────────────────────[ DISASM / x86-64 / set emulate off ]──────────────────
```

```
──────────────────────────────────────[ DISASM / x86-64 / set emulate off ]──────────────────
 ► 0x555555401347 <main+4>     sub    rsp, 0xb0                      RSP => 0x7fffffffe350 - 0xb0
   0x55555540134e <main+11>    mov    dword ptr [rbp - 0xa4], edi
   0x555555401354 <main+17>    mov    qword ptr [rbp - 0xb0], rsi
   0x55555540135b <main+24>    mov    rax, qword ptr fs:[0x28]       RAX, [0x7ffff7fb0768]
   0x555555401364 <main+33>    mov    qword ptr [rbp - 8], rax
   0x555555401368 <main+37>    xor    eax, eax                       EAX => 0
   0x55555540136a <main+39>    lea    rdi, [rip + 0x46c]             RDI => 0x5555554017dd ◂— sub ch, byte ptr [rdx] /
   0x555555401371 <main+46>    call   puts@plt                   <puts@plt>

   0x555555401376 <main+51>    lea    rdi, [rip + 0x478]     RDI => 0x5555554017f5 ◂— sub ch, byte ptr [rdx] /* '**
   0x55555540137d <main+58>    call   puts@plt                   <puts@plt>

   0x555555401382 <main+63>    lea    rdi, [rip + 0x454]     RDI => 0x5555554017dd ◂— sub ch, byte ptr [rdx] /* '******
──────────────────────────────────────[ STACK ]──────────────────────────────────────
00:0000│ rbp rsp 0x7fffffffe350 ◂— 1
01:0008│+008     0x7fffffffe358 —▸ 0x7ffff7c29d90 (__libc_start_call_main+128) ◂— mov edi, eax
02:0010│+010     0x7fffffffe360 ◂— 0
03:0018│+018     0x7fffffffe368 —▸ 0x555555401343 (main) ◂— push rbp
04:0020│+020     0x7fffffffe370 ◂— 0x100000000
05:0028│+028     0x7fffffffe378 —▸ 0x7fffffffe468 —▸ 0x7fffffffe6e7 ◂— '/home/ubuntu/crackme6'
06:0030│+030     0x7fffffffe380 ◂— 0
07:0038│+038     0x7fffffffe388 ◂— 0x48e052766b246d88
──────────────────────────────────────[ BACKTRACE ]──────────────────────────────────────
 ► 0   0x555555401347 main+4
   1   0x7ffff7c29d90 __libc_start_call_main+128
   2   0x7ffff7c29e40 __libc_start_main+128
   3   0x5555554008ea _start+42
──────────────────────────────────────────────────────────────────────────────────────
pwndbg>
```

Upar hum dekh skte hai ki yha pr hume bahut sare sections milte hai. **registers** ki value mil jati with **telescoping**.

Telescoping means kaun sa chij kis chij ko point kr rha hai batat hai.



Jaisa ki hum upar dekh skte hai. **0x7fffffdf88 → 0x7ffffffe2eb** ko point kr rha hai. aur **0x7ffffffe2eb** address pr `'GJS_DEBUG_TOPICS=JS ERROR;JS LOG'` hai ye bhi bta rha hai.

Ab hum ni krte next instruction pdte jate hai.

```
pwndbg> ni
```

Agar aapne ek bar **ni** (jo bhi command) likh diya fir bs enter hit kr skte hai. ye previous command chala dega.

```
                                                              [ DISASM ]
   0x555555401354 <main+17>    mov    qword ptr [rbp - 0xb0], rsi
   0x55555540135b <main+24>    mov    rax, qword ptr fs:[0x28]
   0x555555401364 <main+33>    mov    qword ptr [rbp - 8], rax
   0x555555401368 <main+37>    xor    eax, eax
   0x55555540136a <main+39>    lea    rdi, [rip + 0x46c]
 ► 0x555555401371 <main+46>    call   puts@plt <puts@plt>
        s: 0x5555554017dd ← '**********************'

   0x555555401376 <main+51>    lea    rdi, [rip + 0x478]
   0x55555540137d <main+58>    call   puts@plt <puts@plt>

   0x555555401382 <main+63>    lea    rdi, [rip + 0x454]
   0x555555401389 <main+70>    call   puts@plt <puts@plt>

   0x55555540138e <main+75>    mov    edi, 0xa
```

pwndbg me jo bhi call ke puts funciton me print hone wala ho wo hume dikh deta hai.

```
   0x5555554013b5 <main+114>    call   putchar@plt <putchar@plt>

 ► 0x5555554013ba <main+119>    movabs rax, 0x2073692073696854
   0x5555554013c4 <main+129>    movabs rdx, 0x657320706f742061
   0x5555554013ce <main+139>    mov    qword ptr [rbp - 0x30], rax
   0x5555554013d2 <main+143>    mov    qword ptr [rbp - 0x28], rdx
   0x5555554013d6 <main+147>    movabs rax, 0x7865742074657263
   0x5555554013e0 <main+157>    movabs rdx, 0x67617373656d2074
```

Ab yha pr ye itne bade hex values mov ho rhi hai. generally aisi chij nhi hoti. Iska mtlb ye koi string mov ho rhi hai kai sare pieces me 3-4 registers ka use krke.

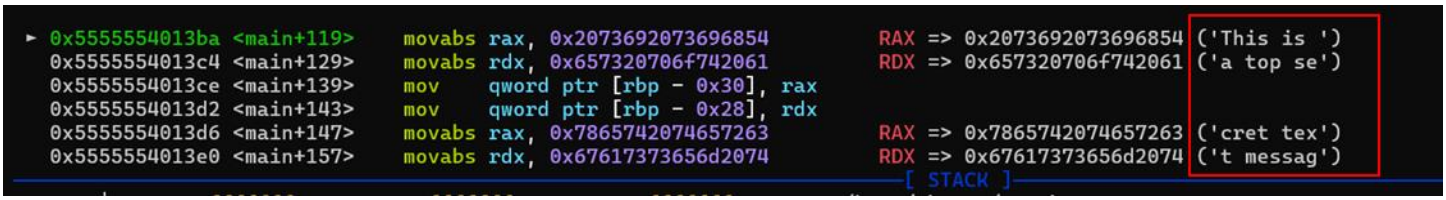
Ise hum **unhex** krke dekhte hai. starting ke **0x** hta denge. Aur unhex command ko pwndbg ke sath aata hai. **vanilla gdb** me nhi aata.

```
pwndbg> unhex 2073692073696854
 si sihTpwndbg> unhex 657320706f742061
es pot apwndbg>
```

To ye ulta print krta hai. little endian format me ye ulta print krta hai.

Likha hai This is a top se (secret hi hoga)

Ye latest **pwndbg** me string krke bta deta hai.



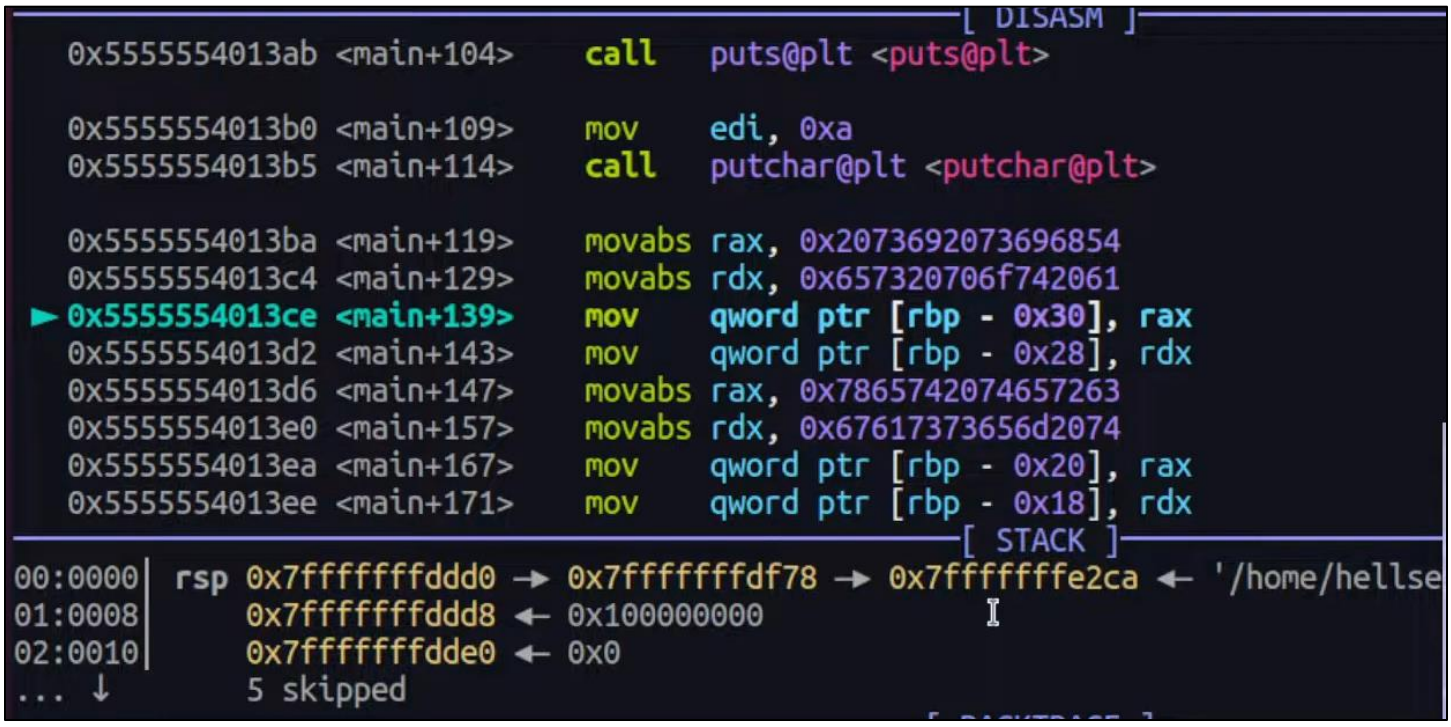
To yha pr ye phle **rax** ke andar mov kr rha hai fir **rdx** ke andar mov kr rha hai fir ye in dono ko **Stack** ke andar mov kr rha hai.

Ab yha **Stack** kya hai. to **Stack** ek location hai hum apne temparery chijo ko store kr skte hai. **Register**s bhi storage hi hai but ye bahut jyada chote hai. jb humari program run ho rha hota hai to wo currently kahan pr store hota hai. to ye **RAM** ke andar store hote hai.

To **RAM** ke andar bhi alag-2 location hote hai jha pr humari chije store hoti hai. like **Stack** hota hai **Heap** hota hai etc.

To **Stack** ke andar hum un chijo ko store kr skte hai jinka use hume bad me hai. **Registers** ke andar wo chije aati hai jinka use currently hai ya hone wala hai ya ho rha hai.

Stack bhi bahut jayada limited hai. isme bhi bahut badi value nhi rakh skte hai isi ke jaisi ek memory location **Heap** hoti hai wo stack ke mukawale bahut badi hoti hai.



To yha hum bdi value ko **Stack** ke andar mov kr denge.

```
  0x5555554013ee <main+171>    mov    qword ptr [rbp - 0x18], rdx
  0x5555554013f2 <main+175>    mov    word ptr [rbp - 0x10], 0x2165
  0x5555554013f8 <main+181>    mov    byte ptr [rbp - 0xe], 0
  0x5555554013fc <main+185>    sidt   [rbp - 0x96]
  0x555555401403 <main+192>    movzx  eax, byte ptr [rbp - 0x91]
► 0x55555540140a <main+199>    cmp    al, 0xff
  0x55555540140c <main+201>    jne    main+225 <main+225>
    ↓
  0x555555401424 <main+225>    lea    rax, [rbp - 0x30]
  0x555555401428 <main+229>    mov    rsi, rax
  0x55555540142b <main+232>    mov    edi, 0xd
  0x555555401430 <main+237>    call   rot <rot>
```

Ab yha pr ye compare kr rha hai. but ye equal nhi hai. jaisa ki hum jante hai **rax** ki last **8 bits al** hoti hai.

To hum register ki value dekhe to.

```
*RAX  0x0
 RBX  0x5555554015a0 (__libc_csu_init) ← push   r15
 RCX  0x7ffff7eca1e7 (write+23) ← cmp    rax, -0x10
 RDX  0x676173736d2074 ('t messag')
 RDI  0x7ffff7fa74c0 (_IO_stdfile_1_lock) ← 0x0
 RSI  0x5555556032a0 ← '\n do not patch, find inste
```

Yha rax ki value **0** hai. next line dekhte hai.

```
  0x555555401403 <main+192>    movzx  eax, byte ptr [rbp - 0x91]
  0x55555540140a <main+199>    cmp    al, 0xff
► 0x55555540140c <main+201>  ✔ jne    main+225 <main+225>
    ↓
  0x555555401424 <main+225>    lea    rax, [rbp - 0x30]
  0x555555401428 <main+229>    mov    rsi, rax
  0x55555540142b <main+232>    mov    edi, 0xd
  0x555555401430 <main+237>    call   rot <rot>
```

To ye equal nhi hoge fir jump karege jne means jump if not equal. Aur hum dekh skte hai **jne** pr right ka tick bn kr bhi aa gya.

Man lo agar hume dekhna hai ki ye jump nhi leta to kya hota.

```
pwndbg> nearpc
   0x5555554013f2 <main+175>    mov    word ptr [rbp - 0x10], 0x2165
   0x5555554013f8 <main+181>    mov    byte ptr [rbp - 0xe], 0
   0x5555554013fc <main+185>    sidt   [rbp - 0x96]
   0x555555401403 <main+192>    movzx  eax, byte ptr [rbp - 0x91]
   0x55555540140a <main+199>    cmp    al, 0xff
 ► 0x55555540140c <main+201>  ✓ jne    main+225 <main+225>

   0x55555540140e <main+203>    lea    rdi, [rip + 0x43c]
   0x555555401415 <main+210>    call   puts@plt <puts@plt>

   0x55555540141a <main+215>    mov    edi, 1
   0x55555540141f <main+220>    call   exit@plt <exit@plt>

   0x555555401424 <main+225>    lea    rax, [rbp - 0x30]
pwndbg>
```

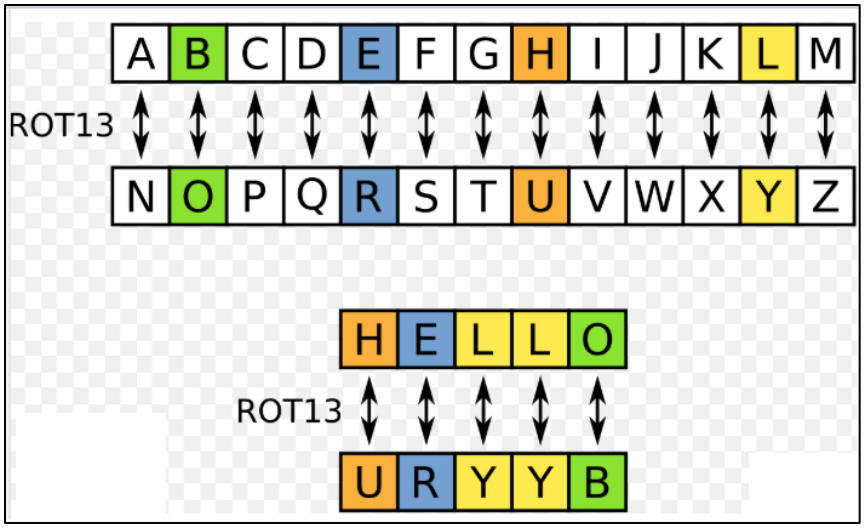
To kuch rdi me put hota hai. iska mtlb hume jump nhi leni chahiye thi.

Aage **ni** krte hai next intruction pr chalte hai.

```
   0x555555401428 <main+229>    mov    rsi, rax
   0x55555540142b <main+232>    mov    edi, 0xd
 ► 0x555555401430 <main+237>    call   rot <rot>
        rdi: 0xd
        rsi: 0x7fffffffde50 ← 'This is a top secret text message!'
        rdx: 0x676173736d2074 ('t messag')
        rcx: 0x7ffff7eca1e7 (write+23) ← cmp    rax, -0x1000 /* 'H=' */

   0x555555401435 <main+242>    lea    rax, [rbp - 0x30]
   0x555555401439 <main+246>    mov    rsi, rax
   0x55555540143c <main+249>    mov    edi, 0xd
   0x555555401441 <main+254>    call   rot <rot>

   0x555555401446 <main+259>    movabs rax, 0x4145443332694841
[ STACK ]
00:0000| rsp 0x7fffffffddd0 → 0x7fffffffdf78 → 0x7fffffffe2ca ← '/home/hellse
01:0008|     0x7fffffffddd8 ← 0x100000000
```

To yha pr **rot** function ko call ho rhi hai. **rot** function kya krte hai rotate krte hai.

Something like this.



But ye function abhi humare kam ka nhi lg rha hai.

Aage ni krte hai.

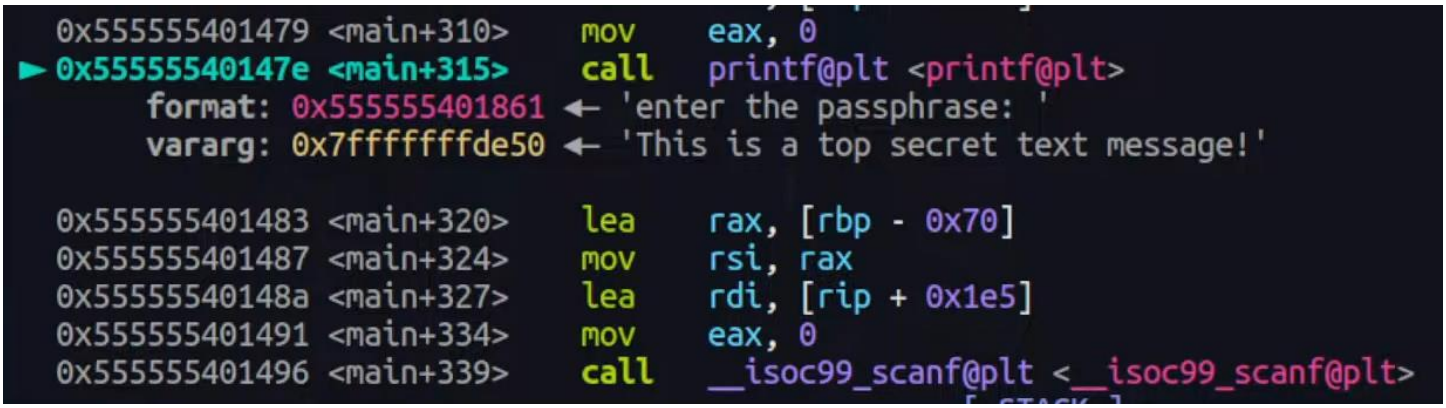
```
   0x555555401439 <main+246>    mov    rsi, rax
   0x55555540143c <main+249>    mov    edi, 0xd
 ► 0x555555401441 <main+254>    call   rot <rot>
        rdi: 0xd
        rsi: 0x7fffffffde50 ◂— 'Guvf vf n gbc frperg grkg zrffntr!'
        rdx: 0x42
        rcx: 0x21

   0x555555401446 <main+259>    movabs rax, 0x4145443332694841
   0x555555401450 <main+269>    movabs rdx, 0x464f434645454244
   0x55555540145a <main+279>    mov    qword ptr [rbp - 0x90], rax
   0x555555401461 <main+286>    mov    qword ptr [rbp - 0x88], rdx
   0x555555401468 <main+293>    mov    word ptr [rbp - 0x80], 0x4546
```

Yha fir ye ek aur **string** ko **rotate** kr rha hai.

Aage ni krte hai.

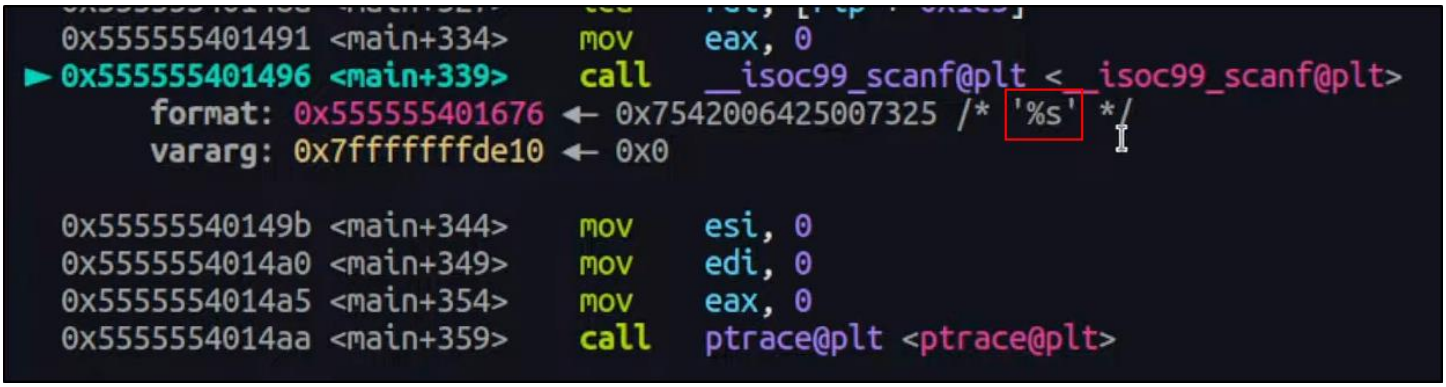
```
 ► 0x555555401446 <main+259>    movabs rax, 0x4145443332694841
   0x555555401450 <main+269>    movabs rdx, 0x464f434645454244
   0x55555540145a <main+279>    mov    qword ptr [rbp - 0x90], rax
   0x555555401461 <main+286>    mov    qword ptr [rbp - 0x88], rdx
   0x555555401468 <main+293>    mov    word ptr [rbp - 0x80], 0x4546
   0x55555540146e <main+299>    mov    byte ptr [rbp - 0x7e], 0x45
──────────────────────────────────────────────[ STACK ]
```

Yha fir se ye ek aur string ko **rax** ke andar put krta aur dusre string ko **rdx** ke andar fir ye ise **Stack** me mov kr rha hai.

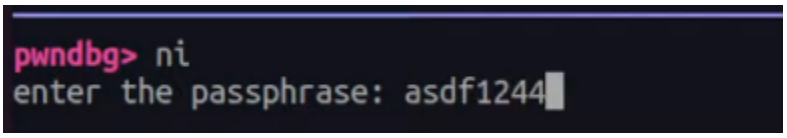


Yha printf ko call kr rha hai enter theh passphase:

Mtlb ye inpur lete hai kuchh instructions ke bad.



Ab ye string type ka input lega **scanf** functin ke through kyoki yha **%s** diya hai.



Yha pr humne input dal diya.

Aur next instruction pr chalte hai.

```
  0x5555554014a5 <main+354>     mov    eax, 0
► 0x5555554014aa <main+359>     call   ptrace@plt <ptrace@plt>
        request: 0x0
        vararg: 0x0

  0x5555554014af <main+364>     test   rax, rax
  0x5555554014b2 <main+367>     jns    main+391 <main+391>

  0x5555554014b4 <main+369>     lea    rdi, [rip + 0x3bd]
  0x5555554014bb <main+376>     call   puts@plt <puts@plt>
```

Aur ye yha **ptrace** function ko call kr rha hai jo ki bahut jyada instresting hai.

Next krte hai.

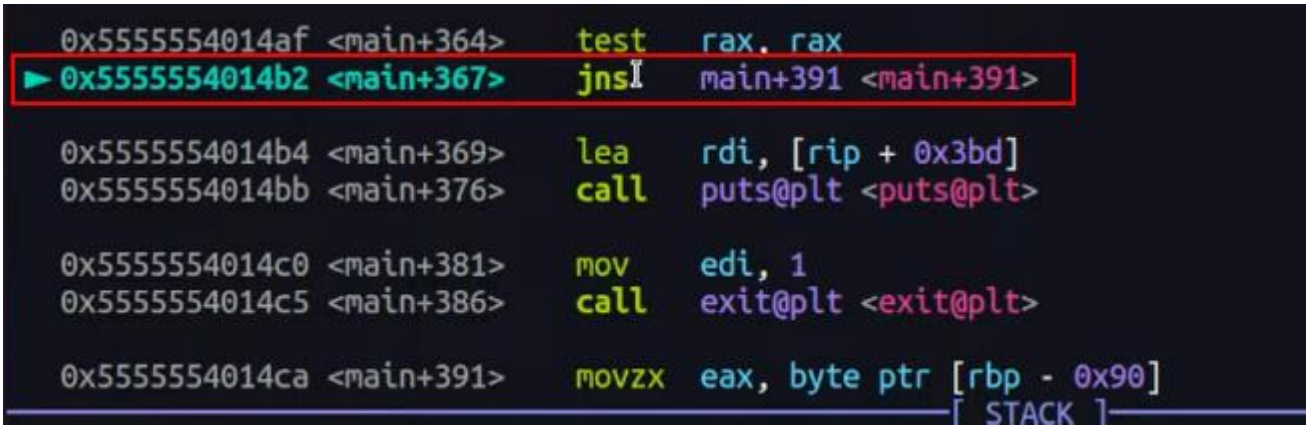
```
  0x5555554014a5 <main+354>     mov    eax, 0
  0x5555554014aa <main+359>     call   ptrace@plt <ptrace@plt>

► 0x5555554014af <main+364>     test   rax, rax
  0x5555554014b2 <main+367>     jns    main+391 <main+391>

  0x5555554014b4 <main+369>     lea    rdi, [rip + 0x3bd]
  0x5555554014bb <main+376>     call   puts@plt <puts@plt>

  0x5555554014c0 <main+381>     mov    edi, 1
```

Yha pr ye check kr rha hai ki rax ki value 0 hai.

```
[ REGISTERS ]
*RAX  0xffffffffffffffff
 RBX  0x5555554015a0 (__libc_csu_init) ← push   r15
 RCX  0x0
*RDX  0xffffffffffffff80
 RDI  0x0
 RSI  0x0
*R8   0xffffffff
 R9   0x7c
*R10  0x0
*R11  0x286
 R12  0x5555554008c0 (_start) ← xor    ebp, ebp
 R13  0x7fffffffdf70 ← 0x1
 R14  0x0
 R15  0x0
 RBP  0x7fffffffde80 ← 0x0
 RSP  0x7fffffffddd0 → 0x7fffffffdf78 → 0x7fffffffe2ca ← '/home/hel
*RIP  0x5555554014af (main+364) ← test   rax, rax
[ DISASM ]
```

To hum rax me dekhe to hex ka sbse bda number hai. theek opposite.

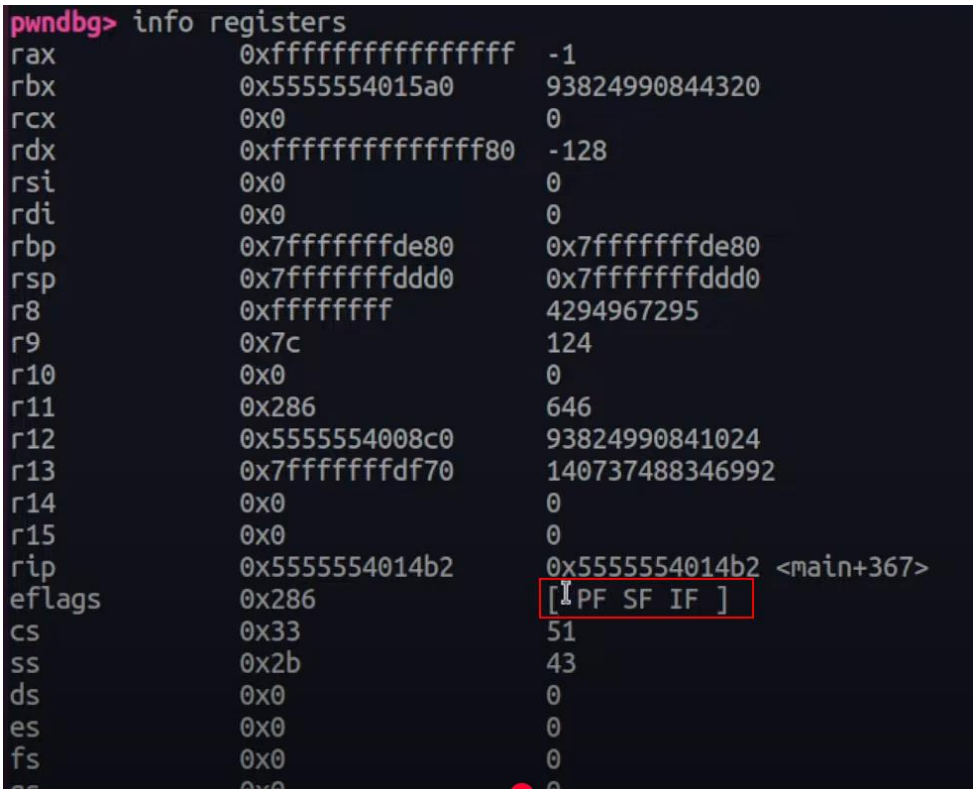
Ye wali situation true nhi hai.



Yha pr ye check kr rha hai ki **sign flag** ki value **zero** hai to jump kare otherwise jump mt karo.

jns means jump if sign flag value is **zero**.

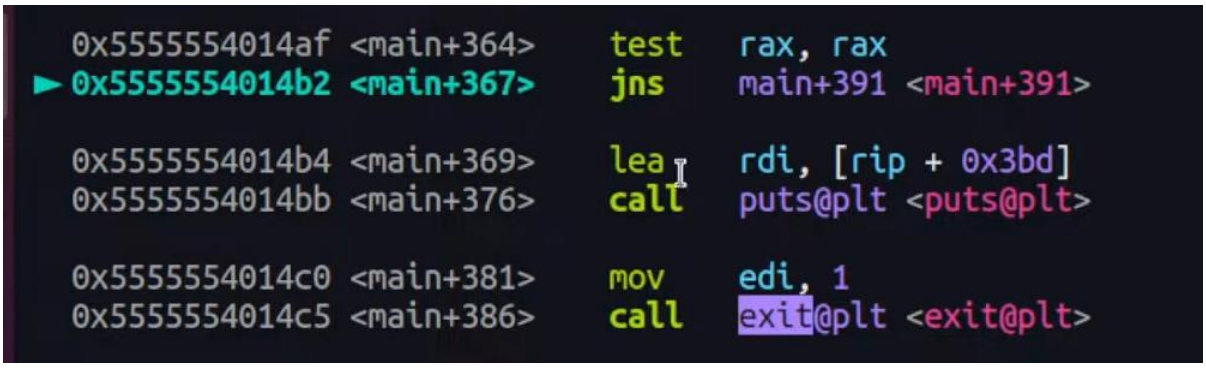
Agar hum registers dekhe to.



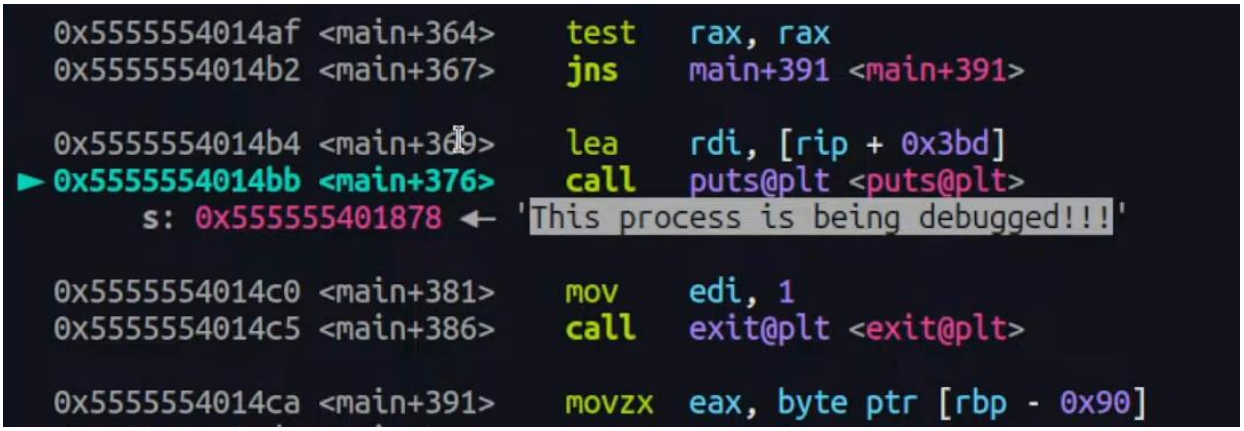
To hum yha dekh skte hai jo bhi flag likh kr aate hai unki value **1** hoti hai. aur jo nhi likh kr aate unki value **zero** hoti hai.

Iska mtlb **SF (sign flag)** ki value **1** hai.

To ye **jump** nhi karega. Agar ye jump nhi karega to kya hoga. Ye kisi chij ko **puts** karega aur **exit** kr jayega.



Next instruction pr jate hai.



Ab hum yha pr dekh skte hai. ki isne detect kr li ki **debugging** ho rhi hai. but jb humne normal run kiya tha to iska try again ka message print kiya tha.

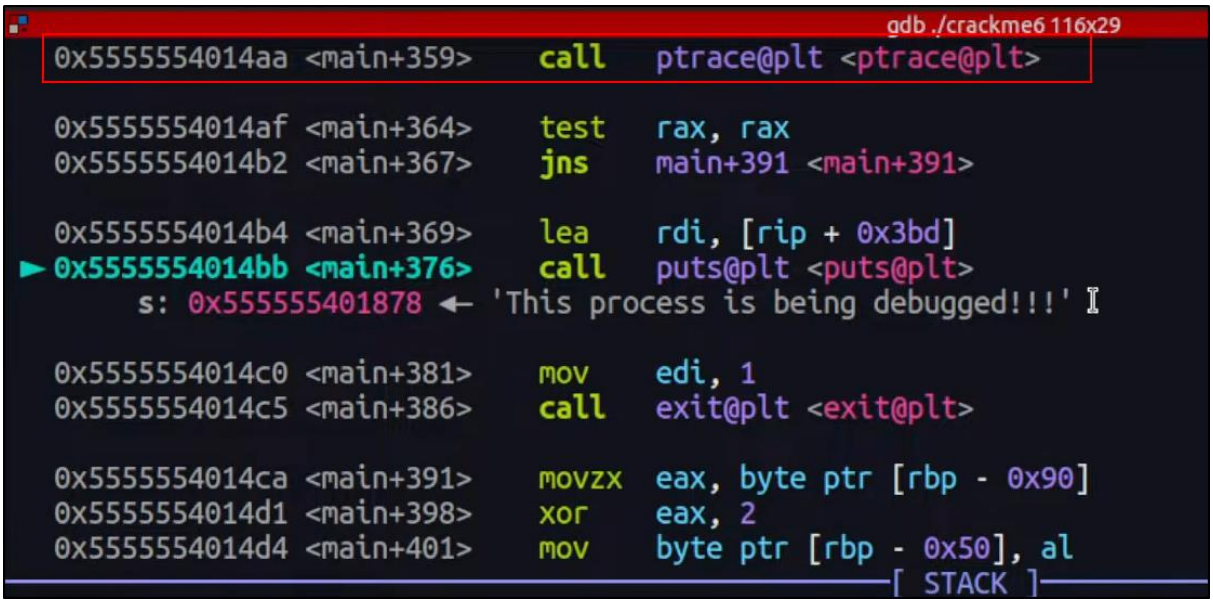
To ye **anti debug** technique hai. bahut sare malware ye techniques use krte hai taki koi unka malware reverse nhi kr paye.

Bahut sare malware writer ye techniques use krte hai taki unka malware reverse na ho paye.

To yha pr protection lagayi gyi hai lekin usko bypass krne ke techniques bhi honge.

Ab hum dekhte hai ki use pta kaise chala ki hum **debugger** use kr rhe hai.

Yha isne **ptrace (process trace)** call kr rha hai. to ptrace ek achha **syscall** hai jo hume batata hai ki.

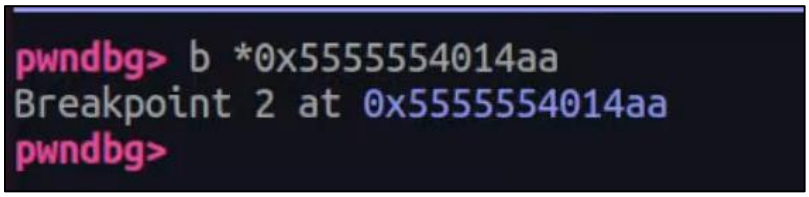


Koi ise **trace** to nhi kr rha hai. **trace** means koi ise step by step run to nhi kr rha hai. koi uski memory padne ya registers value dekhne ki koshish to nhi kr rha.

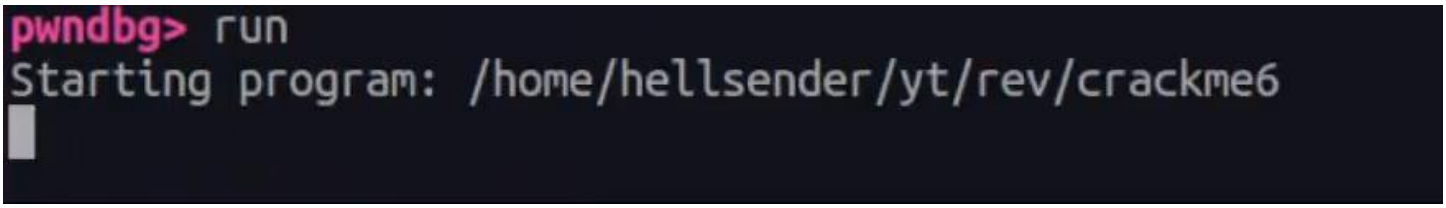
Isi se ise pta chla ki ise koi **debug** kr rha hai.

To **ptrace** ko bypass krne ke two ways hai.

Ab hum ptrace pr breakpoint lagate hai.



Aur run krte hai.



Ab ye main pr ruk gya ise **c (continue)** krte hai.

```
pwndbg> c
Continuing.
**********************
**      rules:       **
**********************

* do not bruteforce
* do not patch, find instead the serial.

enter the passphrase: 12345
```

Passphrase dal dete hai.

```
  0x5555554014a5 <main+354>    mov    eax, 0
  0x5555554014aa <main+359>    call   ptrace@plt <ptrace@plt>

► 0x5555554014af <main+364>    test   rax, rax
  0x5555554014b2 <main+367>    jns    main+391 <main+391>

  0x5555554014b4 <main+369>    lea    rdi, [rip + 0x3bd]
  0x5555554014bb <main+376>    call   puts@plt <puts@plt>

  0x5555554014c0 <main+381>    mov    edi, 1
  0x5555554014c5 <main+386>    call   exit@plt <exit@plt>
```

Yha pr **rax** ki value agar **0** hai to **debugger** nhi run ho rha hai. lekin **0** ke awala koi aur value hai jaise **1** to **debugger** run ho rha hai.

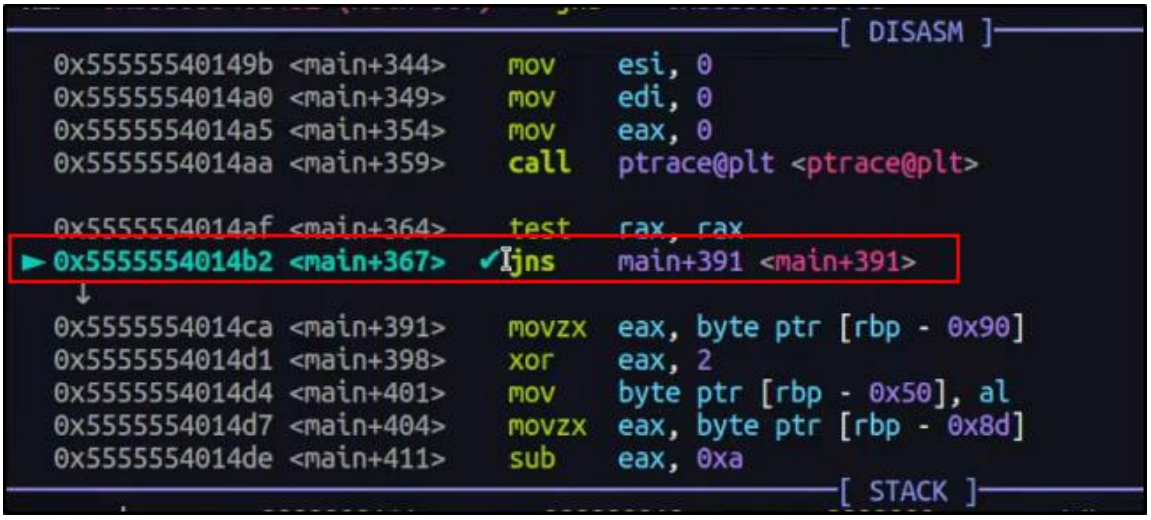
To hume isko bypass krne ke liye rax ki value **0** krni hogi.

```
[ REGISTERS ]
*RAX  0xffffffffffffffff
 RBX  0x5555554015a0 (__libc_csu_init) ← push   r15
 RCX  0x0
*RDX  0xffffffffffffff80
 RDI  0x0
 RSI  0x0
*R8   0xffffffff
 R9   0x7c
*R10  0x0
*R11  0x286
 R12  0x5555554008c0 (_start) ← xor    ebp, ebp
 R13  0x7fffffffdf70 ← 0x1
```

To yha pr hum **rax** ki value **0** set kr dete hai.

```
pwndbg> set $rax = 0
```

Next instruction pr chalte hai.



To yha pr ye **jump** le rha hai.

```
pwndbg> info registers
rax            0x0                 0
rbx            0x5555554015a0      93824990844320
rcx            0x0                 0
rdx            0xffffffffffffff80  -128
rsi            0x0                 0
rdi            0x0                 0
rbp            0x7fffffffde80      0x7fffffffde80
rsp            0x7fffffffddd0      0x7fffffffddd0
r8             0xffffffff          4294967295
r9             0x7c                124
r10            0x0                 0
r11            0x286               646
r12            0x5555554008c0      93824990841024
r13            0x7fffffffdf70      140737488346992
r14            0x0                 0
r15            0x0                 0
rip            0x5555554014b2      0x5555554014b2 <main+367>
eflags         0x246               [ PF ZF IF ]
cs             0x33                51
ss             0x2b                43
ds             0x0                 0
es             0x0                 0
fs             0x0                 0
gs             0x0                 0
pwndbg>
```

To yha hum dekh skte hai ki **SF** nhi set hai mtlb uski value **zero** hai. isliye show nhi kr rha hai.

Ab hum next instruction pr chlte hai.

```
   0x5555554014aa <main+359>    call   ptrace@plt <ptrace@plt>

   0x5555554014af <main+364>    test   rax, rax
   0x5555554014b2 <main+367>    jns    main+391 <main+391>
    ↓
 ► 0x5555554014ca <main+391>    movzx  eax, byte ptr [rbp - 0x90]
   0x5555554014d1 <main+398>    xor    eax, 2
   0x5555554014d4 <main+401>    mov    byte ptr [rbp - 0x50], al
   0x5555554014d7 <main+404>    movzx  eax, byte ptr [rbp - 0x8d]
```

Next instructions pr chalte rhte hai.

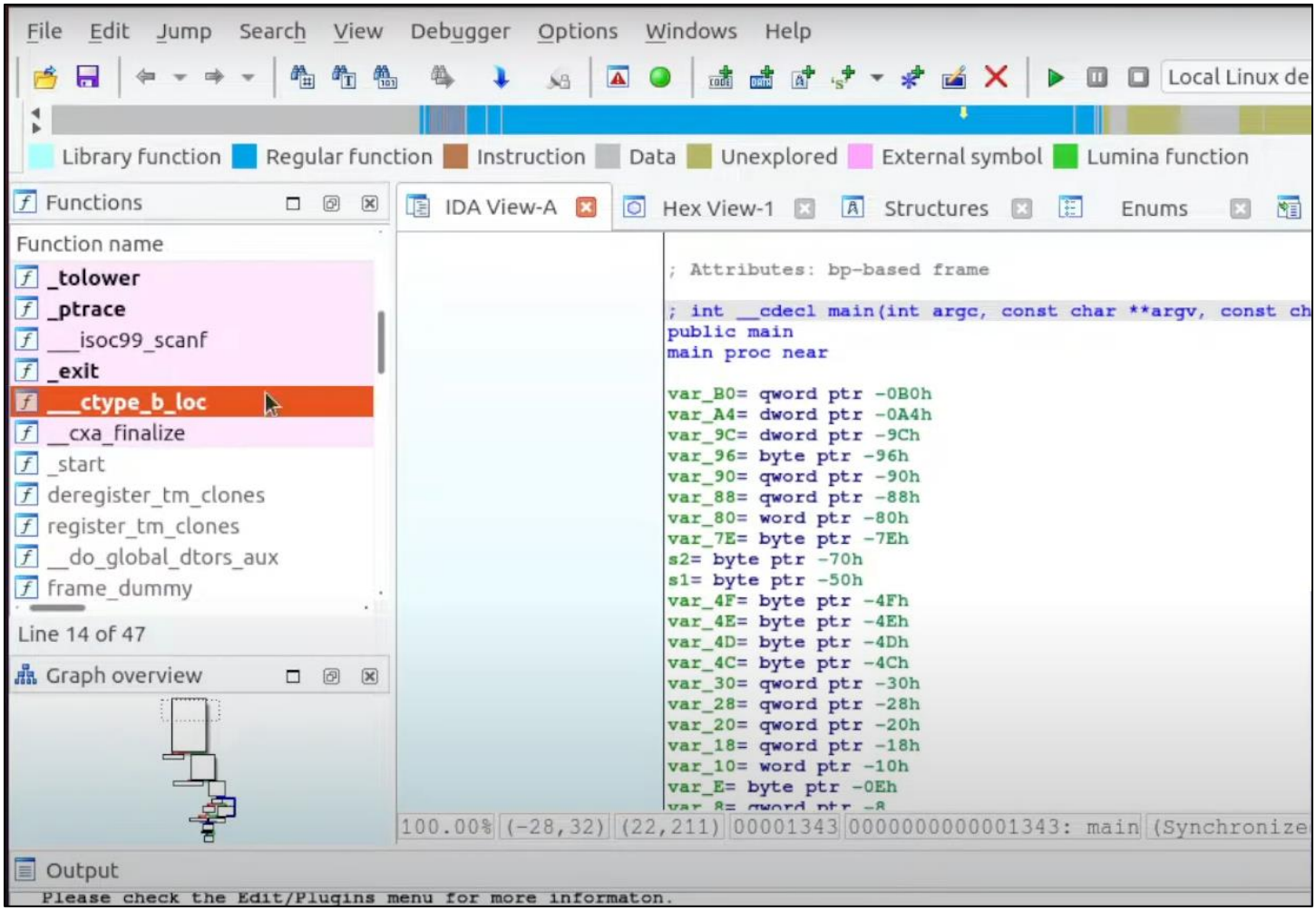
```
   0x5555554014e1 <main+414>     mov    byte ptr [rbp - 0x4f], al
   0x5555554014e4 <main+417>     movzx  eax, byte ptr [rbp - 0x8e]
   0x5555554014eb <main+424>     add    eax, 0xc
   0x5555554014ee <main+427>     mov    byte ptr [rbp - 0x4e], al
 ► 0x5555554014f1 <main+430>     movzx  eax, byte ptr [rbp - 0x8e]
   0x5555554014f8 <main+437>     mov    byte ptr [rbp - 0x4d], al
   0x5555554014fb <main+440>     movzx  eax, byte ptr [rbp - 0x8f]
   0x555555401502 <main+447>     add    eax, 1
   0x555555401505 <main+450>     mov    byte ptr [rbp - 0x4c], al
```

To yha pr assembly me samajhne me der hogi to hum decompiler ka use kr lete hai.

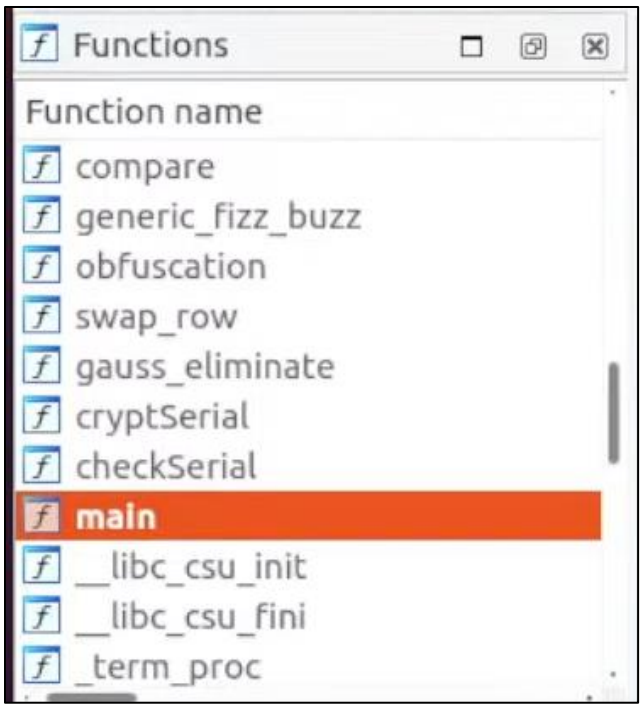
Yha hum IDA ka use karenge.

```
→ idafree-7.6 ./ida64 ~/yt/rev/crackme6
```

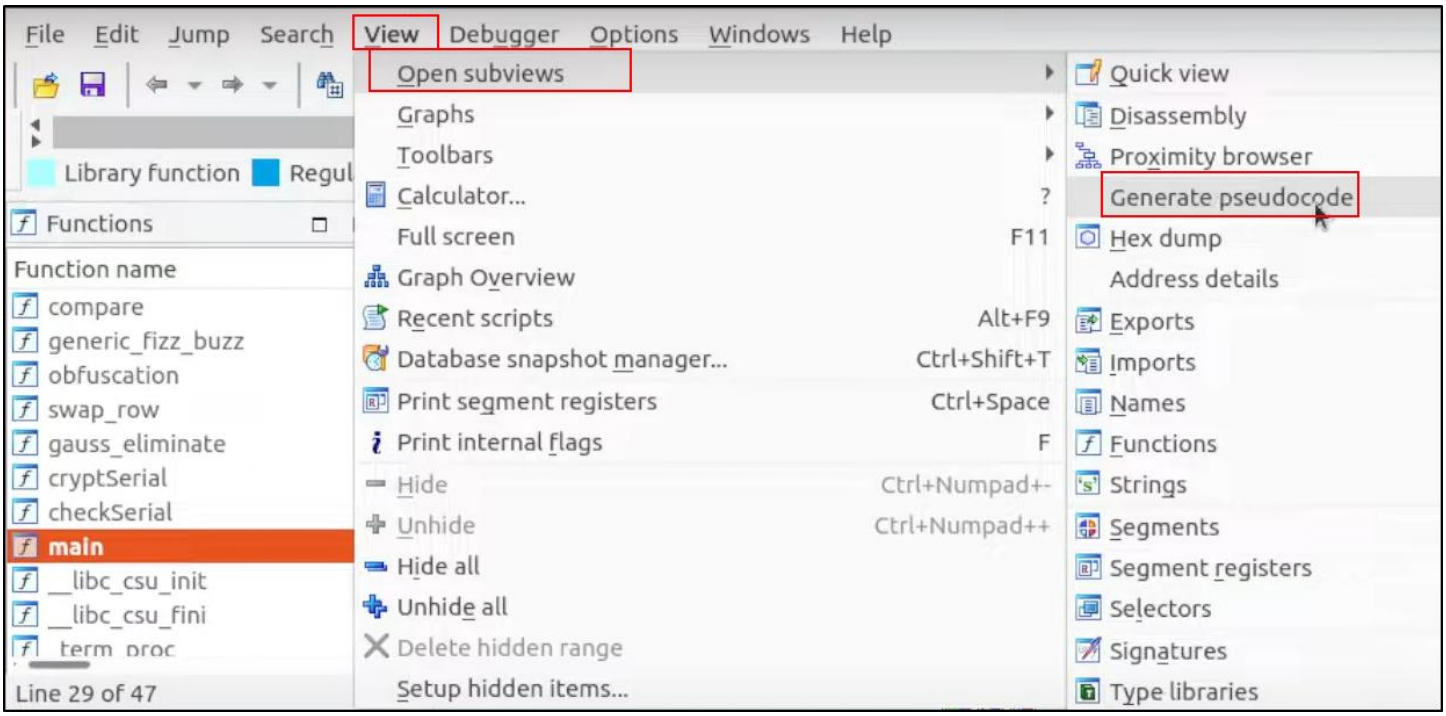
Yha pr binary load ho chuki hai.

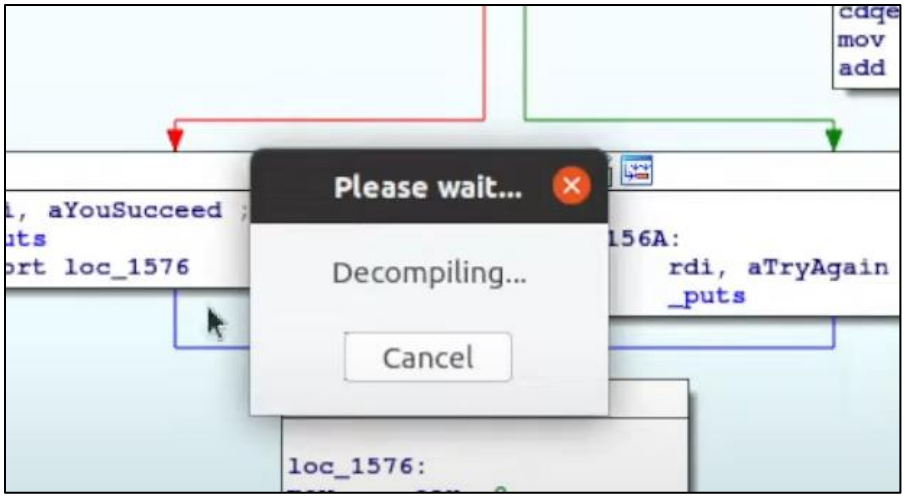


Yha sbse phle **main** function pr aa jana hai.

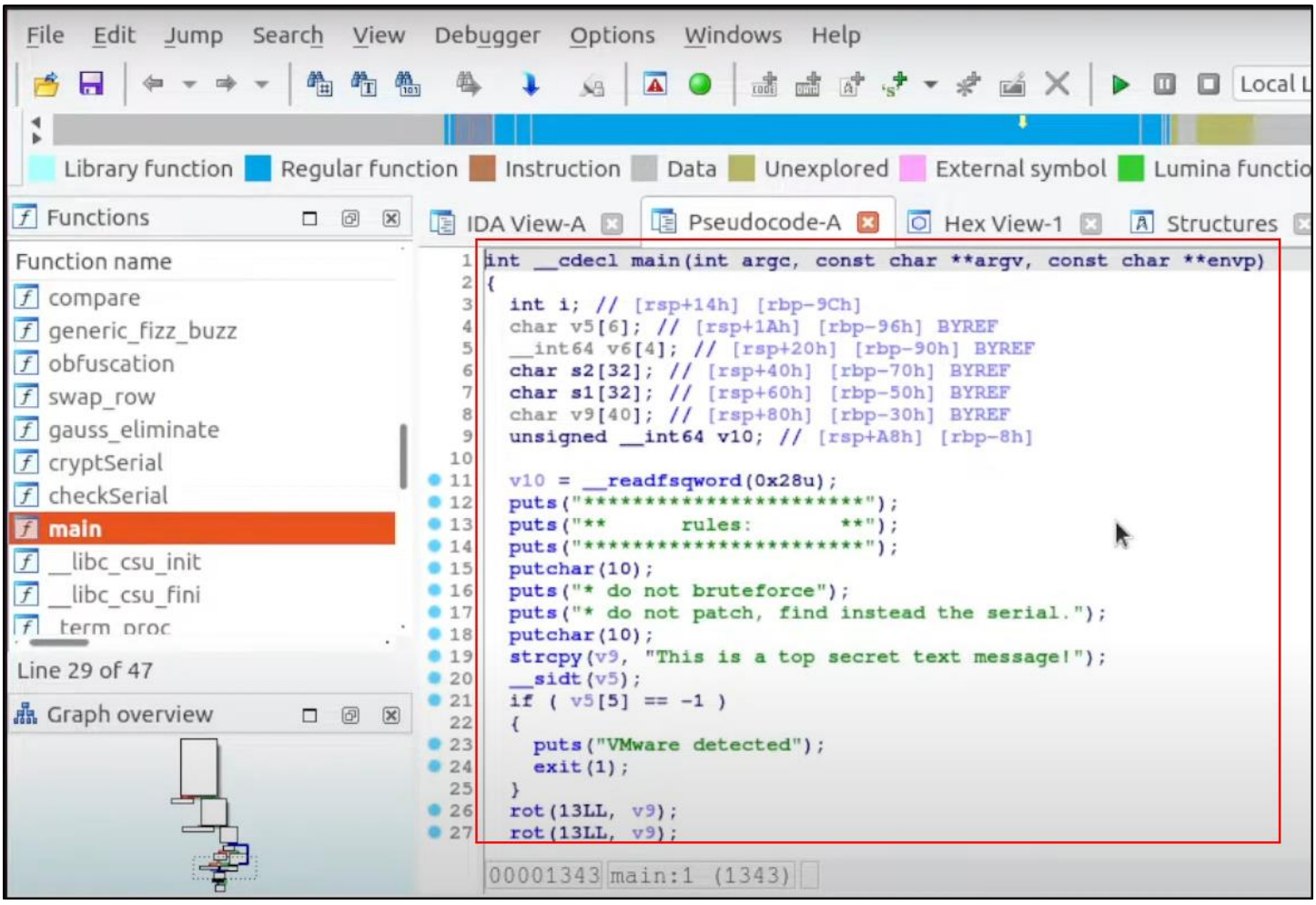


Ab decompiler ke liye **f5** bhi press kr skte hai.





Ye thoda time lega aur psudocode generate kr dega.

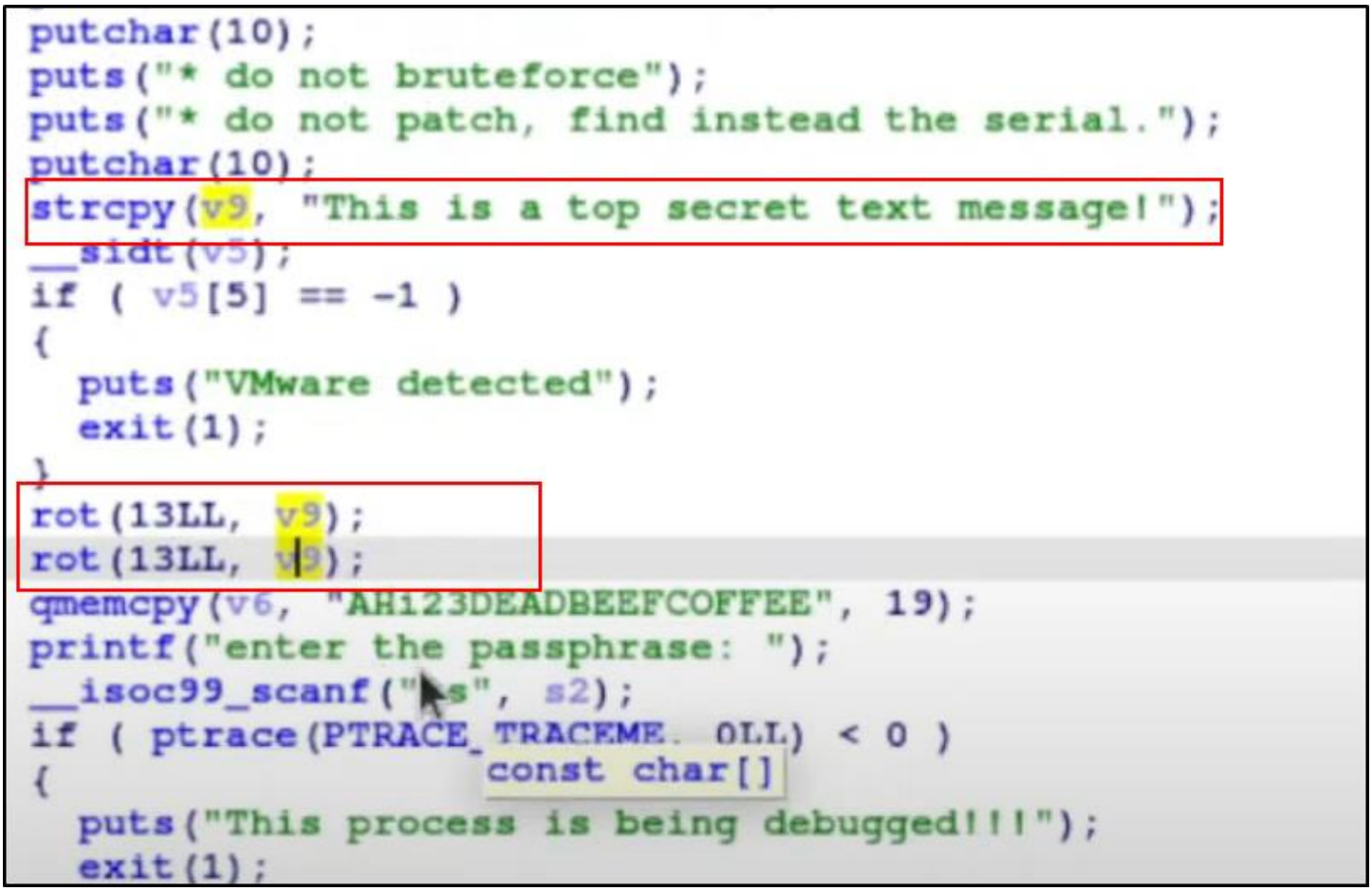


Let’s analyze it.

Yha pr koi array hai. jiska 6th value agar -1 hota hai to ye **"vmware detected"** show krke **exit** ho jayega.

To yha hum **vmware** pr run kare ya host machine pr run kare kya fark padta hai. lekin agar ye **malware** hua to **malware analyst** ka kam kitna hard ho jayega.

Kyoki wo host machine nhi kharab karega aur vmware pr run kar nhi skta. To wo fs jata hai. to ise hume bypass krna pdta hai.



Humne ek chij nhi dekha upar ek message diya tha "this is a top secret text message!"

Aur ise **v9** variable me dal kr do bar **rot** function se **rotate** krwaya ja rha hai. jiska kuchh mtlb nhi hai. bs distract krne ke liye hai. ise rabbit holes khte hai.

Rabbit hole ka mtlb aapko confuse kare aur gol-2 ghumaye. Ye analyst ko confuse krne ke liye diya jata hai taki wo kahin aur bhatak jaye.

Man lijiye hume knowladge na hoti to hum rot ke andar chale jate aur kafi sari calculation hoti aur usi me fase rh jate.

Yha code ko aage dekhe to

```
rot(13LL, v9);
rot(13LL, v9);
qmemcpy(v6, "AHi23DEADBEEFCOFFEE", 19);
printf("enter the passphrase: ");
__isoc99_scanf("%s", s2);
if ( ptrace(PTRACE_TRACEME, 0LL) < 0 )
{
```

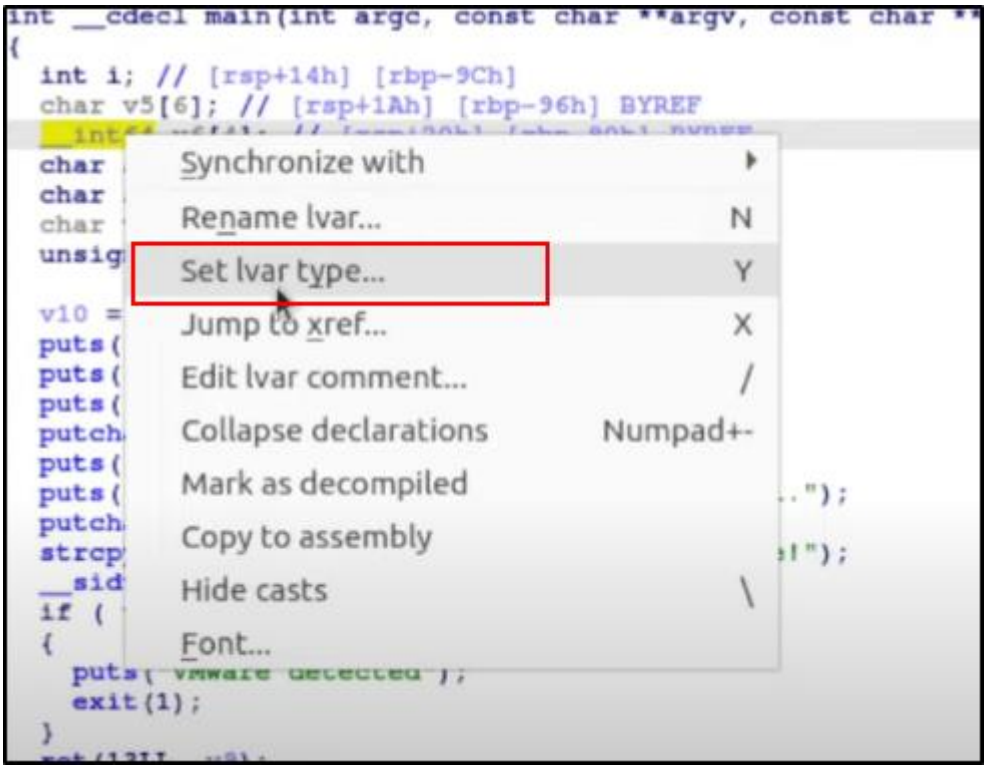
Yha pr **v6** me ek **string** ja rha hai.

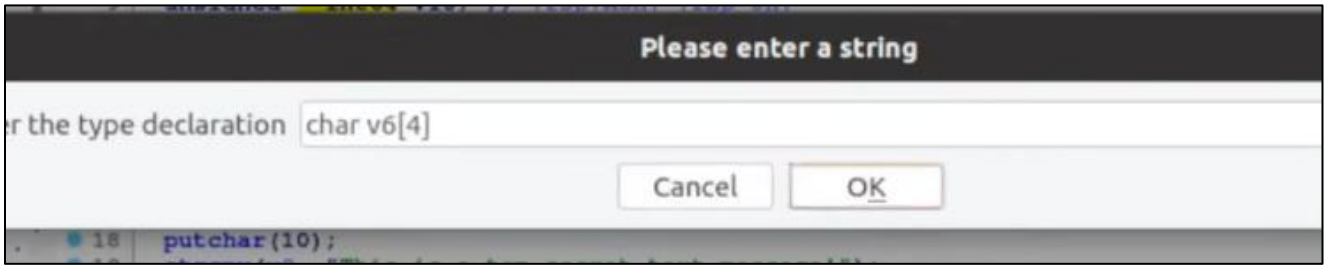
IDA View-A | Pseudocode-A | Hex View-1 | Str

```
1  int __cdecl main(int argc, const char **argv, const char **
2  {
3    int i; // [rsp+14h] [rbp-9Ch]
4    char v5[6]; // [rsp+1Ah] [rbp-96h] BYREF
5    __int64 v6[4]; // [rsp+20h] [rbp-90h] BYREF
6    char s2[32]; // [rsp+40h] [rbp-70h] BYREF
7    char s1[32]; // [rsp+60h] [rbp-50h] BYREF
8    char v9[40]; // [rsp+80h] [rbp-30h] BYREF
9    unsigned __int64 v10; // [rsp+A8h] [rbp-8h]
10
11   v10 = __readfsqword(0x28u);
12   puts("************************");
13   puts("**       rules:       **");
14   puts("************************");
15   putchar(10);
16   puts("* do not bruteforce");
17   puts("* do not patch, find instead the serial.");
18   putchar(10);
19   strcpy(v9, "This is a top secret text message!");
20   __sidt(v5);
```

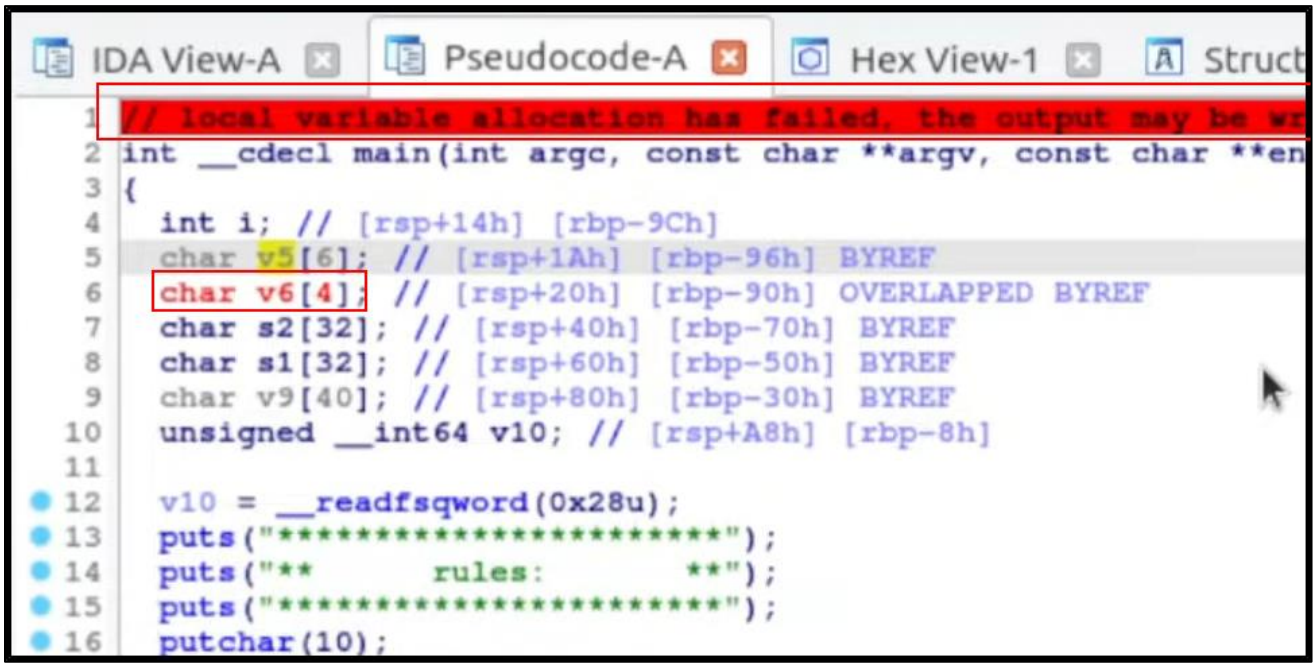
Jaisa ki hum dekh skte hai yha **v6** me ek **string** ja rhi hai aur **IDA** ise **int64** smajh rha hai.

Iska hum type change krke char kr denge.



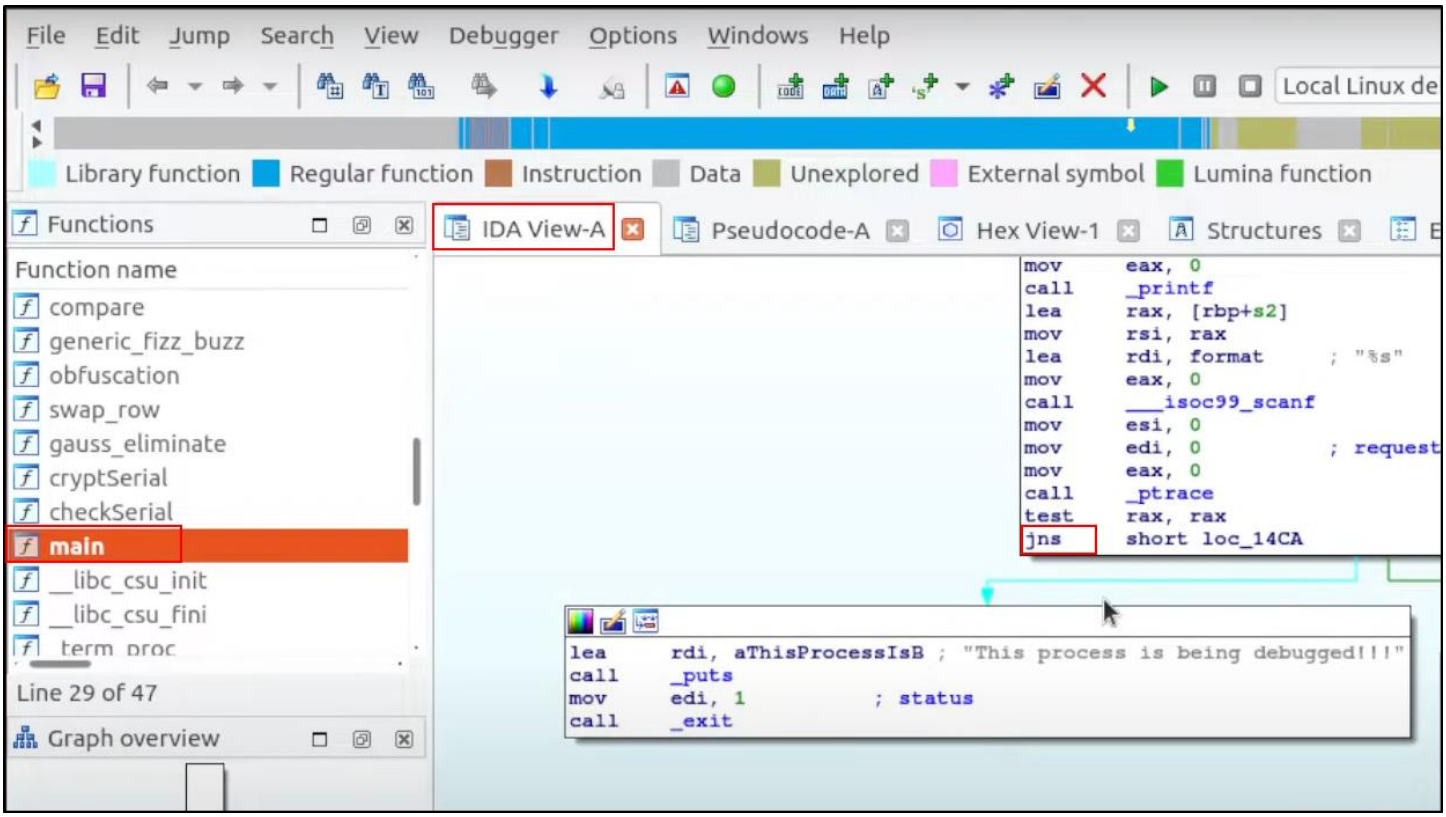


Ab ye hume warning de skta hai. ki aapka output galat ho skta hai.

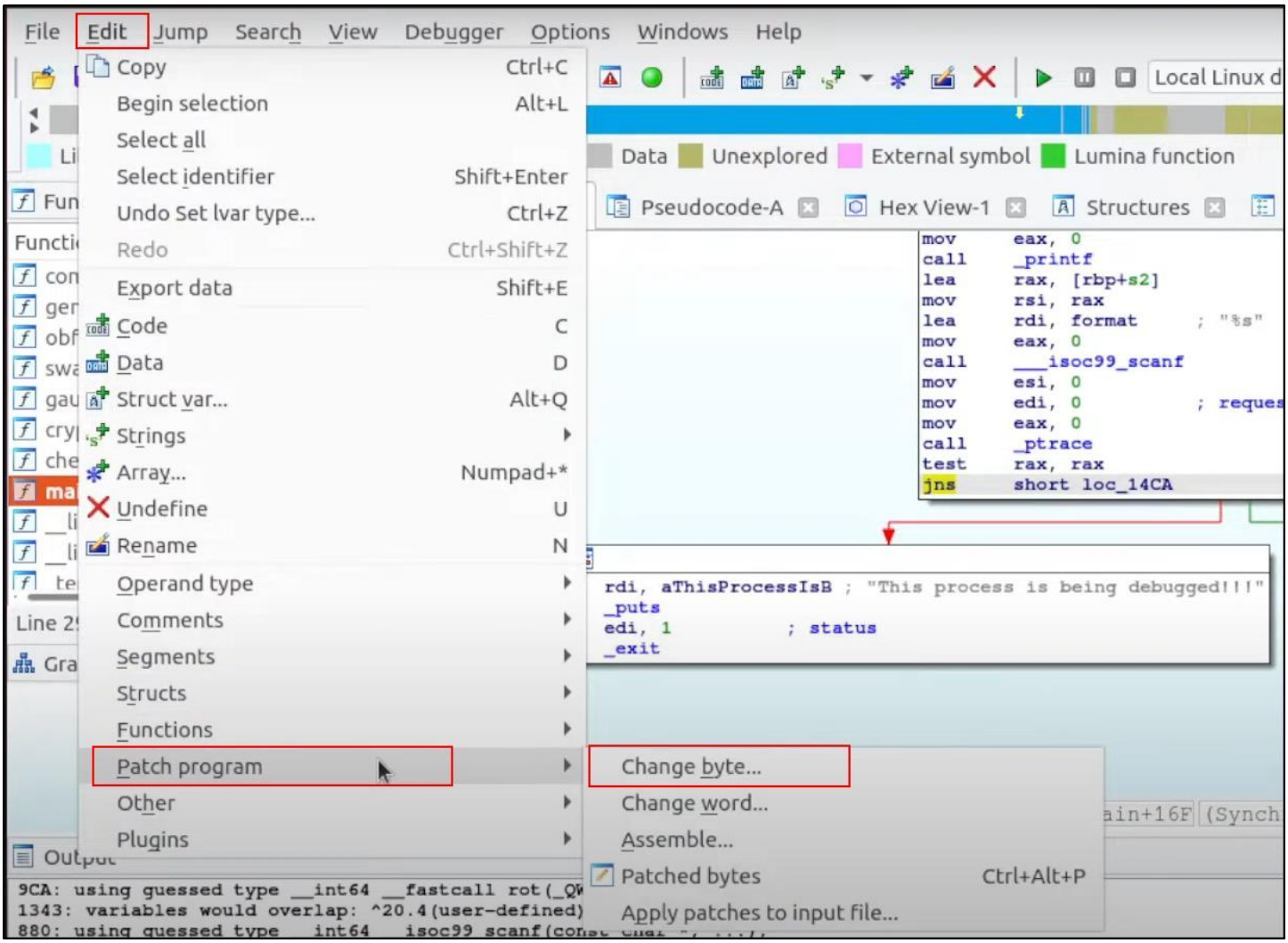


Ab **anti debug** technique ko bypass krne ke liye **binary ninja** se **patch** bna lete hai phle **rax** ke value jo change kiye the wo temporary tha.

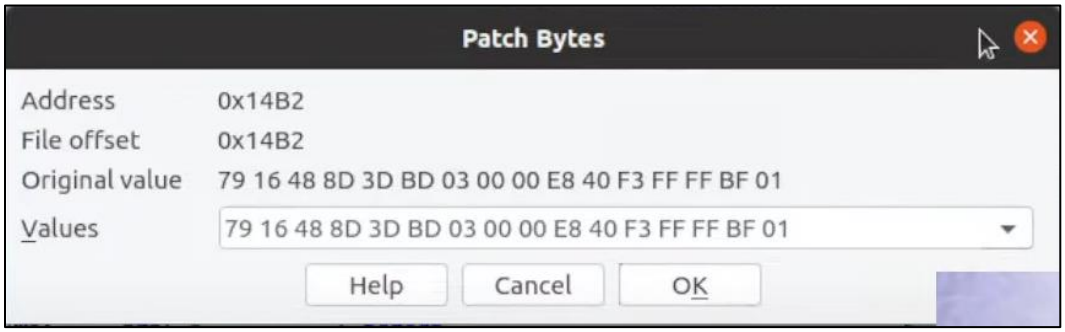
Ab hum **disassembly** pr fir se aa jate hai.



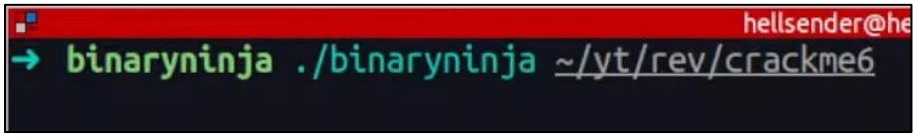
jns ko change krne ke liye hum **edit** pr jate hai. **patch program** pr jayenge. **Change byte** pr click karenge.



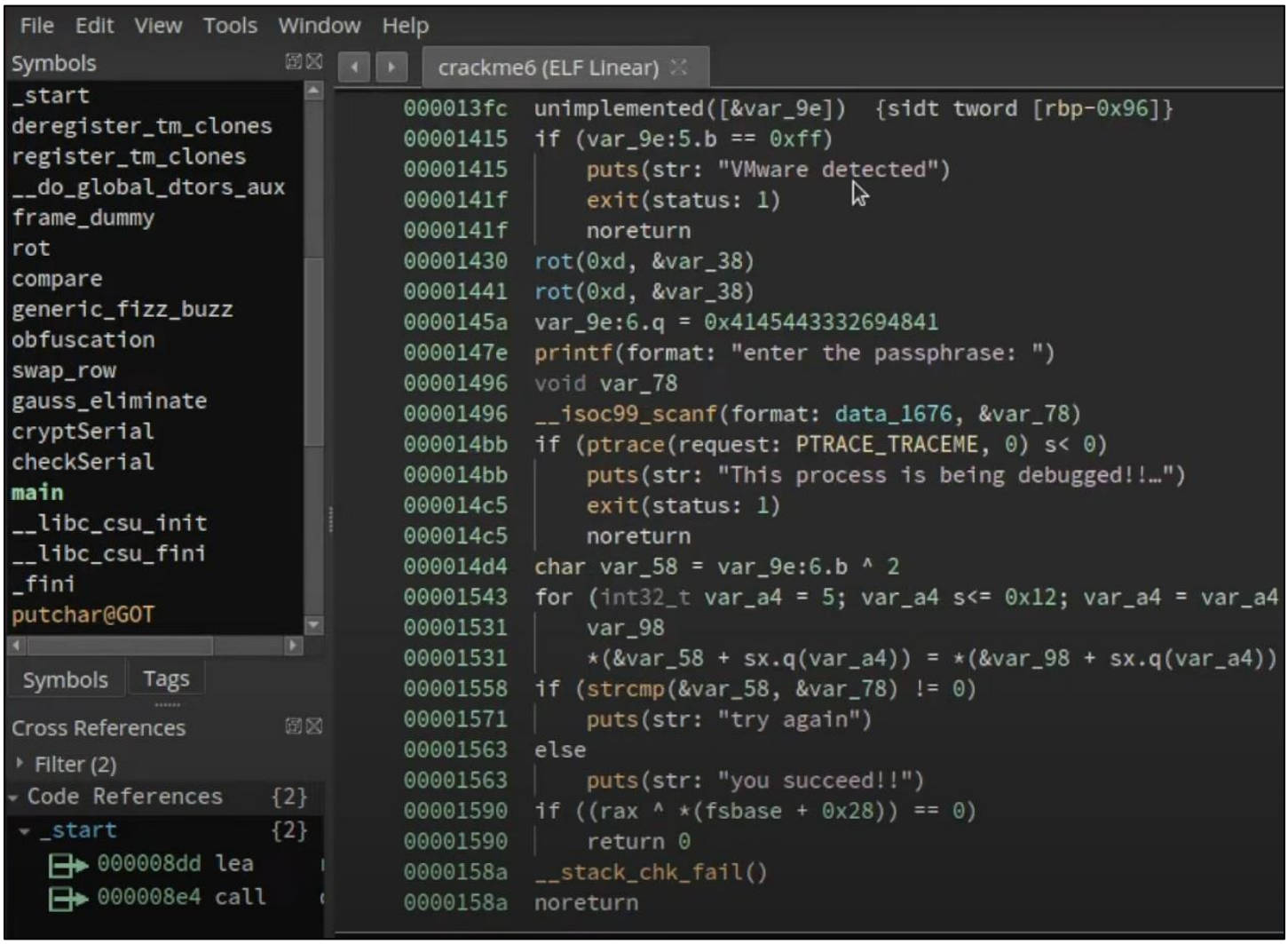
Yha pr aa gye opcode.



Lekin hum yha nhi karenge. Yha jyada calculation krni pdti hai.



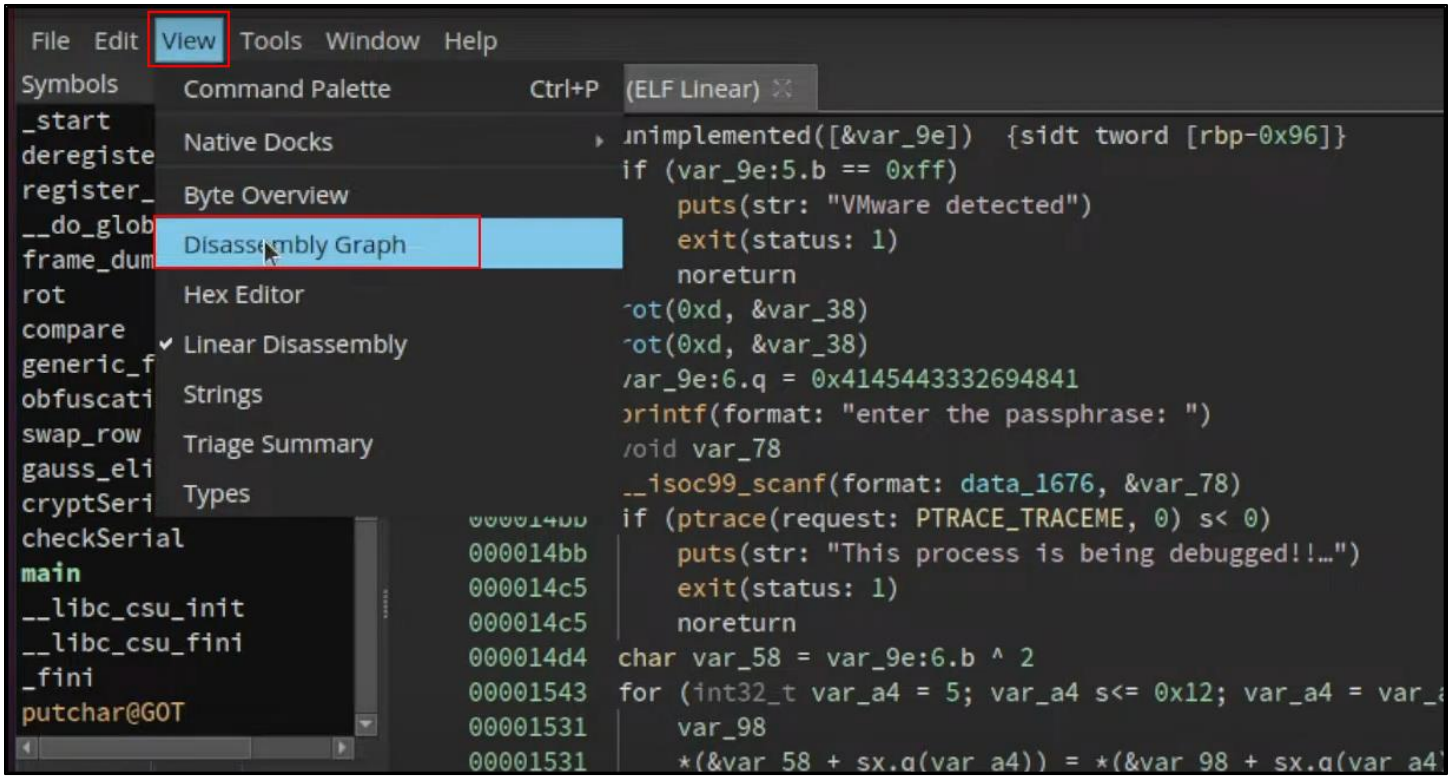
Ab hum apni binary ko load karenge. Aur **main** function pr chlte hai.

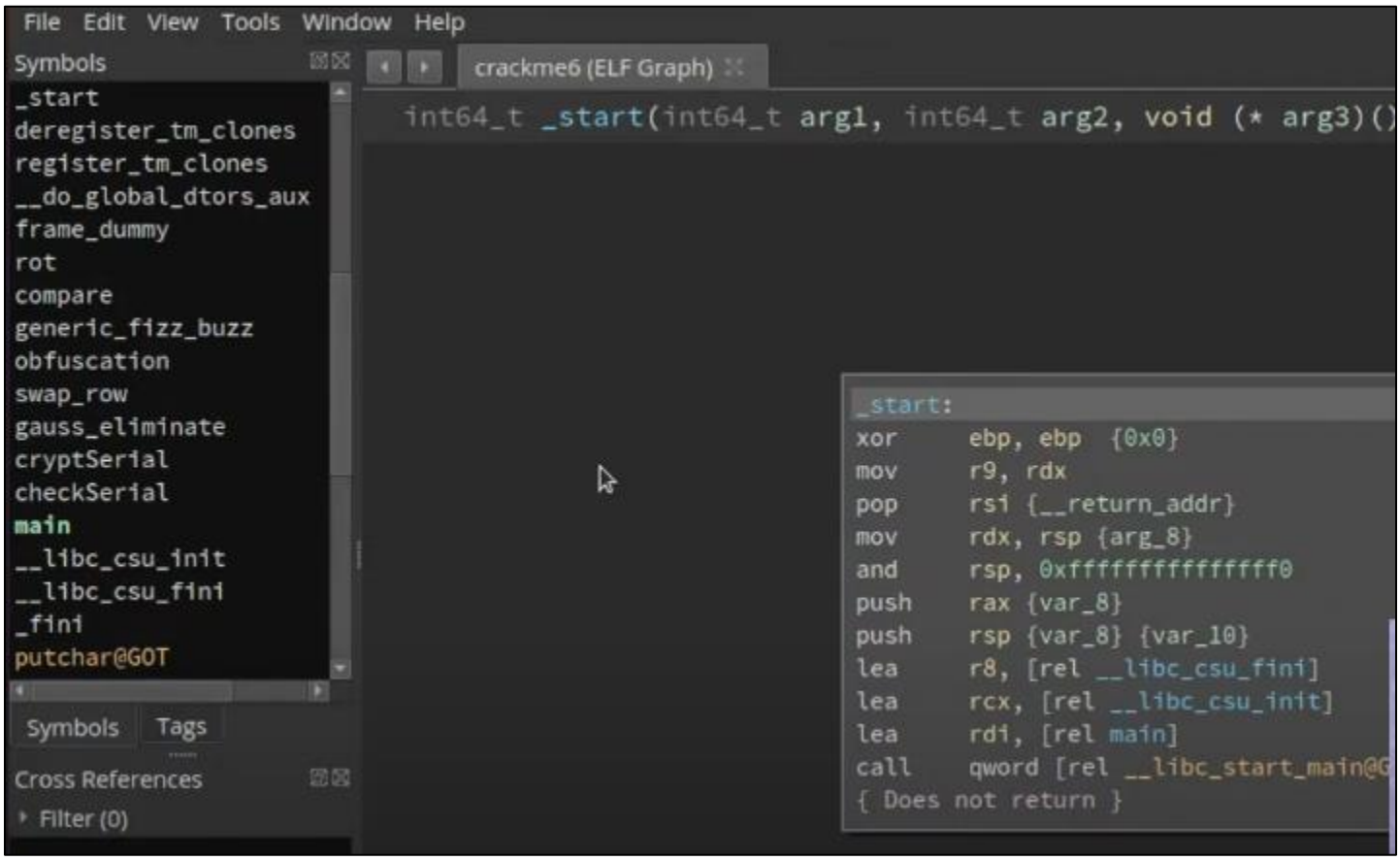


To yha pr hum ise **psudocode** isliye bolte hai kyoki exact **C** ka code hum nhi nikal pate hai.

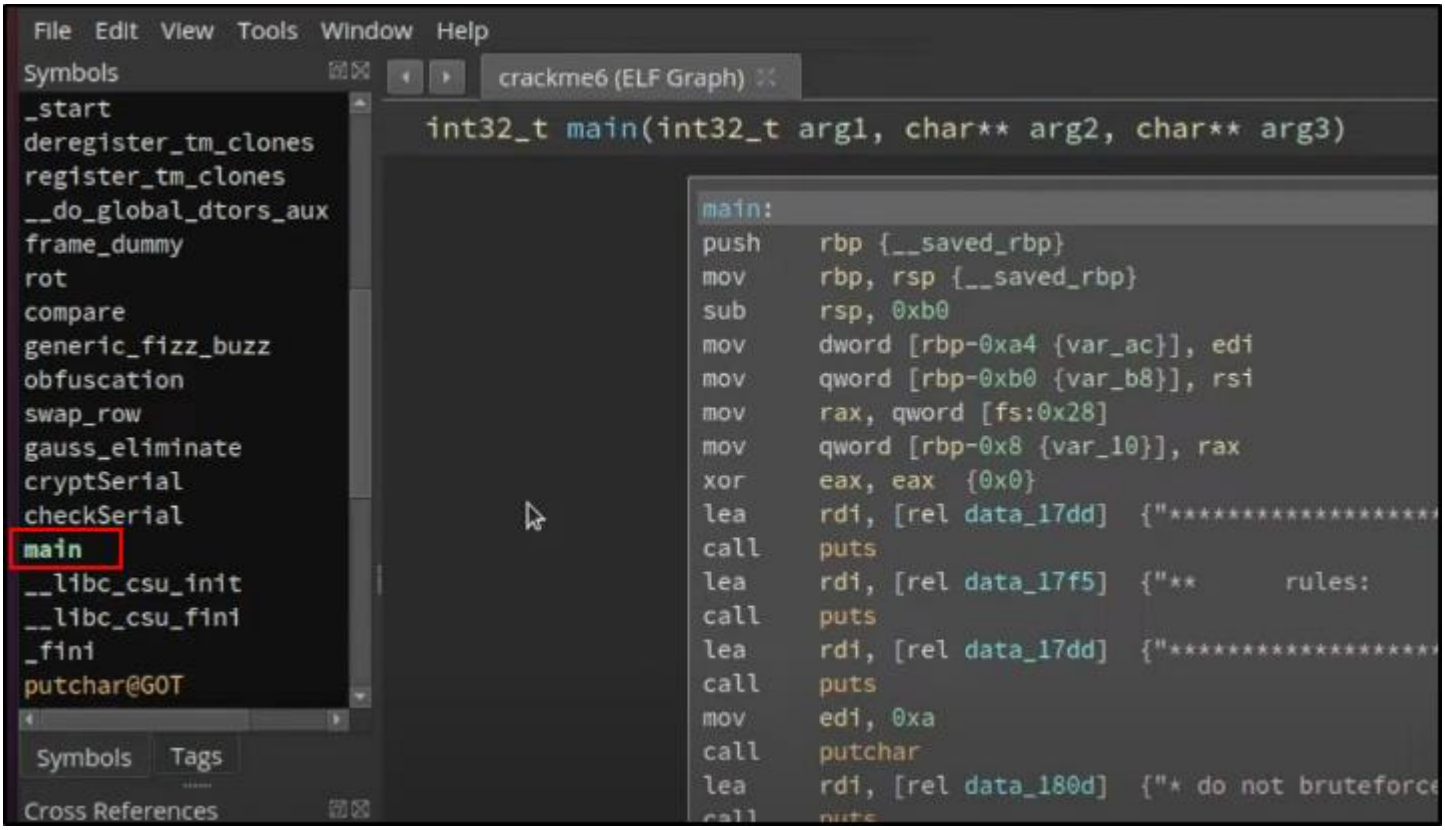
Aur sabhi **decompiler** assembly code ko alag-2 tarike se **decompile** krte hai.

To hum chalte hai **disassembly** me.

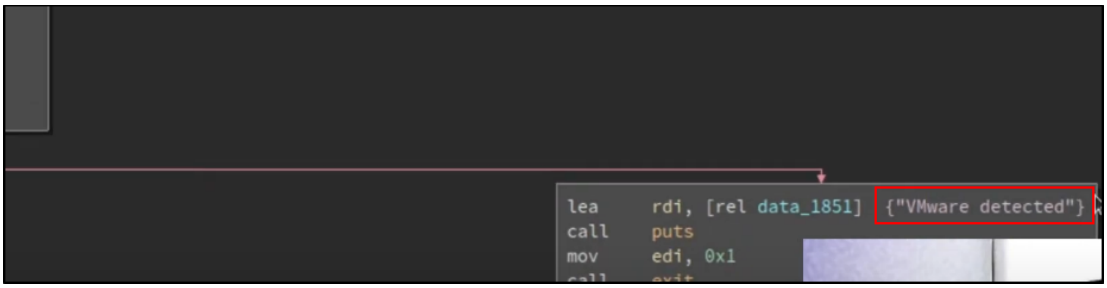

File Edit View Tools Window Help
Symbols
Command Palette Ctrl+P
Native Docks
Byte Overview
Disassembly Graph
Hex Editor
Linear Disassembly
Strings
Triage Summary
Types
(ELF Linear)
_start
deregiste
register_
__do_glob
frame_dum
rot
compare
generic_f
obfuscati
swap_row
gauss_eli
cryptSeri
checkSerial
main
__libc_csu_init
__libc_csu_fini
_fini
putchar@GOT
unimplemented([&var_9e]) {sidt tword [rbp-0x96]}
if (var_9e:5.b == 0xff)
puts(str: "VMware detected")
exit(status: 1)
noreturn
ot(0xd, &var_38)
ot(0xd, &var_38)
ar_9e:6.q = 0x4145443332694841
printf(format: "enter the passphrase: ")
void var_78
__isoc99_scanf(format: data_1676, &var_78)
if (ptrace(request: PTRACE_TRACEME, 0) s< 0)
000014bb puts(str: "This process is being debugged!!…")
000014c5 exit(status: 1)
000014c5 noreturn
000014d4 char var_58 = var_9e:6.b ^ 2
00001543 for (int32_t var_a4 = 5; var_a4 s<= 0x12; var_a4 = var_a
00001531 var_98
00001531 *(&var_58 + sx.q(var_a4)) = *(&var_98 + sx.q(var_a4

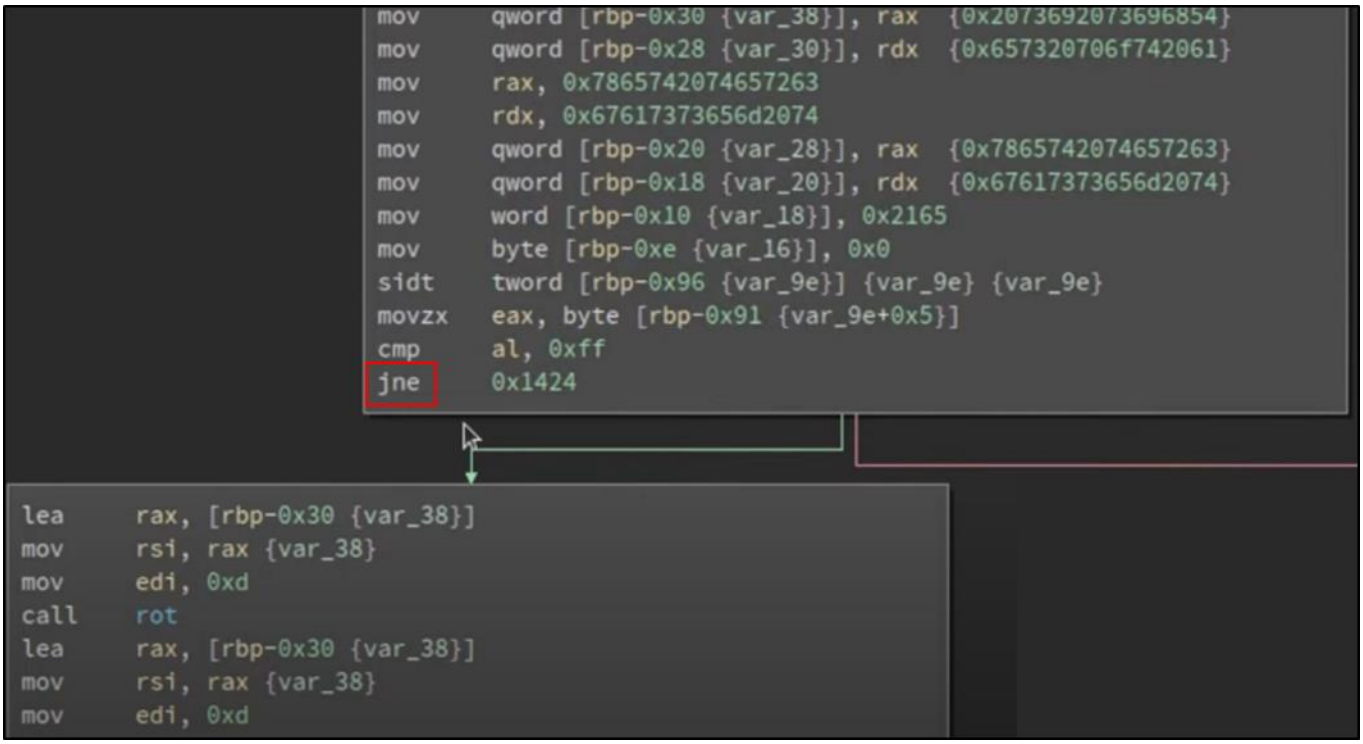

File Edit View Tools Window Help
Symbols
crackme6 (ELF Graph)
int64_t _start(int64_t arg1, int64_t arg2, void (* arg3)()
_start
deregister_tm_clones
register_tm_clones
__do_global_dtors_aux
frame_dummy
rot
compare
generic_fizz_buzz
obfuscation
swap_row
gauss_eliminate
cryptSerial
checkSerial
main
__libc_csu_init
__libc_csu_fini
_fini
putchar@GOT
Symbols Tags
Cross References
Filter (0)
_start:
xor ebp, ebp {0x0}
mov r9, rdx
pop rsi {__return_addr}
mov rdx, rsp {arg_8}
and rsp, 0xfffffffffffffff0
push rax {var_8}
push rsp {var_8} {var_10}
lea r8, [rel __libc_csu_fini]
lea rcx, [rel __libc_csu_init]
lea rdi, [rel main]
call qword [rel __libc_start_main@G
{ Does not return }

Ab hum **main** pr double click krte hai.



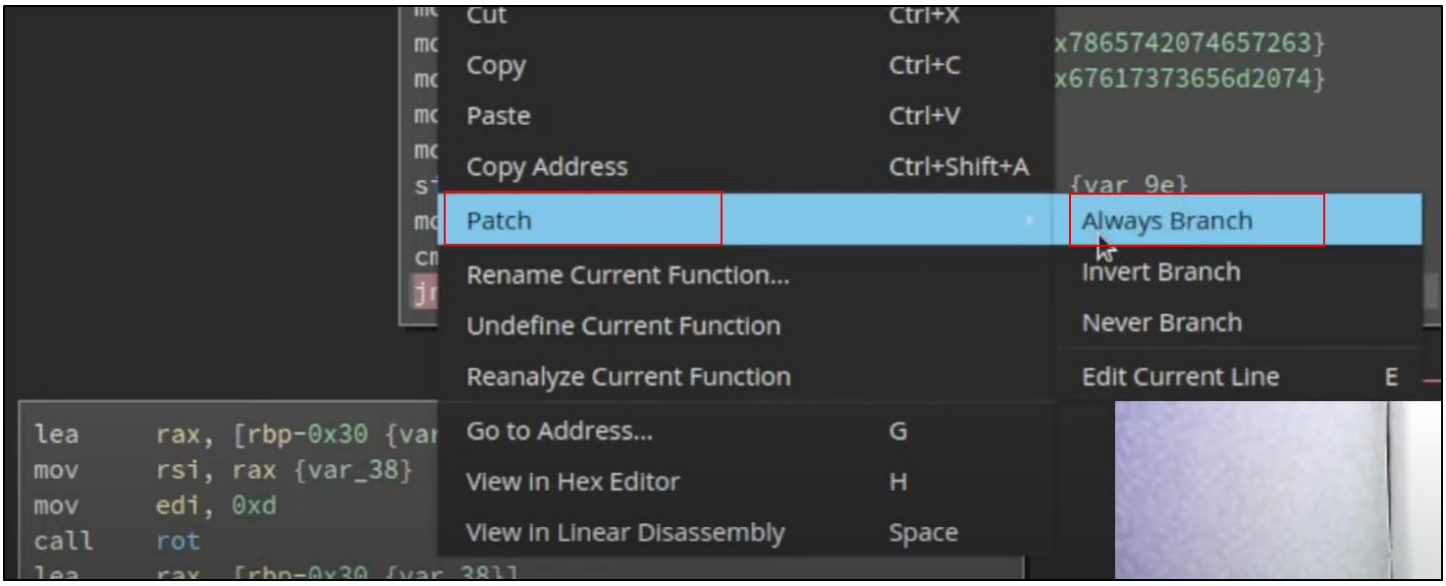
To yha pr **main** function khul gya. Right side dekh skte hai. ki **"vmware detected"** message show ho gya.





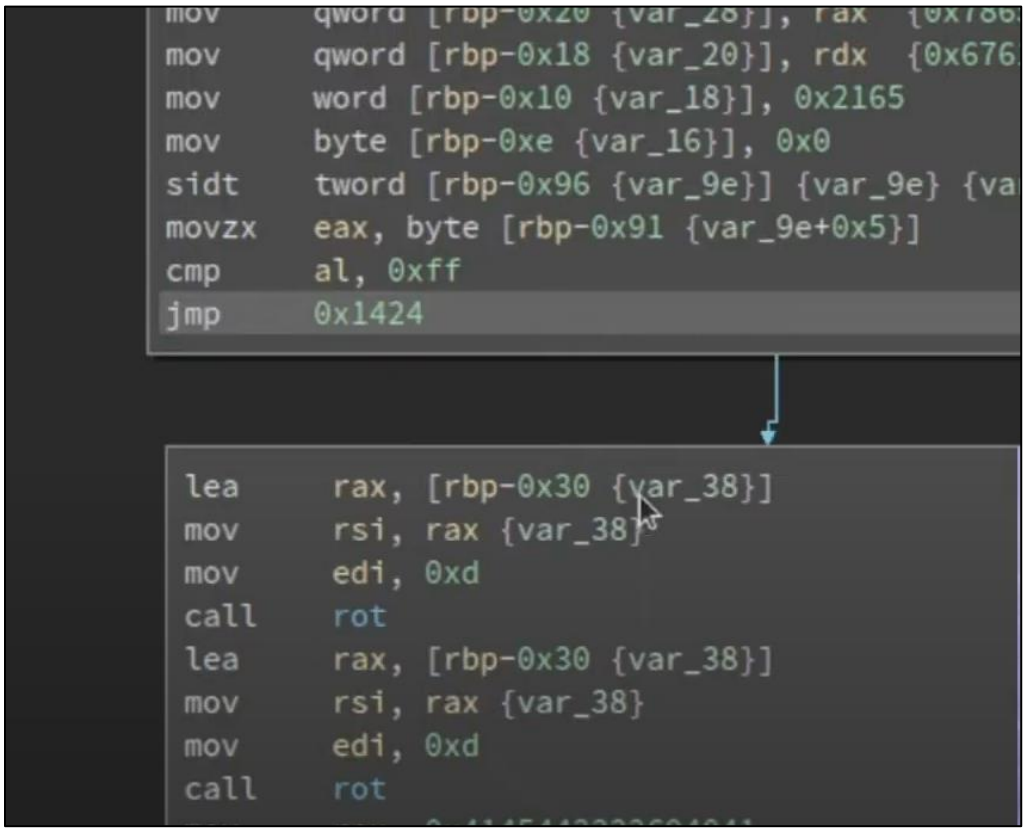
Agar hum jne ko je karenge to ye **virtual machine** pr to run karegi lekin host machine pr run krna band kr degi.

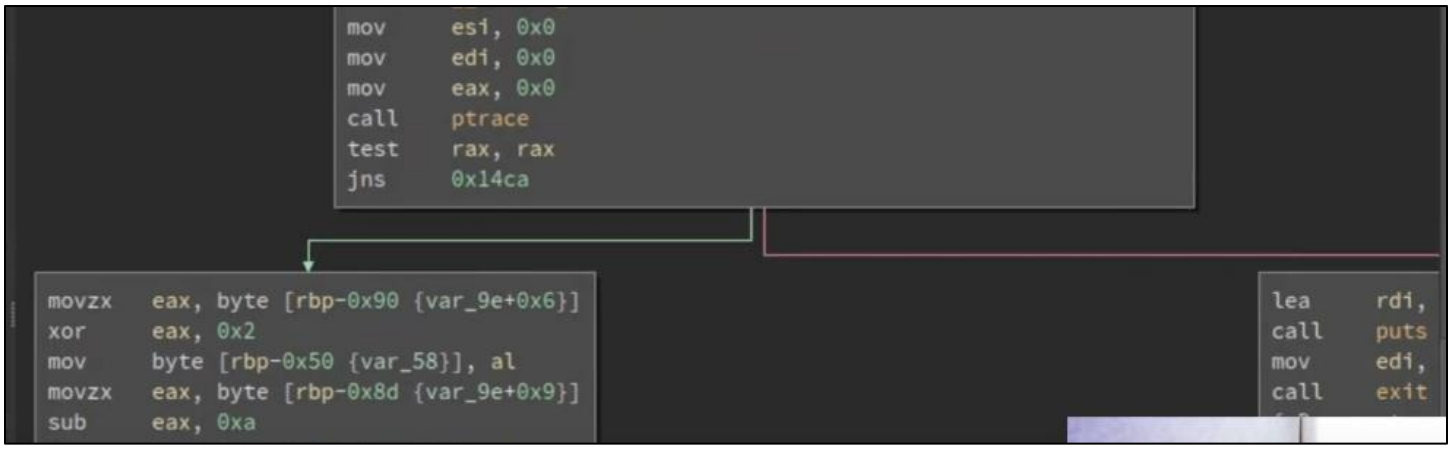
Hume koi aisa way dudna hai ki ye har bar left side wale branch pr aaye. To hum **jne** ki jagah **jmp** use karenge pr right click karenge **patch** pr jayenge fir **always branch** krenge.

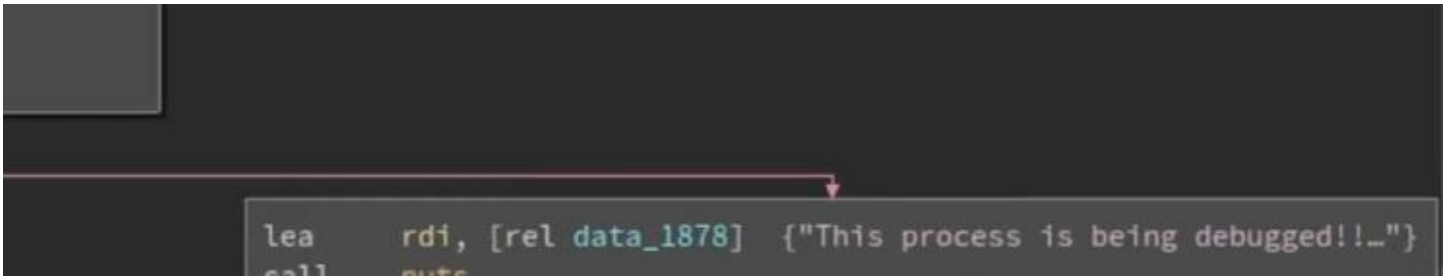


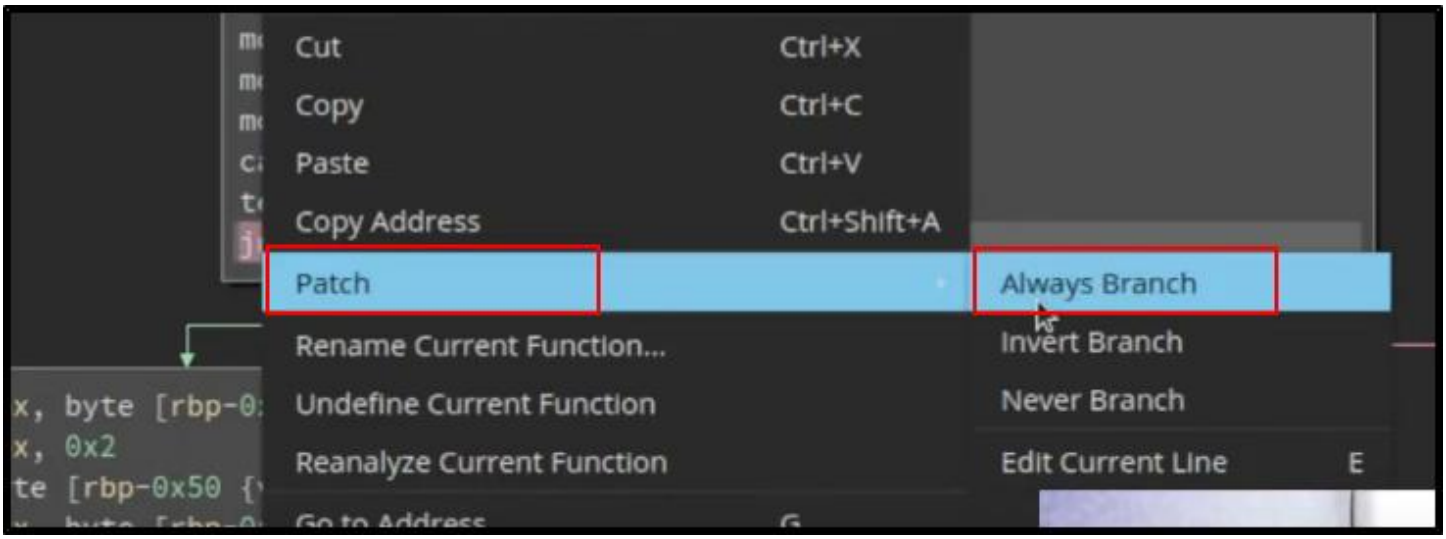
Agar hume **red** wale branch pr jump karana hota to hum **never branch** kr dete. Fir ye humesa **red** wale pr jump krta.

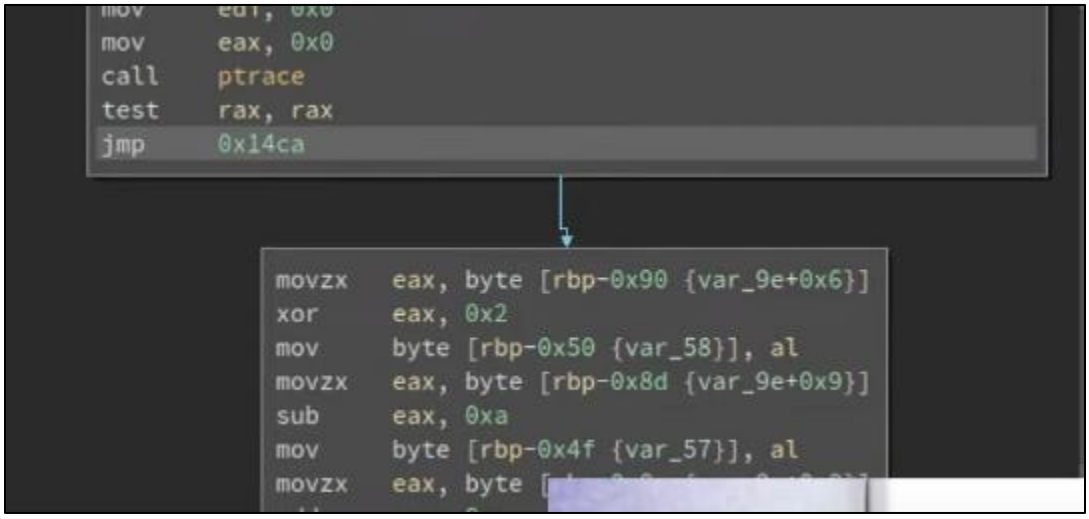
To hune yha pr always branch kr diya hai.





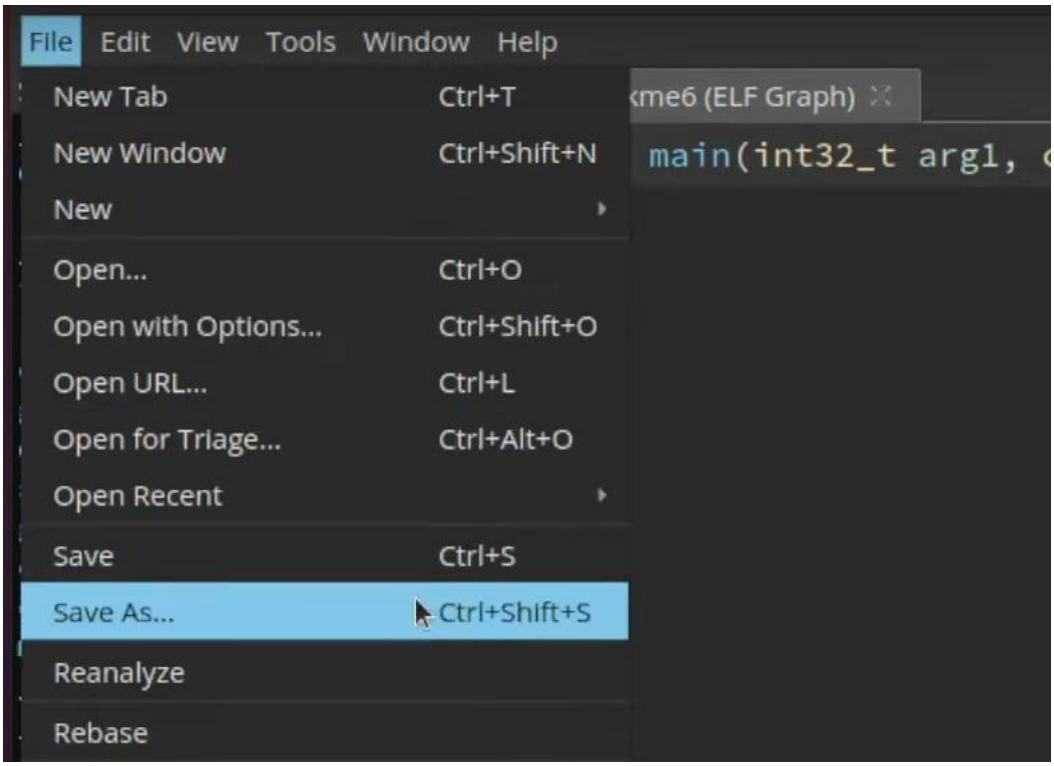


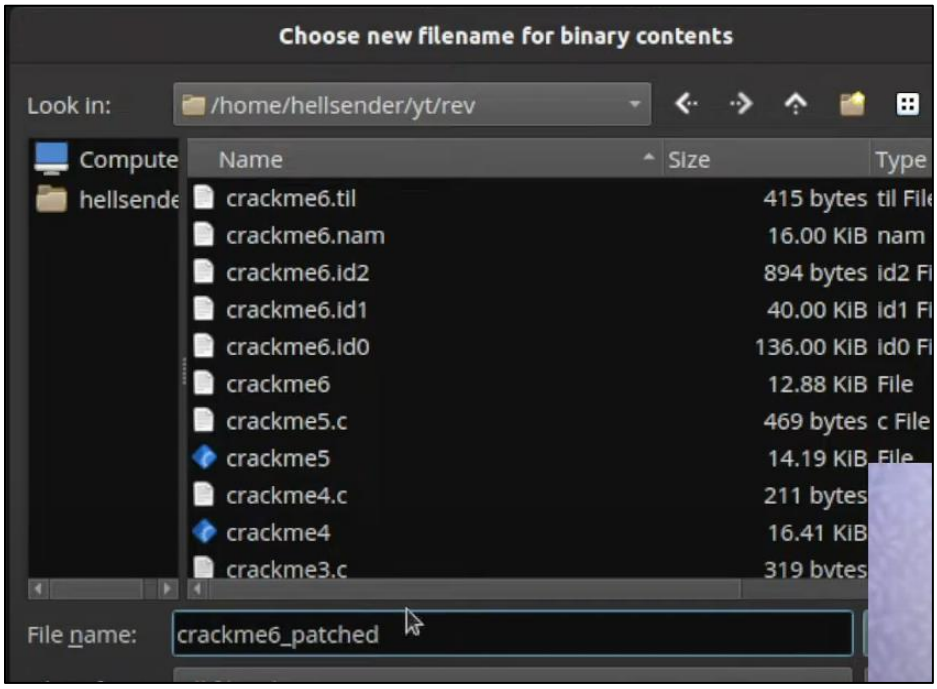




Ab in dono ko kahi bhi run karo koi tension nhi. Ab humne ise bhi **patch** kr di. Anti VM ko bhi aur **anti debugger** ko bhi.

Ab isko **save as** kr lete hai.





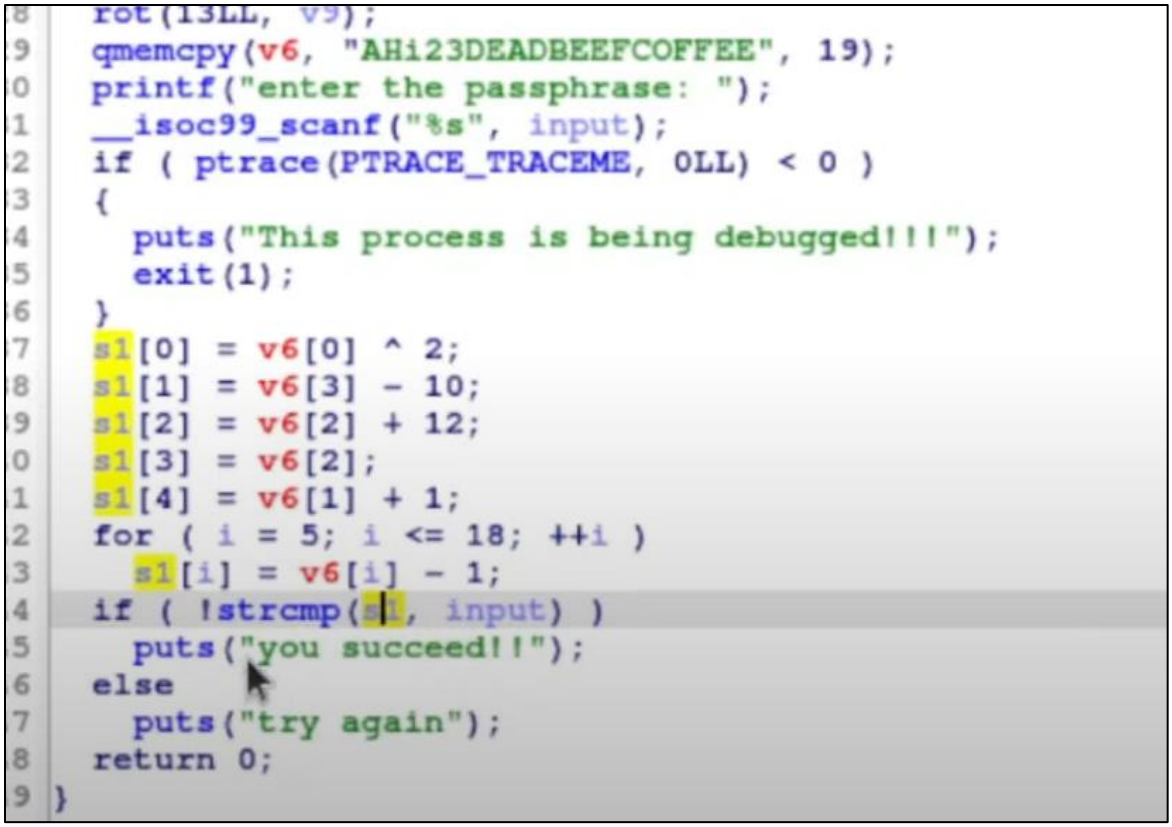
Ab hum ise **run** krke dekh lete hai. ki ye sahi se work kr rhi hai ya nhi. Kyoki abhi-2 ek bhi byte idhar udhar hua to **binary** currupt ho jati hai.

```
pwndbg> q
→ rev chmod +x crackme6_patched
→ rev ./crackme6_patched
**********************
**       rules:       **
**********************

* do not bruteforce
* do not patch, find instead the serial.

enter the passphrase: 12345
try again
→ rev
```

To ab tk humne **anti debugging** aur **anti vm technique** ko bypass kiya. Reversing nhi kiya.

```
30  printf("enter the passphrase: ");
31  __isoc99_scanf("%s", s2);
32  if ( ptrace(PTRACE_TRACEME, 0LL) < 0 )
33  {
34    puts("This process is being debugged!!!");
35    exit(1);
36  }
37  s1[0] = v6[0] ^ 2;
38  s1[1] = v6[3] - 10;
39  s1[2] = v6[2] + 12;
40  s1[3] = v6[2];
41  s1[4] = v6[1] + 1;
42  for ( i = 5; i <= 18; ++i )
43    s1[i] = v6[i] - 1;
44  if ( !strcmp(s1, s2) )
45    puts("you succeed!!");
46  else
47    puts("try again");
48  return 0;
49 }
```

Ye portion humare kam ka lgta hai. ise samajhne ki koshish krte hai.



```
  rot(13LL, v9);
  qmemcpy(v6, "AHi23DEADBEEFCOFFEE", 19);
  printf("enter the passphrase: ");
  __isoc99_scanf("%s", input);
  if ( ptrace(PTRACE_TRACEME, 0LL) < 0 )
  {
    puts("This process is being debugged!!!");
    exit(1);
  }
  s1[0] = v6[0] ^ 2;
  s1[1] = v6[3] - 10;
  s1[2] = v6[2] + 12;
  s1[3] = v6[2];
  s1[4] = v6[1] + 1;
  for ( i = 5; i <= 18; ++i )
    s1[i] = v6[i] - 1;
  if ( !strcmp(s1, input) )
    puts("you succeed!!");
  else
    puts("try again");
  return 0;
}
```

Yha hum dekh skte hai ki **s1** ek variable hai jiske andar **v6** ke values pr operation perform krke ek-2 krke store kiya ja rha hai.

Iske bad **s2** se compare kiya ja rha hai **s2** humara **input** hai.

Agar dono equal hue to ye print kr dega **"you succeed"** otherwise **"try again"**.

Yha **s1** ke andar **original password** hai.

Yha hum algorithm samajhte hai ki password kaise generate kr rha hai.

Isko rename krke hum **original** kr dete hai.

^ means xor

Is code mai subline pr le chalte hai aur syntax C select kr lete hai.

```
untitled
1  v6 = "AHi23DEADBEEFCOFFEE"
2
3  original[0] = v6[0] ^ 2;
4  original[1] = v6[3] - 10;
5  original[2] = v6[2] + 12;
6  original[3] = v6[2];
7  original[4] = v6[1] + 1;
8  for ( i = 5; i <= 18; ++i )
9    original[i] = v6[i] - 1;
```

Isko solve krne ke do tarike hai.

```
solver.c
1  #include<stdio.h>
2
3  int main() {
4  char v6[] = "AHi23DEADBEEFCOFFEE";
5  char original[50];
6  int i;
7  original[0] = v6[0] ^ 2;
8  original[1] = v6[3] - 10;
9  original[2] = v6[2] + 12;
10 original[3] = v6[2];
11 original[4] = v6[1] + 1;
12 for ( i = 5; i <= 18; ++i )
13   original[i] = v6[i] - 1;
14
15 puts(original);
16
17 return 0;
18 }
```

Compile and run krte hai.

```
→ rev gcc solver.c -o solver
→ rev ./solver
C(uiICD@CADDEBNEEDD
→ rev
```

To yha pr ye abnormal output show kr rha hai.

Isko ek bar aur run krke dekh lete hai.

```
→ rev ./solver
C(uiICD@CADDEBNEEDDVe
→ rev ./crackme6
**********************
**      rules:        **
**********************

* do not bruteforce
* do not patch, find instead the serial.

enter the passphrase: C(uiICD@CADDEBNEEDDVe
try again
→ rev
```

Yha pr hum is code ko python me write karenge.

```
untitled
1  main = "AHi23DEADBEEFCOFFEE"
2
3  original = []
4
5  original.append(ord(main[0]) ^ 2)
```

ord() function **character** ko **integer** me convert krta hai. yha pr jo **"A"** hai wo integer me convert hoga fir uska **xor** hoga.

Fir use character me convert karenge.

```python
main = "AHi23DEADBEEFCOFFEE"

original = []

original.append(chr(ord(main[0]) ^ 2))
original.append(chr(ord(main[3]) - 10))
original.append(chr(ord(main[2]) + 12))
original.append(main[2])
original.append(chr(ord(main[1]) + 1))
for i in main[5:]:
    original.append(chr(ord(i)-1))

print("".join(original))
```

Output

```
→ rev chmod +x solver.py
→ rev python3 solver.py
C(uiICD@CADDEBNEEDD
```

Yha pr agar hum **C** ke program se compare kare to

```
→ rev ./solver
C(uiICD@CADDEBNEEDD
→ rev
```

Ye bhi lgbhg same hai. bs last me two extra character add kr diya.

```
→ rev ./crackme6
**********************
**      rules:      **
**********************

* do not bruteforce
* do not patch, find instead the serial.

enter the passphrase: C(uiICD@CADDEBNEEDD
you succeed!!
```

##

Reversing C++ Binaries. How To Deal With Packed Binaries:

Challenge – 7

```
➜ rev ./crackme7
Enter Password: aaaaaa
Wrong Password!
➜ rev
```

Ise hum gdb me open kr lete hai.

```
➜ rev gdb ./crackme7
GNU gdb (Ubuntu 9.2-0ubuntu1~20.04) 9.2
Copyright (C) 2020 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.
Type "show copying" and "show warranty" for details.
This GDB was configured as "x86_64-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
    <http://www.gnu.org/software/gdb/documentation/>.

For help, type "help".
Type "apropos word" to search for commands related to "word"...
pwndbg: loaded 195 commands. Type pwndbg [filter] for a list.
pwndbg: created $rebase, $ida gdb functions (can be used with print/break)
Reading symbols from ./crackme7...
(No debugging symbols found in ./crackme7)
pwndbg>
```

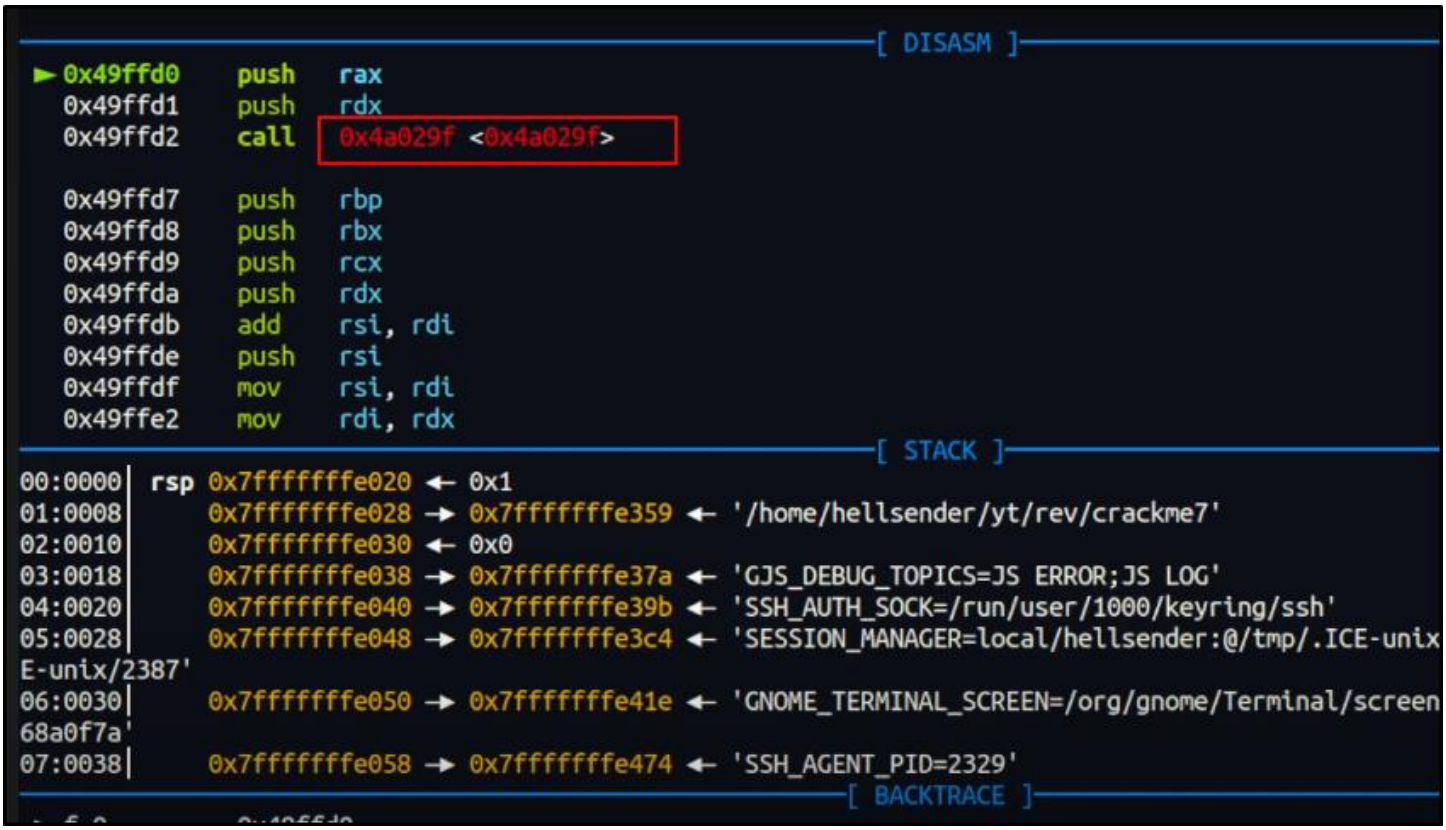
Agar hum info functions kare to.

```
pwndbg> info functions
All defined functions:
pwndbg>
```

Isne ek bhi functions show nhi kiye. Aisa **stripped binary** me bhi nhi hota hai. wha pr bhi kuchh functions or symbols show ho jate hai. jo ki binary ko run hone me jaruri hote hai.

```
pwndbg> disassemble main
No symbol table is loaded.  Use the "file" command.
pwndbg>
```

Agar hum ise start krke dekhe to.



Yha hum dekh skte hai ki ye baki binaries ke kafi different hai. ye upar kisi function ko call kr rha hai.

Jbki baki binary ki sbse phle **_start** call hota hai aur wo **__libc_start_main** ko call krta hai.

To ye thoda unusual binary hai.

Ab hum iske bare information gathering krte hai.

```
→ rev file crackme7
crackme7: ELF 64-bit LSB executable, x86-64, version 1 (GNU/Linux), statically linked, no section header
→ rev
```

Yha **statically linked** ka mtlb isme **shared object file (libc)** ka bhi code aa jata hai aur programmer ne jo code likha hai wo bhi. to kafi badi binary ho jayegi kyoki statically linked hai.

Agar hum normal binary dekhe to uska information kuchh is tarah se aata hai.

```
ubuntu@ip-172-31-8-118:~$ file crackme6
crackme6: ELF 64-bit LSB pie executable, x86-64, version 1 (SYSV), dynamically linked, interpreter /lib64/ld-linux-x86-6
4.so.2, for GNU/Linux 3.2.0, BuildID[sha1]=6d5e1ea9a99de8dd8b9e18a01ec6925571114484, not stripped
ubuntu@ip-172-31-8-118:~$
```

Ab hum strings kr lete hai.

```
ei"579
_vd-id%ABI-
^lT.,"
n.f<Zo
B.eh
gcc`f
ot      +
%}gR
iJent
l;,W
Az"!G
`Q,q
"G^l
H5H%
]l*/
Jl(@b
UPX!
UPX!
→ rev
```

To iska bhu result bahut unusual aaya hai. last me sections ke symbols show hote hai jaise .bss , .text , .data etc ek normal binary me. Lekin yha pr **UPX** show ho rha hai.

To iska ek reason hai jiske wajah se ye ho rha hai.

Hum pwntools install kr lete hai. jiske sath ek tool aata hai **checksec**. Jo binary ka security check krta hai.

```
→ rev sudo pip3 install pwntools
```

```
→ rev checksec crackme7
[*] Checking for new versions of pwntools
    To disable this functionality, set the contents of /home/hellsender/.cache/.pwntools-cache-3.8/update
    Or add the following lines to ~/.pwn.conf or ~/.config/pwn.conf (or /etc/pwn.conf system-wide):
        [update]
        interval=never
[*] You have the latest version of Pwntools (4.6.0)
[*] '/home/hellsender/yt/rev/crackme7'
    Arch:     amd64-64-little
    RELRO:    No RELRO
    Stack:    No canary found
    NX:       NX enabled
    PIE:      No PIE (0x400000)
    Packer:   Packed with UPX
→ rev
```

To yha hum dekh skte hai ki ek packer ka use kiya gya hai. jiska nam hai **UPX.** Aur anti reversing ke kam aata hai.

Ab hum smjhne ki koshish karenge ki **UPX** anti reversing me kaise kam aati hai aur ye reverse engineer ka kam kaise hard kr deti hai.

So, what is **packing** and how to **unpack** it and reverse it.

Man lijiye humare pas ek binary jo hello world print kr rha hai.

Ab chahta hum ki main is binary ko packed binary bna du. to ise ek packer ke help se pack kr dunga. Packer basically ek software hota hai. jo humre binary ko pack krta hai.

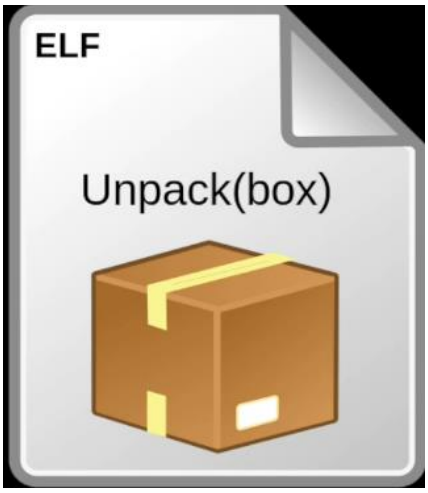
Jb hum kisi binary ko pack krte hai. man lijiye ek example lete hai ise ek box ke andar pack kr dete hai. ab ye jo humne pack kiya ye usually format me pack nhi hoti hai. hum ise is tarike se pack krte hai ki ye compress ho jata hai iska size kafi chhota ho jata hai. aur ye data readable format me bhi nhi rhta.

Software engineer packer ka use isliye krte hai ki unke program ka size chhota ho jaye. Yha packer anti reversing me bhi use hota hai. jaisa ki readable format me nhi hota to ise reverse engineer bhi nhi pd payega. Lekin ye linux me run hoga to linux bhi nhi pd payega

isko. Kyoki ye box me hide ho gya. Linux bhi nhi run kr payega. Iska original code kaise milega linux ko run krne ke liye.

Jb packer kisi program ko pack krta hai. to original code ko compress krke rkh deta hai box me aur apna chhota sa code rkh deta hai box ke bahar. Jo isliye hota hai ki kaise ise unpack krna hai aur oringinal code ko bahar lana hai. jb ye binary run kr rhi ho. Run time pr.

Jb binary pack hoti hai to fayde. Iska koi string nhi dekh skta. Code nhi pd skta. Compress ho jati hai.



How can linux read it.

Jaise hi ye binary run karengi sbse phle unpack wala code run hoga. Aur box ko khol dega. Aur jo original code hoga use wapas le aayega aur run krna suru kr dega. Jo ki print hello world. Aur ye sb run time pr hi hoga.

==========

So, humare pas bhi jo **binary** hai. wo bhi **packed binary** hai. aur use **UPX packer** se pack kiya gya hai.

Agar hume **UPX** install krna hai. to hum **apt install upx** karenge install ho jayega.

```
UPX!
UPX!
→ rev checksec crackme7
[*] Checking for new versions of pwntools
    To disable this functionality, set the contents of /home/hellsender/.cache/.pwntools-cache-3.8/updat
    Or add the following lines to ~/.pwn.conf or ~/.config/pwn.conf (or /etc/pwn.conf system-wide):
        [update]
        interval=never
[*] You have the latest version of Pwntools (4.6.0)
[*] '/home/hellsender/yt/rev/crackme7'
    Arch:     amd64-64-little
    RELRO:    No RELRO
    Stack:    No canary found
    NX:       NX enabled
    PIE:      No PIE (0x400000)
    Packer:   Packed with UPX
→ rev
```

Yha pr hum dekh skte hai. ki **UPX checksec** me likha dikh jayega. Aur **stirngs** me bhi jayega jisse hum identify kr skte hai.

To hum **UPX** se **pack** kr skte hai to usi se **unpack** bhi kr skte hai.

```
→ rev upx -d crackme7 -o crackme7_unpacked
                       Ultimate Packer for eXecutables
                          Copyright (C) 1996 - 2018
UPX 3.95        Markus Oberhumer, Laszlo Molnar & John Reiser   Aug 26th 2018

        File size         Ratio      Format      Name
   --------------------   ------   -----------   -----------
   2370480 <-    771308   32.54%   linux/amd64   crackme7_unpacked

Unpacked 1 file.
→ rev
```

Yha pr humari binary **unpack** ho chuki hai.

```
→ rev ls
crackme   crackme1.c  crackme2.c  crackme3.c  crackme4.c  crackme5.c  crackme7      crackme7_unpacked
crackme1  crackme2    crackme3    crackme4    crackme5    crackme6    crackme7.cpp  crackme.c
→ rev
```

```
→ rev file crackme7_unpacked
crackme7_unpacked: ELF 64-bit LSB executable, x86-64, version 1 (GNU/Linux), statically linked, BuildID[sha1]=5068695043f3
28c83ed08a9a13e9f207e0, for GNU/Linux 3.2.0, not stripped
→ rev
```

Ab yha **file** command binary ki information aasani se pd pa rha hai.

String command bhi run krke dekh skte hai.

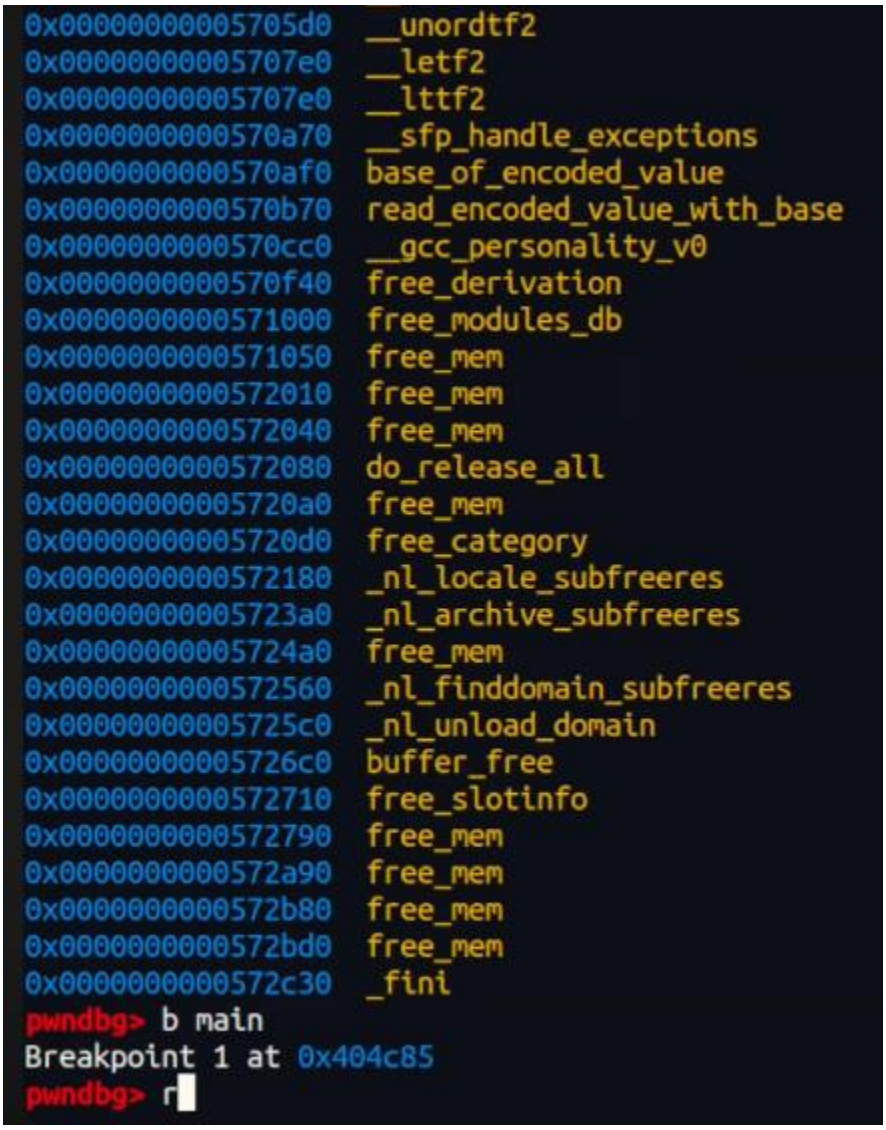
```
_ZNKSt7__cxx1112basic_stringIwSt11char_traitsIwESaIwEE4copyEPwmm
__realloc_hook
_ZNSolsEl
__gconv_get_builtin_trans
_ZN9__gnu_cxxeqIPcNSt7__cxx1112basic_stringIcSt11char_traitsIcESaIcEEEEEbRKNS_17__normal_iteratorIT_T0_EESD_
_ZNKSt7__cxx118numpunctIcE11do_groupingEv
_ZTINSt7__cxx1117moneypunct_bynameIwLb1EEE
_ZNSt6locale5_Impl16_M_install_facetEPKNS_2idEPKNS_5facetE
_ZNKSt13basic_fstreamIcSt11char_traitsIcEE7is_openEv
_ZTVSi
_dl_tlsdesc_resolve_rela
_dl_hwcap
_ZNSbIwSt11char_traitsIwESaIwEE4rendEv
__madvise
_ZNKSt9basic_iosIcSt11char_traitsIcEE4fillEv
_ZNSt7__cxx1117moneypunct_bynameIcLb0EEC1ERKNS_12basic_stringIcSt11char_traitsIcESaIcEEEm
_ZNSt7__cxx1112basic_stringIcSt11char_traitsIcESaIcEE6insertEmPKcm
_ZNSsC2EOSs
_ZNSspLEc
_ZNKSt7num_putIwSt19ostreambuf_iteratorIwSt11char_traitsIwEEE13_M_insert_intIyEES3_S3_RSt8ios_basewT_
_ZNSt10moneypunctIcLb0EED1Ev
_IO_file_jumps
_ZNSolsEj
_ZNSbIwSt11char_traitsIwESaIwEE6assignERKS2_mm
_ZNSbIwSt11char_traitsIwESaIwEEC1EPKwmRKS1
```

```
.note.ABI-tag
.rela.plt
.init
.text
__libc_freeres_fn
.fini
.rodata
.stapsdt.base
.eh_frame
.gcc_except_table
.tdata
.tbss
.init_array
.fini_array
.data.rel.ro
.got
.got.plt
.data
__libc_subfreeres
__libc_IO_vtables
__libc_atexit
.bss
__libc_freeres_ptrs
.comment
.note.stapsdt
→ rev
```

To yha pr sare **sections** show ho rhe hai.

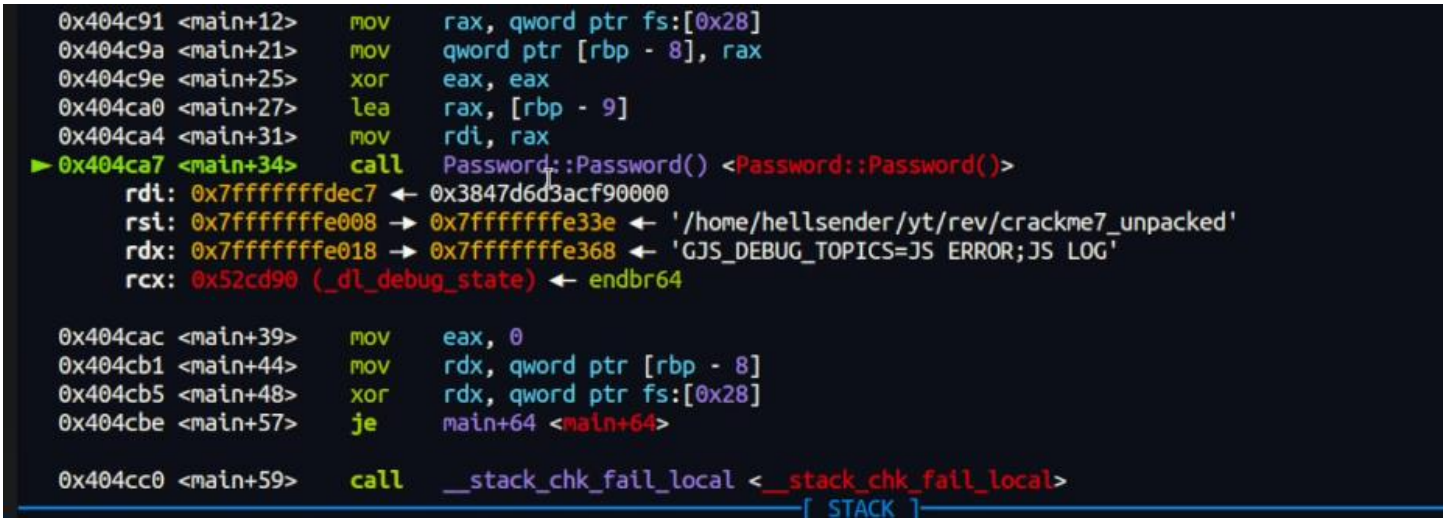
Aur ye c++ ka code hai to strings thode complex hote hai. aur ye statically linked hai to isme bahut sare function aayenga.

Ise **gdb** me open kr lete hai.



Aur **main** pr breakpoint lagate hai. aur **run** krte hai.

ni ke sath aage badte jate hai.



Yha pr **Password** class ke **Password()** function ko call ho rha hai. aur **class** aur **function** ka nam same hai to iska mtlb ye **constructor** hai. class aur constructor ke beech me **scope resolution operator(::)**.

Agar object banega to **constructor** to call hoga hi hoga.

To hum si (step into) to Password() function ke andar aa gye.

```
[ DISASM ]
► 0x404d2e <Password::Password()>       endbr64
  0x404d32 <Password::Password()+4>     push   rbp
  0x404d33 <Password::Password()+5>     mov    rbp, rsp
  0x404d36 <Password::Password()+8>     sub    rsp, 0x30
  0x404d3a <Password::Password()+12>    mov    qword ptr [rbp - 0x28], rdi
  0x404d3e <Password::Password()+16>    mov    rax, qword ptr fs:[0x28]
  0x404d47 <Password::Password()+25>    mov    qword ptr [rbp - 8], rax
  0x404d4b <Password::Password()+29>    xor    eax, eax
  0x404d4d <Password::Password()+31>    lea    rdx, [rbp - 0x12]
  0x404d51 <Password::Password()+35>    mov    rax, qword ptr [rbp - 0x28]
  0x404d55 <Password::Password()+39>    mov    rsi, rdx
[ STACK ]
```

Ye contructor hai to ye kuchh special functions ko call krta hai. ya variable ko initialize krta hai.

ni krke next instructions ke or badte hai.

```
  0x404d51 <Password::Password()+35>    mov    rax, qword ptr [rbp - 0x28]
  0x404d55 <Password::Password()+39>    mov    rsi, rdx
  0x404d58 <Password::Password()+42>    mov    rdi, rax
► 0x404d5b <Password::Password()+45>    call   Password::get_password(char*) <Password::get_password(char*)>
      rdi: 0x7fffffffdec7 ← 0x3847d6d3acf90000
      rsi: 0x7fffffffde9e ← 0x7fffffffe0080000
      rdx: 0x7fffffffde9e ← 0x7fffffffe0080000
      rcx: 0x52cd90 (_dl_debug_state) ← endbr64

  0x404d60 <Password::Password()+50>    nop
  0x404d61 <Password::Password()+51>    mov    rax, qword ptr [rbp - 8]
  0x404d65 <Password::Password()+55>    xor    rax, qword ptr fs:[0x28]
  0x404d6e <Password::Password()+64>    je     Password::Password()+71 <Password::Password()+71>

  0x404d70 <Password::Password()+66>    call   __stack_chk_fail_local <__stack_chk_fail_local>
[ STACK ]
```

To yha pr ye **get_password(char*)** ko call kr rha hai jo argument me character array lete hai. jaisa ki name se smajh skte hai. ye password lene ka kam kr rha hoga.

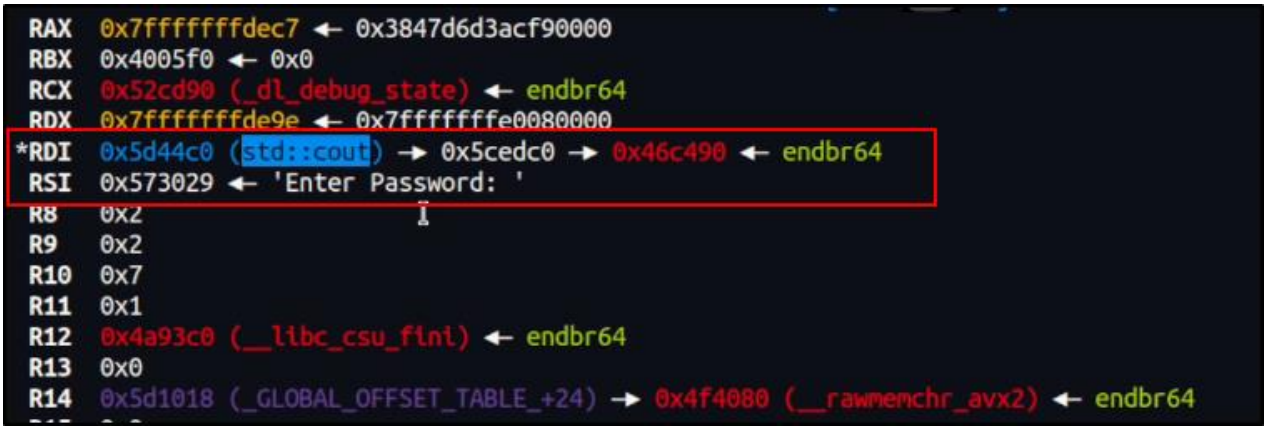
Ab **get_password(char*)** ko **si** krte hai step into aur get password ko read krte hai.

ni krke aage badte hai.

```
[ DISASM ]
  0x404e56 <Password::get_password(char*)+8>     sub    rsp, 0x10
  0x404e5a <Password::get_password(char*)+12>    mov    qword ptr [rbp - 8], rdi
  0x404e5e <Password::get_password(char*)+16>    mov    qword ptr [rbp - 0x10], rsi
  0x404e62 <Password::get_password(char*)+20>    lea    rsi, [rip + 0x16e1c0]
  0x404e69 <Password::get_password(char*)+27>    lea    rdi, [rip + 0x1cf650] <0x5d44c0>
► 0x404e70 <Password::get_password(char*)+34>    call   0x46dbf0 <0x46dbf0>

  0x404e75 <Password::get_password(char*)+39>    mov    rdx, qword ptr [rip + 0x1ccd7c] <0x5d1bf8>
  0x404e7c <Password::get_password(char*)+46>    mov    rax, qword ptr [rbp - 0x10]
  0x404e80 <Password::get_password(char*)+50>    mov    esi, 0xb
  0x404e85 <Password::get_password(char*)+55>    mov    rdi, rax
  0x404e88 <Password::get_password(char*)+58>    call   fgets <fgets>
[ STACK ]
```

Yha pr ek function call ho rha hai. jise **gdb** nhi samjh pa rha hai nhi to ye hume bta deta function ka nam.

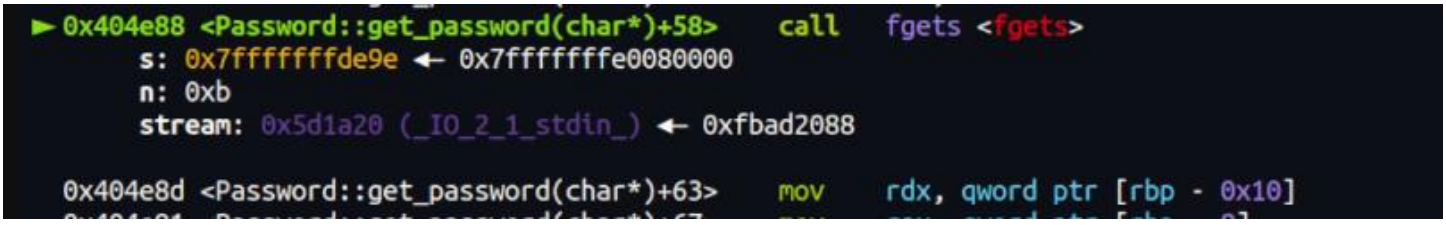
Lekin hum iska **argument** dekhkr smjh skte hai hai. kya function hai. **rdi, rsi** ki value dekhkr.



To hum dekh skte hai **std::cout** function hai. to ye print krne ka kam krta hai.

Aur **rsi** me **"enter password"** hai to ye isi ko print kr rha hai.

Aage **next instructions** pr chalte hai.



Yha **fgets** function call ho rha hai. jaisa ki hume pta hai fgets input lene ka kam krta hai.

Yha pr ye **3 arguments** le rha hai.

First, input ko kis adddress pr store kare.

Second, **input** ki length kitni hai. **0xb** means **11** length. Jha tk hume lgta hai ki fgets **null byte** ko bhi count krta hai. to may bhi input 10 length. Null byte string ko end krne ke kam aata hai.

Third, kha se le rha hai. to **stdin** se.

To jaise hi **ni** karenge to ye input mangega.

```
pwndbg> ni
Enter Password: aaaaaaaaaaaaaaaaaaaaaaaaaaa
```

To hum yha thode se jyada **'a'** de denge taki hum pta kar paye ki input **10** length ka le rha hai ya **11** length ka.

Ab hum us length ko examine krte hai.

```
pwndbg> x/s 0x7fffffffde9e
0x7fffffffde9e: "aaaaaaaaaa"
pwndbg>
```

To yha pr usne **10** length ka input liya hai. aur ek null pointer.

So, password ye password ho skta hai. jo 10 length ka hoga ya usse km length ka.

Next instruction pr chlte hai.

```
   0x404e98 <Password::get_password(char*)+74>    mov    rdi, rax
►  0x404e9b <Password::get_password(char*)+77>    call   Password::check_password(char*) <Passw
        rdi: 0x7fffffffdec7 ← 0x3847d6d3acf90000
        rsi: 0x7fffffffde9e ← 'aaaaaaaaaa'
        rdx: 0x7fffffffde9e ← 'aaaaaaaaaa'
        rcx: 0x6161616161616161 ('aaaaaaaa')

   0x404ea0 <Password::get_password(char*)+82>    nop
```

Ab aa gya **check_password** function jo argument me character array le rha hai. jo ki **humara password** hoga aur **original password** se **check** karega.

Aur ye bhi password class ke andar hi hai.

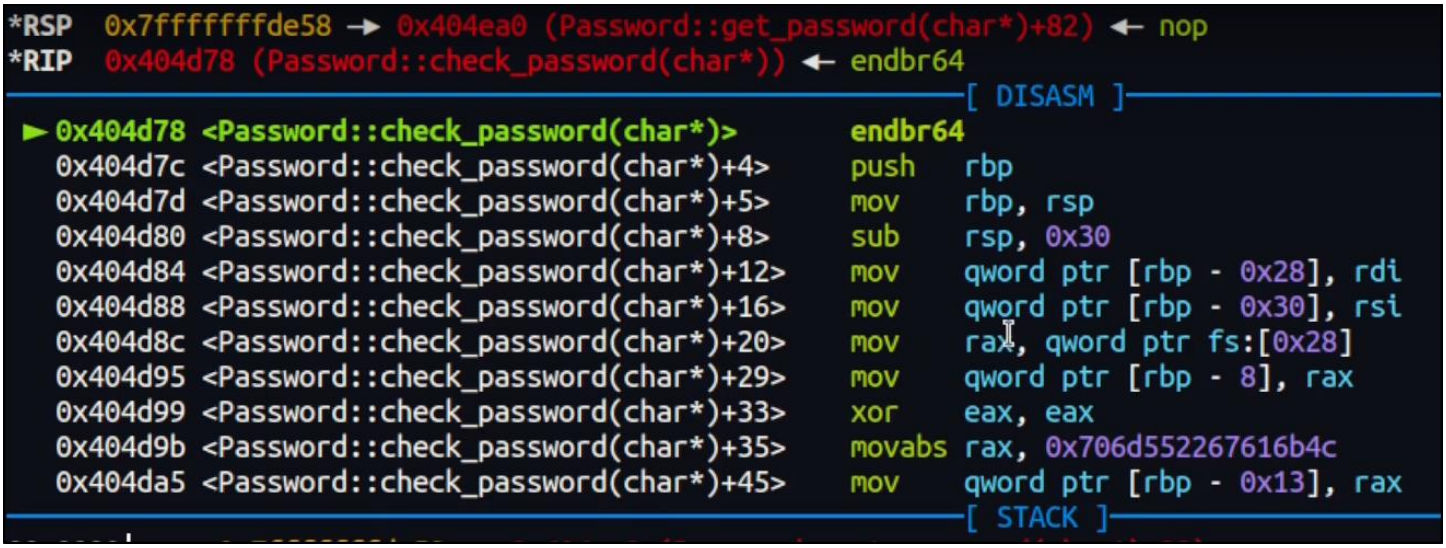
```
Password::check_password(char*)
```

```
►  0x404e9b <Password::get_password(char*)+77>    call   Password::check_password(char*) <Passwor
        rdi: 0x7fffffffdec7 ← 0x3847d6d3acf90000
        rsi: 0x7fffffffde9e ← 'aaaaaaaaaa'
        rdx: 0x7fffffffde9e ← 'aaaaaaaaaa'
        rcx: 0x6161616161616161 ('aaaaaaaa')
```

Yha hum dekh skte hai. ki password **rsi** ke andar pass ho rha hai.

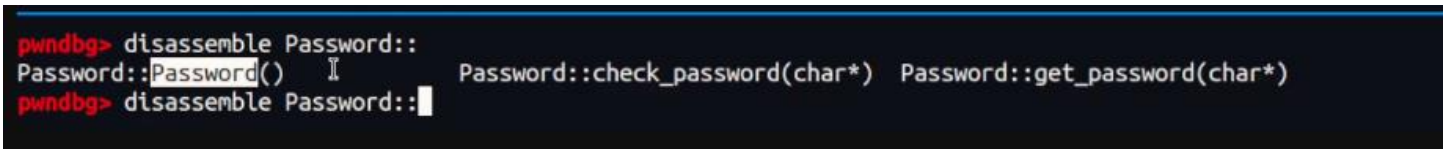
To yha rdi ke andar kyo nhi pass ho rha hai. kyoki **object oriented programming** me **rdi** ke andar first argument **this** pass hota hai.

Ab hum **check_password(char*)** function ke andar chalte hai. **si** command se.

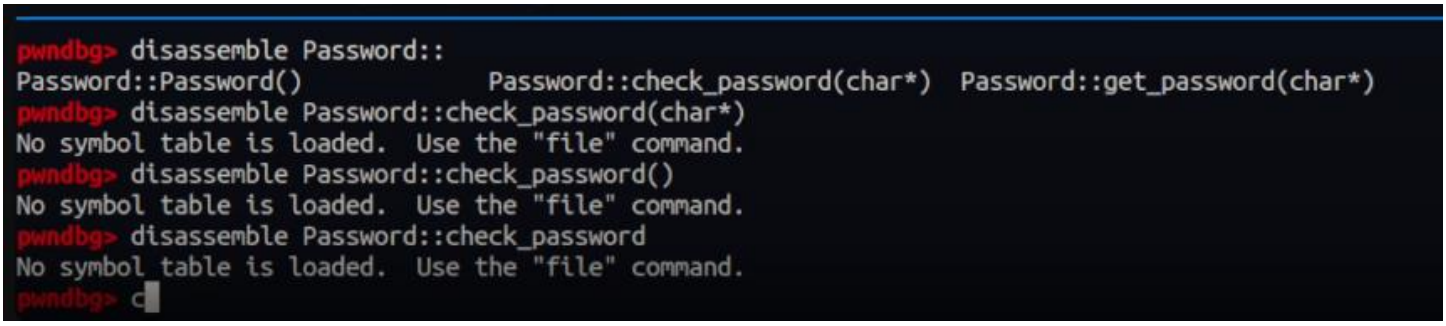


Ab hum dekh lete hai kitne functions hai. Password class ke andar.

disassemble Password:: likhkr **tab** hit karenge. To ye show kr dega total kitne functions hai.

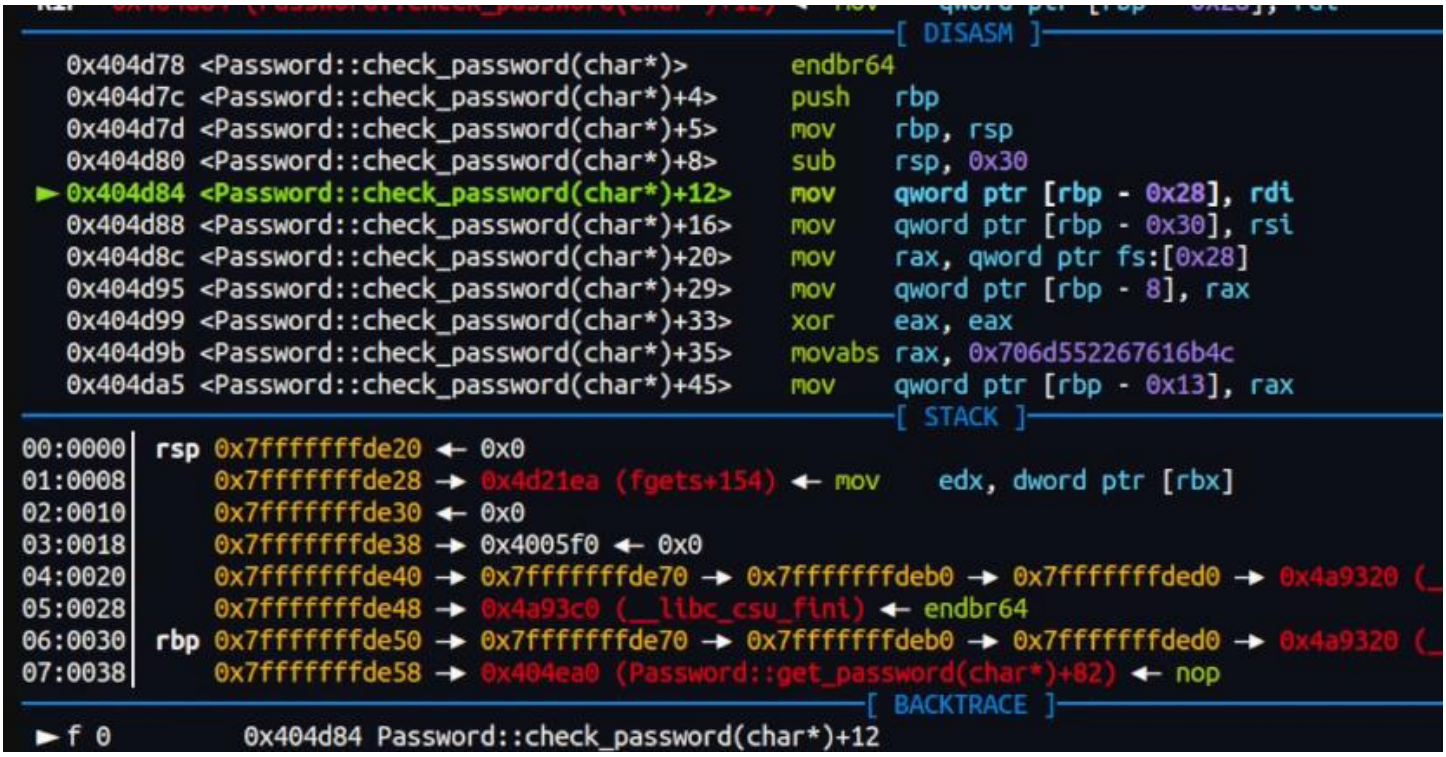


To yha hum **check_password(char*)** ko **disassemble** krte hai.

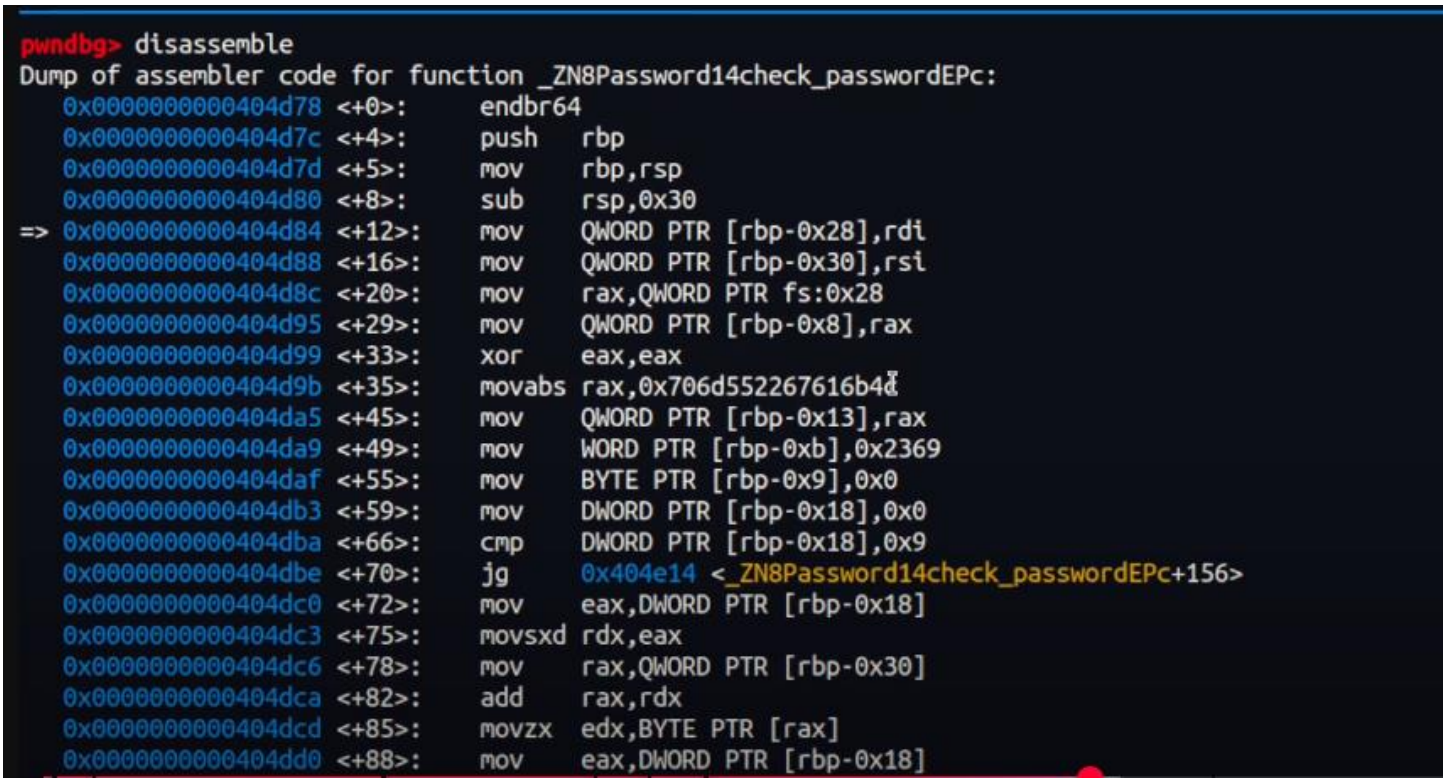


To ye yha disassemble nhi kr pa rha hai.

To hum **context** kr lete hai. jisse ye dubara se print (load) ho jayega.

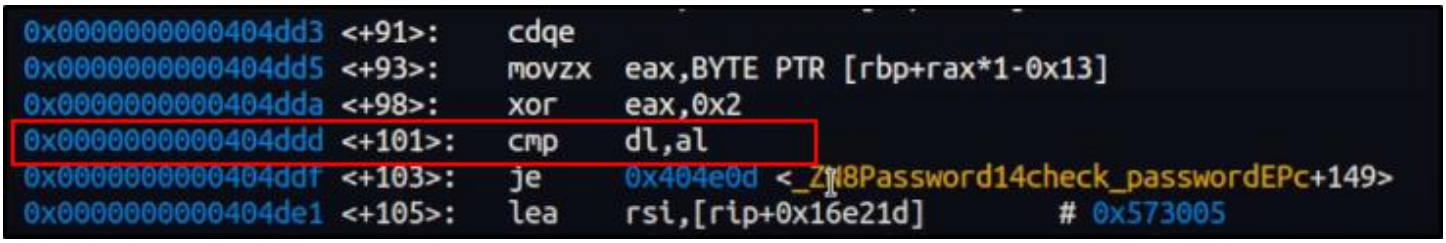


Ab hum **disassemble** likhenge to ye isi function ko **disassemble** kr dega.

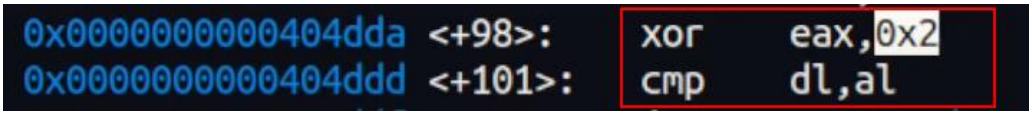


To yha pr ye disassemble ho gya.

To ab hum yha **cmp**, **test** pr focus krte hai. kyoki **cmp, test** ye jyada useful hoti hai reversing point of view se.



Jb bhi **dl, al** ho to yha array variable hota hai. jha ek character **dl** ke andar hoga, ek character **al** ke andar hoga aur dono compare ho rhe honge for loop ke andar ek-2 krke. Jaise humne koi string di. To string ka first char, second char, third char… so on. Aapas me cmp hota hai.



Yha **eax** ka 2 se **xor** ho rha hai. jaise ki hum jante hai. **al** eax ki last byte hoti hai. fir compare ho rha hai.

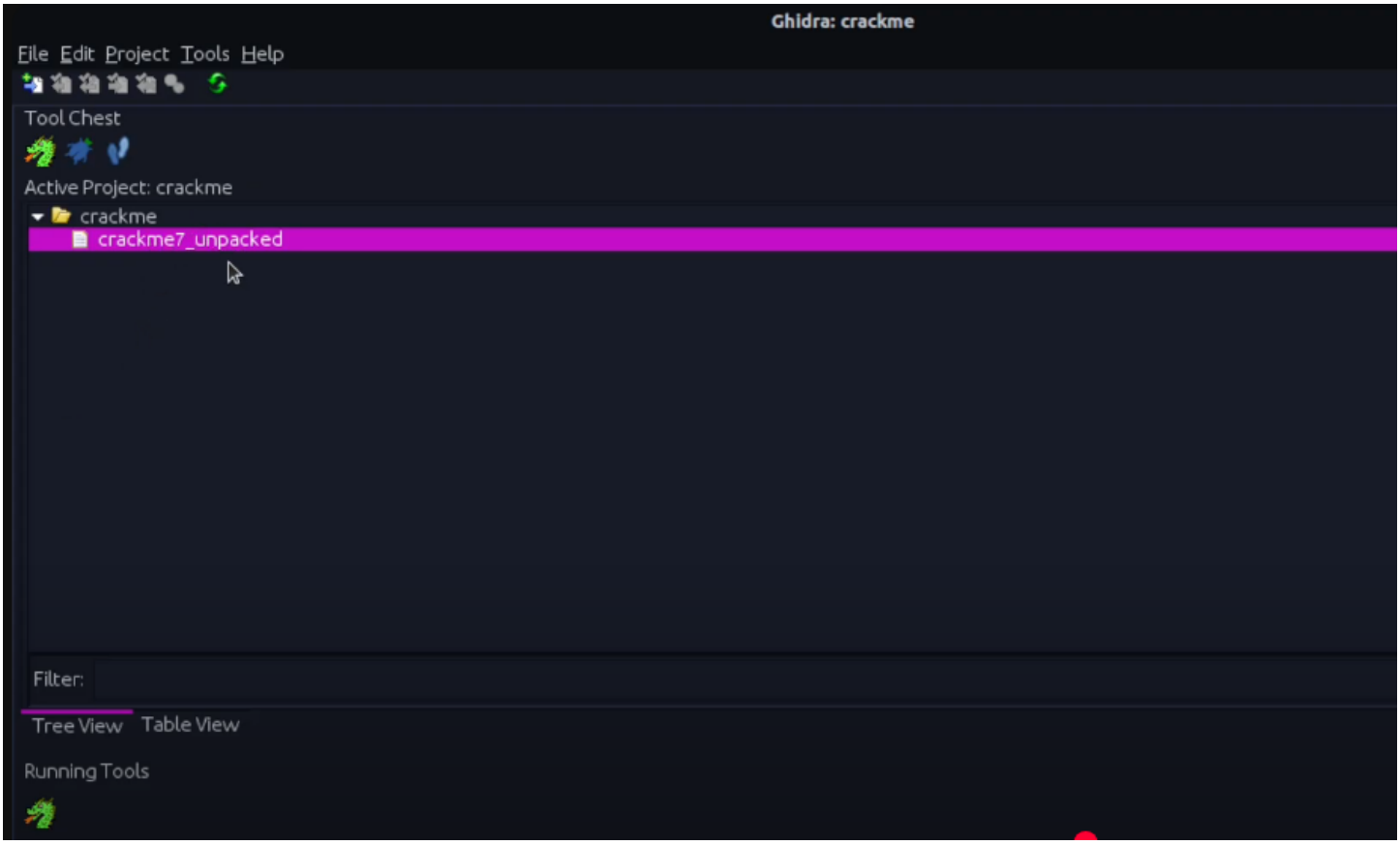
To aisi situation me hum **decompiler** ke pas jate hai. wo ise aasan bna dega. Waise hum yha assembly ko bhi read krke samajh skte hai.

Yha pr hum **al** ki value **registers** ko dekhkr copy krte rhenge aur hume original password pta chal jayega.

To ye tarika hai dynamically analysis ka ye easy hai.

Ab dekhte hai **static analysis decompiler** ki help se.

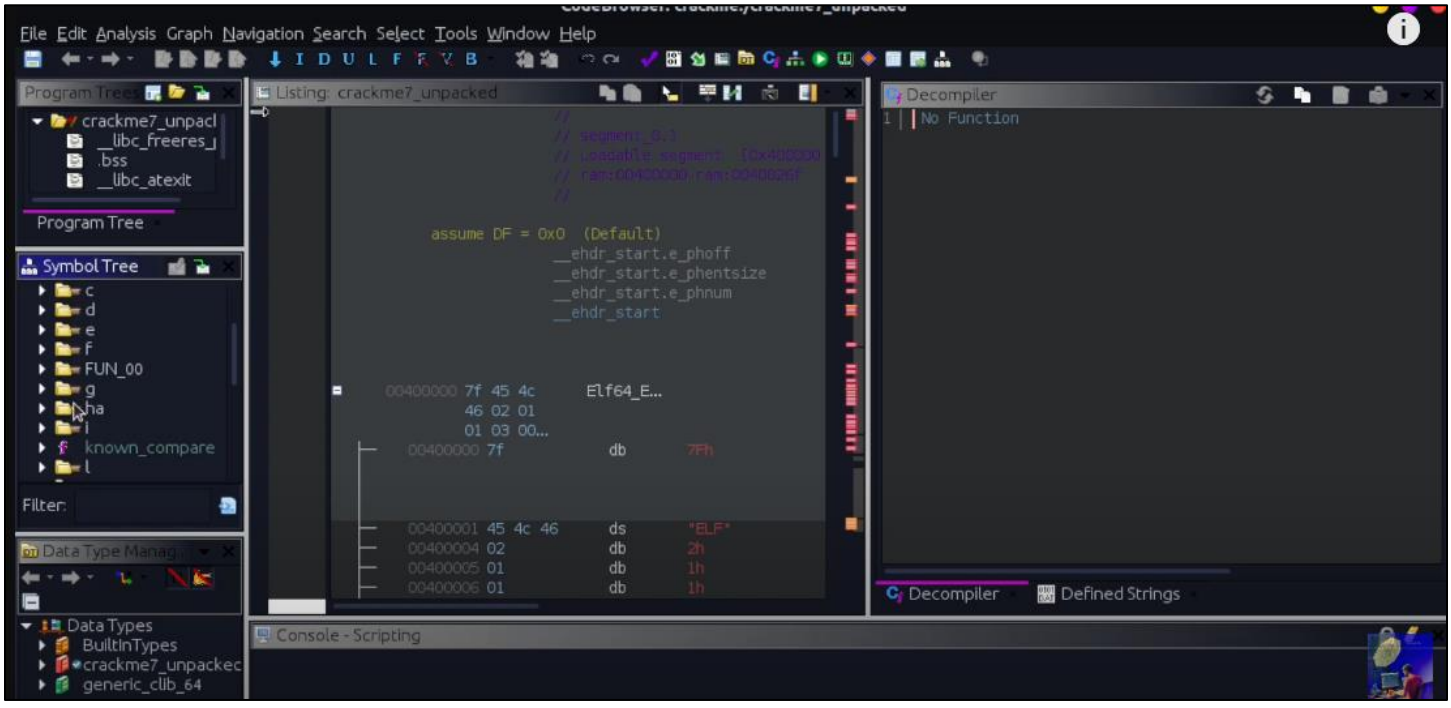
Hum apni binary **ghidra** me load kr lete hai.



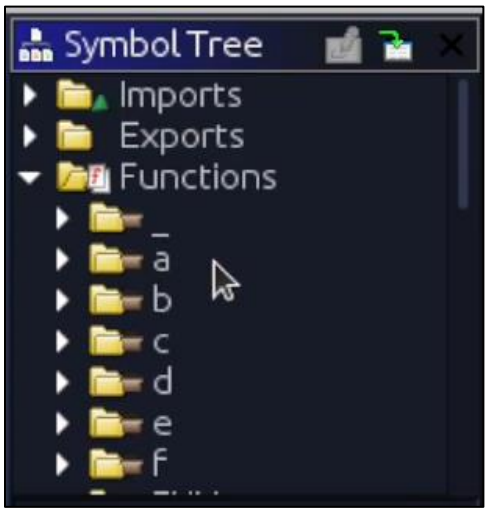
To ye statically linked hai to ye bahut jayada time lega analysis krne me. 5 min ke liye chhod dete hai analysis krne ke liye.

Ye sbka psudocode, decompliel, disassembly banana isliye ye time deta hai.

Yha sb kuchh ready ho gya hai.



Yha hum dekhe to bahut sare functions hai to isne a,b,c,d nam se sort kr diya.



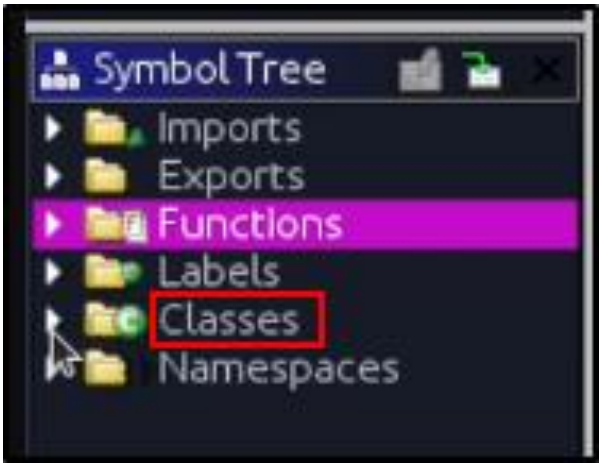
To hum main ke andar jayege. Wahan hume main function mil jayega.

Yha **main** function open ho gya.

```
Decompile: main - (crackme7_unpacked)
1
2  undefined8 main(void)
3
4  {
5    long in_FS_OFFSET;
6    Password local_11;
7    long local_10;
8
9    local_10 = *(long *)(in_FS_OFFSET + 0x28);
10   Password::Password(&local_11);
11   if (local_10 != *(long *)(in_FS_OFFSET + 0x28)) {
12                     /* WARNING: Subroutine does not return
13     __stack_chk_fail();
14   }
15   return 0;
16 }
```

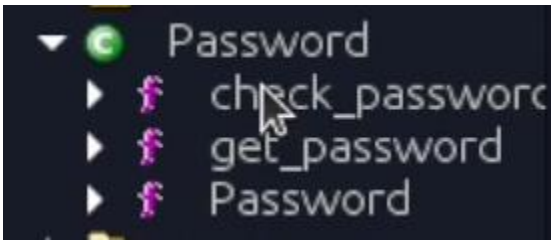
To yha pr kuchh jyada nhi hai bs **Password** class **Password()** function ko call kr rha hai.

Yha pr hume function ke niche classes ka bhi folder show kr rha hai.



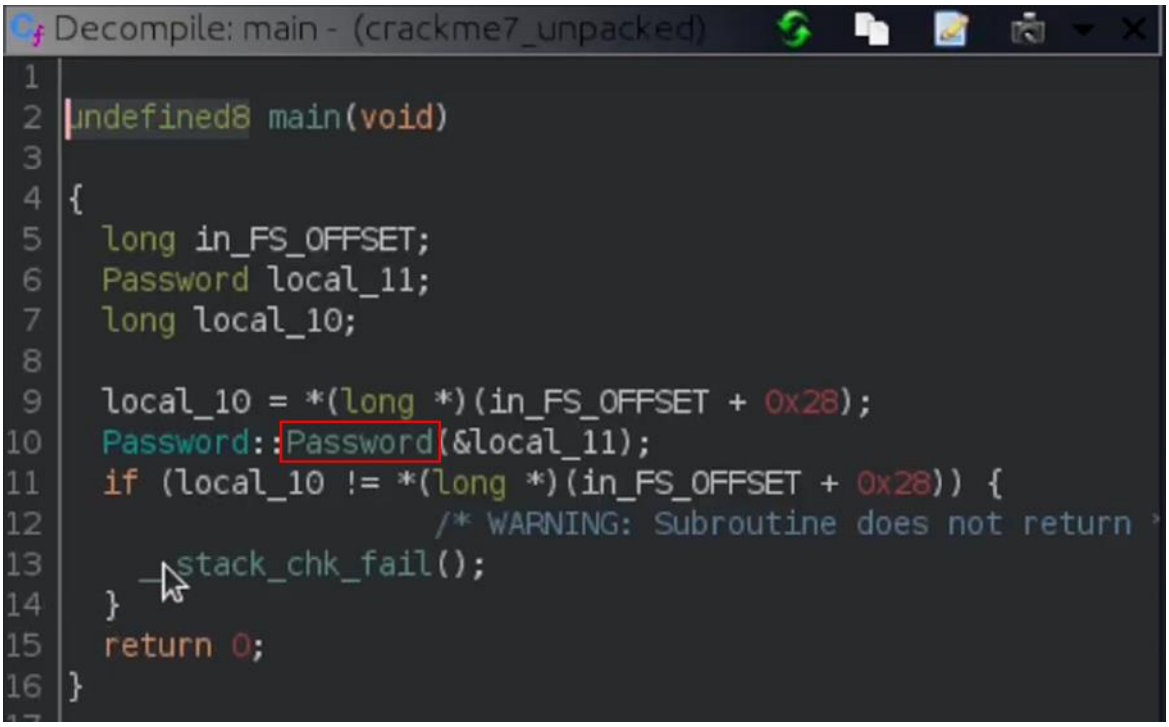
Agar hum class me chale to hume password class bhi mil jayegi.

Agar ise hum expend karenge to sare functions dikh jayenge.



Aap yha se bhi kisi bhi function ko follow kr skte ho.

Hum password pr double click krke open kar lenge.



Decompile: Password - (crackme7_unpacked)

```
1
2  /* Password::Password() */
3
4  void __thiscall Password::Password(Password *this)
5
6  {
7    long in_FS_OFFSET;
8    char local_1a [10];
9    long local_10;
10
11   local_10 = *(long *)(in_FS_OFFSET + 0x28);
12   get_password(this,local_1a);
13   if (local_10 != *(long *)(in_FS_OFFSET + 0x28)) {
14                     /* WARNING: Subroutine does not return */
15     __stack_chk_fail();
16   }
17   return;
18 }
```

Yha **Password()** function open ho gya hai.

To yha pr **Password()** function jayada kam nhi krta bs **get_password()** ko call krta hai.

To hum **get_password()** function pr double click krke open krte hai.

Decompile: get_password - (crackme7_unpacked)

```
1
2  /* Password::get_password(char*) */
3
4  void __thiscall Password::get_password(Password *this,char *param_1)
5
6  {
7    std::operator<<((basic_ostream *)std::cout,"Enter Password: ");
8    fgets(param_1,0xb,(FILE *)stdin);
9    check_password(this,param_1);
10   return;
11 }
12
```

To ye function humare kam ka hai. ye **Enter password** print krta hai aur **fgets** ka use krke user se input leta hai aur **param_1** me store krta hai. uske bad **check_password()** function me pass kr rha hai.

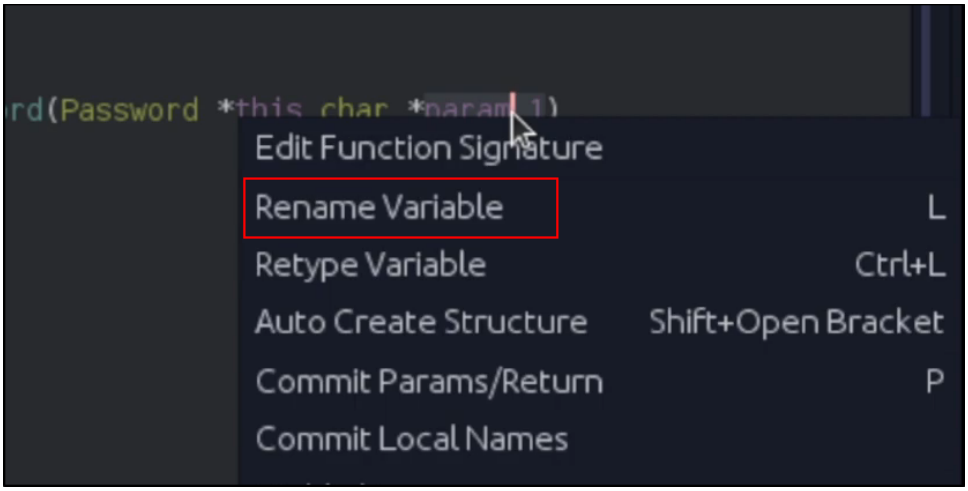
Ab hum chalte hai **check_password()** ke andar.

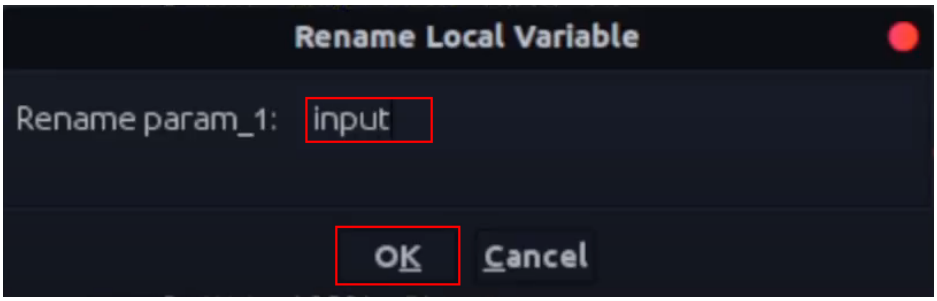
Decompile: check_password - (crackme7_unpacked)

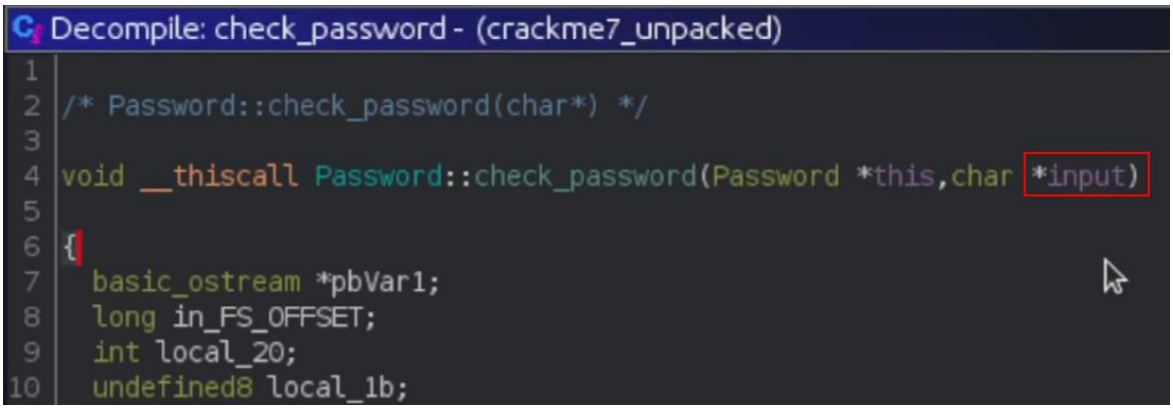
```
1
2  /* Password::check_password(char*) */
3
4  void __thiscall Password::check_password(Password *this,char *param_1)
5
6  {
7    basic_ostream *pbVar1;
8    long in_FS_OFFSET;
9    int local_20;
10   undefined8 local_1b;
11   undefined2 local_13;
12   undefined local_11;
13   long local_10;
14
15   local_10 = *(long *)(in_FS_OFFSET + 0x28);
16   local_1b = 0x706d552267616b4c;
17   local_13 = 0x2369;
18   local_11 = 0;
19   local_20 = 0;
20   while( true ) {
21     if (9 < local_20) {
22       pbVar1 = std::operator<<((basic_ostream *)std::cout,"Correct Password!");
23       std::operator<<(pbVar1,"\n");
```

```
while( true ) {
  if (9 < local_20) {
    pbVar1 = std::operator<<((basic_ostream *)std::cout,"Correct Password!");
    std::operator<<(pbVar1,"\n");
    if (local_10 != *(long *)(in_FS_OFFSET + 0x28)) {
                    /* WARNING: Subroutine does not return */
      __stack_chk_fail();
    }
    return;
  }
  if (input[local_20] != (*(byte *)((long)&local_1b + (long)local_20) ^ 2)) break;
  local_20 = local_20 + 1;
}
pbVar1 = std::operator<<((basic_ostream *)std::cout,"Wrong Password!");
std::operator<<(pbVar1,"\n");
```

Yha hum param1 ko change krke input kr lete hai.







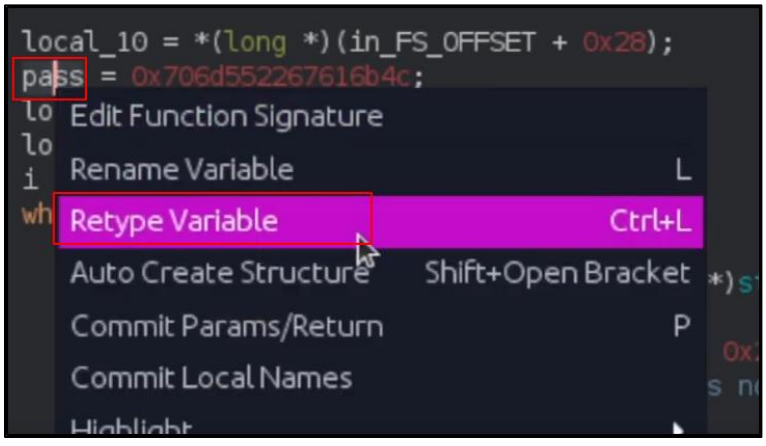
Yha hum **local_20** ko rename krke **i** kr lete hai kyoki ye iterator hai.

Decompile: check_password - (crackme7_unpacked)

```
13   long local_10;
14
15   local_10 = *(long *)(in_FS_OFFSET + 0x28);
16   local_1b = 0x706d552267616b4c;
17   local_13 = 0x2369;
18   local_11 = 0;
19   i = 0;
20   while( true ) {
21     if (9 < i) {
22       pbVar1 = std::operator<<((basic_ostream *)std::cout,"Correct Password!");
23       std::operator<<(pbVar1,"\n");
24       if (local_10 != *(long *)(in_FS_OFFSET + 0x28)) {
25                     /* WARNING: Subroutine does not return */
26         __stack_chk_fail();
27       }
28       return;
29     }
30     if (input[i] != (*(byte *)((long)&local_1b + (long)i) ^ 2)) break;
31     i = i + 1;
32   }
33   pbVar1 = std::operator<<((basic_ostream *)std::cout,"Wrong Password!");
34   std::operator<<(pbVar1,"\n");
```

Yha pr ye if condition humare kam ka hai.

Yha hum **local_1b** ko rename kr lete hai. ise if condition me long dikha rha to ise retype krke char bna dete hai.



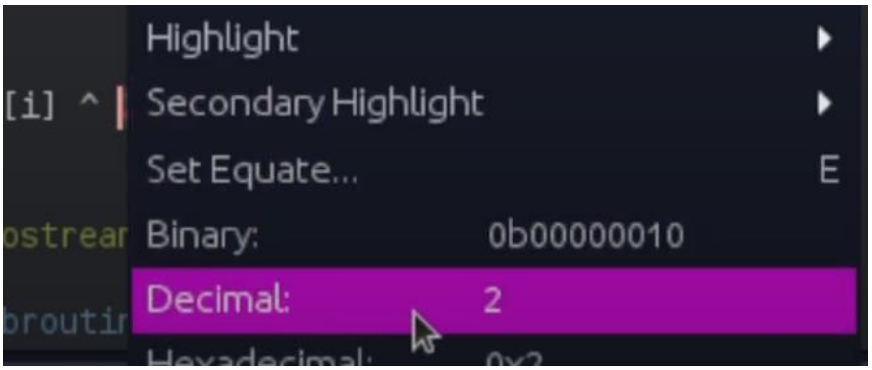
Now,

Decompile: check_password - (crackme7_unpacked)

```
13   long local_10;
14
15   local_10 = *(long *)(in_FS_OFFSET + 0x28);
16   _pass = 0x706d552267616b4c;
17   local_13 = 0x2369;
18   local_11 = 0;
19   i = 0;
20   while( true ) {
21     if (9 < i) {
22       pbVar1 = std::operator<<((basic_ostream *)std::cout,"Correct Password!");
23       std::operator<<(pbVar1,"\n");
24       if (local_10 != *(long *)(in_FS_OFFSET + 0x28)) {
25                     /* WARNING: Subroutine does not return */
26         __stack_chk_fail();
27       }
28       return;
29     }
30     if (input[i] != (byte)((&pass)[i] ^ 2U)) break;
31     i = i + 1;
32   }
33   pbVar1 = std::operator<<((basic_ostream *)std::cout,"Wrong Password!");
34   std::operator<<(pbVar1,"\n");
```

Yha pass **i** value ko ek-2 krke **2** se **xor** krke rha hai. fir original pura password bn jayega. Jisko compare karega **input** se.

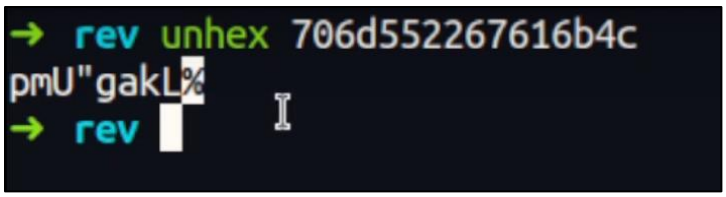
Yha ye **2U** likha hai. ise decimal me dekhenge to ye **2** hai.




```
_pass = 0x706d552267616b4c;
```

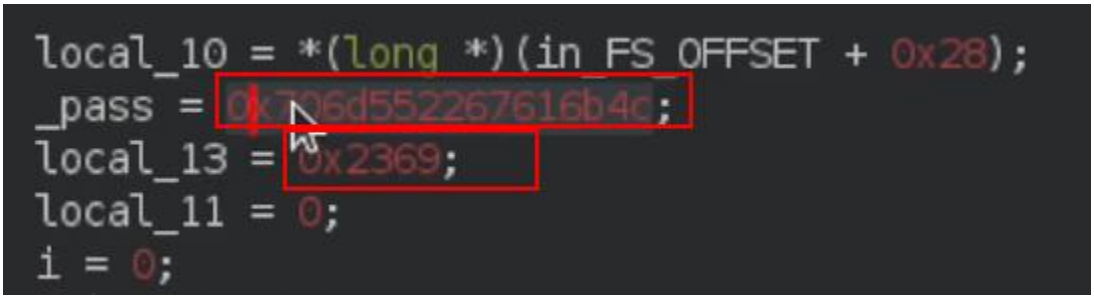
Yha hum python ki help se iske every value ko **2** se **xor** karenge to hume pura password mil jayega.

Isko copy krke unhex kr lete hai.



Yha pr ye **8 length** ka hai yha pr **%** ka sign count nhi hoga ye **zsh** apne glti se deta hai.

Lekin yha 8 length ka password nhi ye ghidra ke glti se ho rha hai.

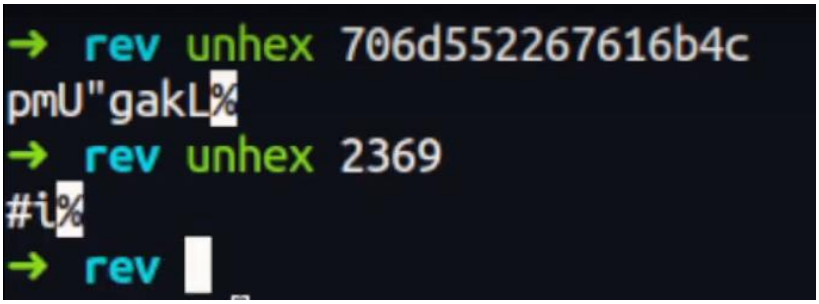


Yha do character niche dusre variable me stored hai. ise copy krte hai aur ise bhi **unhex** kr lete hai.

Yha pr **ghidra** jb bhi **8 length** se jyads password hota hai. To use dusre variable me dal deta hai.

Kyoki ek register ke andar **8 bytes** hi aa skte hai. kyoki registers maximum **64 bit** ka hi hota hai. 64 bit / 8 bit = 8 bytes.

Agar aapko **password** ya **flag** half milta hai to use dusre variable me dekh lena chahiye.



Ab hum ise jod lete hai. Note: **unhex** hamesa result ulta deta hai **little endia**n format me.

Ye humari final string hai. jiske every character ko hum **2 se xor** karenge.

Ab hum python ka program likhna suru krte hai.

```
string = 'Lkag"Umpi#'
for i in string:
    print(chr(ord(i)^2))
```

Yha single quote humne isliye use kiya kyoki string me double phle se hi hai.

```
print(chr(ord(i)^2))
```

Yha **ord()** function se phle humne i ko **integer** me convert kiya fir **2 se xor** kiya.

Fir humne jo bhi **result** aaya use **char()** function se **character** me convert kiya.

```
➜ rev python3
Python 3.8.10 (default, Jun  2 2021, 10:49:15)
[GCC 9.4.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> string = 'Lkag"Umpi#'
>>> for i in string:
...     print(chr(ord(i)^2))
...
N
i
c
e

W
o
r
k
!
>>>
```

To yha pr **"Nice Work!"** humara password hai.

Let 's test the password.

```
➜ rev ./crackme7
Enter Password: Nice Work!
Correct Password!
➜ rev
```

Congratulation! Yha humne packed binary ko reverse engineer kr liya. Lekin hume abhi-2 manually bhi unpacking krni pdti hai. kyoki malware banane wale khud ka packer bnate hai.

##

Reverse Engineering Python Binaries

Challenge - 8

```
➜ rev ./crackme8
Enter Password - aaaa
W04K H4RD!!!
➜ rev
```

Sbse phle hum **file** command run krke dekh lete hai.

```
➜ rev file crackme8
crackme8: ELF 64-bit LSB executable, x86-64, version 1 (SYSV), dynamically linked, interpreter /lib64,
dID[sha1]=f6af5bc244c001328c174a6abf855d682aa7401b, for GNU/Linux 2.6.32, stripped
➜ rev
```

Yha pr kuchh aisa nhi milta ki hum pta kr ske ki ye binary kis language ka use krke banayi gyi hai.

Ab hum stirngs command run kr lete hai. isse hume pta chal jayega ki kis language pr bni hai kyoki **C, C++, python** inki binary alag-2 hoti hai.

```
➜ rev strings crackme8
```

```
blibz.so.1
xbase_library.zip
zPYZ-00.pyz
&libpython3.8.so.1.0
.shstrtab
.interp
.note.gnu.build-id
.note.ABI-tag
```

```
.rela.plt
.init
.text
.fini
.rodata
.eh_frame_hdr
.eh_frame
.init_array
.fini_array
.dynamic
.got
.got.plt
.data
.bss
.comment
pydata
➜ rev
```

Python ke binary ke andar py word bahut dekhne ko milta hai.

Agar hum strings ko grep py kare to hume pta chal jayega.

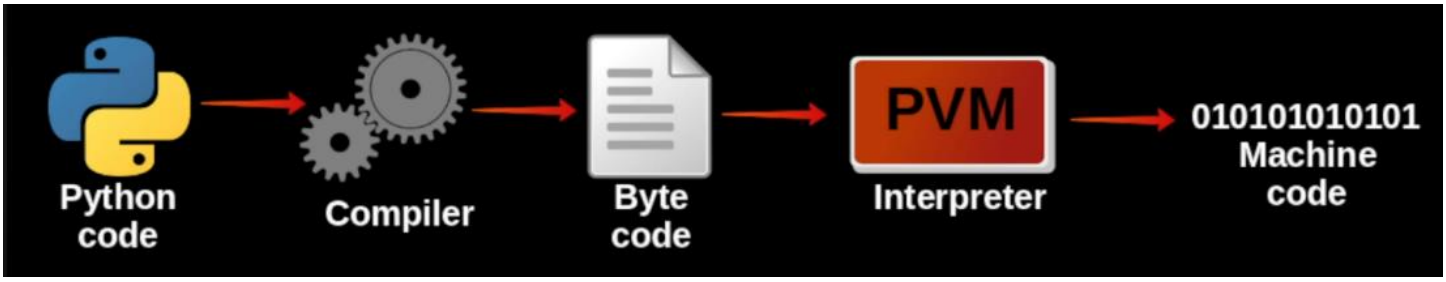
```
➜ rev strings crackme8 | grep -i "py"
```

```
Cannot dlsym for PyObject_SetAttrString
Cannot dlsym for PyObject_GetAttrString
Cannot dlsym for PyObject_Str
Cannot dlsym for PyRun_SimpleString
Cannot dlsym for PySys_AddWarnOption
Cannot dlsym for PySys_SetArgvEx
Cannot dlsym for PySys_GetObject
Cannot dlsym for PySys_SetObject
Cannot dlsym for PySys_SetPath
Cannot dlsym for PyEval_EvalCode
PyMarshal_ReadObjectFromString
Cannot dlsym for PyMarshal_ReadObjectFromString
Cannot dlsym for PyUnicode_FromString
Cannot dlsym for Py_DecodeLocale
Cannot dlsym for PyMem_RawFree
Cannot dlsym for PyUnicode_FromFormat
Cannot dlsym for PyUnicode_Decode
Cannot dlsym for PyUnicode_DecodeFSDefault
Cannot dlsym for PyUnicode_AsUTF8
Cannot dlsym for PyUnicode_Join
Cannot dlsym for PyUnicode_Replace
pyi-
Error loading Python lib '%s': dlopen: %s
```

Bahut sare **py** likhe mil jayenge.

Ab hum phle dekhte hai ki jo python ka high level code hota hai. use machine level code me covert kaise kare. Fir hum use reverse engineer karenge.

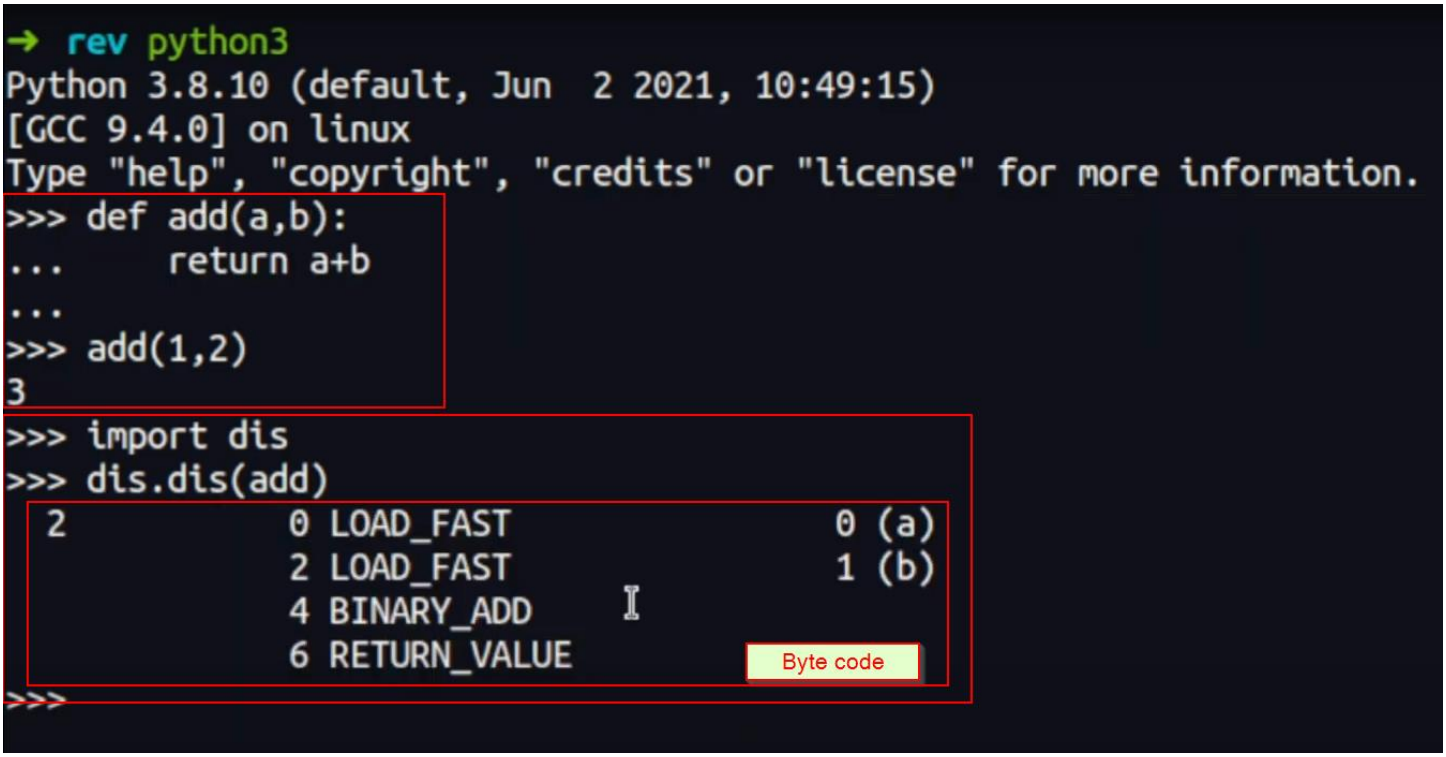
Python ka code directly binary me nhi convert hota hai. jaisa ki hum jante hai **C** ka code phle **assembly** me covert hota hai. fir **machine code** me convert hota hai. python ke andar dono use hota hai **compiler** bhi aur **interpreter** bhi.



Sabse phle python ka **compiler** high level code ko **Byte code** me convert krta hai. fir **PVM (python Virtual Machine)** use machine code me convert krta hai. jaisa JVM hota hai theek waisa hi **PVM** bhi hota hai.

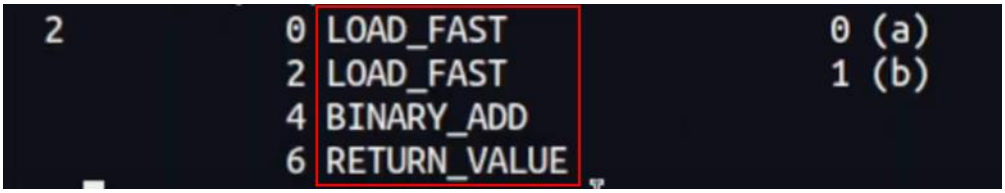
Byte code assembly ke jaisa code hota hai.

Let's see Byte code in python.



Yha humne byte code dekhne ke liye. **dis** module ko import kiya **dis** means **disassemble**.

Aur uske bad **add() function** ko disassemble kiya.

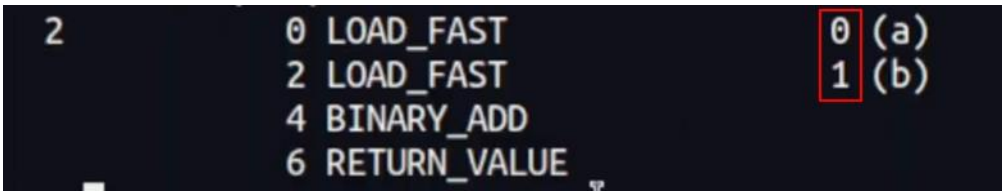


Yha pr instructions likhe hai. aur instruction kis pr perform krna hai. wo bhi likha hai.

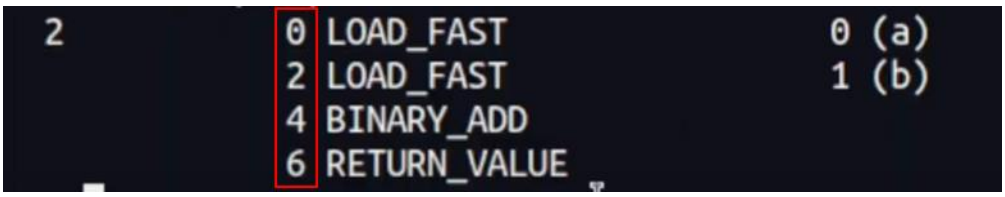
Yha pr **LOAD_FAST** instruction phle a ko stack ke andar load kr rha hai. fir b ko load kr rha hai.

BINARY_ADD instruction do variable ko **add** kr rha hai.

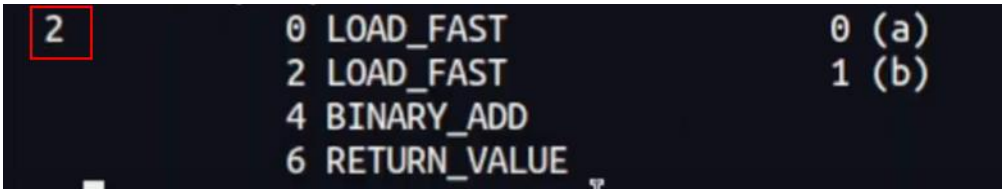
Uske bad **RETURN_VALUE** value return kr rha hai.



aur **(a)** ke aage jo likha hai wo number hai. variable ka **0,1** agar koi **c** variable hota to uska number **2** ho jata.



Aur instruction se phle jo number likha hai wo **offsets** hai. har instruction do bytes ka hota hai. ek hota hai instruction ek hoti hai value dono milakar do byte. Isliye number **0,2,4,6** hai. do-2 ke distance pr.



Ye **2** line number hai code ka.

Actual me **byte code** memory me hota hai. wo human readable format me nhi hota. **disassembly** dikhati hai ki **byte code** dikhta kaisa hai. **dis** hume dikhane ki koshish krti hai humare readable format me. **Byte code** aisa nhi hota hai **byte code** ko terminal **print** nhi kr skta. **byte code** bytes me hota hai. jise hum nhi pd skte hai.

==========

Hume **python** ke **binary** ko **reverse engineering** karne ke liye **byte code** chahiye.

Jaisa ki hum jante hai ki Agar hume **.py** to **.exe** covert krna ya **.py to .elf** convert krna. To hum **pyinstaller** use krte hai.

pyinstaller ka ek khas bat hai. jb **pyinstaller** koi binary banata hai python ki to wh ek kam krta hai. ki jaise **.text section** hota hai **.bss section** hota hai. waise hi ek section add kr deta hai. jiska nam hota hai **pydata**. Aur uske python ka kafi sara data rkh deta hai.

Aur us data ke andar **byte code** bhi hota hai.

```
→ rev ls
crackme   crackme1.c  crackme2.c  crackme3.c  crackme4.c  crackme5.c  crackme7      crackme8
crackme1  crackme2    crackme3    crackme4    crackme5    crackme6    crackme7.cpp  crackme8.py
→ rev
```

Mtlb **crackme8.py** hai uska **byte code, crackme8** binary ke andar hoga. **pydata** section ke andar.

To hum check kr lete hai. ki crackme8 jo hai. usme pydata available hai ki nhi.

```
→ rev readelf -a crackme8
```

Yha **readelf** command use krenge **-a** for all uske bad binary file.

```
[16] .eh_frame_hdr     PROGBITS        0000000000409f80  00009f80
     0000000000000314  0000000000000000   A       0     0     4
[17] .eh_frame         PROGBITS        000000000040a298  0000a298
     0000000000001250  0000000000000000   A       0     0     8
[18] .init_array       INIT_ARRAY      000000000040cde8  0000bde8
     0000000000000008  0000000000000008  WA       0     0     8
[19] .fini_array       FINI_ARRAY      000000000040cdf0  0000bdf0
     0000000000000008  0000000000000008  WA       0     0     8
[20] .dynamic          DYNAMIC         000000000040cdf8  0000bdf8
     0000000000000200  0000000000000010  WA       6     0     8
[21] .got              PROGBITS        000000000040cff8  0000bff8
     0000000000000008  0000000000000008  WA       0     0     8
[22] .got.plt          PROGBITS        000000000040d000  0000c000
     0000000000000280  0000000000000008  WA       0     0     8
[23] .data             PROGBITS        000000000040d280  0000c280
     0000000000000004  0000000000000000  WA       0     0     1
```

```
[23] .data             PROGBITS        000000000040d280  0000c280
     0000000000000004  0000000000000000  WA       0     0     1
[24] .bss              NOBITS          000000000040d2a0  0000c284
     00000000000173f0  0000000000000000  WA       0     0     32
[25] .comment          PROGBITS        0000000000000000  0000c284
     0000000000000059  0000000000000001  MS       0     0     1
[26] pydata            PROGBITS        0000000000000000  0000c2dd
     000000000067d615  0000000000000000           0     0     1
```

To jo **pydata** section hai isme **byte code** hai. usko extract krne ke liye. hum ek tool use karenge. Jiska nam **objcopy** hai.

```
➜ rev objcopy --dump-section pydata=pydata.data crackme8
```

--dump-section ➔ means section ko dump karna hai.

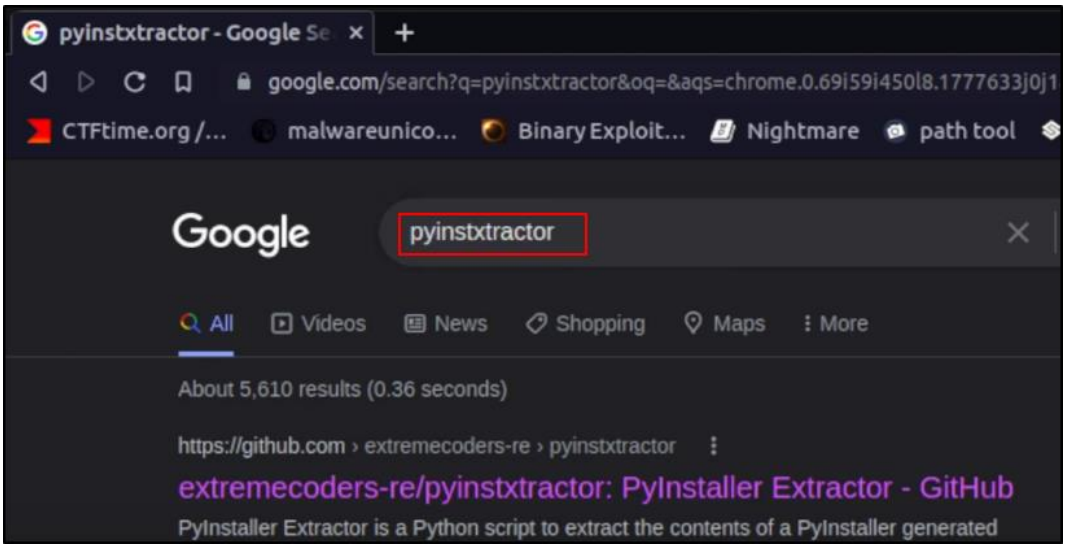
pydata=pydata.data ➔ means pydata section uske bad kis nam se save krna hai **pydata.data** uske bad file ka nam.

```
➜ rev objcopy --dump-section pydata=pydata.data crackme8
➜ rev ls
crackme   crackme1.c  crackme2.c  crackme3.c  crackme4.c  crackme5.c  crackme7      crackme8     crackme.c
crackme1  crackme2    crackme3    crackme4    crackme5    crackme6    crackme7.cpp  crackme8.py  pydata.data
➜ rev
```

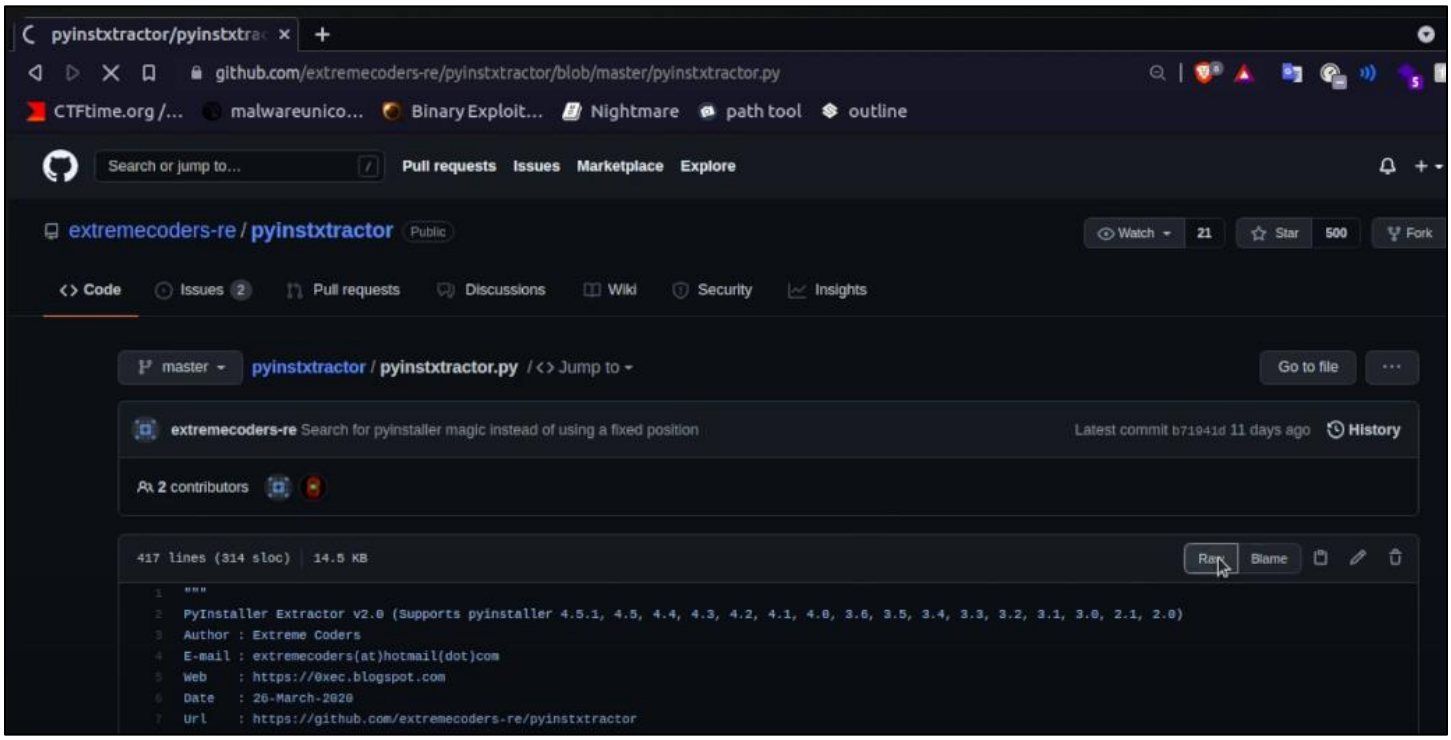
To yha pr **pydata** ke andar only **byte code** hi nhi hota hai uske sath bahut sara code aur bhi hota hai.

```
➜ rev file pydata.data
pydata.data: zlib compressed data
➜ rev
```

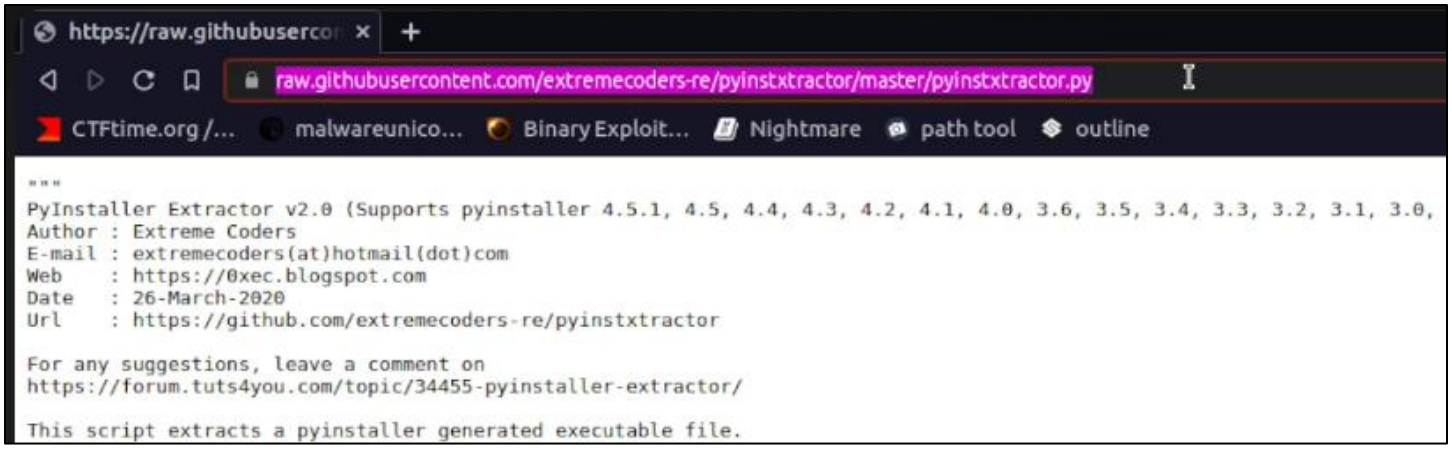
Uske liye hum phle se bane ek script ka use lenge. Jiske liye google pr jana hai. **pyinstxtractor** likhna hai.



Sbse phla github ka link visit krte hai. aur **pyinstxtractor.py** file khol lete hai.



Raw pr click krte hai. aur ise terminal pr **wget** kr lete hai.



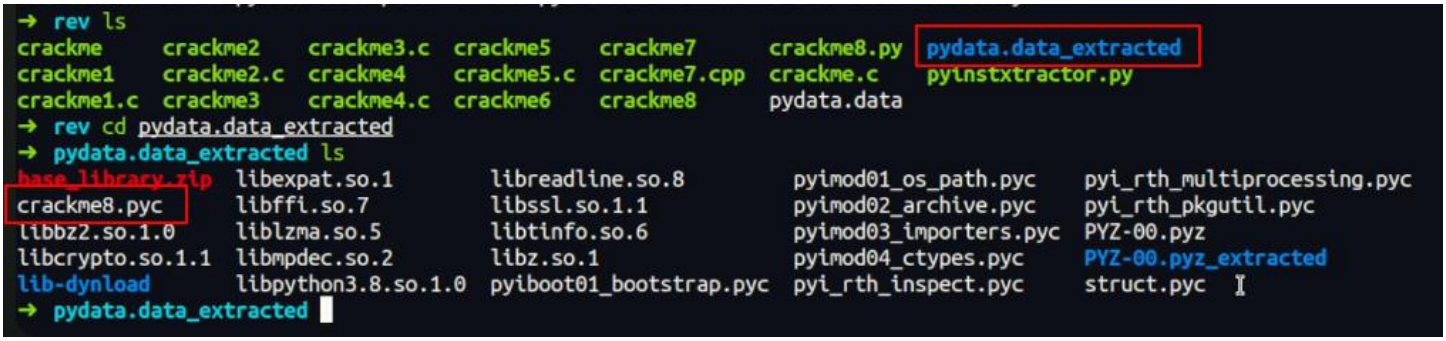

```
→ rev wget https://raw.githubusercontent.com/extremecoders-re/pyinstxtractor/master/pyinstxtractor.py
Will not apply HSTS. The HSTS database must be a regular and non-world-writable file.
ERROR: could not open HSTS store at '/home/hellsender/.wget-hsts'. HSTS will be disabled.
--2021-09-21 23:31:22--  https://raw.githubusercontent.com/extremecoders-re/pyinstxtractor/master/pyinstxtractor.py
Resolving raw.githubusercontent.com (raw.githubusercontent.com)... 185.199.111.133, 185.199.110.133, 185.199.109.133, ...
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|185.199.111.133|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 14870 (15K) [text/plain]
Saving to: 'pyinstxtractor.py'

pyinstxtractor.py              100%[=====================================================>]  14.52K  --.-KB/s    in 0s

2021-09-21 23:31:23 (35.9 MB/s) - 'pyinstxtractor.py' saved [14870/14870]

→ rev
```

Yha pr ye download ho jayegi.

```
→ rev ls
crackme   crackme1.c  crackme2.c  crackme3.c  crackme4.c  crackme5.c  crackme7      crackme8     crackme.c    pyinstxtractor.py
crackme1  crackme2    crackme3    crackme4    crackme5    crackme6    crackme7.cpp  crackme8.py  pydata.data
→ rev chmod +x pyinstxtractor.py
→ rev
```

```
→ rev chmod +x pyinstxtractor.py
→ rev python3 pyinstxtractor.py pydata.data
[+] Processing pydata.data
[+] Pyinstaller version: 2.1+
[+] Python version: 38
[+] Length of package: 6805013 bytes
[+] Found 46 files in CArchive
[+] Beginning extraction...please standby
[+] Possible entry point: pyiboot01_bootstrap.pyc
[+] Possible entry point: pyi_rth_pkgutil.pyc
[+] Possible entry point: pyi_rth_multiprocessing.pyc
[+] Possible entry point: pyi_rth_inspect.pyc
[+] Possible entry point: crackme8.pyc
[+] Found 223 files in PYZ archive
[+] Successfully extracted pyinstaller archive: pydata.data

You can now use a python decompiler on the pyc files within the extracted directory
→ rev
```

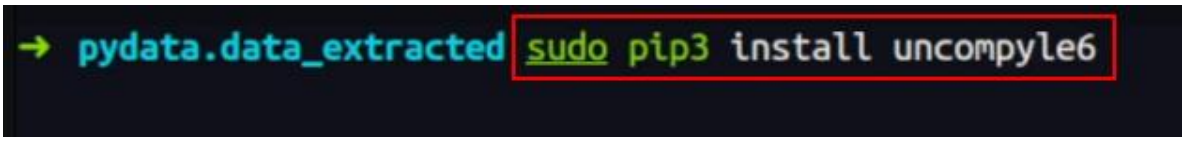
Yha pr isne sara data extract kr diya.



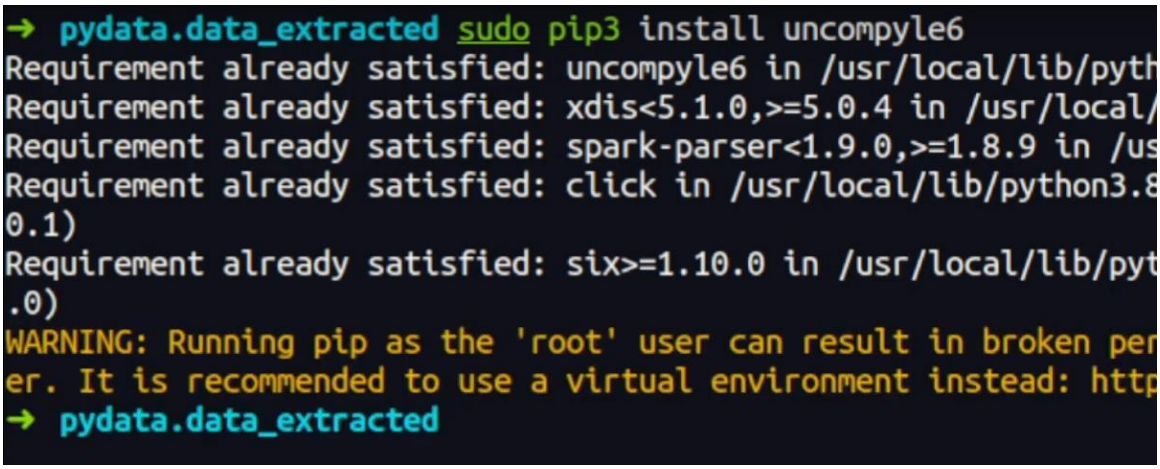
Yha pr humare kam ka file **crackme8.pyc** hi hai.

To ye **byte code** hai.agar ise cat kare to ye human readable format me nhi hota hai.

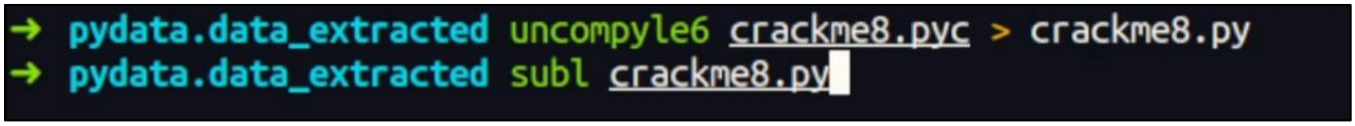
Ab isko wapas **Python ke code** me convert krne ke liye ek tool use karenge. Jiska nam **uncompyle6** hai.



To yha pr phle se hi install hai.



Ab hum tool ko run krte hai.



Aur ye **byte code** ko bilkul ecxact python ke original code me convert kr dega. Yha pr **C** ke jaisa nhi hota ki **psudocode** me convert kare.

Yha hume bilkul **original code** milta hai.

```
crackme8.py
 1  # uncompyle6 version 3.7.4
 2  # Python bytecode 3.8 (3413)
 3  # Decompiled from: Python 3.8.10 (default, Jun  2 2021, 10:49:15)
 4  # [GCC 9.4.0]
 5  # Embedded file name: crackme8.py
 6  import sys
 7  passwd = input('Enter Password - ').replace('\n', '')
 8  if 'cj{bj^ewcjfxj' == lambda passwd: ''.join((chr((ord(i) ^ 9) - 4 + 2) for i in
 9      sys.exit('G00D J08!!')
10  else:
11      sys.exit('W04K H4RD!!!')
12  # okay decompiling crackme8.pyc
13
```

```
in passwd))(passwd):
```

Ye python ke original bs yha minor sa changes hai. lekin code ke logic pr koi impact nhi pda.

```
lambda passwd: ''.join((chr((ord(i) ^ 9) - 4 + 2) for i in passwd))(passwd)
```

Ab hum bs is code ko samjhna hai.

```
def abc(passwd):
    ''.join((chr((ord(i) ^ 9) - 4 + 2) for i in passwd))
abc(passwd)
```

Yha humne thoda simplify kiya hai.

Hum ise thoda aur simplify kr lete hai.

```
def abc(passwd):
    a = ""
    for i in passwd:
        a += (chr((ord(i) ^ 9) - 4 + 2)



abc(passwd)
```

Yha hum is code ko reverse krne ka code likhenge.

```
b = ""
string = 'cj{bj^ewcjfxj'
for i in string:
    b+= chr(((ord(i)-2)+4)^9)
print(b)
```

Yha is code ko reverse order me likhenge. Jaise ki 2 plus ho rha tha to 2 minus hoga. 4 minus ho rha tha to 4 plus hoga. Aur sbse last me 9 xor ho rha tha to 9 xor hi hoga. Kyoki xor ka ek rule hota hai. aur last me sbko character me convert kr lenge.

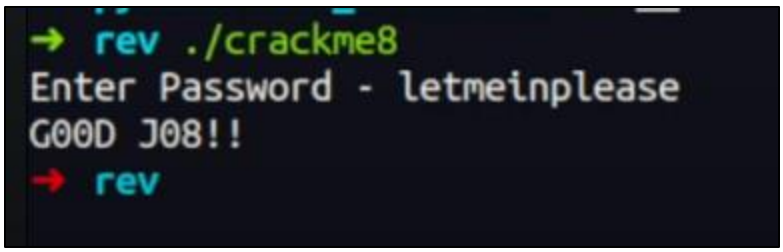
xor ka rule.

```
a^b=c
a^c=b
c^b=a
```

Ab hum program ko run krte hai. aur password get krte hai.

```
→ pydata.data_extracted python3
Python 3.8.10 (default, Jun  2 2021, 10:49:15)
[GCC 9.4.0] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> b = ""
>>> string = 'cj{bj^ewcjfxj'
>>> for i in string:
...     b+= chr(((ord(i)-2)+4)^9)
...
>>> print(b)
letmeinplease
>>>
```

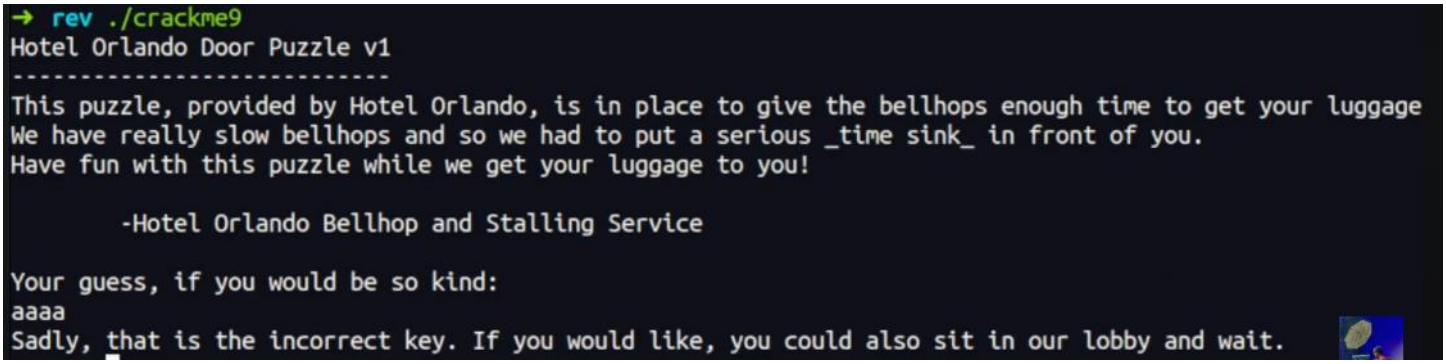
Let’s check the password.



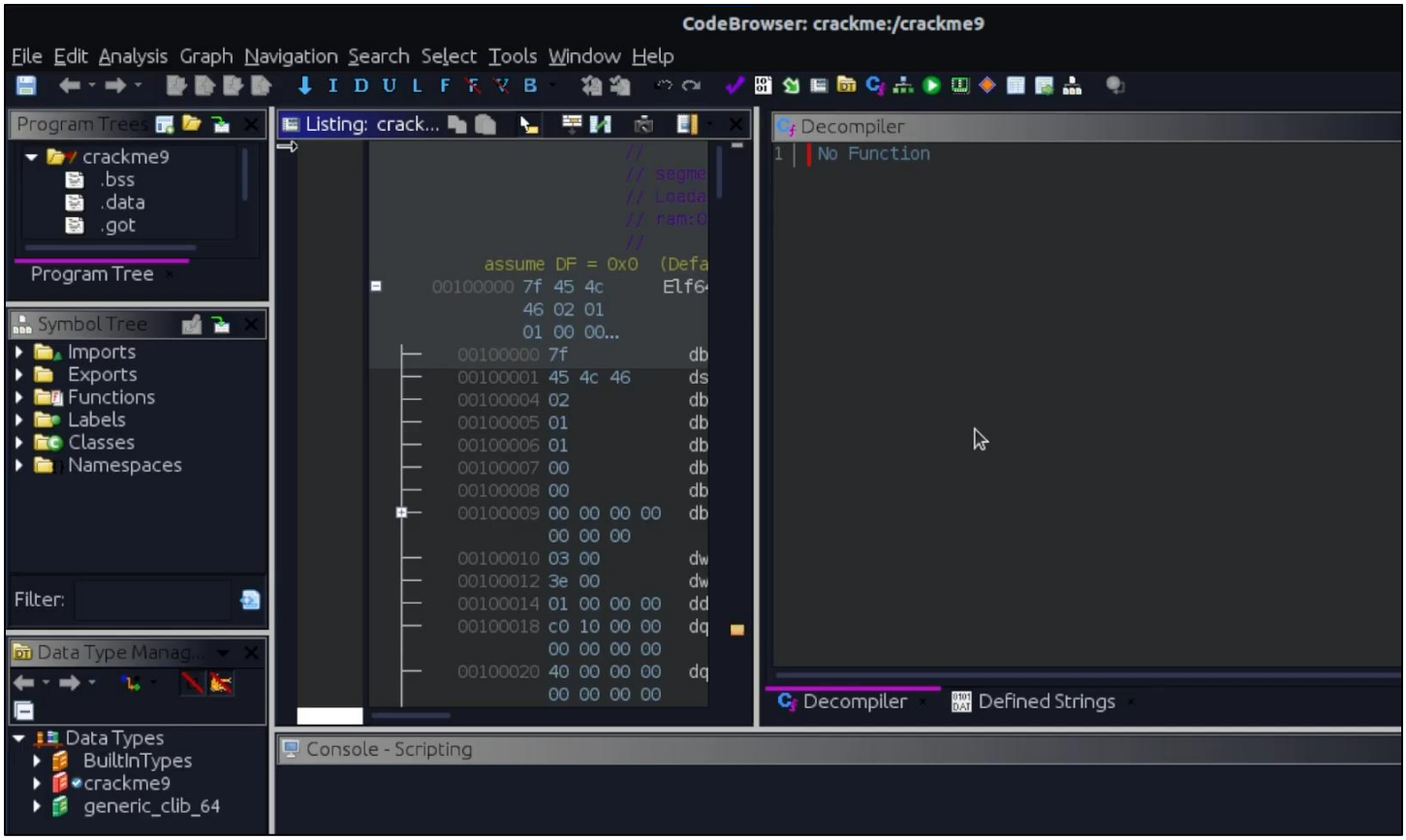
##

Automated Reverse Engineering Using Python Angr :

Challenge - 9



Descriptin:- Yha pr ye ek reverse engineering ka **CTF** hai jisme ek hotel ke room ka door kholna hai. door kholne ke liye hume **flag** ki jarurat padegi. Jisse door khola ja ske. Aur flag pane ke liye hume ise reverse engineer krna pdega.


CodeBrowser: crackme:/crackme9
File Edit Analysis Graph Navigation Search Select Tools Window Help
Program Trees
crackme9
.bss
.data
.got
Program Tree
Symbol Tree
Imports
Exports
Functions
Labels
Classes
Namespaces
Filter:
Data Type Manag...
Data Types
BuiltInTypes
crackme9
generic_clib_64
Listing: crack...
assume DF = 0x0 (Defa
00100000 7f 45 4c Elf6
46 02 01
01 00 00...
00100000 7f db
00100001 45 4c 46 ds
00100004 02 db
00100005 01 db
00100006 01 db
00100007 00 db
00100008 00 db
00100009 00 00 00 00 db
00 00 00
00100010 03 00 dw
00100012 3e 00 dw
00100014 01 00 00 00 dd
00100018 c0 10 00 00 dq
00 00 00 00
00100020 40 00 00 00 dq
00 00 00 00
Decompiler
1 No Function
Decompiler
Defined Strings
Console - Scripting

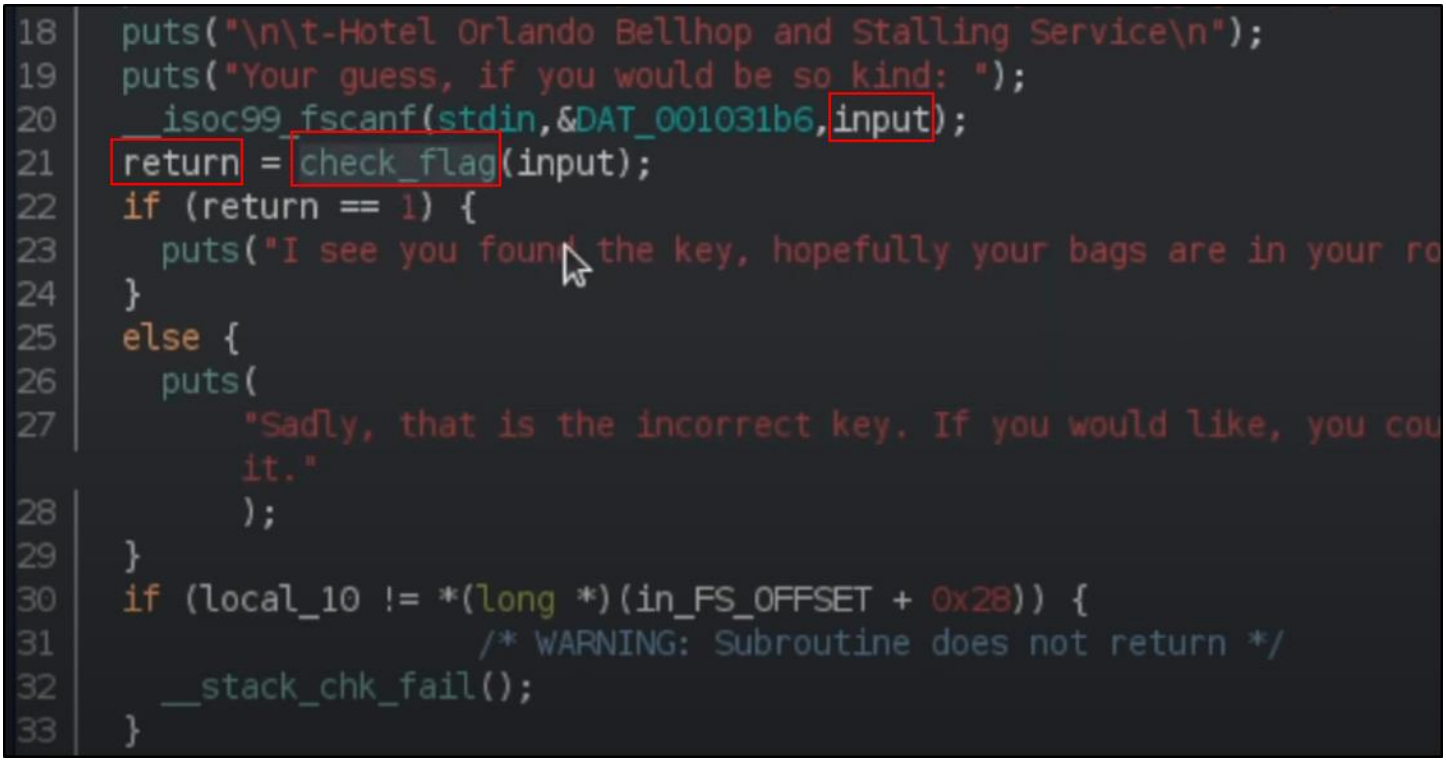

Symbol Tree
_ITM_deregisterTM
_ITM_registerTMC
_start
check_flag
deregister_tm_clo
frame_dummy
FUN_00101020
main
local_10

Decompile: main - (crackme9)

```
1
2  undefined8 main(void)
3
4  {
5    int iVar1;
6    long in_FS_OFFSET;
7    undefined local_58 [72];
8    long local_10;
9
10   local_10 = *(long *)(in_FS_OFFSET + 0x28);
11   puts("Hotel Orlando Door Puzzle v1");
12   puts("----------------------------");
13   puts(
14       "This puzzle, provided by Hotel Orlando, is in place to give the bellhops
        our luggage to you."
15       );
16   puts("We have really slow bellhops and so we had to put a serious _time sink_
17   puts("Have fun with this puzzle while we get your luggage to you!");
18   puts("\n\t-Hotel Orlando Bellhop and Stalling Service\n");
19   puts("Your guess, if you would be so kind: ");
20   __isoc99_fscanf(stdin,&DAT_001031b6,local_58);
21   iVar1 = check_flag(local_58);
22   if (iVar1 == 1) {
```

```
20   __isoc99_fscanf(stdin,&DAT_001031b6,local_58);
21   iVar1 = check_flag(local_58);
22   if (iVar1 == 1) {
23     puts("I see you found the key, hopefully your bags are in your room by this
24   }
25   else {
26     puts(
27         "Sadly, that is the incorrect key. If you would like, you could also sit
        it."
28         );
29   }
30   if (local_10 != *(long *)(in_FS_OFFSET + 0x28)) {
31                     /* WARNING: Subroutine does not return */
32     __stack_chk_fail();
33   }
```

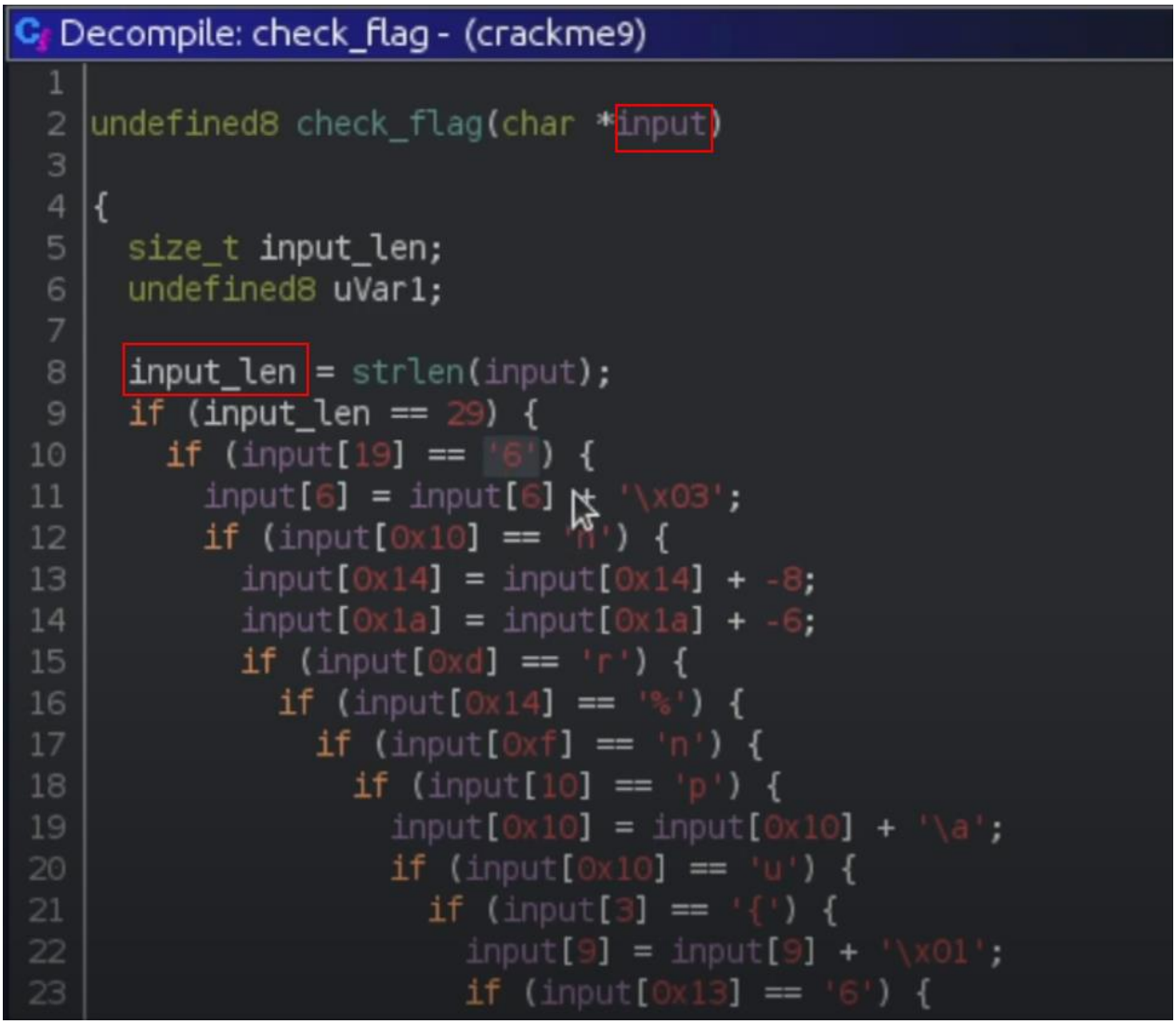
Ab hum **main** function ko pdna suru karenge.



```
18  puts("\n\t-Hotel Orlando Bellhop and Stalling Service\n");
19  puts("Your guess, if you would be so kind: ");
20    __isoc99_fscanf(stdin,&DAT_001031b6,input);
21  return = check_flag(input);
22  if (return == 1) {
23    puts("I see you found the key, hopefully your bags are in your ro
24  }
25  else {
26    puts(
27         "Sadly, that is the incorrect key. If you would like, you cou
         it."
28         );
29  }
30  if (local_10 != *(long *)(in_FS_OFFSET + 0x28)) {
31                      /* WARNING: Subroutine does not return */
32    __stack_chk_fail();
33  }
```

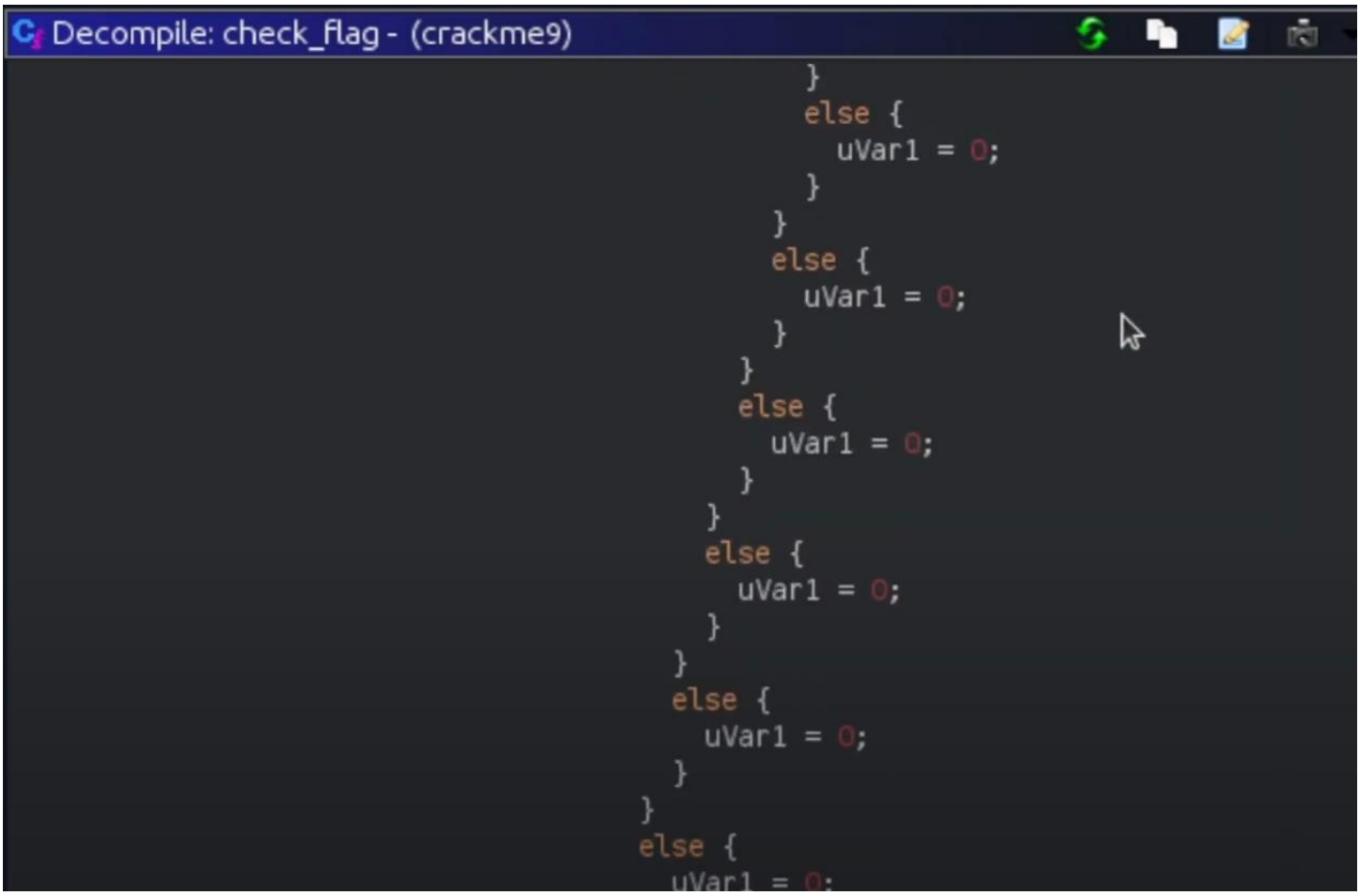
Yha humne kuchh variables ka nam rename krke meaningful rkh diya hai.

Ab hum **check_flag()** function ke andar chalte hai.


Decompile: check_flag - (crackme9)
undefined8 check_flag(char *input)
{
size_t input_len;
undefined8 uVar1;
input_len = strlen(input);
if (input_len == 29) {
if (input[19] == '6') {
input[6] = input[6] + '\x03';
if (input[0x10] == 'n') {
input[0x14] = input[0x14] + -8;
input[0x1a] = input[0x1a] + -6;
if (input[0xd] == 'r') {
if (input[0x14] == '%') {
if (input[0xf] == 'n') {
if (input[10] == 'p') {
input[0x10] = input[0x10] + '\a';
if (input[0x10] == 'u') {
if (input[3] == '{') {
input[9] = input[9] + '\x01';
if (input[0x13] == '6') {


Decompile: check_flag - (crackme9)
input[7] = input[7] + '\b';
input[8] = input[8] + '\x04';
input[0xd] = input[0xd] + -10;
input[0x1a] = input[0x1a] + '\a';
if (input[0xe] == 'u') {
if (input[0x16] == 't') {
if (input[2] == 'n') {
input[0xf] = input[0xf] +
if (input[0x1a] == 'm') {
input[6] = input[6] + '\x05';
input[0x13] = input[0x13] + -10;
input[0x1c] = input[0x1c] + '\x04';
if (input[6] == 'k') {
input[3] = input[3] + -9;
if (input[6] == 'k') {
input[0x11] = input[0x11] + -5;
input[0x11] = input[0x11] + -6;
if (input[1] == 's') {
if (input[0x12] == 'e') {
input[4] = input[4] + '\x05';
if (input[6] == 'k') {
if (input[0xc] == '*') {
if (input[2] == 'n') {

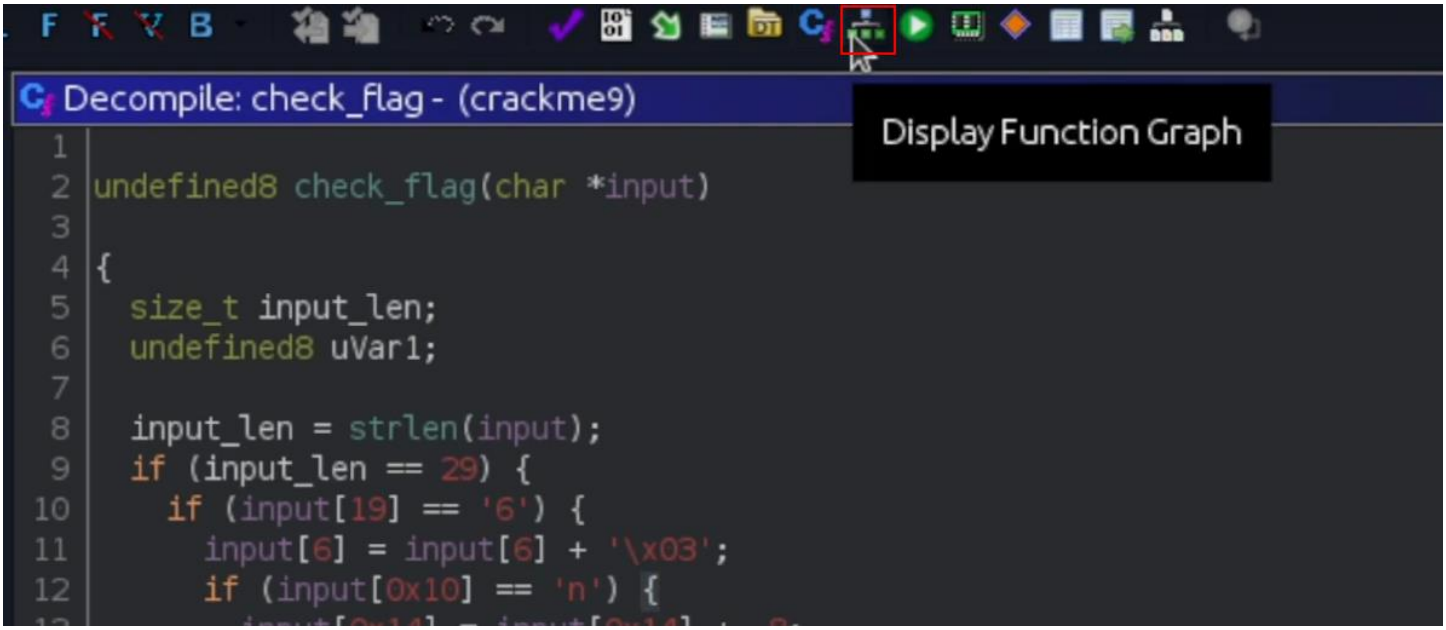

Decompile: check_flag - (crackme9)
if (input[2] == 'n') {
if (input[0x1b] == 'y') {
if (input[0x1c] == 'y') {
if (input[0x13] == '*') {
if (input[8] == 'f') {
if (input[0x1c] == 'y') {
if (input[9] == ',') {
if (input[2] == 'n') {
if (input[0xd] == 'd') {
if (input[0x16] == 't') {
if (input[5] == '8') {
if (input[7] == 'k') {
if (input[9] == ',') {
if (input[1] == 's') {
if (*input == 'k') {
if (input[8] == 'f')
{
if (input[1] ==
's') {
if (input[0x15]
== 'q') {
if (input[0x



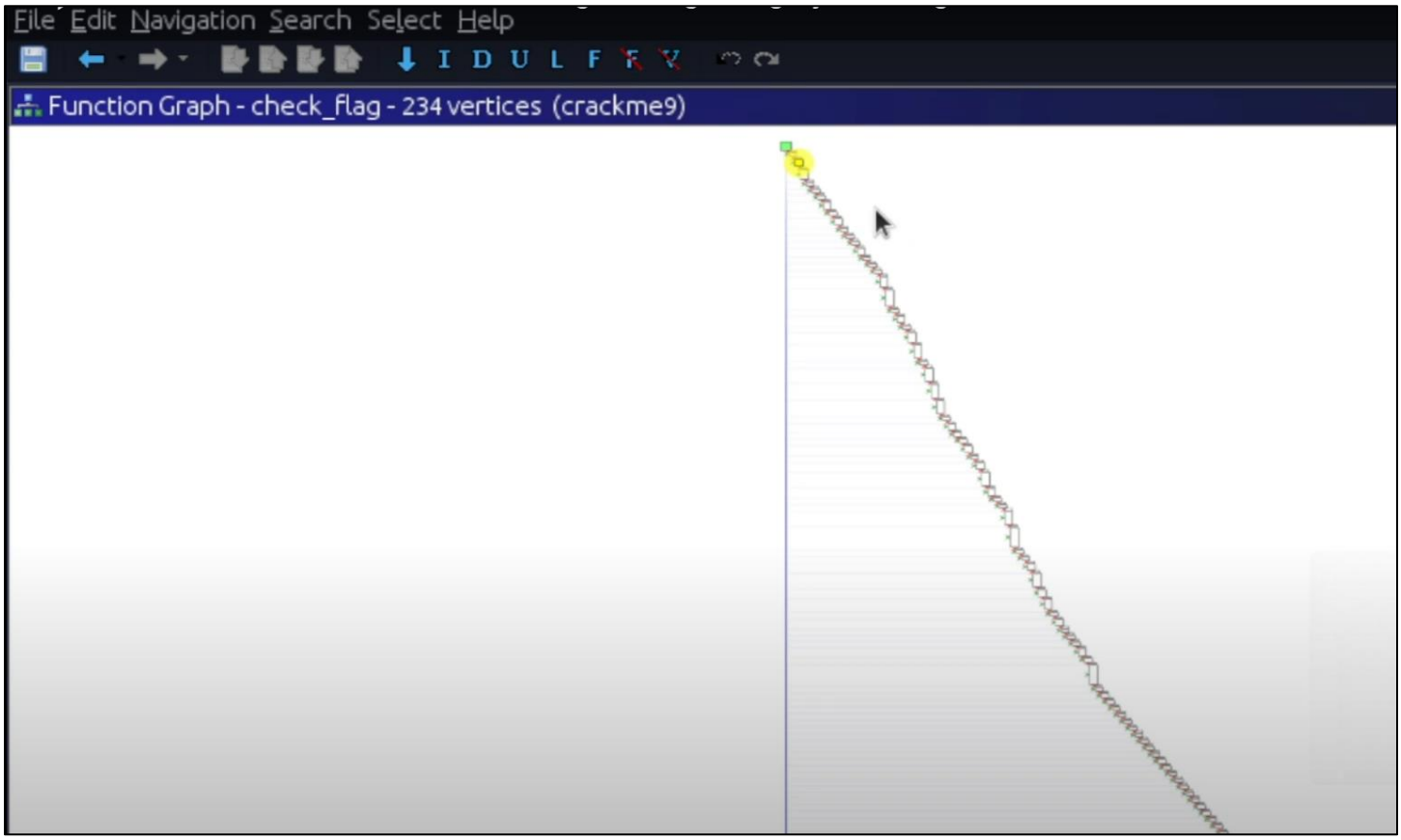
Jaisa ki hum dekh skte hai. yha pr bahut sare **if-else** conditions hai. agar hum paper pen lekar solve karenge to bahut sara time lag jayega.

To hum python ka help lenge. Iske 6-7 line ka humari ye problem solve kr dega.

Yha hum **angr** module ka use karenge. Ye automated me help krta hai **symbolic execution** ka help leta hai.

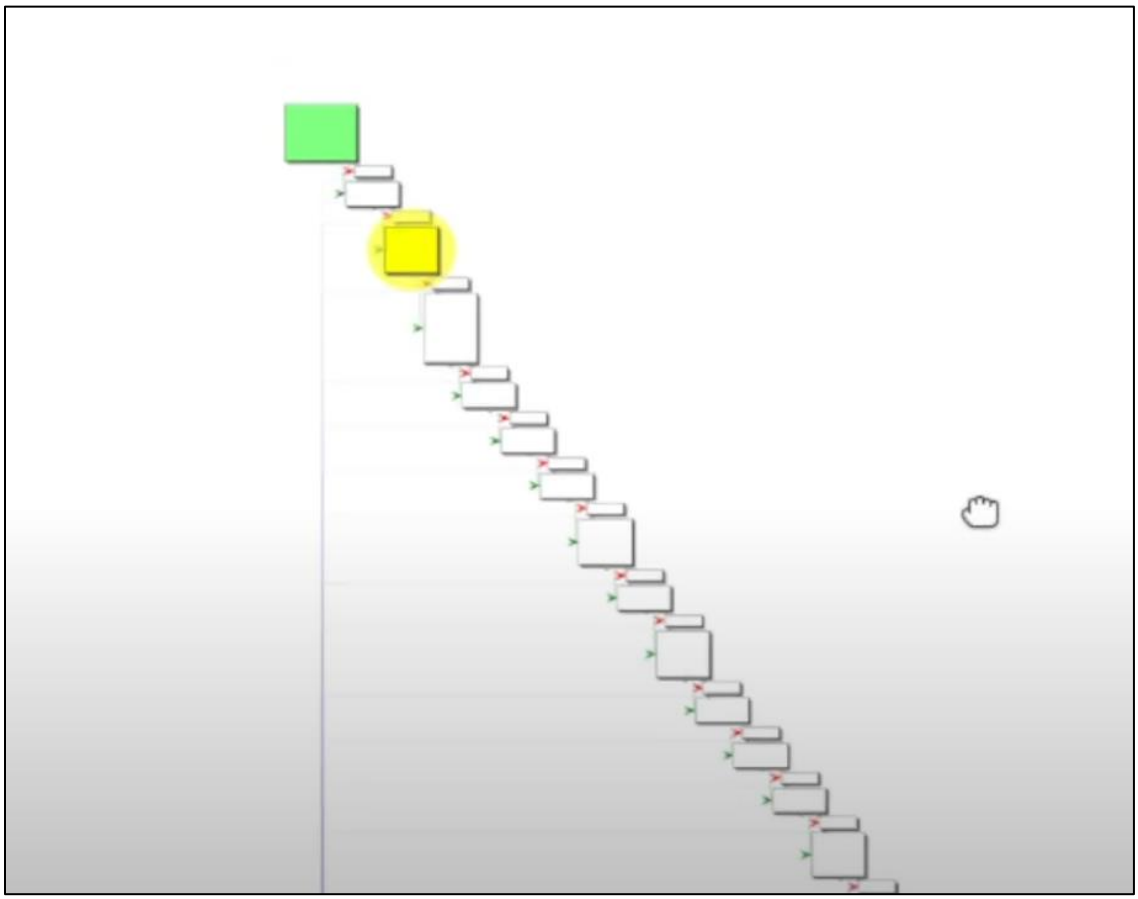


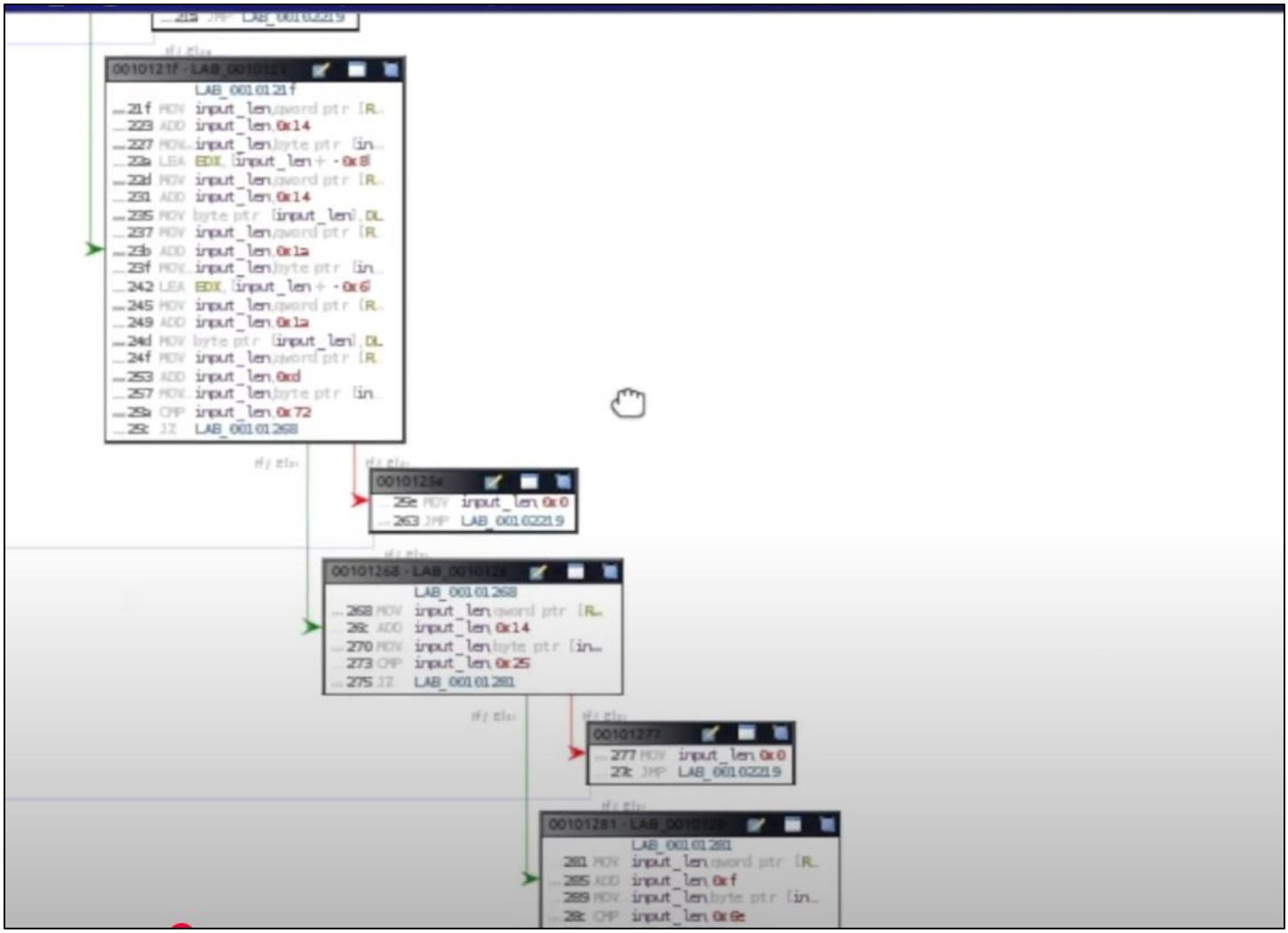
Symbolic execution smjhne ke liye hum ghidra pr chalte hai. aur flow chart ya function graph jo bhi hai. usko open krte hai.



Ab hum yha dekh skte hai. ki ek accha sa graph bn gya hai.

Hum ise zoom krte jate hai.





Yha hum dekh skte hai. ki kitne sare branches hai.

Upar length compare kr rha hai agar itna hai to yha jayega, agar itna nhi hua to kahan jayega.

Yha pr python **input** me kuchh bhi value nhi put kr deta. Wo har branch pr jata hai. aur uska ek **equation** banata hai. ki agar mai isme ye wala **symbolic value** put karunga to kis branch pr jayega.

Equation ko solve ye **z3** ki help se krta hai. **z3** ek **liabrary** hai. jise microsoft ne banayi hai **theorums** ko proof krne ke liye. **equations** ko solve krne ke liye.

To **z3** ki help se equations ko solve krta hai. aur sbke andar jayega aur check karega ki kya value put karunga to is branch me jaunga. Jitne posible routes hote hai. to sabke andar wo jata hai.

Yha hum **bruteforce** nhi kr rhe hai. yha pr wo **intelligently equation** banakr kr solve kr rha hai. ki kya value rkhunga to mai andar ja skta hun aur kya value rkhunga to mai bahar aa skta hun.

Kuchh logo claim kiya ki **AI(Artificial Intelligent)** hai. lekin **angr** walo aisa kuchh nhi likha hai iske bare me.

To yha hum angr ko batayenge ki jb tk tujhe correct password nhi mil jaye tu sare branches pr jata ja. Jaise hi correct password mil jaye wahi ruk ja aur bta ki tune aisa kaun sa input dala ki correct password mil gya.

==========

crackme9.py

```
1  #!/usr/bin/python3
2
3  import angr
4
5  project = angr.Project('./crackme9')
```

Yha humne angr ko import kr liya.

Uske bad hume project banana hota hai. jaise ghidra ko aise hi nhi start krte hai. phle project banana hota hai.

Project function ka **P** capital hota hai. usme humen **binary ka path** dena hota hai as argument.

crackme9.py

```
1  #!/usr/bin/python3
2
3  import angr
4
5  project = angr.Project('./crackme9')
6  entry = project.factory.entry_state()
```

Yha pr humen batana padega ki kahan se start krna hai. to hume address dene ki jarurat nhi hai. automatic pta laga leta hai entry point kya hai. **main** function se start krna hai ya **_start** se automatic pta lga leta hai.

Yha **entry_state()** function pta laga leta hai. ki kahan se entery hai program ki. Jo bhi entery point milega **entry** variable ke andar store kr dega.

Agar hume khud se address dena hai entry point ka to hum aise de skte hai.

```
entry = project.factory.entry_state(addr=0x4567)
```

Hex ke format me.

Ab hum ek manager banayenge to input output ko manage karega. Jo binary run karega binary ka output aa rha hai. binary ka input hai wo bhi wahi manage karega. Kyoki itne sare branches hai iske andar kaun kahan ja rha hai sb manage karega. Kya output aa rha hai kya input ja rha hai.

```
7  manager = project.factory.simgr(entry)
```

To yha pr project ke andar factory hota hai. aur manager factory me hota hai jise hum khte hai **simulation manager**.

simgr() function me hum entry put karenge kahan se run krna hai.

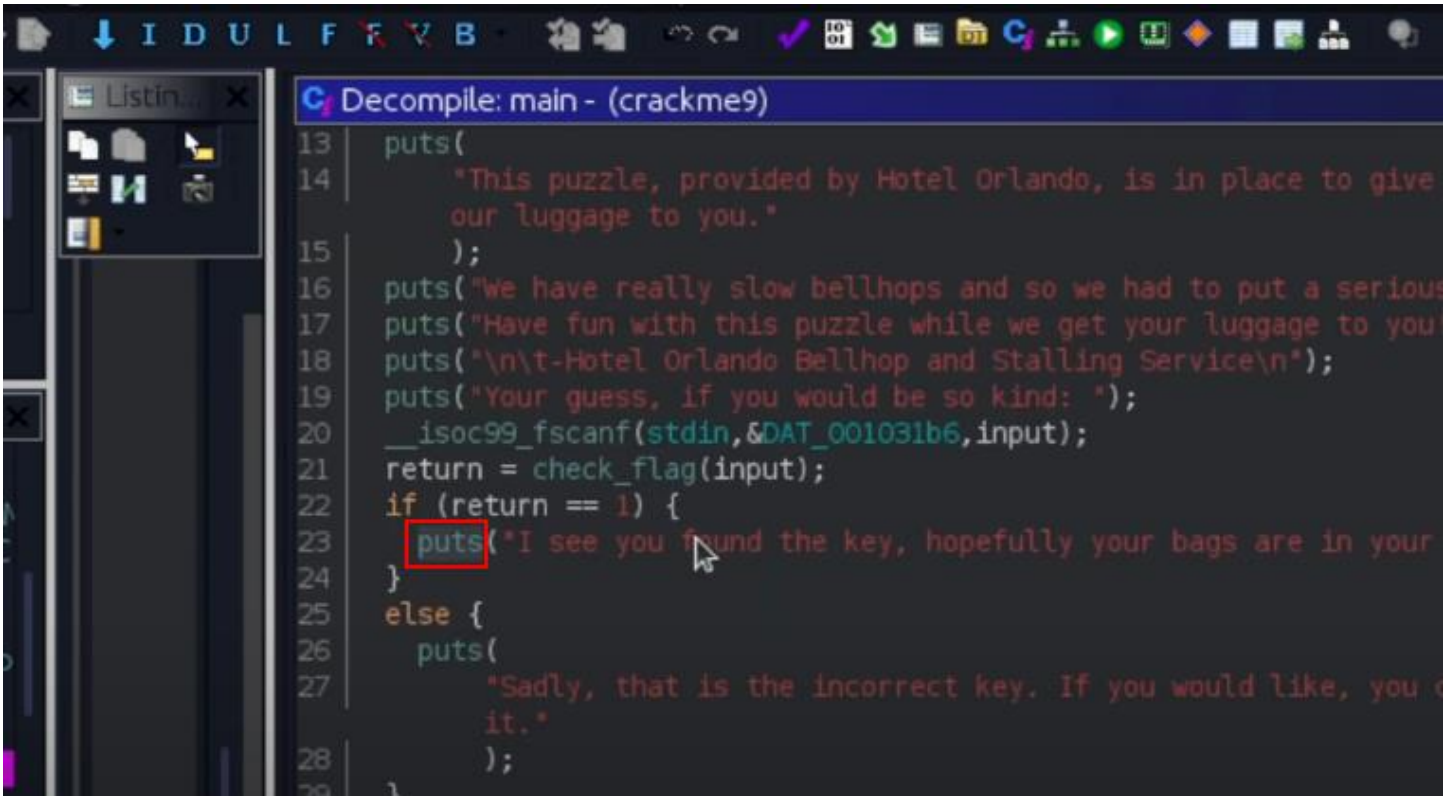
```
8  manager.explore(find=0x004022c1,avoid=0x004022cf)
```

Yha pr explore function pure binary ko explore karega. Har routes pr jayega.

To yha pr **find =** ke andar hum koi string bhi de skte hai. ya address de skte hai. address sahi rhta hai. to is address pr pahuch kr ruk jayega. Analysis krna band kr dega.

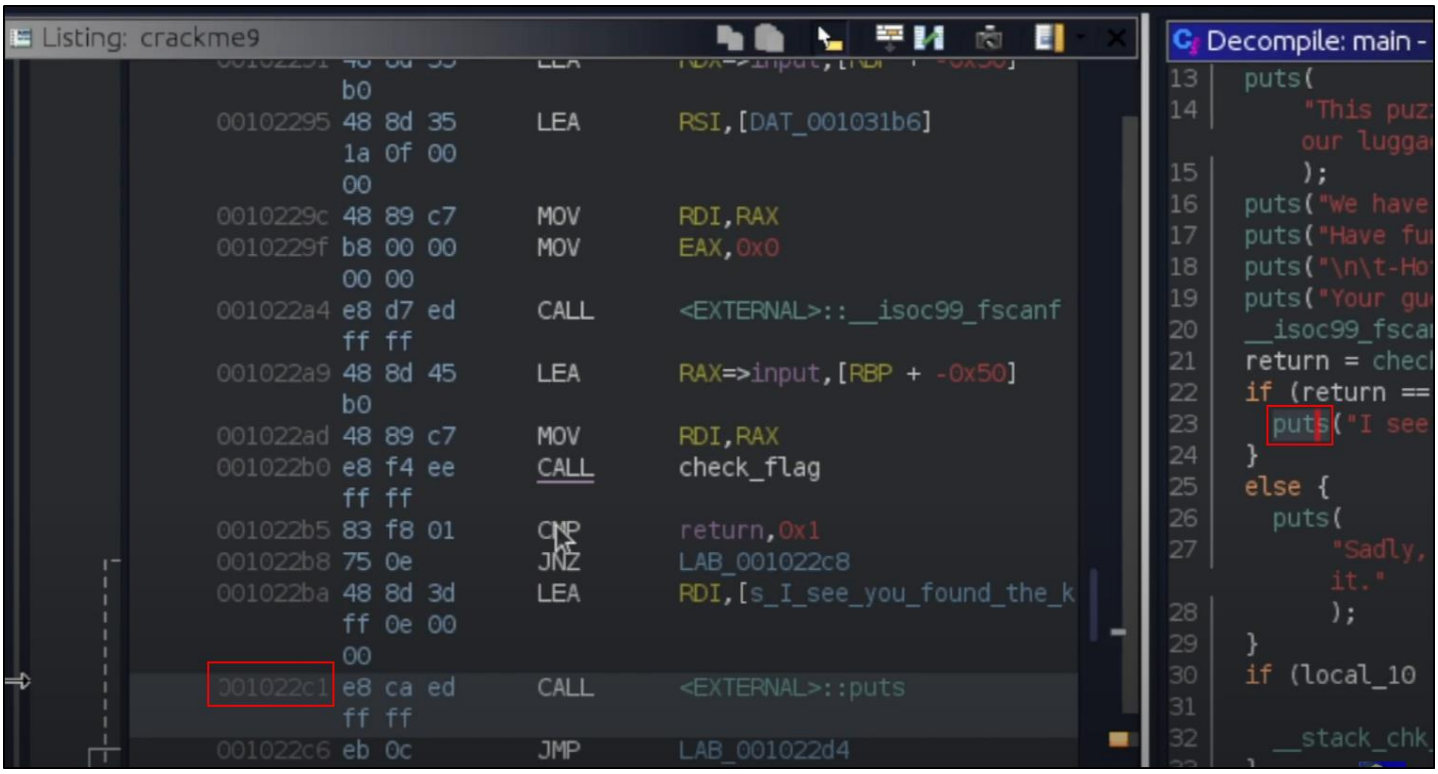
Iske bad kis addres ko avoid krna hai. **avoid=** ke andar use de dete hai.

To hume kis jagah pr jana hai. iske liye hum ghidra me chalte hai.



Yha hume is puts pr jana hai. jahan **"I see you found the key"** likha hai. to hum isi ka address de denge ki tu jaise hi yha pr aaye yhi ruk ja. Aur jo bhi input dala tha print kr de.

To puts pr click karenge. Aur dissassembly me jayenge aur iska address copy kr lenge.

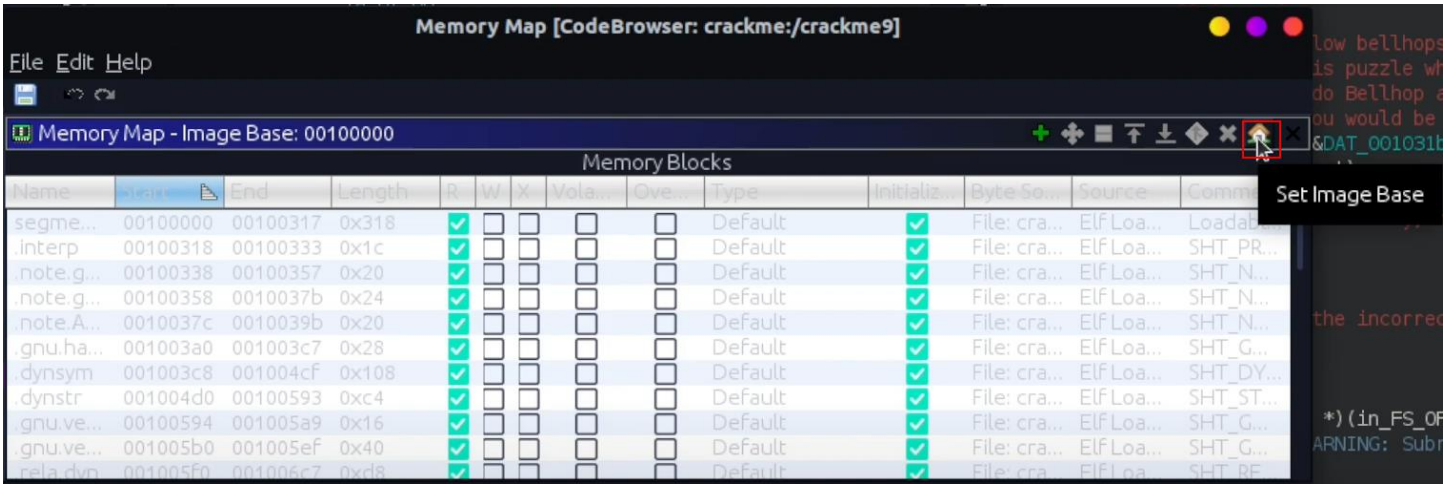


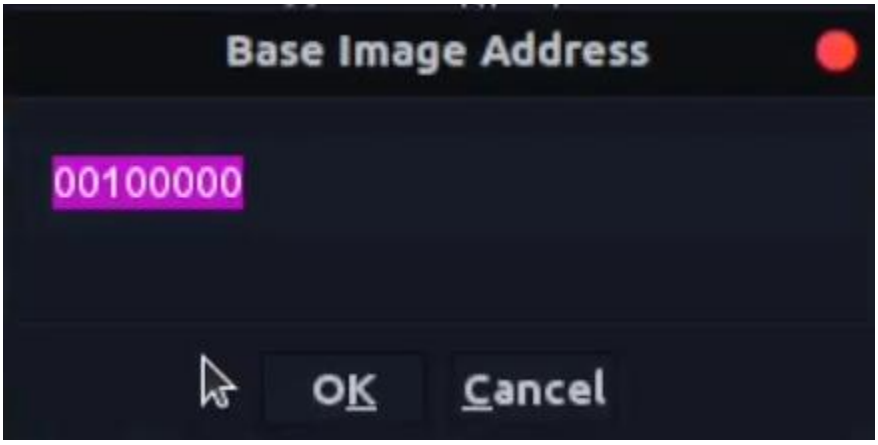
Lekin jaisa ki hum jante hai. binary ka addreass randomise hota rhta hai. yha jb **angar** run hoga to uske **puts** ka address dusra hoga aur **ghidra** ke **puts** ka address dusra kyoki memory address to randomise hoti rhti hai.

To iske liye hum **ghidra** ka **base address** fir se set kr dete hai jo **angr** ka hota hai.

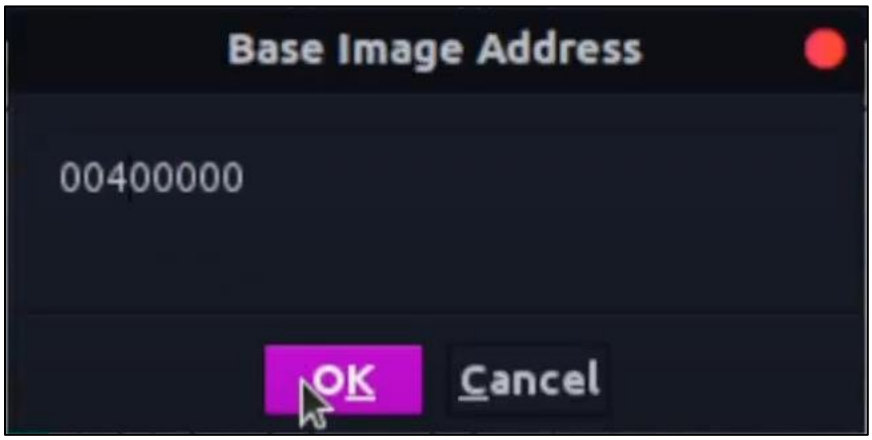
Uske liye ye chip wale icon pr click krte hai.

Uske bad house ka icon aa rha hoga. Set image base.

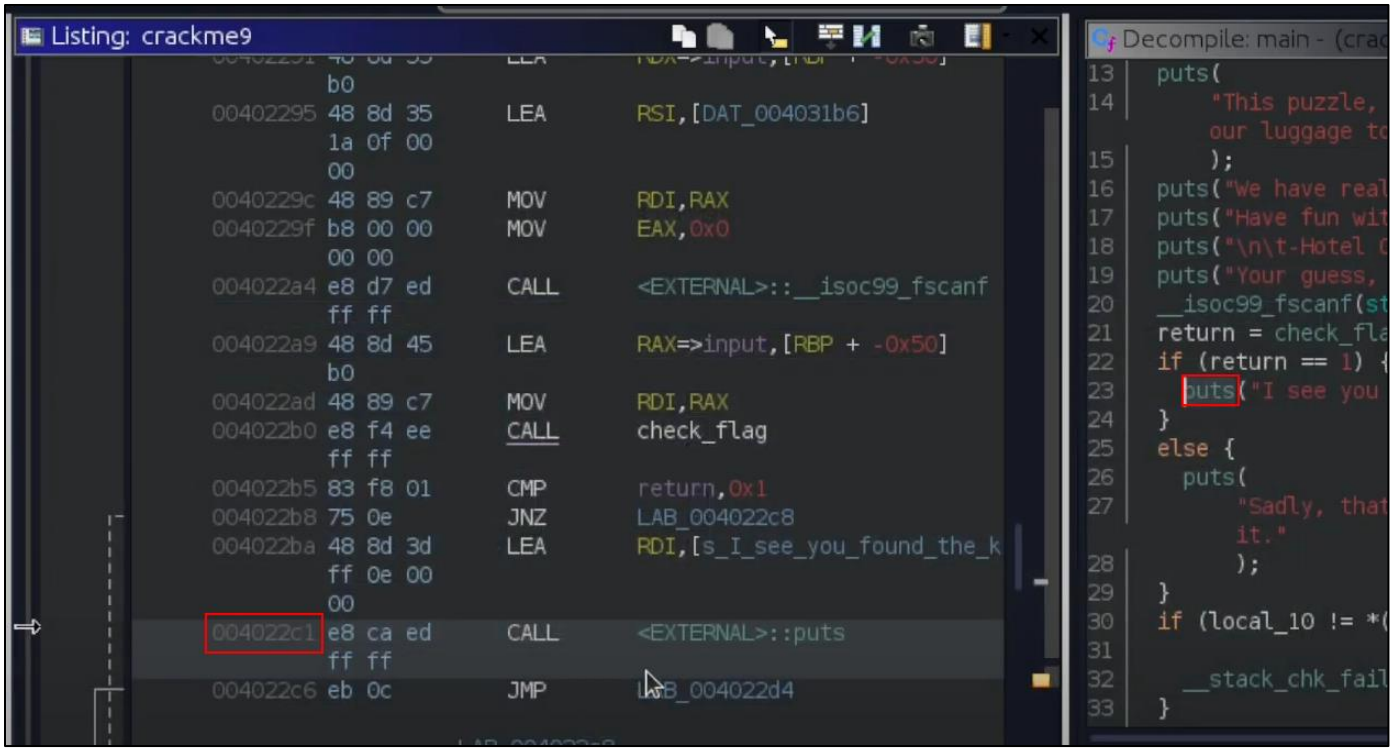




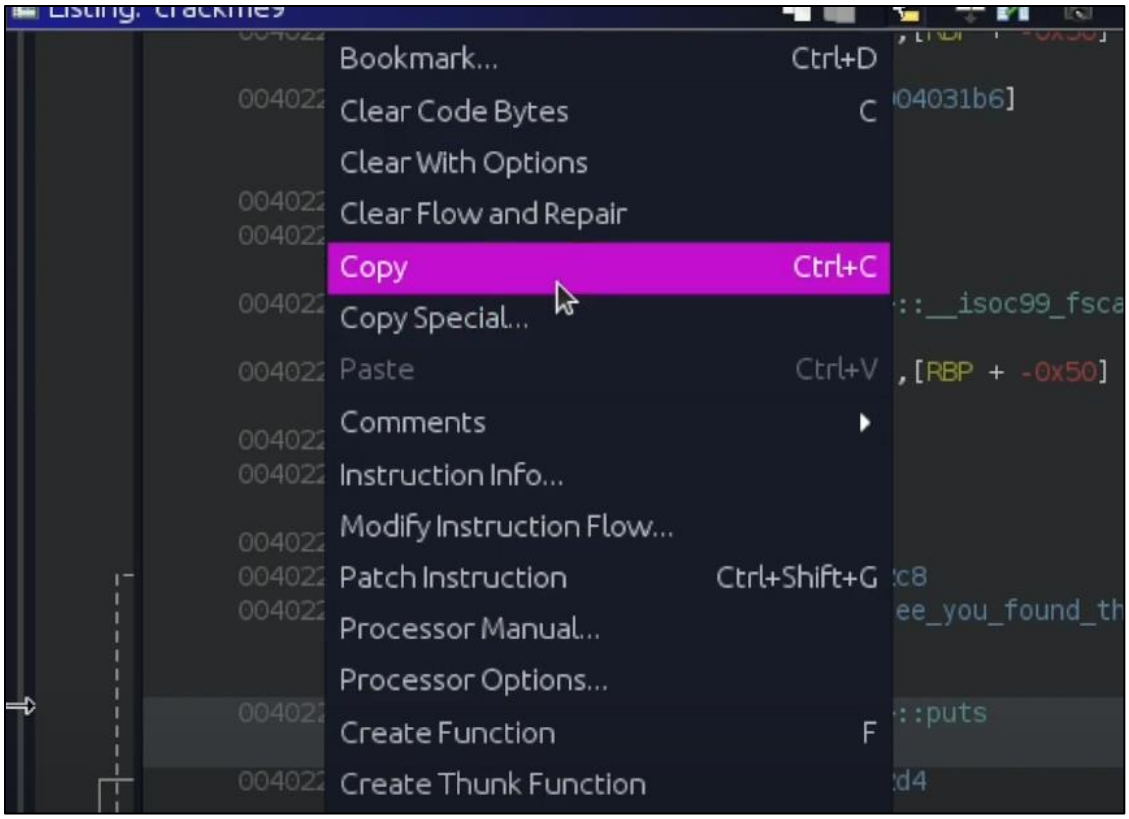
Isko change krke 4 lakh kr dena hai.



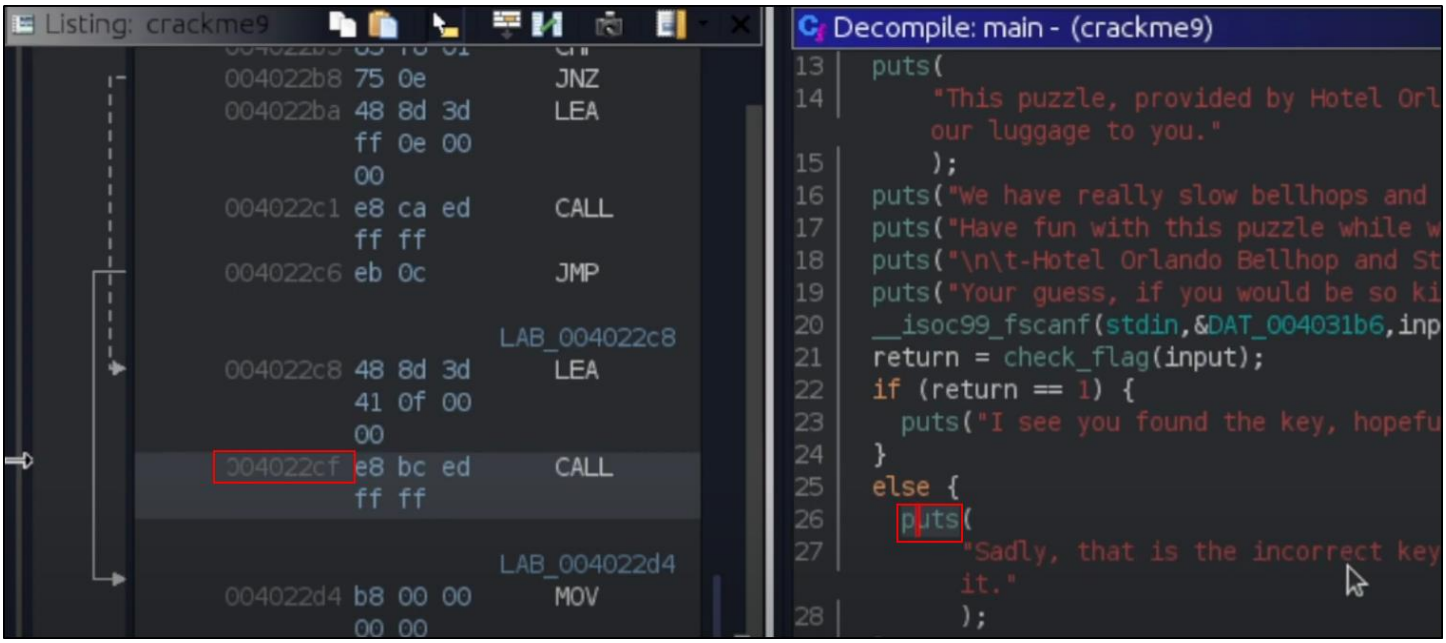
Yha hume 00400000 isliye kiya kyoki **angr** jb bhi run hota hai. to **base address** 00400000 leta hai **by defualt**.

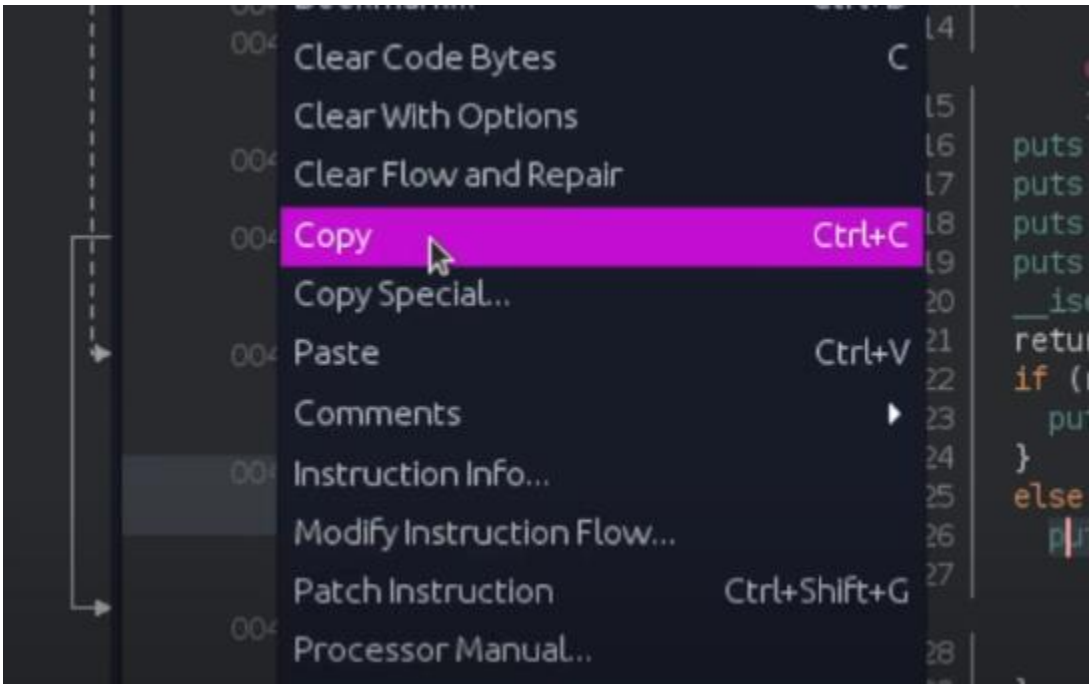


Iske bad puts ka address copy kr lena hai.



Aur avoid wala address bhi copy kr lete hai. jo **incorrect key** ka hai.





Aur avoid wale me paste kr denge.

Ab yha pr hum if-else se check kr lete hai. ki key mila ki nhi. Agar mila to print kr do agar nhi mila to **"not found"** show kr do. Otherwise nhi milega to ye error throw kr dega.

```
if manager.found:
    print(manager.found[0].posix.dumps(0))
else:
    print("Not Found!")
```

Yha ek binary ke bahut sare key ho skte hai. isliye found ki humne index value set kr di **[0]** means first key.

Aur dumps me **(0)** isliye hai. jaisa ki jante hai assmbly me **stdin (standard input)** ki value **0** hoti hai.

crackme9.py

```python
#!/usr/bin/python3

import angr

project = angr.Project('./crackme9')
entry = project.factory.entry_state()
manager = project.factory.simgr(entry)
manager.explore(find=0x004022c1,avoid=0x004022cf)
if manager.found:
    print(manager.found[0].posix.dumps(0))
else:
    print("Not Found!")
```

Ab hum is program ko run krte hai.

```
→ rev chmod +x crackme9.py
→ rev ./crackme9.py
WARNING | 2021-09-26 02:27:48,887 | cle.loader | The main binary is a position-independent executable. It i
 base address of 0x400000.
WARNING | 2021-09-26 02:27:52,098 | angr.storage.memory_mixins.default_filler_mixin | The program is access
rs with an unspecified value. This could indicate unwanted behavior.
WARNING | 2021-09-26 02:27:52,098 | angr.storage.memory_mixins.default_filler_mixin | angr will cope with t
unconstrained symbolic variable and continuing. You can resolve this by:
WARNING | 2021-09-26 02:27:52,098 | angr.storage.memory_mixins.default_filler_mixin | 1) setting a value to
WARNING | 2021-09-26 02:27:52,098 | angr.storage.memory_mixins.default_filler_mixin | 2) adding the state o
STRAINED_{MEMORY,REGISTERS}, to make unknown regions hold null
WARNING | 2021-09-26 02:27:52,098 | angr.storage.memory_mixins.default_filler_mixin | 3) adding the state o
ONSTRAINED_{MEMORY,REGISTERS}, to suppress these messages.
WARNING | 2021-09-26 02:27:52,098 | angr.storage.memory_mixins.default_filler_mixin | Filling memory at 0x7
 unconstrained bytes referenced from 0x5a27b0 (strlen+0x0 in libc.so.6 (0xa27b0))
b'sun{b3llh0p5-runn1n6-qu1ckly}\x00\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9\xd9
xd9\xd9\xd9\xd9\xd9\xd9\xd9'
→ rev
```

Let’s check the flag correct or not.

```
➜ rev ./crackme9
Hotel Orlando Door Puzzle v1
----------------------------
This puzzle, provided by Hotel Orlando, is in place to give the bellhops enough time to get your
We have really slow bellhops and so we had to put a serious _time sink_ in front of you.
Have fun with this puzzle while we get your luggage to you!

        -Hotel Orlando Bellhop and Stalling Service

Your guess, if you would be so kind:
sun{b3llh0p5-runn1n6-qu1ckly}
I see you found the key, hopefully your bags are in your room by this point.
➜ rev
```

References:

https://www.tutorialspoint.com/assembly_programming/index.htm

https://asmtutor.com/#lesson1

https://www.nasm.us/

https://github.com/NationalSecurityAgency/ghidra/releases

https://zydis.re/

https://github.com/mschwartz/assembly-tutorial?tab=readme-ov-file#linux-syscalls

https://github.com/mytechnotalent/Reverse-Engineering