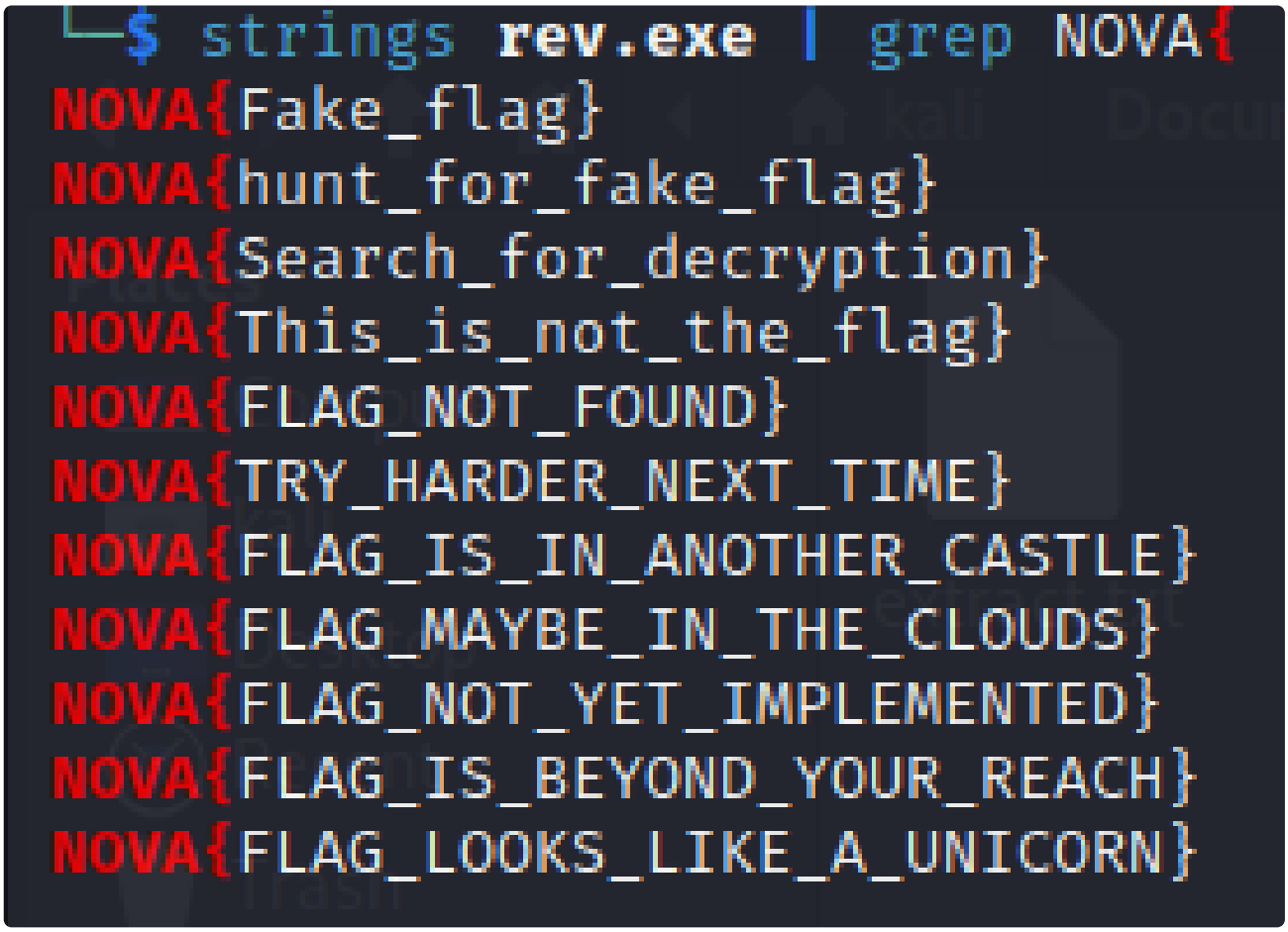
The cipher used remains a mystery, requiring your keen reverse engineering skills. Only those who delve deep, find decryption cunningly, and think beyond the conventional can unravel the secrets within. Approach with curiosity, analyze meticulously, and piece together the puzzle.Are you up for the challenge? Dive in, crack the code, and claim your victory!

Analysing the File:

```
┌──(kali㉿kali)-[~/Documents]
└─$ file rev.exe
rev.exe: PE32+ executable (console) x86-64, for MS Windows, 15 sections
```

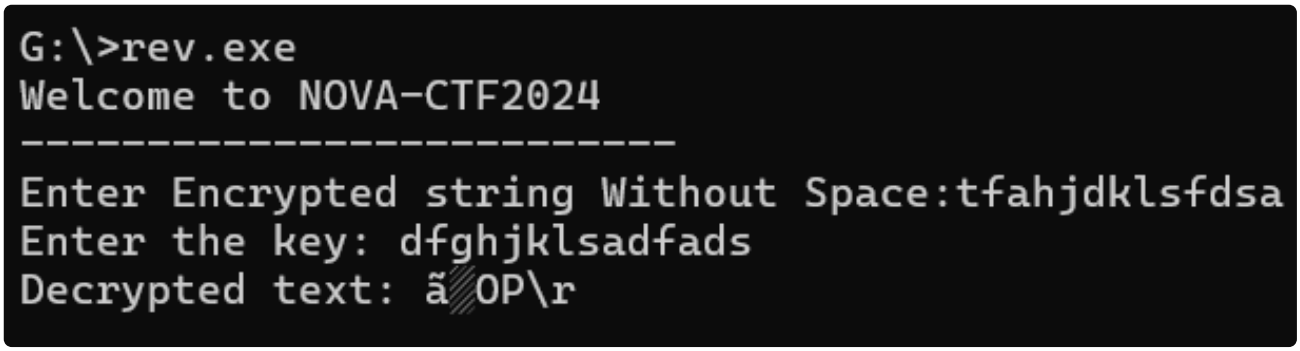
PE32+ is the Portable Executable 64-bit format. PE files are the standard file format for executables, object code, and Dynamic Link Libraries (DLLs) in Windows operating systems.

Strings:



It seems everything is fake flags.
To gather some context, run this in Windows. You're prompted to enter

Enter Encrypted string Without Space and Key. By entering the random string and key we will get the Decrypted text.



As this is a reversing challenge static analysis would be helpful. By using the decryption process We need to find the cipher and look for the encrypted string and key to get the flag.

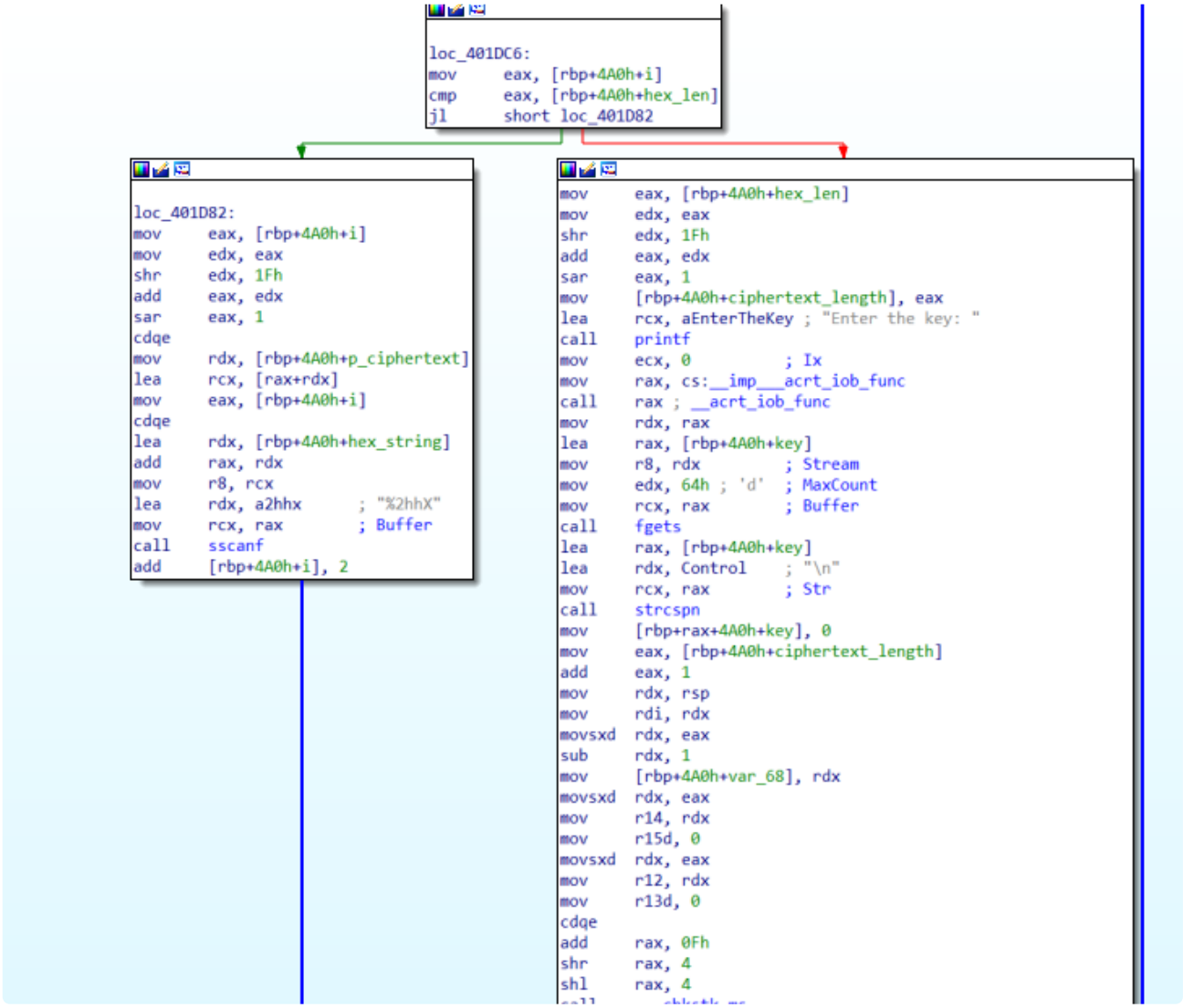
The decryption algorithm used in this challenge is a variant of the RC4 stream cipher. It takes the ciphertext and key as inputs and returns the decrypted plaintext. The algorithm initializes an array `S` with values from 0 to 255, shuffles the values based on the key, and then uses the shuffled array to decrypt the ciphertext.

After opening in IDA

Looking into Main Function

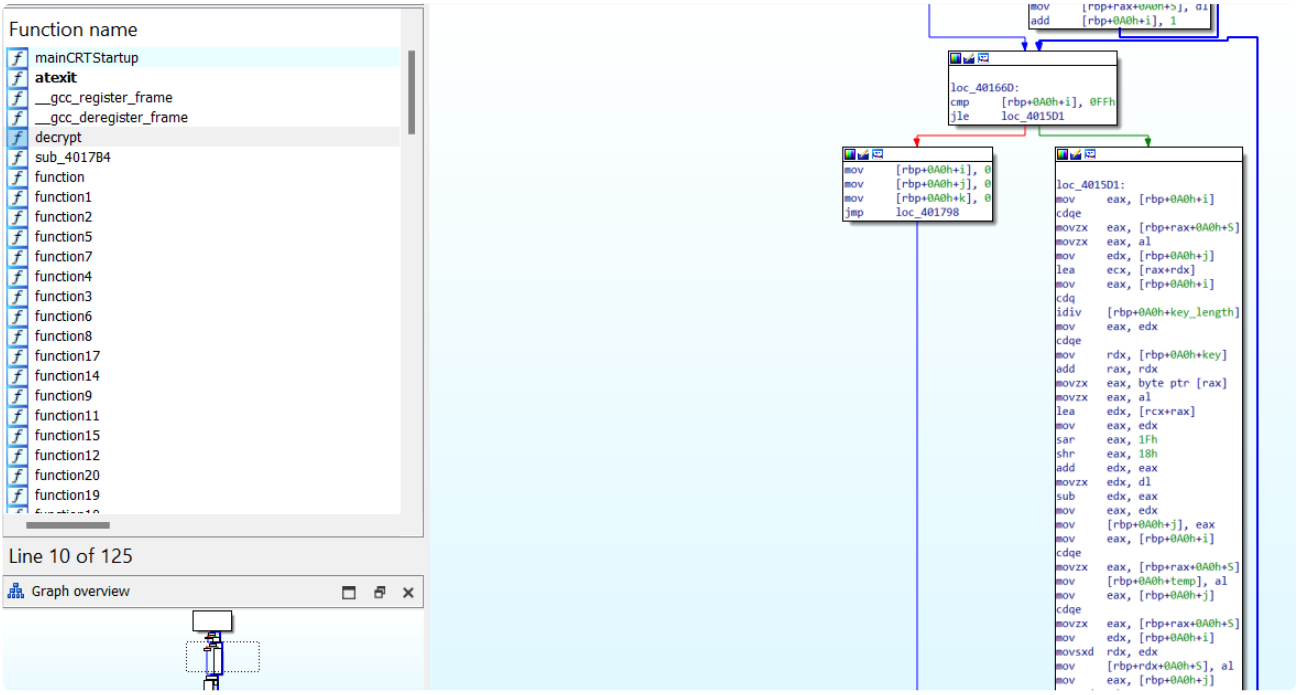
Structures | Enums | Imports

```
call    puts
lea     rcx, asc_405148 ; "-------------------------"
call    puts
lea     rcx, Format     ; "Enter Encrypted string Without Space:"
call    printf
mov     ecx, 0          ; Ix
mov     rax, cs:__imp___acrt_iob_func
call    rax ; __acrt_iob_func
mov     rdx, rax
lea     rax, [rbp+4A0h+hex_string]
mov     r8, rdx         ; Stream
mov     edx, 3E8h       ; MaxCount
mov     rcx, rax        ; Buffer
call    fgets
lea     rax, [rbp+4A0h+hex_string]
lea     rdx, Control    ; "\n"
mov     rcx, rax        ; Str
call    strcspn
mov     [rbp+rax+4A0h+hex_string], 0
lea     rax, [rbp+4A0h+hex_string]
mov     rcx, rax        ; Str
call    strlen
mov     [rbp+4A0h+hex_len], eax
mov     eax, [rbp+4A0h+hex_len]
mov     edx, eax
shr     edx, 1Fh
add     eax, edx
sar     eax, 1
movsxd  rdx, eax
sub     rdx, 1
mov     [rbp+4A0h+var_50], rdx
movsxd  rdx, eax
mov     [rbp+4A0h+var_4E0], rdx
mov     [rbp+4A0h+var_4D8], 0
movsxd  rdx, eax
mov     [rbp+4A0h+var_4F0], rdx
mov     [rbp+4A0h+var_4E8], 0
cdqe
add     rax, 0Fh
shr     rax, 4
shl     rax, 4
call    ___chkstk_ms
sub     rsp, rax
lea     rax, [rsp+520h+var_4F0]
add     rax, 0
mov     [rbp+4A0h+p_ciphertext], rax
mov     [rbp+4A0h+i], 0
jmp     short loc_401DC6
```


loc_401DC6:
mov eax, [rbp+4A0h+i]
cmp eax, [rbp+4A0h+hex_len]
jl short loc_401D82
loc_401D82:
mov eax, [rbp+4A0h+i]
mov edx, eax
shr edx, 1Fh
add eax, edx
sar eax, 1
cdqe
mov rdx, [rbp+4A0h+p_ciphertext]
lea rcx, [rax+rdx]
mov eax, [rbp+4A0h+i]
cdqe
lea rdx, [rbp+4A0h+hex_string]
add rax, rdx
mov r8, rcx
lea rdx, a2hhx ; "%2hhX"
mov rcx, rax ; Buffer
call sscanf
add [rbp+4A0h+i], 2
mov eax, [rbp+4A0h+hex_len]
mov edx, eax
shr edx, 1Fh
add eax, edx
sar eax, 1
mov [rbp+4A0h+ciphertext_length], eax
lea rcx, aEnterTheKey ; "Enter the key: "
call printf
mov ecx, 0 ; Ix
mov rax, cs:__imp___acrt_iob_func
call rax ; __acrt_iob_func
mov rdx, rax
lea rax, [rbp+4A0h+key]
mov r8, rdx ; Stream
mov edx, 64h ; 'd' ; MaxCount
mov rcx, rax ; Buffer
call fgets
lea rax, [rbp+4A0h+key]
lea rdx, Control ; "\n"
mov rcx, rax ; Str
call strcspn
mov [rbp+rax+4A0h+key], 0
mov eax, [rbp+4A0h+ciphertext_length]
add eax, 1
mov rdx, rsp
mov rdi, rdx
movsxd rdx, eax
sub rdx, 1
mov [rbp+4A0h+var_68], rdx
movsxd rdx, eax
mov r14, rdx
mov r15d, 0
movsxd rdx, eax
mov r12, rdx
mov r13d, 0
cdqe
add rax, 0Fh
shr rax, 4
shl rax, 4

```
movsxd  rdx, eax
mov     r12, rdx
mov     r13d, 0
cdqe
add     rax, 0Fh
shr     rax, 4
shl     rax, 4
call    ___chkstk_ms
sub     rsp, rax
lea     rax, [rsp+520h+var_4F0]
add     rax, 0
mov     [rbp+4A0h+p_decrypted_string], rax
mov     rbx, [rbp+4A0h+p_decrypted_string]
lea     rax, [rbp+4A0h+key]
mov     rcx, rax        ; Str
call    strlen
mov     r8d, eax
mov     rax, [rbp+4A0h+p_ciphertext]
lea     rcx, [rbp+4A0h+key]
mov     edx, [rbp+4A0h+ciphertext_length] ; ciphertext_length
mov     [rsp+520h+plaintext], rbx ; plaintext
mov     r9d, r8d        ; key_length
mov     r8, rcx         ; key
mov     rcx, rax        ; ciphertext
call    decrypt
mov     rdx, [rbp+4A0h+p_decrypted_string]
mov     eax, [rbp+4A0h+ciphertext_length]
cdqe
mov     byte ptr [rdx+rax], 0
mov     rax, [rbp+4A0h+p_decrypted_string]
mov     rdx, rax
lea     rcx, aDecryptedTextS ; "Decrypted text: %s\n"
call    printf
mov     eax, 0
mov     rsp, rdi
mov     rsp, rsi
lea     rsp, [rbp+468h]
pop     rbx
pop     rsi
pop     rdi
pop     r12
pop     r13
pop     r14
pop     r15
pop     rbp
retn
main endp
```

opening the decrypt function,



Analysing the code

Load `i` Index and Retrieve `S[i]` Value:

```
mov     eax, [rbp+0A0h+i]       ; Load the value of i into EAX
cdqe                             ; Sign-extend EAX to RAX
movzx   eax, [rbp+rax+0A0h+S]   ; Load the value of S[i] into EAX
movzx   eax, al                  ; Zero-extend AL to AX
```

This sequence loads the current value of the `i` index, extends it to a full quad-word register, and retrieves the value of `S[i]` from memory.

Load `j` Index and Calculate Index for XOR Operation:

```
mov     edx, [rbp+0A0h+j]       ; Load the value of j into EDX
lea     ecx, [rax+rdx]          ; Calculate the index for XOR operation: S[i] +
S[j]
```

These instructions load the value of the `j` index into EDX and calculate the effective index for the XOR operation by adding `S[i]` and `S[j]`

Calculate XOR Operation with Key:

```
mov     eax, [rbp+0A0h+i]       ; Load the value of i into EAX
cdq                              ; Sign-extend EAX to EDX:EAX
```

```
idiv    [rbp+0A0h+key_length]   ; Divide EDX:EAX by key_length
mov     eax, edx                ; Store the remainder (modulus) in EAX
cdqe                            ; Sign-extend EAX to RAX
mov     rdx, [rbp+0A0h+key]     ; Load the address of key into RDX
add     rax, rdx                ; Add the offset to the base address of key
movzx   eax, byte ptr [rax]     ; Load the byte value from the key into EAX
movzx   eax, al                 ; Zero-extend AL to AX
```

These instructions calculate the key index based on the current `i` index, retrieve the corresponding byte from the key, and store it in EAX.

Update `j` Index:

```
lea     edx, [rcx+rax]          ; Calculate the sum of the previously
calculated index and the key value
sar     eax, 1Fh                ; Arithmetic shift right to get the sign bit
into all bits
shr     eax, 18h                ; Shift right by 24 bits to extract the lowest
byte
add     edx, eax                ; Add the extracted byte to the sum
movzx   edx, dl                 ; Zero-extend DL to EDX
sub     edx, eax                ; Subtract the sign-extended key byte from EDX
mov     eax, edx                ; Move the updated value of j into EAX
mov     [rbp+0A0h+j], eax       ; Store the updated value of j
```

These instructions update the value of the `j` index based on the calculated sum and the extracted byte from the key.

Update `S[i]` and `S[j]`:

```
mov     eax, [rbp+0A0h+i]       ; Load the value of `i` into EAX
cdqe                            ; Sign-extend EAX to RAX
movzx   eax, [rbp+rax+0A0h+S]   ; Load the value of `S[i]` into EAX
mov     [rbp+0A0h+temp], al     ; Store the value of `S[i]` in a temporary
variable
mov     eax, [rbp+0A0h+j]       ; Load the value of `j` into EAX
cdqe                            ; Sign-extend EAX to RAX
movzx   eax, [rbp+0A0h+temp]    ; Load the temporary value into EAX
mov     edx, [rbp+0A0h+i]       ; Load the value of `i` into EDX
movsxd  rdx, edx                ; Sign-extend EDX to RDX
```

```
mov     [rbp+rdx+0A0h+S], al     ; Store the value of `S[i]` in memory at the
correct index
```

These instructions swap the values of `S[i]` and `S[j]` by temporarily storing `S[i]`, retrieving `S[j]`, and then updating `S[i]` and `S[j]` in memory.

Increment `i` Index:

```
add     [rbp+0A0h+i], 1          ; Increment the value of i by 1
```

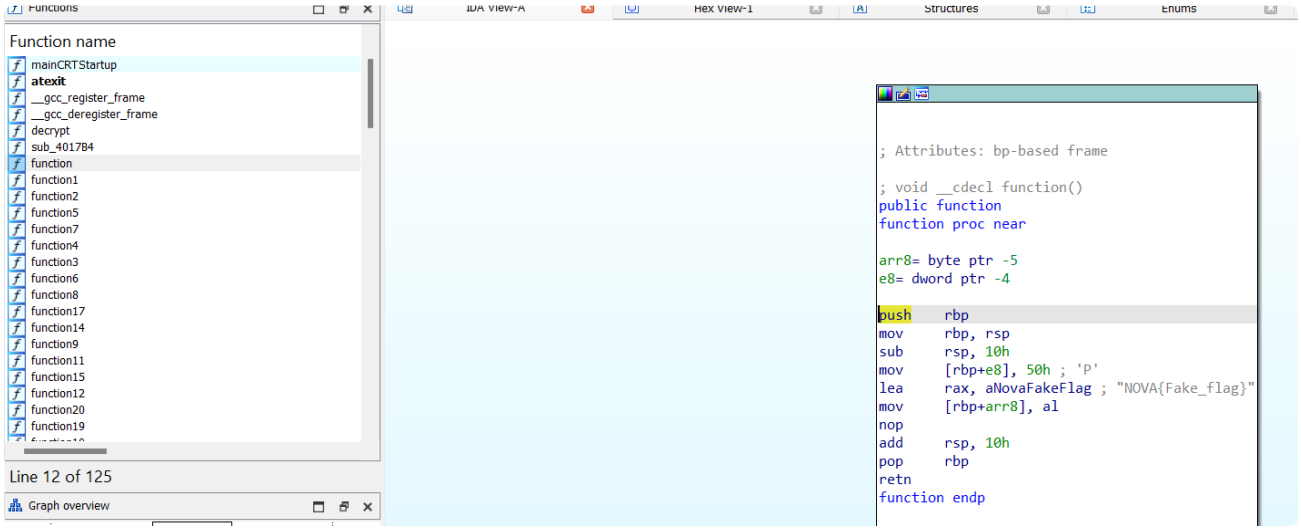
This instruction increments the value of the `i` index, preparing for the next iteration of the decryption loop.

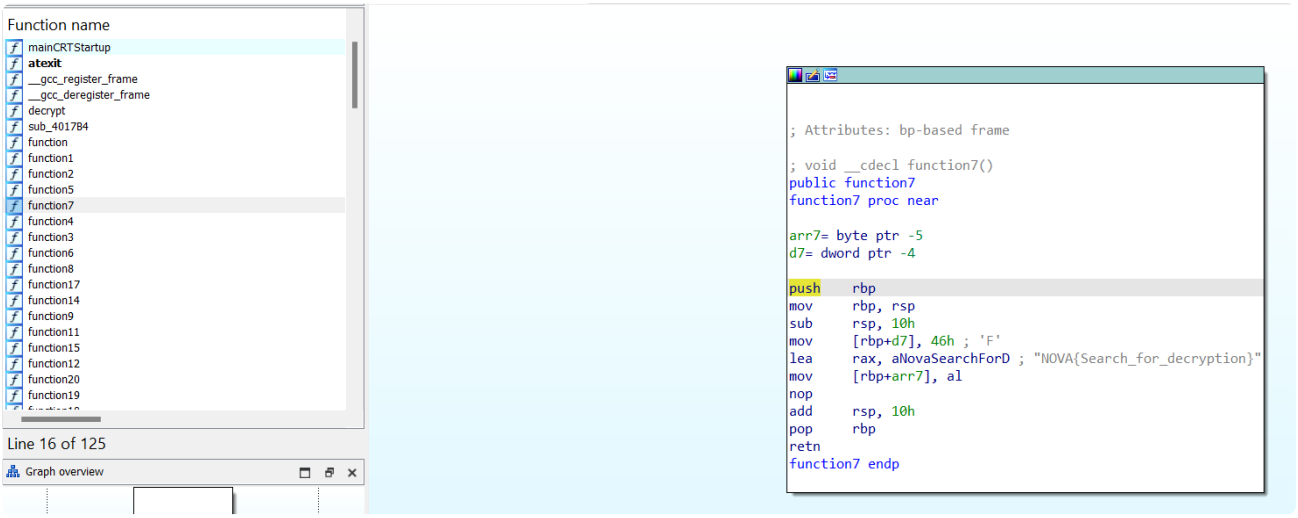
Perform XOR Operation with Ciphertext and Update Plaintext:

```
mov     eax, [rbp+0A0h+k]        ; Load the value of k into EAX
cdqe                             ; Sign-extend EAX to RAX
```

```
mov     rdx, [rbp+0A0h+ciphertext] ; Load the address of ciphertext into RDX
add     rax, rdx                   ; Add the offset to the base address of
ciphertext
movzx   r8d, byte ptr [rax]        ; Load the byte value from the ciphertext into
R8D
mov     eax, [rbp+0A0h+t]          ; Load the temporary value into EAX
cdqe                               ; Sign-extend EAX to RAX
movzx   ecx, [rbp+rax+0A0h+S]    ; Load the value of S[t] into ECX
mov     eax, [rbp+0A0h+k]        ; Load the value of k into EAX
cdqe                               ; Sign-extend EAX to RAX
mov     rdx, [rbp+0A0h+plaintext] ; Load the address of plaintext into RDX
add     rax, rdx                   ; Add the offset to the base address of
plaintext
mov     edx, r8d                   ; Move the ciphertext byte value into EDX
xor     edx, ecx                   ; Perform the XOR
```

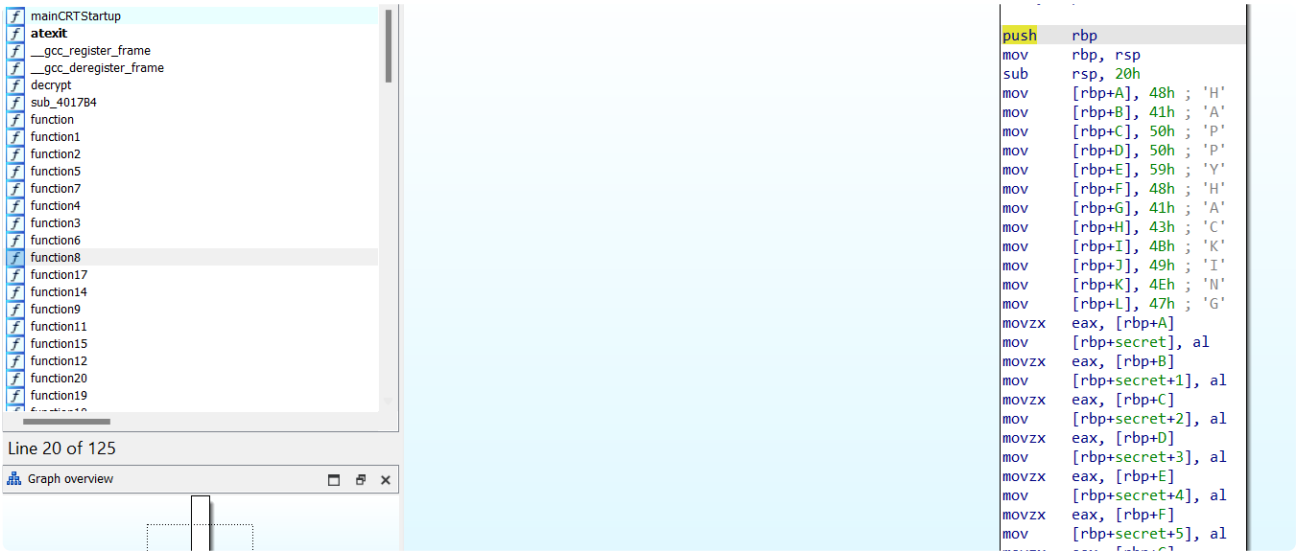
In the challenge, we encounter various functions, some of which contain fake flags. However, upon examining the code, we identify that the decryption algorithm being used is RC4. To progress and obtain the correct flag, we must locate the ciphertext and the corresponding key.



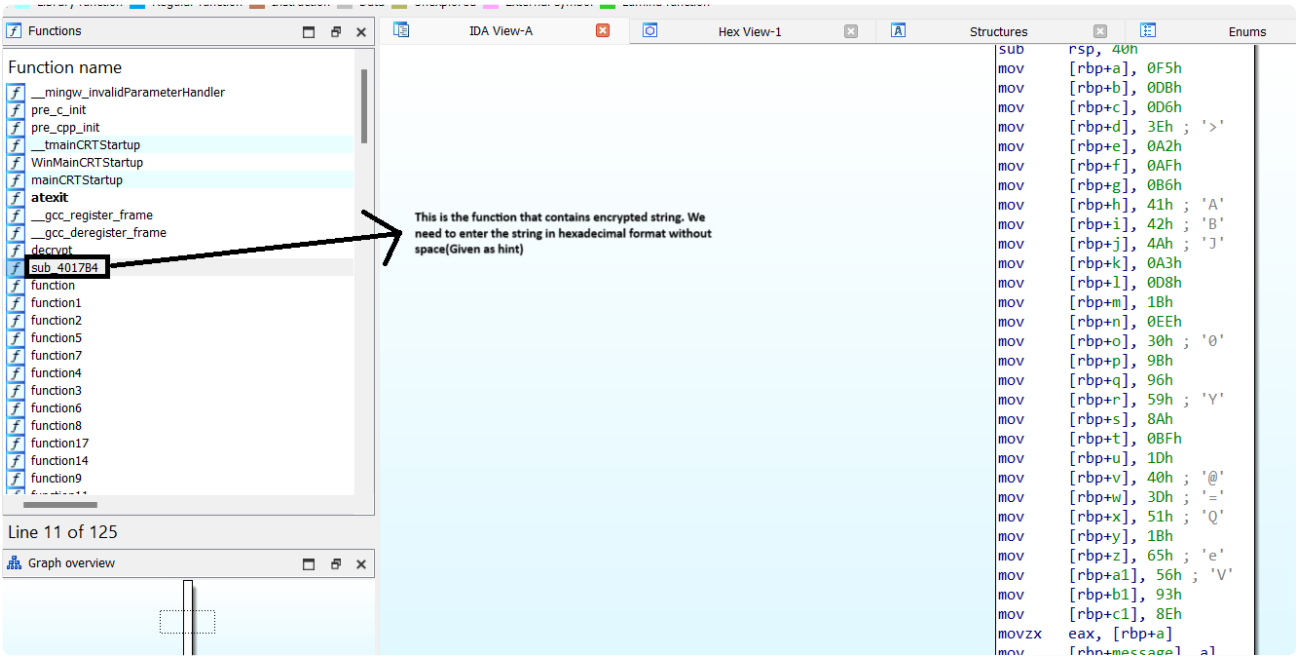


Also there was a hint "Search for decryption".

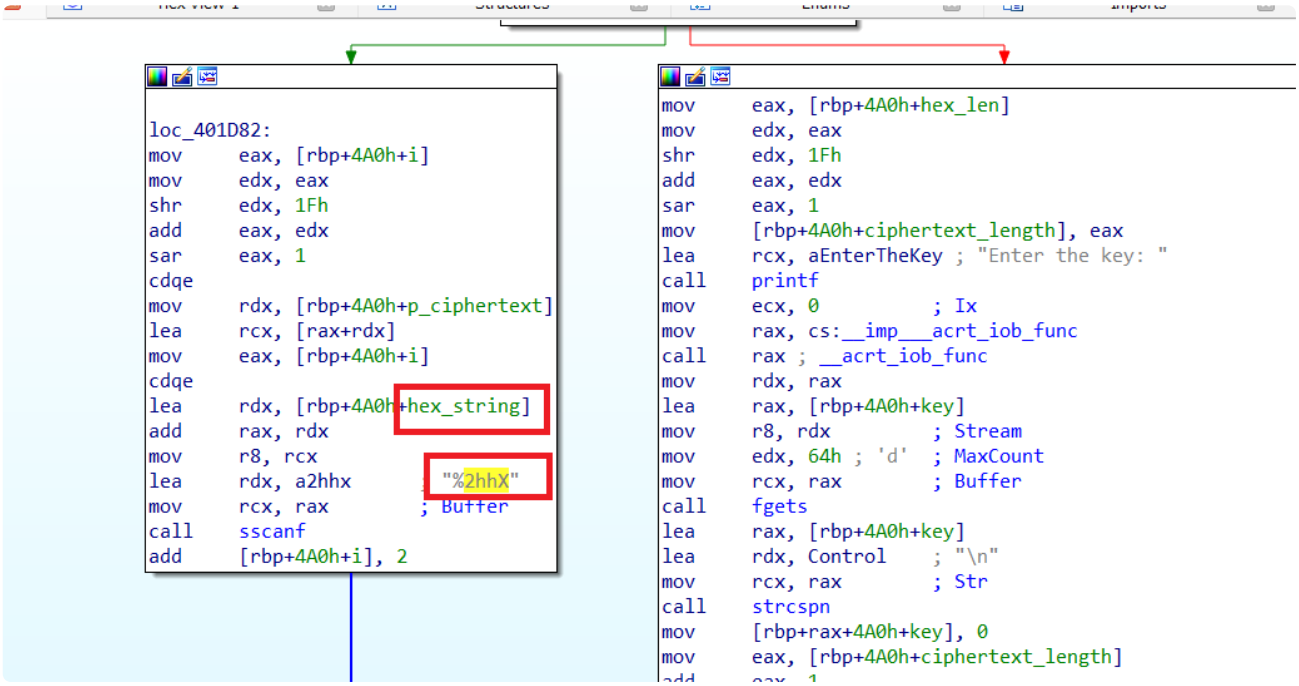
At function "8". You can see the "Secret" which is the key for decryption as "HAPPYHACKING"



But still we need ciphertext to decrypt the plaintext and find the flag and lets look dig deeper in remaining functions.



By analysing the main function we can infer that it gets the encrypted string as hexadecimal value.



By Extracting all the hex values we can get the encrypted string:

```
F5 DB D6 3E A2 AF B6 41 42 4A A3 D8 1B EE 30 9B 96 59 8A BF 1D 40 3D 51 1B 65
56 93 8E
```

It is mentioned as without space

```
F5DBD63EA2AFB641424AA3D81BEE309B96598ABF1D403D511B6556938E
```

We got the Encrypted string(hex) as

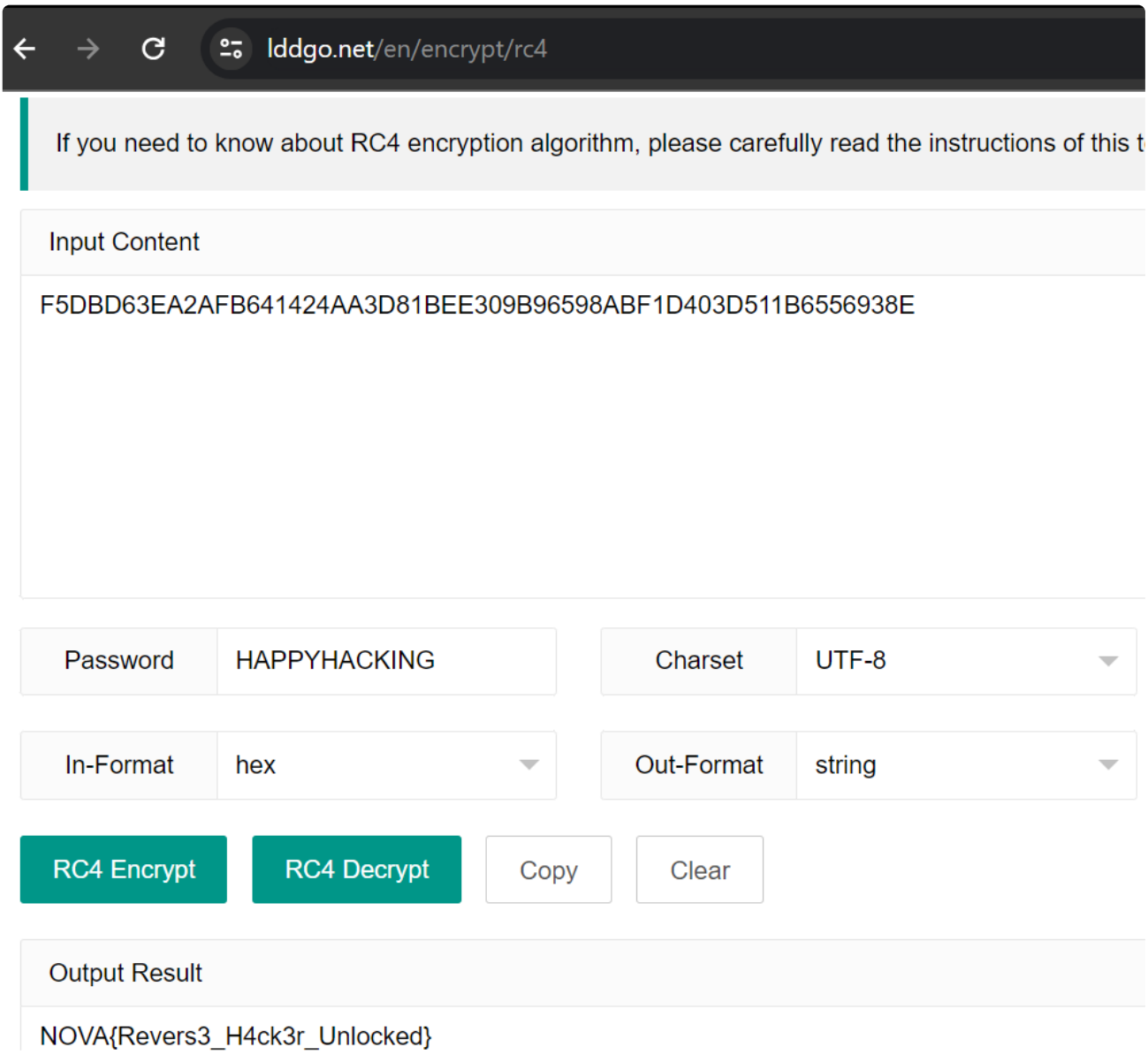
```
F5DBD63EA2AFB641424AA3D81BEE309B96598ABF1D403D511B6556938E
```

We already got key as

```
HAPPYHACKING
```

```
G:\>rev.exe
Welcome to NOVA-CTF2024
-----------------------
Enter Encrypted string Without Space:F5DBD63EA2AFB641424AA3D81BEE309B96598ABF1D403D511B6556938E
Enter the key: HAPPYHACKING
Decrypted text: NOVA{Revers3_H4ck3r_Unlocked}
```

Also we can decrypt online:



Finally we found the flag as
NOVA{Revers3_H4ck3r_Unlocked}