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Instructor's Name
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Security Lab3

Brute-Force and Dictionary Attack

Brute force Attack

Create a python script to find corresponding inputs by computing hash values for each possible combination. For this exercise, only require to consider passwords with 5 lowercase and or numeric characters.

The output of the brute force method is shown above, it took 174 seconds to run the code. The brute force method is shown below.

```
def bruteforce():
    ans={}
    counter=0
    for a in range(len(key)):
        tried[0] = key[a]
        for b in range(len(key)):
            tried[1] = key[b]
            for c in range(len(key)):
                tried[2] = key[c]
                for d in range (len(key)):
                    tried[3] =key[d]
                    for e in range (len(key)):
                        tried[4] = key[e]
                        new_try = ''.join(tried)
                        new_try_code = hashlib.md5(new_try.encode('utf-8')).hexdigest()
                        print(new_try_code)
                        if new_try_code in hashlist:
                            print("====================================")
                            print("{} : {}".format(new_try,new_try_code))
                            print("====================================")
                            ans[new_try]=new_try_code
                            counter+=1
                            if counter>=15:
                                # Return a dictionary of the unciphered clear password and
                                print(ans)
                                print(list(ans.keys()))
                                return 0
```

3b. Dictionary Attack

Dictionary attack is a form of brute force attack for deciphering. The difference is that dictionary attack on try those possibilities which are deemed likely to succeed.

My dictionary attack took short time to find 14/15 of the passwords, however was unable to find the 15th password. This may be because the 15th password is not a common word, and not included inside words5.txt. Hence not able to find it at all.

dictAttack.py

```
#!/usr/bin/python3

import hashlib
import itertools

dgts = set()
f5 =open('hash5.txt')
for d in f5:
    dgts.add(d.strip())
f5.close()

fout = open('FOUND.txt', 'w')
foundCount = 0
digits = '0123456789'
fin = open('words5.txt')
checkedCharSet = set()
alreadyChecked = set()
wc = 0

for w in fin:
    wc += 1
    print(wc)
    w = w.strip()
    sortedchars = tuple(sorted(w))  # If the character are the same, skip
    if sortedchars in checkedCharSet:
        continue
    else:
        checkedCharSet.add(sortedchars)

    for t in itertools.permutations(w+digits, 5):
        ww = ''.join(t)
        if ww in alreadyChecked:
            continue
        md5 = hashlib.md5(ww.encode('ascii')).hexdigest()
        if md5 in dgts:
            print('------>found:', ww)
            print(ww, '-->', md5, file=fout, flush=True)
            foundCount += 1
            if foundCount == 15:
                break
        alreadyChecked.add(ww)
```

For each word in words5.txt, we permutate it and hash it, to find if there is a match, if there is, we found the hashed words. We also need to ensure there is no repeated words when the word is permutated, this to save time-complexity.

4. Creating Rainbow Table

Generating Rainbow Table

```
zenger@zenger-VirtualBox:~/Downloads/rainbowcrack-1.7-linux64$ ./rtgen md5 loweralpha-numeric 5 5 0 3800 600000 0
rainbow table md5_loweralpha-numeric#5-5_0_3800x600000_0.rt parameters
hash algorithm:           md5
hash length:              16
charset name:             loweralpha-numeric
charset data:             abcdefghijklmnopqrstuvwxyz0123456789
charset data in hex:      61 62 63 64 65 66 67 68 69 6a 6b 6c 6d 6e 6f 70 71 72 73 74 75 76 77 78 79 7a 30 31 32 33 34 35 36 37 38 39
charset length:           36
plaintext length range:   5 - 5
reduce offset:            0x00000000
plaintext total:          60466176

sequential starting point begin from 0 (0x0000000000000000)
generating...
196608 of 600000 rainbow chains generated (0 m 23.0 s)
393216 of 600000 rainbow chains generated (0 m 22.9 s)
589824 of 600000 rainbow chains generated (0 m 23.0 s)
600000 of 600000 rainbow chains generated (0 m 1.2 s)
```

Sorting Rainbow Table

```
zenger@zenger-VirtualBox:~/Downloads/rainbowcrack-1.7-linux64$ ./rtsort .
./md5_loweralpha-numeric#5-5_0_3800x600000_0.rt:
3088826368 bytes memory available
loading data...
sorting data...
writing sorted data...
```

Rcrack the md5 ciphertext

```
zenger@zenger-VirtualBox:~/Downloads/rainbowcrack-1.7-linux64$ ./rcrack .  -l hash5.txt
1 rainbow tables found
memory available: 2473793945 bytes
memory for rainbow chain traverse: 60800 bytes per hash, 912000 bytes for 15 hashes
memory for rainbow table buffer: 2 x 9600016 bytes
disk: ./md5_loweralpha-numeric#5-5_0_3800x600000_0.rt: 9600000 bytes read
disk: finished reading all files
plaintext of 81466b6bb4be5a48e2230be1338bcde6 is lou0g
plaintext of a92b66a9802704ca8616c4b092378272 is opmen
plaintext of 836626589007d7dd5304c8d22815fffc is di5gv
plaintext of 1b31905c59f481958d2eb72158c27ac7 is egunb
plaintext of 1b4baba3ae3be69857b323cf6b7fcd80 is sso55
plaintext of 78c1b8edd1bc3ffc438432479289a9e1 is nized
plaintext of 0d5b558d5f6744deaaf5b016c6c77a57 is tpoin
plaintext of a8218c67a5b4e652e30a59372e07df59 is hed4e
plaintext of a74edf83748e3c4fa5f31ec10bad79db is dsmto
plaintext of ddaafa5d551a582bc924d09cc8d33ee5 is aseas
plaintext of 6e313b70d12de950443527a33d802b76 is mlhdi
plaintext of d4efdba5e9725e77c9b9051fa8136f0a is tthel
plaintext of 644674d142ba2174a80889f833b32563 is owso9
plaintext of de952f5454fb0ee79bca249f80e9fe8f is ofror
plaintext of 96f6065d8f2dd1376eff88fba65d1d83 is cance

statistics
--------------------------------------------------------------
plaintext found:                          15 of 15
total time:                               5.86 s
time of chain traverse:                   3.90 s
time of alarm check:                      1.89 s
time of disk read:                        0.01 s
hash & reduce calculation of chain traverse: 108243000
hash & reduce calculation of alarm check:    41924830
number of alarm:                          144576
performance of chain traverse:            27.74 million/s
performance of alarm check:               22.21 million/s

result
--------------------------------------------------------------
a92b66a9802704ca8616c4b092378272  opmen  hex:6f706d656e
d4efdba5e9725e77c9b9051fa8136f0a  tthel  hex:747468656c
96f6065d8f2dd1376eff88fba65d1d83  cance  hex:63616e6365
78c1b8edd1bc3ffc438432479289a9e1  nized  hex:6e697a6564
0d5b558d5f6744deaaf5b016c6c77a57  tpoin  hex:74706f696e
ddaafa5d551a582bc924d09cc8d33ee5  aseas  hex:6173656173
a74edf83748e3c4fa5f31ec10bad79db  dsmto  hex:64736d746f
1b31905c59f481958d2eb72158c27ac7  egunb  hex:6567756e62
6e313b70d12de950443527a33d802b76  mlhdi  hex:6d6c686469
de952f5454fb0ee79bca249f80e9fe8f  ofror  hex:6f66726f72
a8218c67a5b4e652e30a59372e07df59  hed4e  hex:6865643465
836626589007d7dd5304c8d22815fffc  di5gv  hex:6469356776
644674d142ba2174a80889f833b32563  owso9  hex:6f77736f39
1b4baba3ae3be69857b323cf6b7fcd80  sso55  hex:73736f3535
81466b6bb4be5a48e2230be1338bcde6  lou0g  hex:6c6f753067
```

5. Salting

Salting is an additional add-on to passwords, that concatenate a random string (salt)to the password before hashing it. This way, it allows for later authentication without keeping and therefore risking the plaintext password.

Salts help to defend hashed passwords against dictionary attacks or a generally pre-computed rainbow table attack. Since salts are different from each case, they also protect common passwords.

In this exercise I used my salting python script to concatenate a single random lowercase alphabet to the plaintext password, as you can see below even when it is cracked by rainbowcrack 6/15 of the passwords, the passwords are still tainted with a random character at the back. The hacker would have to guess what the salt is, and how many character of salt the hash-owner have added, this however some flaws which is for certain examples.

Flaws

Lets say I had a password that is “ILikeApples”, and after concatenate a random string /salt of “3e5d” it becomes “ILikeApples3e5d”, the hacker can guess that “3e5d” is just a random string after using brute-force/rainbow table.

```
zenger@zenger-VirtualBox:~/Downloads/rainbowcrack-1.7-linux64$ ./rcrack .  -l hash5.tx
1 rainbow tables found
memory available: 2473793945 bytes
memory for rainbow chain traverse: 60800 bytes per hash, 912000 bytes for 15 hashes
memory for rainbow table buffer: 2 x 9600016 bytes
disk: ./md5_loweralpha-numeric#5-5_0_3800x600000_0.rt: 9600000 bytes read
disk: finished reading all files
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plaintext of a92b66a9802704ca8616c4b092378272 is opmen
plaintext of 836626589007d7dd5304c8d22815fffc is di5gv
plaintext of 1b31905c59f481958d2eb72158c27ac7 is egunb
plaintext of 1b4baba3ae3be69857b323cf6b7fcd80 is sso55
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plaintext of 0d5b558d5f6744deaaf5b016c6c77a57 is tpoin
plaintext of a8218c67a5b4e652e30a59372e07df59 is hed4e
plaintext of a74edf83748e3c4fa5f31ec10bad79db is dsmto
plaintext of ddaafa5d551a582bc924d09cc8d33ee5 is aseas
plaintext of 6e313b70d12de950443527a33d802b76 is mlhdi
plaintext of d4efdba5e9725e77c9b9051fa8136f0a is tthel
plaintext of 644674d142ba2174a80889f833b32563 is owso9
plaintext of de952f5454fb0ee79bca249f80e9fe8f is ofror
plaintext of 96f6065d8f2dd1376eff88fba65d1d83 is cance

statistics
----------------------------------------------------------------
plaintext found:                        15 of 15
total time:                             5.86 s
time of chain traverse:                 3.90 s
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time of disk read:                      0.01 s
hash & reduce calculation of chain traverse: 108243000
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number of alarm:                        144576
performance of chain traverse:          27.74 million/s
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result
----------------------------------------------------------------
a92b66a9802704ca8616c4b092378272  opmen  hex:6f706d656e
d4efdba5e9725e77c9b9051fa8136f0a  tthel  hex:747468656c
96f6065d8f2dd1376eff88fba65d1d83  cance  hex:63616e6365
78c1b8edd1bc3ffc438432479289a9e1  nized  hex:6e697a6564
0d5b558d5f6744deaaf5b016c6c77a57  tpoin  hex:74706f696e
ddaafa5d551a582bc924d09cc8d33ee5  aseas  hex:6173656173
a74edf83748e3c4fa5f31ec10bad79db  dsmto  hex:64736d746f
1b31905c59f481958d2eb72158c27ac7  egunb  hex:6567756e62
6e313b70d12de950443527a33d802b76  mlhdi  hex:6d6c686469
de952f5454fb0ee79bca249f80e9fe8f  ofror  hex:6f66726f72
a8218c67a5b4e652e30a59372e07df59  hed4e  hex:6865643465
836626589007d7dd5304c8d22815fffc  di5gv  hex:6469356776
644674d142ba2174a80889f833b32563  owso9  hex:6f77736f39
1b4baba3ae3be69857b323cf6b7fcd80  sso55  hex:73736f3535
81466b6bb4be5a48e2230be1338bcde6  lou0g  hex:6c6f753067
```
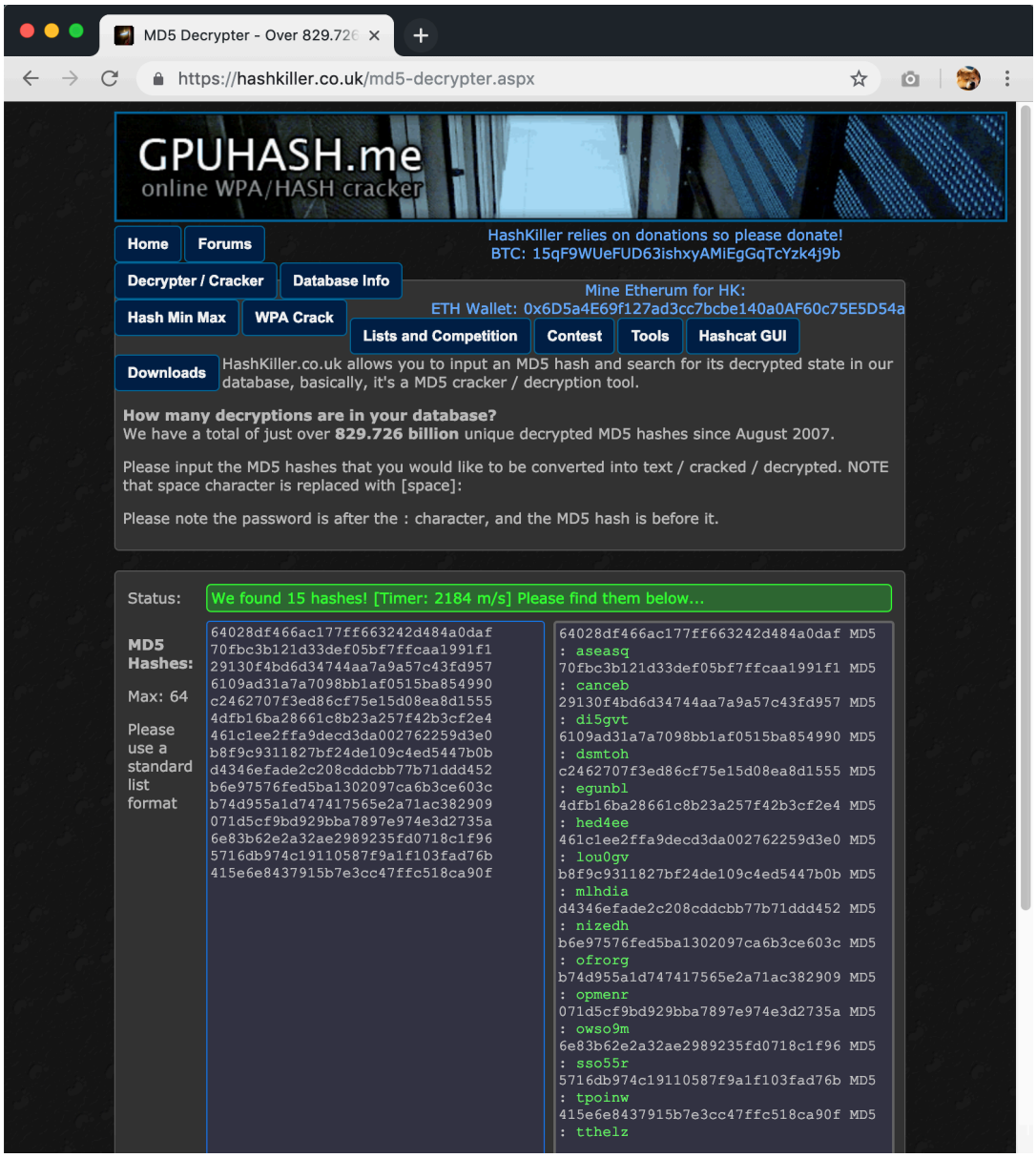

```
zenger@zenger-VirtualBox:~/Downloads/rainbowcrack-1.7-linux64$ ./
2 rainbow tables found
memory available: 2461754982 bytes
memory for rainbow chain traverse: 60800 bytes per hash, 912000 b
memory for rainbow table buffer: 2 x 9600016 bytes
disk: ./md5_loweralpha-numeric#5-5_0_3800x600000_0.rt: 9600000 by
disk: ./md5_loweralpha-numeric#6-6_0_3800x600000_0.rt: 9600000 by
disk: finished reading all files
plaintext of 6109ad31a7a7098bb1af0515ba854990 is dsmtoh
plaintext of b74d955a1d747417565e2a71ac382909 is opmenr
plaintext of 5716db974c19110587f9a1f103fad76b is tpoinw
plaintext of d4346efade2c208cddcbb77b71ddd452 is nizedh
plaintext of 6e83b62e2a32ae2989235fd0718c1f96 is sso55r
plaintext of 29130f4bd6d34744aa7a9a57c43fd957 is di5gvt

statistics
----------------------------------------------------------------
plaintext found:                        6 of 15
total time:                             65.96 s
time of chain traverse:                 14.94 s
time of alarm check:                    50.57 s
time of disk read:                      0.01 s
hash & reduce calculation of chain traverse: 216486000
hash & reduce calculation of alarm check:    1390055034
number of alarm:                        1097307
performance of chain traverse:          14.49 million/s
performance of alarm check:             27.49 million/s

result
----------------------------------------------------------------
64028df466ac177ff663242d484a0daf  <not found>  hex:<not found>
70fbc3b121d33def05bf7ffcaa1991f1  <not found>  hex:<not found>
29130f4bd6d34744aa7a9a57c43fd957  di5gvt  hex:646935677674
6109ad31a7a7098bb1af0515ba854990  dsmtoh  hex:64736d746f68
c2462707f3ed86cf75e15d08ea8d1555  <not found>  hex:<not found>
4dfb16ba28661c8b23a257f42b3cf2e4  <not found>  hex:<not found>
461c1ee2ffa9decd3da002762259d3e0  <not found>  hex:<not found>
b8f9c9311827bf24de109c4ed5447b0b  <not found>  hex:<not found>
d4346efade2c208cddcbb77b71ddd452  nizedh  hex:6e697a656468
b6e97576fed5ba1302097ca6b3ce603c  <not found>  hex:<not found>
b74d955a1d747417565e2a71ac382909  opmenr  hex:6f706d656e72
071d5cf9bd929bba7897e974e3d2735a  <not found>  hex:<not found>
6e83b62e2a32ae2989235fd0718c1f96  sso55r  hex:73736f353572
5716db974c19110587f9a1f103fad76b  tpoinw  hex:74706f696e77
415e6e8437915b7e3cc47ffc518ca90f  <not found>  hex:<not found>
```

The time it takes to crack a salted password as seen above will also increase, as the cracker have to say process 5-X number of characters instead to account for the salts. Seen above with minimum 6, and max 6 hashes, rainbow crack only managed to crack 6/15 hashes in 10 times the time, and a lot of extra space complexity. Thereafter even knowing the password say “dsmtoh”, the cracker will have to guess which is the salt and the original password, and when more salts and random the password string is, it might be too difficult.

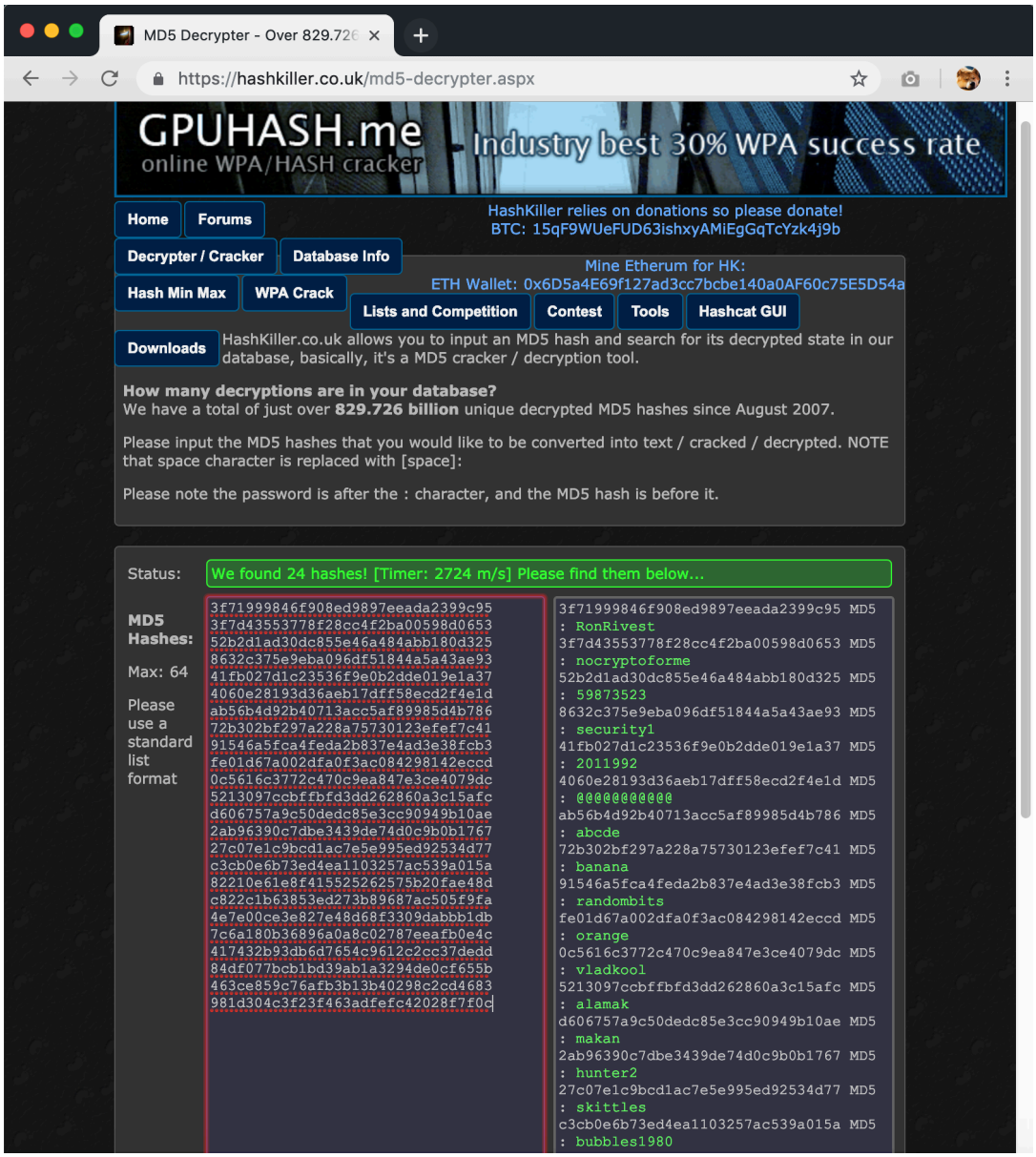


HASHKILLER.CO.UK

Incomes hashkiller, this website contains a database of 829.726 billion decrypted MD5 hashes, with a tool like this, due to its space complexity, can easily break any hashes. However the hacker still do not know which part of it is the salt, unless it gets the file containing the salt tagged to the original password.

6. Hash breaking competition

Again, with modern tools like hashkiller.co.uk, MD5 is no longer secure, as it has such a big database of 829.726 billion decrypted MD5 hashes.



It can easily crack any passwords. Though some harder passwords are difficult to crack even with such a large database. We could use a bigger rainbow table, however my computer ran out of space to do so.