

## rev\_mt2

August 17, 2022

```
[ ]: import re
import glob
import hashlib
from tqdm import tqdm, trange

from Crypto.Cipher import AES
from Crypto.Util.Padding import pad, unpad

[ ]: EMPTY = set()
state = None

def add(v1, v2):
    return [x ^ y for x, y in zip(v1, v2)]

def int64_to_vec(x):
    return vector(GF(2), [(x >> i) & 1 for i in range(64)])

def vec_to_int64(x):
    return sum(ZZ(x.get(i)) << i for i in range(64))

def _lshift_vec(vec, k):
    return [EMPTY] * k + list(vec)[: -k]

def _rshift_vec(vec, k):
    return list(vec)[k:] + [EMPTY] * k

def _mask_mask(vec, mask):
    _mask = int64_to_vec(mask)
    return [vec[i] if k else EMPTY for i, k in enumerate(_mask)]

def _mask_const(term, const):
    _mask = int64_to_vec(const)
    return [term if k else EMPTY for k in _mask]

def _process_vec(y):
    y = add(y, _mask_mask(_rshift_vec(y, 29), 0x5555555555555555))
    y = add(y, _mask_mask(_lshift_vec(y, 17), 0x71d67ffeda60000))
    y = add(y, _mask_mask(_lshift_vec(y, 37), 0xfff7eee000000000))
```

```

y = add(y, _rshift_vec(y, 43))
return y

```

```
[ ]: const = 0xb5026f5aa96619e9
```

```
[ ]: def twist():
    global state
    print("[+] twist()", flush=True)
    for i in range(312):
        # print("[*]", state[i], state[(i + 1) % 312], flush=True)
        # y = _mask_mask(state[(i + 1) % 312], lower) + _mask_mask(state[i],
        ↪upper)
        state[i] = state[(i + 1) % 312][1:31] + state[i][31:] + [EMPTY]
        state[i] = add(state[i], state[(i + 156) % 312])
        state[i] = add(state[i], _mask_const(state[(i + 1) % 312][0], const))

```

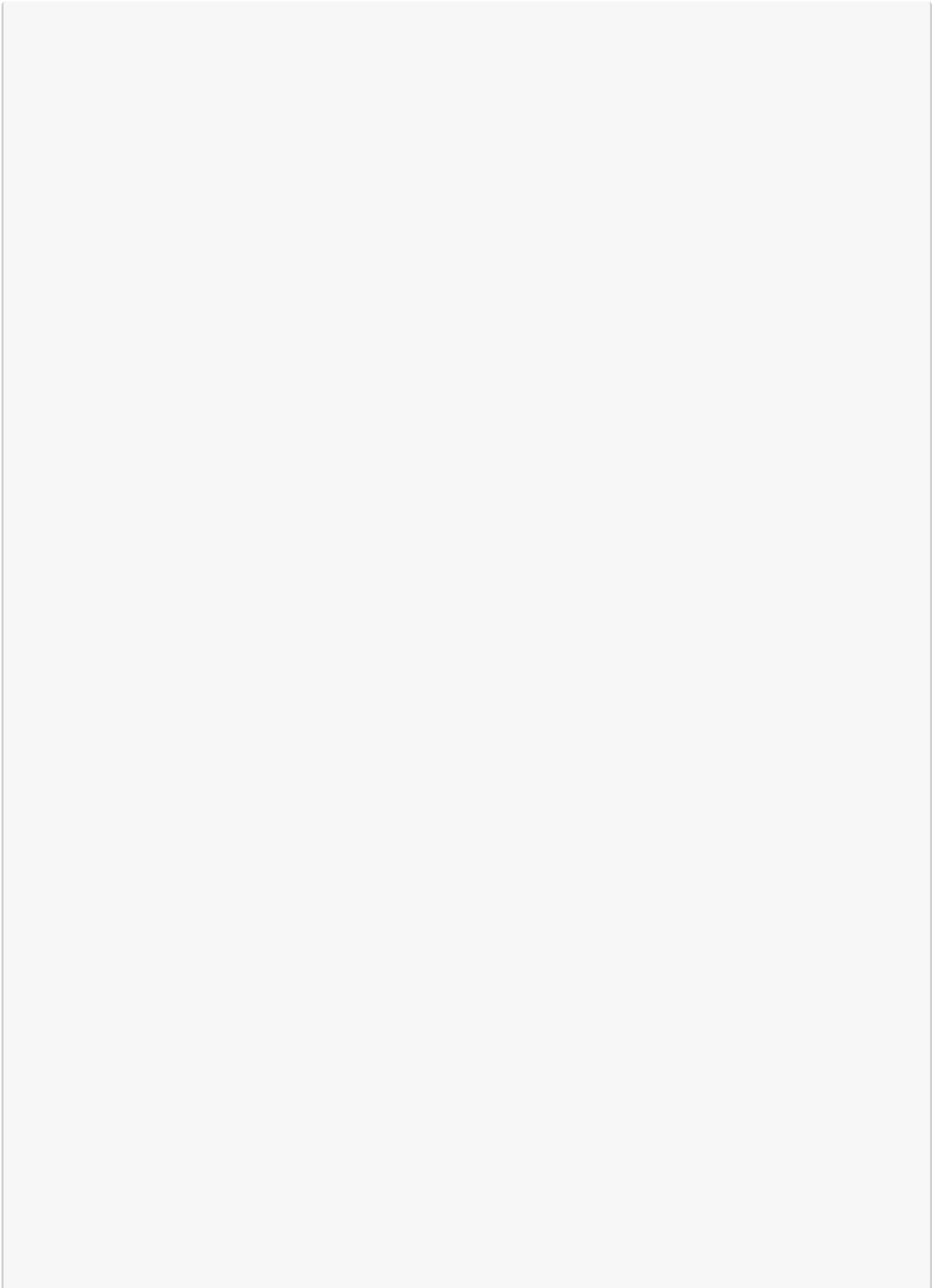
```
[ ]: print("Loading data", flush=True)
    with open("public/output.txt", "r") as fin:
        ct = bytes.fromhex(fin.readline().split(" = ")[1].strip())
        iv = bytes.fromhex(fin.readline().split(" = ")[1].strip())
        _iv = int.from_bytes(iv, "big")
    bits = [None] * 64 + list(map(int, bin(_iv)[2:].zfill(20000 - 64)[::-1]))
    print("bits:", bits[:100], flush=True)

```

Loading data

```
bits: [None, None, None, None, None, None, None, None, None, None, None, None,
None, None, None, None, None, None, None, None, None, None, None, None,
None, None, None, None, None, None, None, None, None, None, None, None,
None, None, None, None, None, None, None, None, None, None, None, None,
None, None, None, None, None, None, None, None, None, None, None, None, 1,
1, 0, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 0, 0, 0, 1, 0, 1, 1, 0, 1, 1, 1, 1,
1, 1, 0, 0, 0, 0, 0, 0]
```

```
[ ]:
```



```
# correct_coef = [[(correct_state[i] >> j) & 1 for j in range(64)] for i in
↳range(len(correct_state))]
# correct_coef = sum(correct_coef, [])
# correct_coef = vector(GF(2), correct_coef)
```

```
[ ]: print("Initialising variables", flush=True)
state = [[{i * 64 + j} for j in range(64)] for i in range(312)]

res_mat = Matrix(GF(2), 64, 312 * 64)
coef_mat = Matrix(GF(2), len(bits) - 64, 312 * 64)
rhs = vector(GF(2), len(bits) - 64, bits[64:])
```

Initialising variables

```
[ ]: print("Calculating coefficients", flush=True)
idx = 0
for i in range(len(bits)):
    # for i in range(1000):
        if idx == 0:
            twist()

        y = state[idx]
        idx = (idx + 1) % 312

        y = _process_vec(y)
        msb = y[63]

        if bits[i] is not None:
            # calculated = sum(correct_coef[k] for k in msb) % 2
            # print(f"[{i:<5}]", calculated, "==", bits[i], flush=True)
            # assert calculated == bits[i]

            if idx == 0:
                msb_s = str(msb)
                print(f"[{i:<5}] {msb_s[:20]}...{msb_s[-20:]} == {bits[i]}",
↳flush=True)

            if bits[i] is not None:
                # extract coefficients from msb
                for k in msb:
                    coef_mat[i - 64, k] = 1
            else:
                for k in msb:
                    res_mat[i, k] = 1

print("Done!")
```

Calculating coefficients

```

[+] twist()
[311 ] {65, 19960, 19913, 7...6, 19930, 92, 19967} == 0
[+] twist()
[623 ] {9984, 10049, 130, 6..., 10076, 157, 19967} == 0
[+] twist()
[935 ] {128, 129, 130, 9976... 19960, 9978, 19967} == 1
[+] twist()
[1247 ] {10112, 257, 10113, ...19961, 19963, 19967} == 1
[+] twist()
[1559 ] {10112, 10113, 10114...19963, 19964, 19967} == 1
[+] twist()
[1871 ] {10240, 10241, 10242... 9980, 19965, 19967} == 1
[+] twist()
[2183 ] {256, 257, 258, 387,..., 9978, 9982, 19967} == 1
[+] twist()
[2495 ] {10240, 10241, 258, ...19961, 19963, 19960} == 1
[+] twist()
[2807 ] {9984, 513, 10240, 1..., 9978, 19963, 9980} == 0
[+] twist()
[3119 ] {10240, 513, 10242, ...19961, 19964, 19965} == 0
[+] twist()
[3431 ] {10240, 10241, 10242...19960, 19962, 19966} == 0
[+] twist()
[3743 ] {512, 513, 10242, 10...19961, 19963, 19967} == 1
[+] twist()
[4055 ] {576, 10305, 577, 10...19963, 19964, 19967} == 1
[+] twist()
[4367 ] {10240, 10241, 10242...19964, 19965, 19967} == 1
[+] twist()
[4679 ] {576, 577, 578, 64, ...19962, 19966, 19967} == 0
[+] twist()
[4991 ] {10752, 513, 1026, 1..., 19961, 19963, 712} == 0
[+] twist()
[5303 ] {10752, 10753, 10242...19962, 19963, 19964} == 1
[+] twist()
[5615 ] {10240, 10241, 514, ...19964, 19965, 10176} == 0
[+] twist()
[5927 ] {10752, 1025, 10241,...7, 711, 1220, 19966} == 0
[+] twist()
[6239 ] {10241, 10242, 10243...1, 1220, 712, 19967} == 0
[+] twist()
[6551 ] {512, 10753, 514, 51...19963, 19964, 19967} == 1
[+] twist()
[6863 ] {10240, 10241, 10242...10218, 10220, 10224} == 1
[+] twist()
[7175 ] {10240, 1025, 512, 1...2, 1220, 19966, 712} == 1
[+] twist()
[7487 ] {11264, 10241, 10242..., 19963, 11397, 712} == 0

```

```

[+] twist()
[7799 ] {10240, 10241, 10242...10222, 10226, 11397} == 0
[+] twist()
[8111 ] {10241, 10242, 10243...10224, 10226, 10228} == 1
[+] twist()
[8423 ] {10241, 10242, 10243...10114, 10210, 10226} == 1
[+] twist()
[8735 ] {10240, 10241, 10242...10214, 10228, 10230} == 0
[+] twist()
[9047 ] {64, 10305, 10306, 1...10206, 10214, 10230} == 1
[+] twist()
[9359 ] {10240, 10241, 10242...10208, 10216, 10232} == 0
[+] twist()
[9671 ] {1025, 1028, 1030, 1...19962, 19966, 19967} == 0
[+] twist()
[9983 ] {2048, 10241, 10242,...10210, 10218, 10234} == 0
[+] twist()
[10295] {2048, 10241, 10242,...10210, 10218, 10234} == 1
[+] twist()
[10607] {10240, 2049, 10242,...10220, 10234, 10236} == 0
[+] twist()
[10919] {2048, 10241, 10242,...10210, 10218, 10234} == 1
[+] twist()
[11231] {2048, 2049, 10242, ...10234, 10236, 10238} == 0
[+] twist()
[11543] {2048, 10240, 2055, ...10222, 10234, 10238} == 0
[+] twist()
[11855] {12288, 2048, 10242,...10224, 10234, 10236} == 1
[+] twist()
[12167] {10240, 2048, 2057, ... 2437, 10218, 10234} == 0
[+] twist()
[12479] {12288, 10240, 10241...10234, 10236, 10238} == 1
[+] twist()
[12791] {12288, 2048, 10242,...10226, 10234, 10238} == 0
[+] twist()
[13103] {12288, 2048, 10242,...10228, 10234, 10236} == 1
[+] twist()
[13415] {12288, 2048, 10242,... 2025, 10226, 10234} == 1
[+] twist()
[13727] {12288, 2048, 10242,...10234, 10236, 10238} == 0
[+] twist()
[14039] {10240, 2048, 2055, ...10230, 10234, 10238} == 1
[+] twist()
[14351] {12288, 2049, 10242,...10232, 10234, 10236} == 0
[+] twist()
[14663] {2048, 2049, 2058, 2..., 2027, 2029, 10234} == 1
[+] twist()
[14975] {10240, 12289, 12290... 2030, 10236, 10238} == 1

```

```

[+] twist()
[15287] {10240, 12289, 12290..., 2031, 2439, 10238} == 0
[+] twist()
[15599] {12288, 12289, 10241...0, 2029, 2031, 2032} == 1
[+] twist()
[15911] {12289, 10242, 12290...8, 2027, 2030, 2033} == 0
[+] twist()
[16223] {12289, 12290, 10241..., 10222, 2031, 2034} == 1
[+] twist()
[16535] {12289, 2049, 12291,...1, 2032, 2034, 2035} == 0
[+] twist()
[16847] {10240, 2049, 10242,..., 2035, 2036, 11396} == 0
[+] twist()
[17159] {12288, 10240, 12290...2, 3337, 2035, 2037} == 1
[+] twist()
[17471] {12288, 12289, 12290..., 2036, 2038, 11397} == 1
[+] twist()
[17783] {65, 75, 92, 128, 12... 10885, 2820, 11210} == 1
[+] twist()
[18095] {12288, 12289, 12290...8, 2036, 2037, 2040} == 0
[+] twist()
[18407] {12288, 12289, 12290...6, 2037, 2038, 2041} == 0
[+] twist()
[18719] {10240, 10241, 10242...0, 2039, 2439, 2042} == 0
[+] twist()
[19031] {12289, 2049, 12291,...0, 2042, 2043, 3663} == 0
[+] twist()
[19343] {65, 75, 92, 129, 14...13915, 13917, 11340} == 1
[+] twist()
[19655] {2057, 2058, 2062, 2...1, 2043, 2045, 3663} == 1
[+] twist()
[19967] {65, 75, 92, 129, 14...14042, 14045, 11269} == 1
[+] twist()
Done!

```

```

[ ]: # print("TESTING")
      # correct_recover = ''.join(map(str, rhs[64:1000]))
      # our_recover = ''.join(map(str, (coef_mat * correct_coef)[64:1000]))
      # print("Correct:", correct_recover)
      # print(" We got:", our_recover)
      # assert correct_recover == our_recover

```

TESTING

```

Correct: 11011000000110000001111100000110110110110111000000101110001000011011111
10110010011101110001001111010101010000111000100001111111000010000011001101011010
0100101011000110000101111011011010101111011010000100011011101100101010111100010
1110111101000011010111111101111101101001111010011010110010111110110100001000110
01000101101011101000100000100010010001111100110111011110000110100000101001010001

```

```

011110100100001000001100110100011001011010011101001111111100111011111110110111
10001101110110001001010001101100110000101101011111010101110000101011001000001100
10101100010101101001011001000011010111101010000110001001100001111100001100011110
100001100111110110010001010010101101100001110110010000100010111010111101101010
00001011011000011011011111100010110011001111010110111001100100000010111010010000
01100000011111011101011110000110011100001010001100111101111011000000011001100011
11110011000100001101010010101000001011011111110000000001001000011

```

```

We got: 01110101000011110010100000111100101101011000111100010011010010111001011
00001010001101110111001000000111000110101101011010011011011110100110001101101111
00101100111110001101110111001110011110000001100010110100101000101101011000100110
10000101010001101001000100011001010000001011001011101111101001000111101100010010
0000111010000001110110110011101111011110111101101100100100100101000001000101101
111001111001101100001101110110010111101111111100111001001011111010110111110100
1000101001011110111101101100000011001000000101010001001011011101111110101111110
01100100110100011010111111011100010110010011001100101000011010101100110000010100
0110100111011100100111111110000111001101101010101001100001011101001101111100000
0011110010011110011110000001101110101000010011011001001001100100111100000111100
10000000101100110111011111000100111110101100000011110101111110000000110000110011
10111010110101000000000011010111100011101010100111001001000011110

```

```

-----
AssertionError                                Traceback (most recent call last)
/tmp/ipykernel_18299/157692655.py in <module>
      4 print("Correct:", correct_recover)
      5 print(" We got:", our_recover)
----> 6 assert correct_recover == our_recover

AssertionError:

```

```

[ ]: print("Started solving equations...", flush=True)

res = coef_mat.solve_right(rhs)
print("solution:", res, flush=True)

ker = coef_mat.right_kernel()
print("kernel:", ker, flush=True)

```

```

Started solving equations...
solution: (0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0,
0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0,
0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0, 0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1, 1,
0, 1, 1, 0, 1, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0,
0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1,
1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0,
1, 0, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 0,
1, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 1,

```



1, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 1,  
 1, 1, 0, 1, 0, 0, 0, 0, 1, 1, 1, 0, 0, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1,  
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```
kernel: Vector space of degree 19968 and dimension 32 over Finite Field of size 2
```

```
32 x 19968 dense matrix over Finite Field of size 2
```

(19936, 19968)

[illegible]



```

00000000000000000000 00000000000000000000 1
00000000000000000000 00000000000000000000 1
00000000000000000000 00000000000000000000 1
00000000000000000000 00000000000000000000 1
00000000000000000000 00000000000000000000 1
00000000000000000000 00000000000000000000 1
00000000000000000000 00000000000000000000 1
00000000000000000000 00000000000000000000 1
00000000000000000000 01100111000000110110 9907

```

```

[ ]: required = set()
     for vec in res_mat:
         for idx in range(312 * 64):
             if vec[idx] == 1:
                 required.add(idx)

```

```

[ ]: for vec in res_mat:
     print([idx for idx in range(312 * 64) if vec[idx] == 1])

```

```

[56, 64, 74, 91, 9993, 10010, 10039, 10047]
[120, 128, 138, 155, 10057, 10074, 10103, 10111]
[184, 192, 202, 219, 10121, 10138, 10167, 10175]
[248, 256, 266, 283, 10185, 10202, 10231, 10239]
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[1080, 1088, 1098, 1115, 11017, 11034, 11063, 11071]
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[1784, 1792, 1802, 1819, 11721, 11738, 11767, 11775]
[1848, 1856, 1866, 1883, 11785, 11802, 11831, 11839]
[1912, 1920, 1930, 1947, 11849, 11866, 11895, 11903]

```

```

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[2168, 2176, 2186, 2203, 12105, 12122, 12151, 12159]
[2232, 2240, 2250, 2267, 12169, 12186, 12215, 12223]
[2296, 2304, 2314, 2331, 12233, 12250, 12279, 12287]
[2360, 2368, 2378, 2395, 12297, 12314, 12343, 12351]
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[3128, 3136, 3146, 3163, 13065, 13082, 13111, 13119]
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[3768, 3776, 3786, 3803, 13705, 13722, 13751, 13759]
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[3960, 3968, 3978, 3995, 13897, 13914, 13943, 13951]
[4024, 4032, 4042, 4059, 13961, 13978, 14007, 14015]
[4088, 4096, 4106, 4123, 14025, 14042, 14071, 14079]

```

```

[ ]: basis = list(basis)
basis = [vec for vec in basis if len(set(idx for idx in range(len(vec)) if
↳vec[idx]) & required) > 0]
for vec in basis:
    s = ''.join(map(str, vec))
    print(s[:20], s[-20:], s.count('1'))

```

```
00000000000000000000 01100111000000110110 9907
```

```

[ ]: def AES_decrypt(key, iv, ct):
    key = hashlib.md5(key).digest()
    iv = hashlib.md5(iv).digest()
    cipher = AES.new(key=key, iv=iv, mode=AES.MODE_CBC)

```

```

msg = cipher.decrypt(ct)
try:
    return unpad(msg, 16).decode()
except ValueError:
    return

for _null in span(basis):
    _sol = res + _null
    _recovered = res_mat * _sol
    key = ''.join(map(str, _recovered))[:-1]
    key = int(key, 2).to_bytes(len(key) // 8, 'big')
    print(AES_decrypt(key, iv, ct))

```

None

flag{w3\_d0n7\_know\_d03s\_g0D\_p14y\_d1c3\_w1th\_th3\_un1ver53\_8u7\_3e\_k0n3\_4t\_13457\_c0mp  
u73rs\_d07}

[ ]: