impossible_password

analysis

We are instructed to retrieve the flag?

After downloading the file we first use the file command to see what type of file we are messing with

~/Desktop/HTB/file
impossible_password.bin
impossible_password.bin: ELF 64-bit LSB executable, x86-64, version 1 (SYSV), dynamically linked, interpreter /lib64/ld-linux-x86-64.so.2, for GNU/Linux 2.6.32, BuildID[sha1]=ba116ba1912a8c3779ddeb579404e2fdf34b1568, stripped

We know that its a 64-bit Linux ELF and it's stripped.
That means that it does not contain any debug information.

Next we use string to list the contents of the file.
we do this becuase often flags are hidden as strings in a .bin but are hard to interpret.
We also do this to see if we can find any other clues that will lead us to the flag.

libc.so.6
exit
srand
__isoc99_scanf
time
putchar
printf
malloc
strcmp
__libc_start_main
__gmon_start__
GLIBC_2.7

GLIBC_2.2.5
UH-x
UH-x
=1
[]A\A]A^A_
SuperSeKretKey
%20s
[%s]
;*3$"
GCC: (GNU) 4.8.5 20150623 (Red Hat 4.8.5-11)
.shstrtab
.interp
.note.ABI-tag
.note.gnu.build-id
.gnu.hash
.dynsym
.dynstr
.gnu.version
.gnu.version_r
.rela.dyn
.rela.plt
.init
.text
.fini
.rodata
.eh_frame_hdr
.eh_frame
.init_array
.fini_array
.jcr
.dynamic
.got
.got.plt
.data
.bss
.comment

and it appears that we found a clue **SuperSeKretKey**
this is obviously not the flag but its a start.
---

running the file

Next we run the binary file to see what happens

./
impossible_password.bin
* blah
[blah]

We see are prompted to enter a password but luckily we have the SuperSeKretKey.

./
impossible_password.bin
* SuperSeKretKey
[SuperSeKretKey]
**

It appears that after we enter the SuperSeKretKey it prompts us again for another password.
So meaning we are dealing with multilevel password protection.
Now that we found the first password we need to find the second.

It accepts that string and print that in a new line closed by brackets, also it printed a new line with ** and asking for input.
Inputting anything doesn't output anything

Using **ltrace**, a diagnostic tool, debugging, instructional user space, utility for linux

```
__libc_start_main(0x40085d, 1, 0x7ffee85f6218, 0x4009e0 <unfinished ...>
printf("* ")                                            = 2
__isoc99_scanf(0x400a82, 0x7ffee85f6100, 0, 0* SuperSeKretKey
)         = 1
printf("[%s]\n", "SuperSeKretKey"[SuperSeKretKey]
)                     = 17
strcmp("SuperSeKretKey", "SuperSeKretKey")              = 0
printf("** ")                                          = 3
__isoc99_scanf(0x400a82, 0x7ffee85f6100, 0, 0** givemeflag
)         = 1
time(0)                                                 = 1605491924
srand(0x7b62e7a1, 10, 0x79e54090, 0)                    = 0
malloc(21)                                              = 0xf0bac0
rand(0xf0bac0, 21, 33, 0xf0bad0)                        = 0x20a1dd80
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bac0, 94)      = 0x2cf0ac66
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bac1, 94)      = 0x745157a5
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bac2, 94)      = 0x7f76c58d
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bac3, 94)      = 0x60686316
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bac4, 94)      = 0x2accd466
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bac5, 94)      = 0x20759beb
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bac6, 94)      = 0x6a707127
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bac7, 94)      = 0x44caa3e6
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bac8, 94)      = 0x48316a03
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bac9, 94)      = 0x77c381b4
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0baca, 94)      = 0x65bc3115
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bacb, 94)      = 0x47a3304e
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bacc, 94)      = 0x3b97af1e
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bacd, 94)      = 0x3a497bd5
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bace, 94)      = 0x3dc27782
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bacf, 94)      = 0x10b4e92c
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bad0, 94)      = 0x42651256
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bad1, 94)      = 0x5aba2fb
rand(0x7ffb46c31740, 0x7ffee85f6064, 0xf0bad2, 94)      = 0x706e6d9e
strcmp("givemeflag", "gG`>mGdrO\\+n;)Lwoad}")           = 34
+++ exited (status 34) +++
```

We see that __isoc99_scanf is being used to read input.
Since After enter the SuperSeKretKey at the first prompt we see it again on the second
prompt. printf("[%s]\n", "SuperSeKretKey"[SuperSeKretKey]
We also see it comparing SuperSeKretKey for the right password.
After we enter the 2nd password we see calls time() and rand() to generate random data.
And we see our second input being compared.

strcmp("givemeflag", "gG`>mGdrO\\+n;)Lwoad}")

Here our input is being compared to another string “givemeflag” and "gG`>mGdrO\\+n;)Lwoad}"
If this is what our input is being compared to the this must be password right?
Sadly no, this is the wrong password after rerunning ltrace we get error.
After analyzing the output once more we get the following:

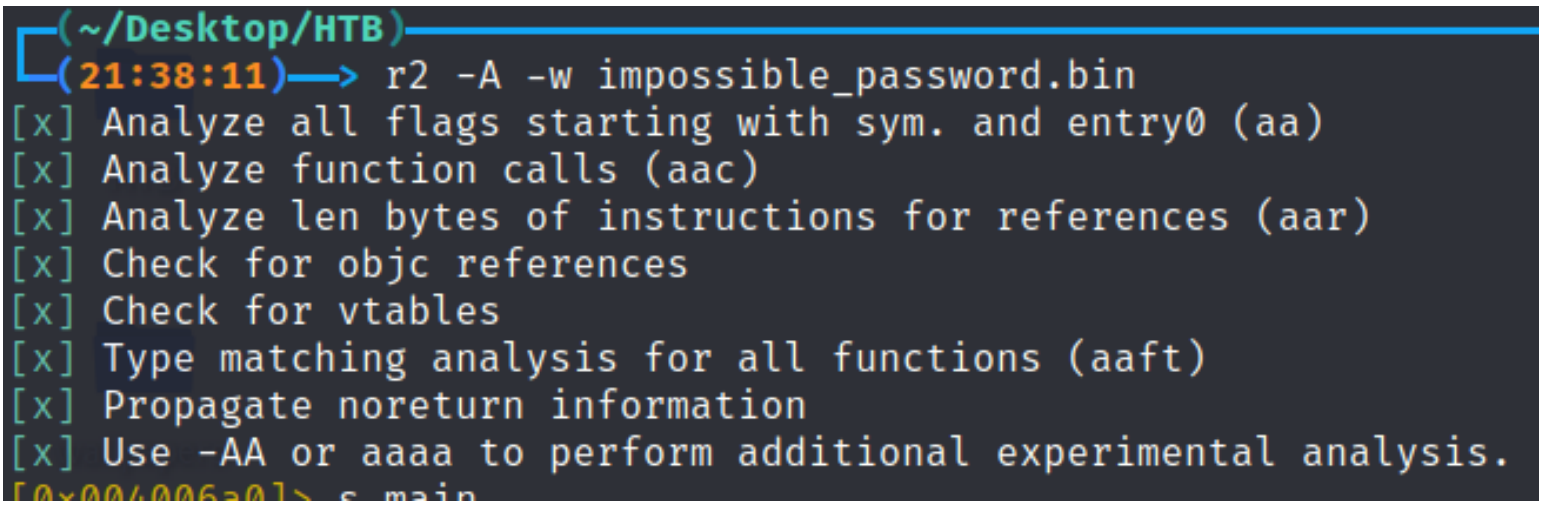
strcmp(">mGdrO\\\\+n;)Lwoad}", "8iS<wr(-;Ib}(O^S]-TW")'

This means that our pasword is dynamic but it changes on runtime.
Well this explains the time() and rand() calls we saw.
To summerize the password is gernerated on runtime using the timestamp and random data.

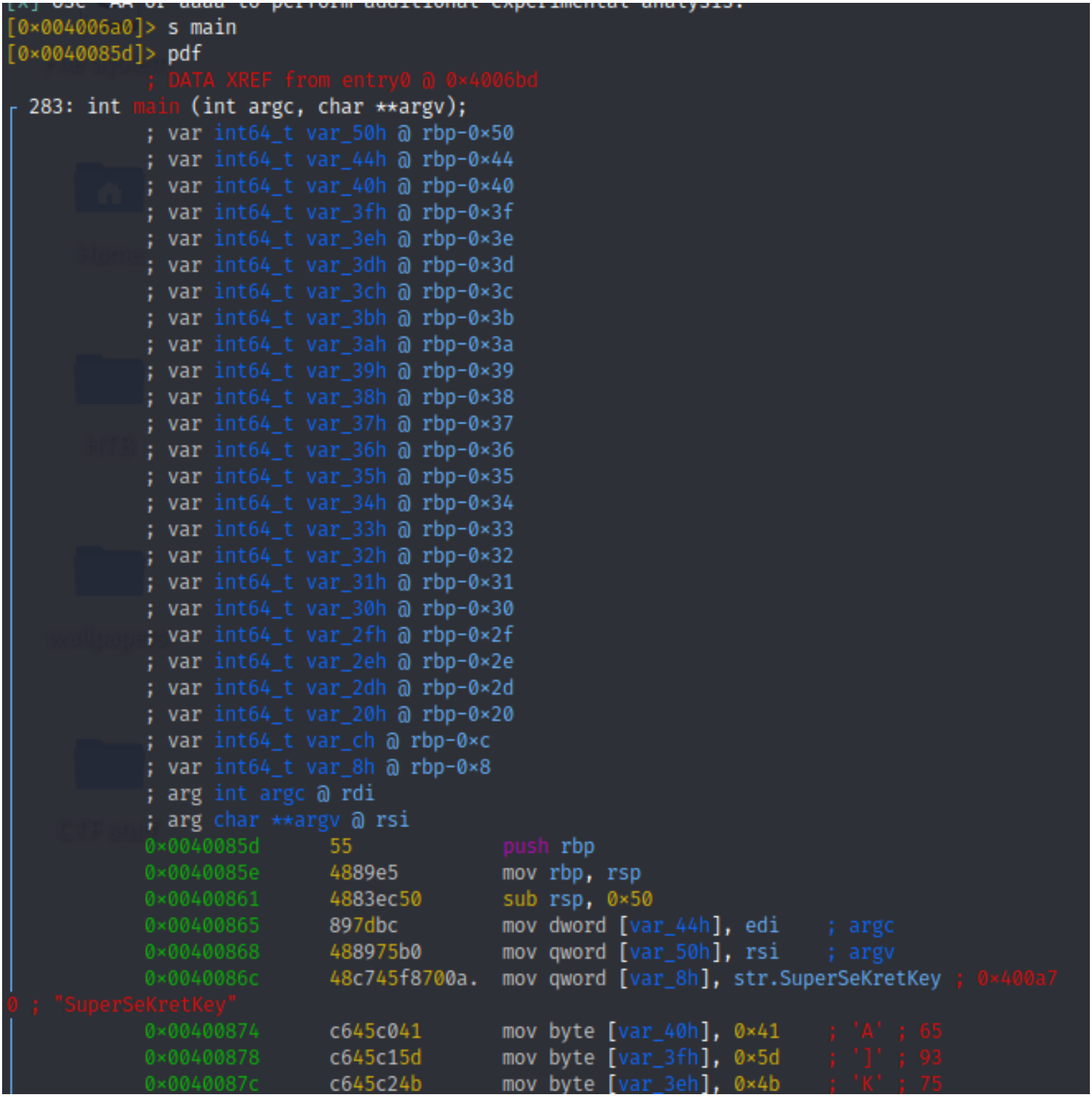
disassembly

Next is some reverse enginnering.
I am going to be using radare2 but there are alot of other options for this.

First lets open the file in Analysis and write mode using
r2 -A -w impossible_password.bin



Next we open the main function



While looking at the main function we notice those input statements that we saw in the ltrace.

```
        mov qword [var_50h], rsi    ; argv
700a.   mov qword [var_8h], str.SuperSeKretKey ; 0x400a70 ; "SuperSeKretKey"
        mov byte [var_40h], 0x41    ; 'A' ; 65
        mov byte [var_3fh], 0x5d    ; ']' ; 93
        mov byte [var_3eh], 0x4b    ; 'K' ; 75
        mov byte [var_3dh], 0x72    ; 'r' ; 114
        mov byte [var_3ch], 0x3d    ; '=' ; 61
        mov byte [var_3bh], 0x39    ; '9' ; 57
        mov byte [var_3ah], 0x6b    ; 'k' ; 107
        mov byte [var_39h], 0x30    ; '0' ; 48
        mov byte [var_38h], 0x3d    ; '=' ; 61
        mov byte [var_37h], 0x30    ; '0' ; 48
        mov byte [var_36h], 0x6f    ; 'o' ; 111
        mov byte [var_35h], 0x30    ; '0' ; 48
        mov byte [var_34h], 0x3b    ; ';' ; 59
        mov byte [var_33h], 0x6b    ; 'k' ; 107
        mov byte [var_32h], 0x31    ; '1' ; 49
        mov byte [var_31h], 0x3f    ; '?' ; 63
        mov byte [var_30h], 0x6b    ; 'k' ; 107
        mov byte [var_2fh], 0x38    ; '8' ; 56
        mov byte [var_2eh], 0x31    ; '1' ; 49
        mov byte [var_2dh], 0x74    ; 't' ; 116
000     mov edi, 0x400a7f           ; const char *format
000     mov eax, 0
ff      call sym.imp.printf         ; int printf(const char *format)
        lea rax, qword [var_20h]
        mov rsi, rax
000     mov edi, str.20s            ; 0x400a82 ; "%20s" ; const char *format
000     mov eax, 0
ff      call sym.imp.__isoc99_scanf ; int scanf(const char *format)
        lea rax, qword [var_20h]
        mov rsi, rax
000     mov edi, str.s              ; 0x400a87 ; "[%s]\n" ; const char *format
000     mov eax, 0
ff      call sym.imp.printf         ; int printf(const char *format)
        mov rdx, qword [var_8h]
        lea rax, qword [var_20h]
        mov rsi, rdx                ; const char *s2
        mov rdi, rax                ; const char *s1
ff      call sym.imp.strcmp         ; int strcmp(const char *s1, const char *s2)
        mov dword [var_ch], eax
        cmp dword [var_ch], 0
        je 0x400925
```

After first strcmp() call, it’s comparing our input with that string.

```
0x00400907      4889d6          mov rsi, rdx                ; const char *s2
0x0040090a      4889c7          mov rdi, rax                ; const char *s1
0x0040090d      e81efdffff      call sym.imp.strcmp         ; int strcmp(const char *s1, const char *s2)
0x00400912      8945f4          mov dword [var_ch], eax
0x00400915      837df400        cmp dword [var_ch], 0
0x00400919      740a            je 0x400925
0x0040091b      bf01000000      mov edi, 1                  ; int status
0x00400920      e85bfdffff      call sym.imp.exit           ; void exit(int status)
; CODE XREF from main @ 0x400919
0x00400925      bf8d0a4000      mov edi, 0x400a8d           ; const char *format
0x0040092a      b800000000      mov eax, 0
0x0040092f      e8ccfcffff      call sym.imp.printf         ; int printf(const char *format)
0x00400934      488d45e0        lea rax, [var_20h]
```

We see a void exit statement which is thrown when the wrong input is detected which stops the program.
Otherwise it will continue to the next function.

```
0x00400934      488d45e0        lea rax, qword [var_20h]
0x00400938      4889c6          mov rsi, rax
0x0040093b      bf820a4000      mov edi, str.20s            ; 0x400a82 ; "%20s" ; const char *format
0x00400940      b800000000      mov eax, 0
0x00400945      e826fdffff      call sym.imp.__isoc99_scanf ; int scanf(const char *format)
0x0040094a      bf14000000      mov edi, 0x14               ; 20 ; size_t arg1
0x0040094f      e839feffff      call fcn.0040078d
0x00400954      4889c2          mov rdx, rax
0x00400957      488d45e0        lea rax, qword [var_20h]
0x0040095b      4889d6          mov rsi, rdx                ; const char *s2
0x0040095e      4889c7          mov rdi, rax                ; const char *s1
```

We see a interesting function call fcn.0040078d when we seek to this function.
It seems to be related to the malloc, srand, and time function.

```
0x00400795      897ddc          mov dword [var_24h], edi    ; arg1
0x00400798      48c745f00000.   mov qword [var_10h], 0
0x004007a0      c745ec7e0000.   mov dword [var_14h], 0x7e   ; '~' ; 126
0x004007a7      c745e8210000.   mov dword [var_18h], 0x21   ; '!' ; 33
0x004007ae      bf00000000      mov edi, 0                  ; time_t *timer
0x004007b3      e898feffff      call sym.imp.time           ; time_t time(time_t *timer)
0x004007b8      89c2            mov edx, eax
0x004007ba      8b45dc          mov eax, dword [var_24h]
0x004007bd      0fafd0          imul edx, eax
0x004007c0      8b05ae082000    mov eax, dword [0x00601074] ; [0x601074:4]=0x17da710
0x004007c6      83c001          add eax, 1
0x004007c9      8905a5082000    mov dword [0x00601074], eax ; [0x601074:4]=0x17da710
0x004007cf      8b059f082000    mov eax, dword [0x00601074] ; [0x601074:4]=0x17da710
0x004007d5      01d0            add eax, edx
0x004007d7      89c7            mov edi, eax                ; int seed
0x004007d9      e842feffff      call sym.imp.srand          ; void srand(int seed)
0x004007de      8b45dc          mov eax, dword [var_24h]
0x004007e1      83c001          add eax, 1
0x004007e4      4898            cdqe
0x004007e6      4889c7          mov rdi, rax                ; size_t size
0x004007e9      e872feffff      call sym.imp.malloc         ;  void *malloc(size_t size)
0x004007ee      488945f0        mov qword [var_10h], rax
0x004007f2      48837df000      cmp qword [var_10h], 0
0x004007f7      7458            je 0x400851
0x004007f9      c745fc000000.   mov dword [var_4h], 0
0x00400800      eb31            jmp 0x400833
; CODE XREF from fcn.0040078d @ 0x400839
0x00400802      e889feffff      call sym.imp.rand           ; int rand(void)
0x00400807      8b55ec          mov edx, dword [var_14h]
0x0040080a      83c201          add edx, 1
0x0040080d      89d1            mov ecx, edx
```

It appears the this function is our random data is generated.
Due to the amount of rands being called.
Lets go back the main and see what we can do with this new information.

```
0x0040095b      4889d6          mov rsi, rdx                ; const char *s2
0x0040095e      4889c7          mov rdi, rax                ; const char *s1
0x00400961      e8cafcffff      call sym.imp.strcmp         ; int strcmp(const char *s1, const char *s2)
0x00400966      85c0            test eax, eax
0x00400968      750c            jne 0x400976
0x0040096a      488d45c0        lea rax, qword [var_40h]
0x0040096e      4889c7          mov rdi, rax                ; int64_t arg1
0x00400971      e802000000      call fcn.00400978
; CODE XREF from main @ 0x400968
0x00400976      c9              leave
0x00400977      c3              ret
0085d]>
```

On main, it’s the second strcmp call we’ve seen using ltrace.
It will set it’s return value to eax register.

```
0×0040095b      4889d6          mov rsi, rdx                ; const char *s2
0×0040095e      4889c7          mov rdi, rax                ; const char *s1
0×00400961      e8cafcffff      call sym.imp.strcmp         ; int strcmp(const char *s1, const char *s2)
0×00400966      85c0            test eax, eax
0×00400968      750c            jne 0×400976
0×0040096a      488d45c0        lea rax, qword [var_40h]
0×0040096e      4889c7          mov rdi, rax                ; int64_t arg1
0×00400971      e802000000      call fcn.00400978
; CODE XREF from main @ 0×400968
0×00400976      c9              leave
```

The next instruction is test, it performs a bitwise AND operation on two operands. This will set ZF(Zero_Flag) to 1 if eax is < 0.

```
0×00400961      e8cafcffff      call sym.imp.strcmp         ; int strcmp(const char *s1, const char *s2)
0×00400966      85c0            test eax, eax
0×00400968      750c            jne 0×400976
0×0040096a      488d45c0        lea rax, qword [var_40h]
0×0040096e      4889c7          mov rdi, rax                ; int64_t arg1
0×00400971      e802000000      call fcn.00400978
; CODE XREF from main @ 0×400968
0×00400976      c9              leave
0×00400977      c3              ret
[0×0040085d]>
```

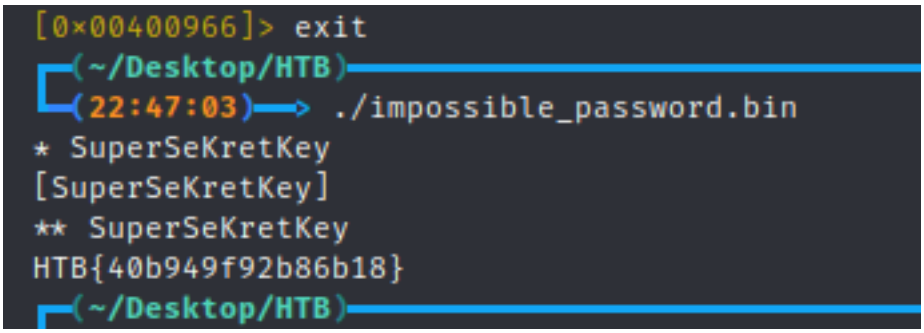
In next instruction jne 0x400976 means, if ZF is not 1 jump to instruction 0x400976. Meaning if the input is incorrect then it will not call fcn.00400978().
Lets seek to instruction pointer 0x00400966 and patch it.

```
0×00400977      c3              ret
[0×0040085d]> s 0×00400966
[0×00400966]> wa jmp 0×0040096a
Written 2 byte(s) (jmp 0×0040096a) = wx eb02
[0×00400966]> pdf
            ; DATA XREF from entry0 @ 0×4006bd
```

We write jmp 0x00400966 to make a jump on that instruction as if our password matched

```
0×00400961      e8cafcffff      call sym.imp.strcmp         ; int strcmp(const char *s1, const char *s2)
0×00400966      eb02            jmp 0×40096a
0×00400968      750c            jne 0×400976
0×0040096a      488d45c0        lea rax, qword [var_40h]
0×0040096e      4889c7          mov rdi, rax                ; int64_t arg1
0×00400971      e802000000      call fcn.00400978
; CODE XREF from main @ 0×400968
0×00400976      c9              leave
0×00400977      c3              ret
[0×00400966]>
```

Finally we run it binary file entering the SuperSeKretKey for both inputs.



And we recieve our flag!