King Saud University
College of Computer and Information Sciences
Computer Science Department

380 Project
Stock Exchange Database
Fall 2020

Stock Exchange Database

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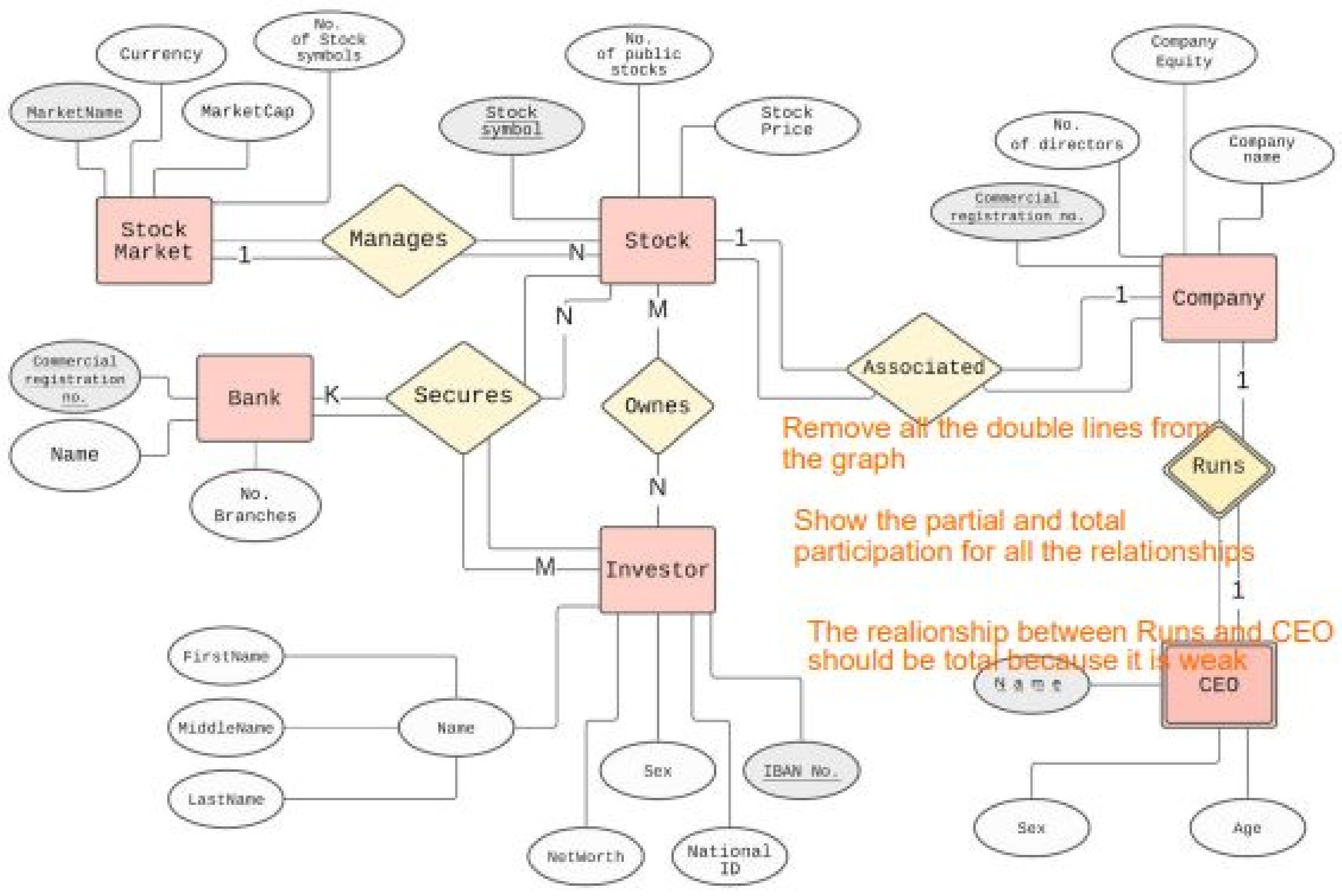
Old ERD

Entity Relationship Diagram (ERD)



Remove all the double lines from the graph

Show the partial and total participation for all the relationships

The realionship between Runs and CEO should be total because it is weak

Introduction

In simple terms, the **Stock Exchange Market** (or Stock Market for short) is a market in which companies sell stocks (i.e. shares) to investors.

Concretely, companies must acquire money to finance their expansion and growth, companies do that by selling what's called a *stock,* which is, stocks are traded to *Investors*.

Companies rely on a *Stock Market* to moderate and manage the transactions and security of their stocks. In Saudi Arabia, the only existing stock market is called *Tadawul* (تداول) and it moderates 202 different stocks identified by their *Stock Symbol* (e.g. *Othaim Markets* Stock symbol is *4001*).

A company may sell a number of stocks publicly through Tadawul, and a *Bank* which processes the money exchange from investors. The person in charge of deciding whether a company sells stocks or not is usually the *CEO* of the company.

So the database we're aiming to build should enable the management of the stock market via secure transactions between companies, investors, and banks.

Objectives

- Manage company stocks by building a database to store stock data (Company associated with Stock, number of stocks, etc.)
- Accelerate the trade of stocks by systematizing the process online via a database (In the past trading was not done over the internet)
- Securely trade stocks between companies and investors

Data requirements

- **Stock Market's** name, market cap, currency
- Info about a **Company's** name, commercial registration number (رقم السجل التجاري) is collected as well as info about the **CEO** of the company
- In each transaction, we should store the **Investor** info such as his name and IBAN, along with the **Stock** he bought (identified by its stock symbol) and the **Bank** that made this transaction. This is to ensure secure trade among parties

Functions

- Display a **Stock's** data (e.g. price, no. of available Stock)
- Display a **Company's** data to **investors** (e.g. Company Equity, CEO data, etc.)
- Process buy and sell transactions
- Add new Companies, Stocks, Investors, etc
- Delete Companies, Stocks, Investors, etc
- Keep track of each **Stock's** data and update it periodically

Entities and attributes

- Stock Market is identified by Name. Currency, market cap, and number of stock symbols are also recorded
- Stock is identified by Stock symbol. Number of public stocks, stock price are also recorded
- Investor is identified by IBAN No. Networth, ID, sex, age, name are also recorded.
- Company is identified by Commercial registration number. Company equity, company name, number of directors are also recorded
- Bank is identified by Commercial registration number. name, number of branches are also recorded
- The CEO is identified by Name. Sex, age are also recorded

Red	Primary Key
Green	Composite Attribute
Yellow	Partial Key

Relationships

- Stock Market has a relationship **Manage** with Stock **(1-m)**
- Company has a relationship **Run** by with CEO **(1-1)**
- Company has a relationship **Associated** with Stock **(1-1)**
- Stock has a relationship **Owned** with Investor **(n-m)**
- Stock has a relationship **Secures** with Bank **(n-m)**
- Investors has a relationship **Secures** with Bank **(n-m)**

Business rules

Constraints

- The CEO **can't** run more than one Company
- Company **can't** be associated with more than one Stock
- Stock **can only** be managed by one Stock Market

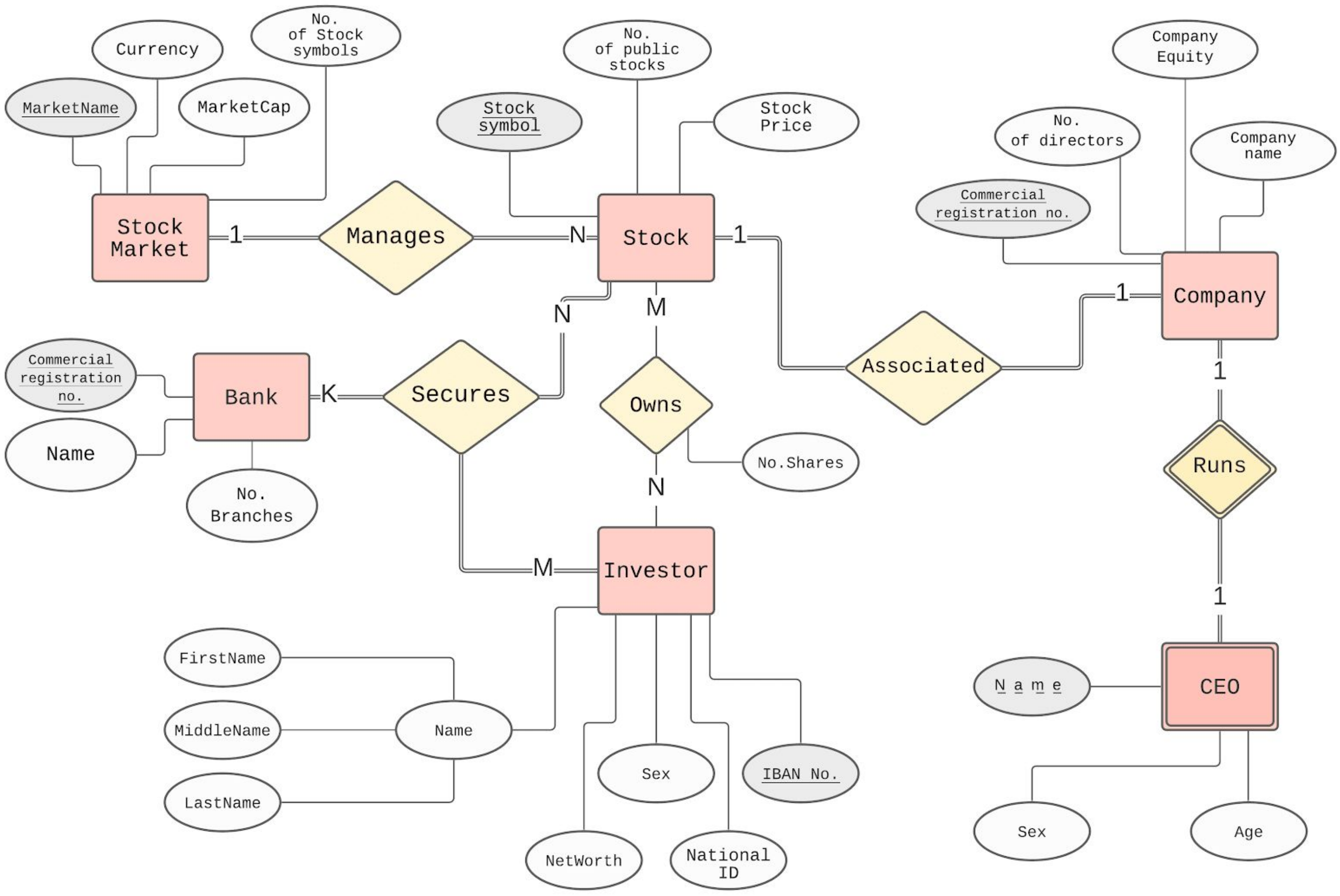
Participation

- Stock Market **totally participate** in manage
- Stock **totally participate** in manage
- Stock **totally participate** in secures
- Stock **totally participate** in associate
- Stock **partially participate** in own
- Company **totally participate** in associate
- Company **totally participate** in run
- CEO **totally participate** in run
- Investors **totally participate** in secures
- Investors **partially participate** in own
- Bank **totally participate** in secures

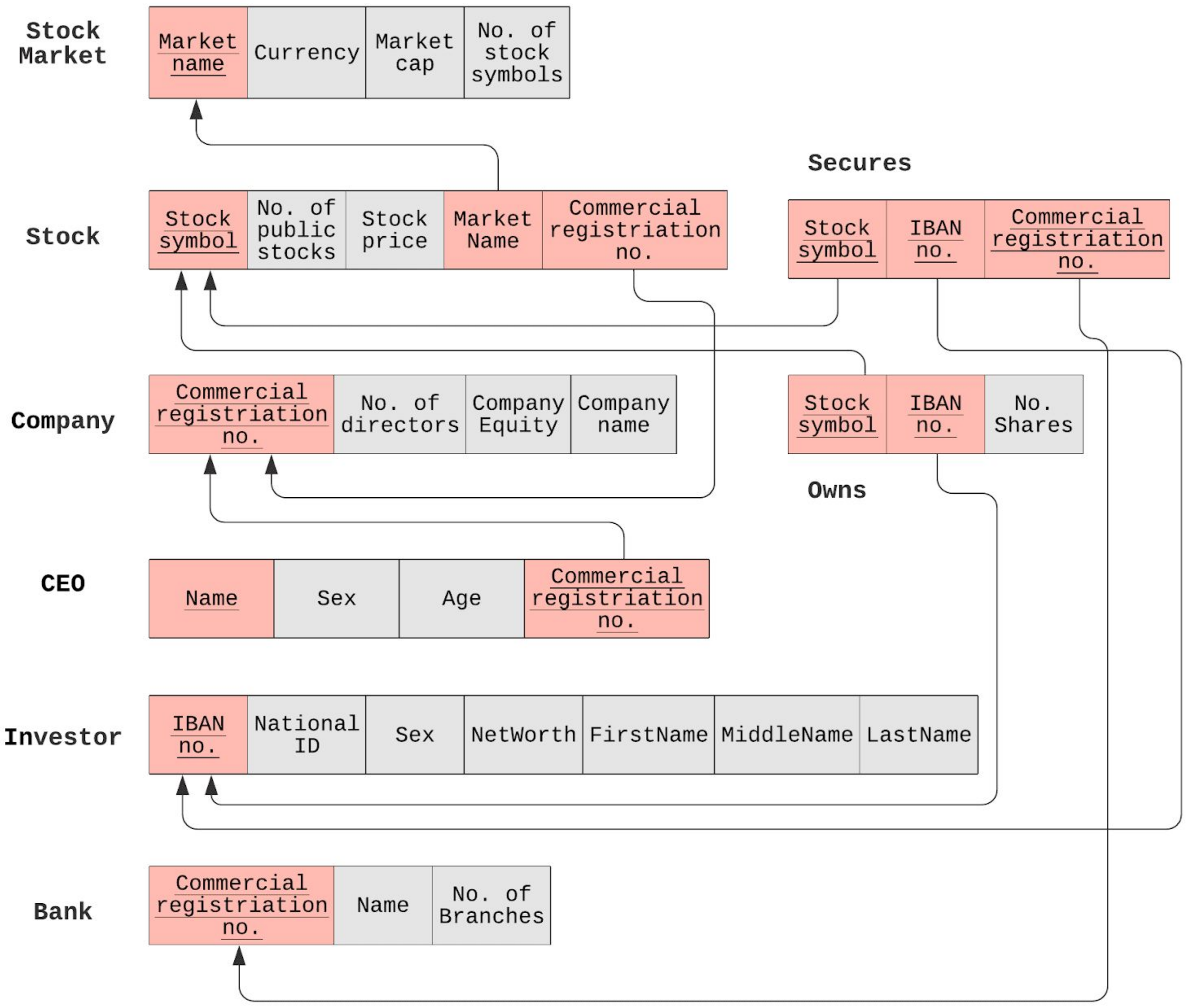
Queries

1	SELECT ALL **INVESTORS** WITH NETWORTH > 420 MILLION RIYALS
2	SELECT ALL **STOCKS** WITH NO. PUBLIC STOCKS < 2000
3	DISPLAY LAST NAME OF **INVESTOR** WITH IBAN NO. NL12RABO8139718173
4	SELECT ALL **INVESTORS** WHO ARE SECURED BY **BANKS** WITH COMMERCIAL REGISTRATION NO. 1110001116
5	SELECT ALL **INVESTORS** WHO OWN **STOCK** WITH STOCK SYMBOL 4001
6	LIST ALL **COMPANIES** WITH **STOCK** WITH STOCK PRICE > 103.5
7	LIST ALL **STOCKS** ASSOCIATED WITH **COMPANIES** THAT HAS MINIMUM NO. OF DIRECTORS OF 3
8	LIST ALL **BANKS** WHO SECURE **INVESTORS** WITH OWNED **STOCK** WITH STOCK SYMBOL 4161
9	SELECT ALL **CEOS** WHO RUN **COMPANIES** WHICH ARE ASSOCIATED WITH **STOCK** WITH STOCK PRICE < 200
10	SELECT ALL MALE **CEOS** THAT RUN **COMPANIES** ASSOCIATED WITH **STOCKS** OWNED BY **INVESTORS** WHOSE NETWORTH IS OVER 50,000

Entity Relationship Diagram (ERD)



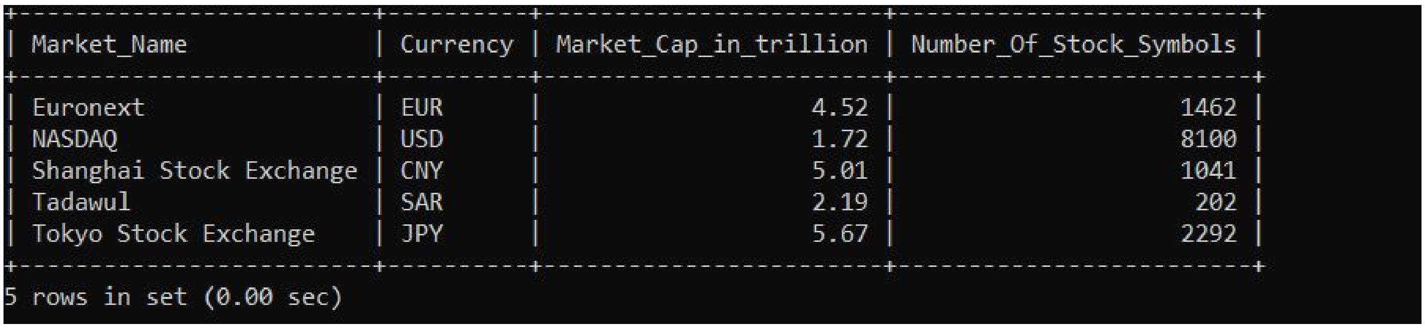
Relational Model Diagram



Implementation Using SQL

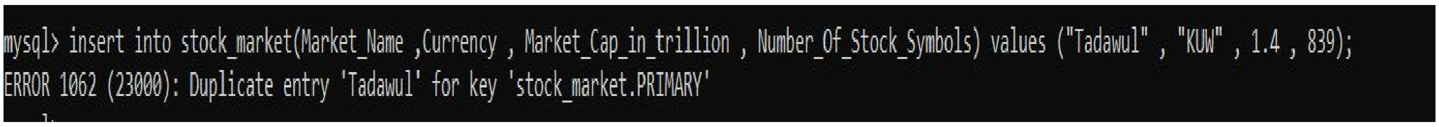
Add:

We can see that the Stock_Market table has the market *Tadawul*, let's try **Adding a an existing tuple**



```
+-------------------------+----------+-----------------------+-------------------------+
| Market_Name             | Currency | Market_Cap_in_trillion | Number_Of_Stock_Symbols |
+-------------------------+----------+-----------------------+-------------------------+
| Euronext                | EUR      |                  4.52 |                    1462 |
| NASDAQ                  | USD      |                  1.72 |                    8100 |
| Shanghai Stock Exchange | CNY      |                  5.01 |                    1041 |
| Tadawul                 | SAR      |                  2.19 |                     202 |
| Tokyo Stock Exchange    | JPY      |                  5.67 |                    2292 |
+-------------------------+----------+-----------------------+-------------------------+
5 rows in set (0.00 sec)
```

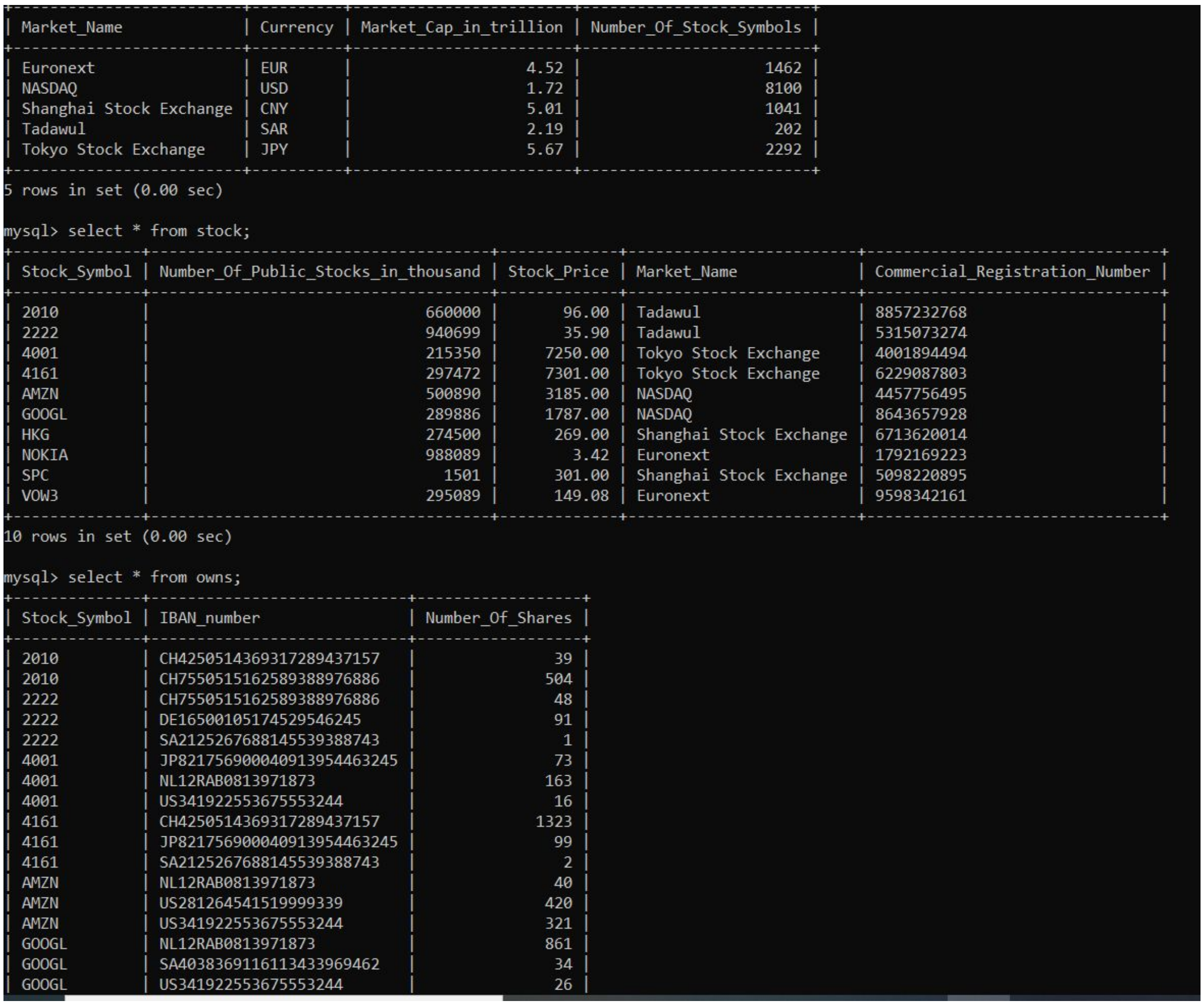
The database returned an error, saying *Tadawul* already exists, we know addition is functioning properly



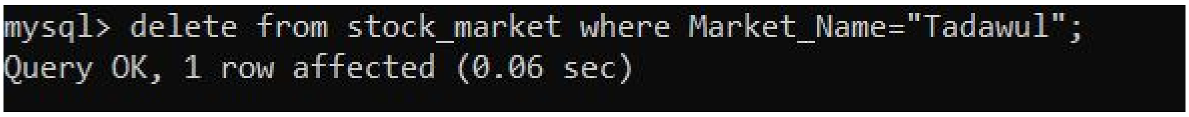
```
mysql> insert into stock_market(Market_Name ,Currency , Market_Cap_in_trillion , Number_Of_Stock_Symbols) values ("Tadawul" , "KUW" , 1.4 , 839);
ERROR 1062 (23000): Duplicate entry 'Tadawul' for key 'stock_market.PRIMARY'
```

Delete:

We can see that the tables *Stock_Market*, *Stock* and *Owns* are displaying data, let’s try to delete the stock market *Tadawul* and see if stocks related to it will **cascade delete**. For reference keep an eye for the first two stock in the *Stock* table, they should be deleted

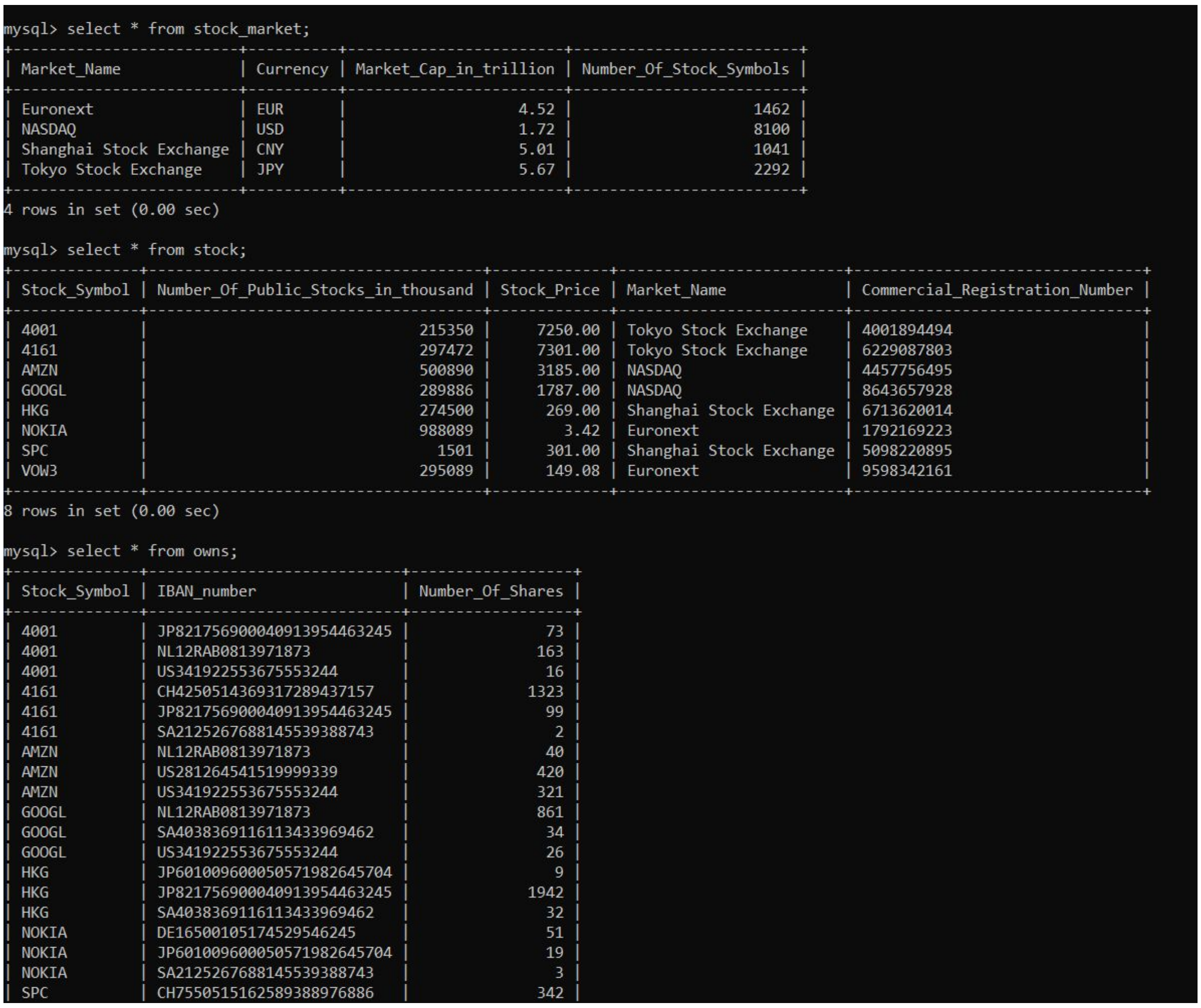


```
+-------------------------+----------+------------------------+-------------------------+
| Market_Name             | Currency | Market_Cap_in_trillion | Number_Of_Stock_Symbols |
+-------------------------+----------+------------------------+-------------------------+
| Euronext                | EUR      |                   4.52 |                    1462 |
| NASDAQ                  | USD      |                   1.72 |                    8100 |
| Shanghai Stock Exchange | CNY      |                   5.01 |                    1041 |
| Tadawul                 | SAR      |                   2.19 |                     202 |
| Tokyo Stock Exchange    | JPY      |                   5.67 |                    2292 |
+-------------------------+----------+------------------------+-------------------------+
5 rows in set (0.00 sec)

mysql> select * from stock;
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
| Stock_Symbol | Number_Of_Public_Stocks_in_thousand | Stock_Price | Market_Name             | Commercial_Registration_Number |
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
| 2010         |                              660000 |       96.00 | Tadawul                 | 8857232768                     |
| 2222         |                              940699 |       35.90 | Tadawul                 | 5315073274                     |
| 4001         |                              215350 |     7250.00 | Tokyo Stock Exchange    | 4001894494                     |
| 4161         |                              297472 |     7301.00 | Tokyo Stock Exchange    | 6229087803                     |
| AMZN         |                              500890 |     3185.00 | NASDAQ                  | 4457756495                     |
| GOOGL        |                              289886 |     1787.00 | NASDAQ                  | 8643657928                     |
| HKG          |                              274500 |      269.00 | Shanghai Stock Exchange | 6713620014                     |
| NOKIA        |                              988089 |        3.42 | Euronext                | 1792169223                     |
| SPC          |                                1501 |      301.00 | Shanghai Stock Exchange | 5098220895                     |
| VOW3         |                              295089 |      149.08 | Euronext                | 9598342161                     |
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
10 rows in set (0.00 sec)

mysql> select * from owns;
+--------------+----------------------------+------------------+
| Stock_Symbol | IBAN_number                | Number_Of_Shares |
+--------------+----------------------------+------------------+
| 2010         | CH4250514369317289437157   |               39 |
| 2010         | CH7550515162589388976886   |              504 |
| 2222         | CH7550515162589388976886   |               48 |
| 2222         | DE16500105174529546245     |               91 |
| 2222         | SA2125267688145539388743   |                1 |
| 4001         | JP821756900040913954463245 |               73 |
| 4001         | NL12RAB0813971873          |              163 |
| 4001         | US341922553675553244       |               16 |
| 4161         | CH4250514369317289437157   |             1323 |
| 4161         | JP821756900040913954463245 |               99 |
| 4161         | SA2125267688145539388743   |                2 |
| AMZN         | NL12RAB0813971873          |               40 |
| AMZN         | US281264541519999339       |              420 |
| AMZN         | US341922553675553244       |              321 |
| GOOGL        | NL12RAB0813971873          |              861 |
| GOOGL        | SA4038369116113433969462   |               34 |
| GOOGL        | US341922553675553244       |               26 |
```



```
mysql> delete from stock_market where Market_Name="Tadawul";
Query OK, 1 row affected (0.06 sec)
```

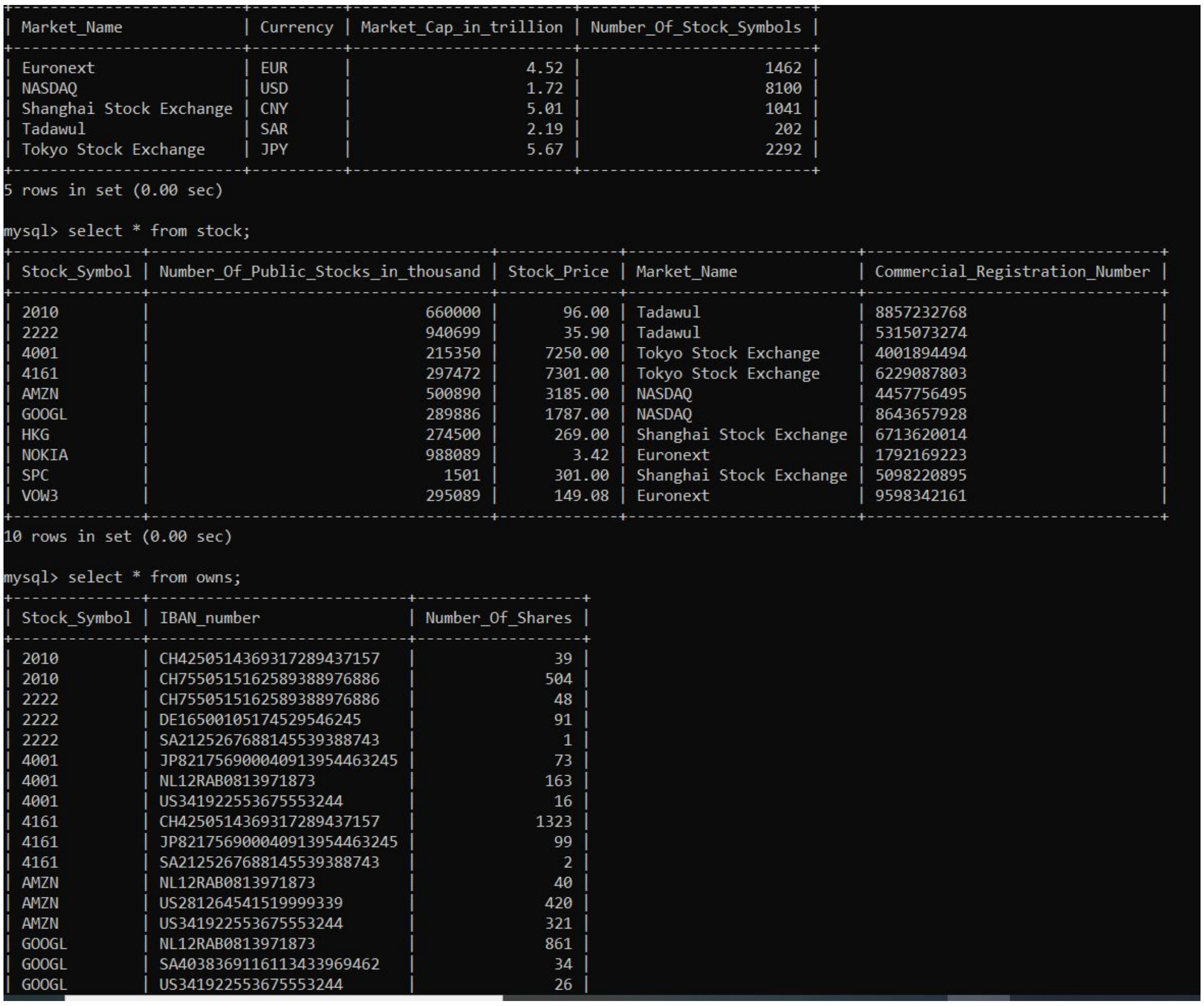
We can see that from the picture below, our cascade delete was successful in deleting all tuples that possess a foreign key of *Tadawul*



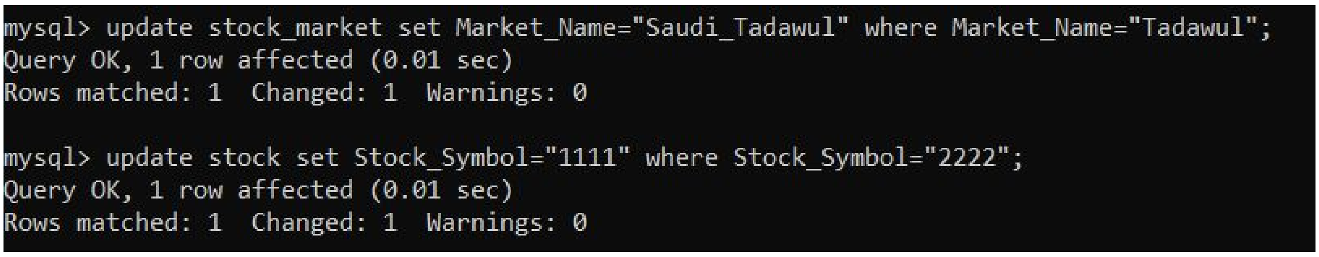
```
mysql> select * from stock_market;
+-------------------------+----------+------------------------+-------------------------+
| Market_Name             | Currency | Market_Cap_in_trillion | Number_Of_Stock_Symbols |
+-------------------------+----------+------------------------+-------------------------+
| Euronext                | EUR      |                   4.52 |                    1462 |
| NASDAQ                  | USD      |                   1.72 |                    8100 |
| Shanghai Stock Exchange | CNY      |                   5.01 |                    1041 |
| Tokyo Stock Exchange    | JPY      |                   5.67 |                    2292 |
+-------------------------+----------+------------------------+-------------------------+
4 rows in set (0.00 sec)

mysql> select * from stock;
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
| Stock_Symbol | Number_Of_Public_Stocks_in_thousand | Stock_Price | Market_Name             | Commercial_Registration_Number |
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
| 4001         |                              215350 |     7250.00 | Tokyo Stock Exchange    | 4001894494                     |
| 4161         |                              297472 |     7301.00 | Tokyo Stock Exchange    | 6229087803                     |
| AMZN         |                              500890 |     3185.00 | NASDAQ                  | 4457756495                     |
| GOOGL        |                              289886 |     1787.00 | NASDAQ                  | 8643657928                     |
| HKG          |                              274500 |      269.00 | Shanghai Stock Exchange | 6713620014                     |
| NOKIA        |                              988089 |        3.42 | Euronext                | 1792169223                     |
| SPC          |                                1501 |      301.00 | Shanghai Stock Exchange | 5098220895                     |
| VOW3         |                              295089 |      149.08 | Euronext                | 9598342161                     |
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
8 rows in set (0.00 sec)

mysql> select * from owns;
+--------------+----------------------------+------------------+
| Stock_Symbol | IBAN_number                | Number_Of_Shares |
+--------------+----------------------------+------------------+
| 4001         | JP821756900040913954463245 |               73 |
| 4001         | NL12RAB0813971873          |              163 |
| 4001         | US341922553675553244       |               16 |
| 4161         | CH4250514369317289437157   |             1323 |
| 4161         | JP821756900040913954463245 |               99 |
| 4161         | SA2125267688145539388743   |                2 |
| AMZN         | NL12RAB0813971873          |               40 |
| AMZN         | US281264541519999339       |              420 |
| AMZN         | US341922553675553244       |              321 |
| GOOGL        | NL12RAB0813971873          |              861 |
| GOOGL        | SA4038369116113433969462   |               34 |
| GOOGL        | US341922553675553244       |               26 |
| HKG          | JP601009600050571982645704 |                9 |
| HKG          | JP821756900040913954463245 |             1942 |
| HKG          | SA4038369116113433969462   |               32 |
| NOKIA        | DE16500105174529546245     |               51 |
| NOKIA        | JP601009600050571982645704 |               19 |
| NOKIA        | SA2125267688145539388743   |                3 |
| SPC          | CH7550515162589388976886   |              342 |
```

Update:

Let’s try and update a foreignkey and see if our database will **cascade update.** Let’s update *Tadawul* to *Saudi_Tadawul* and update the stock symbol “*2222*” to “*1111*”

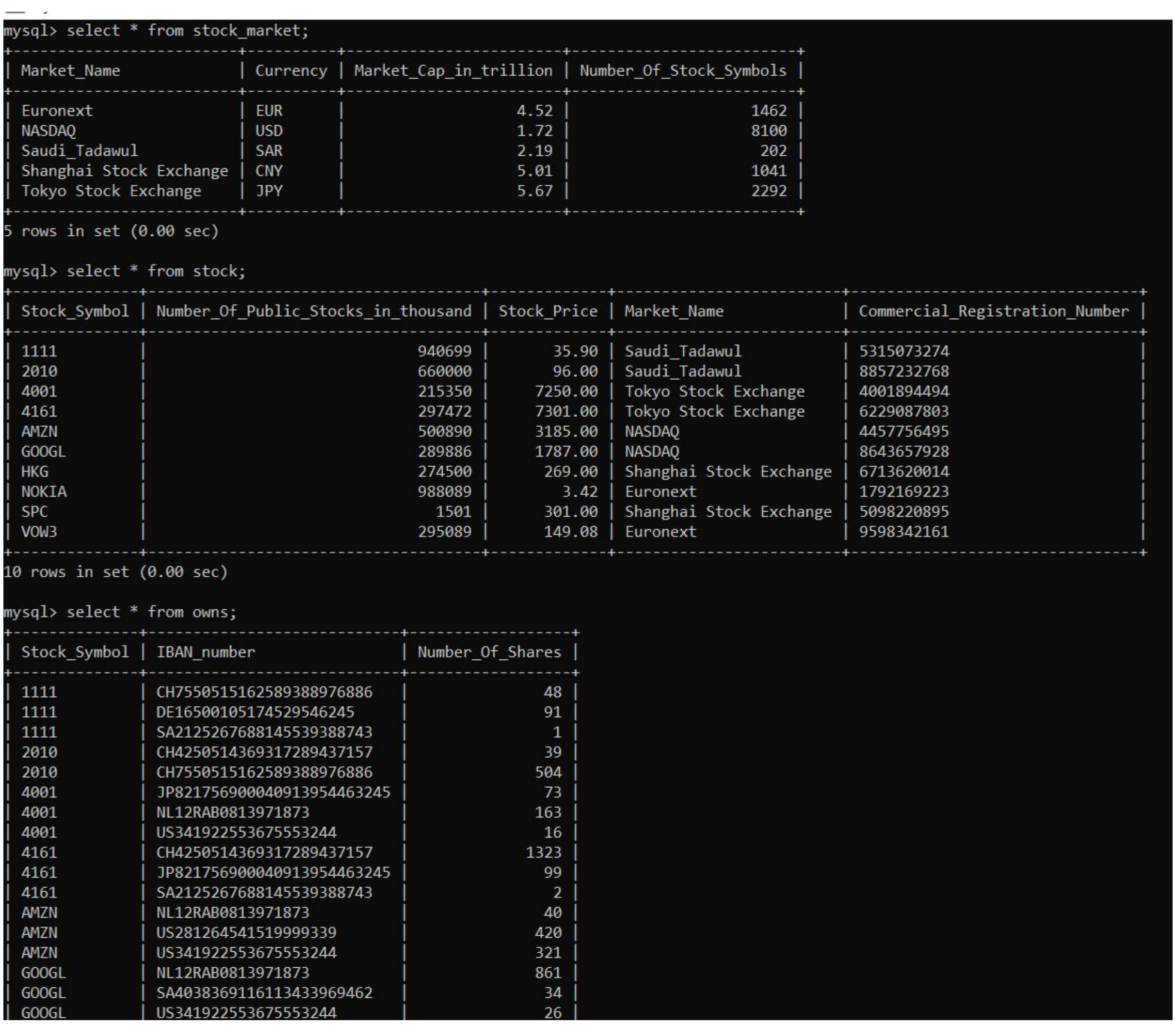


```
+-------------------------+----------+---------------------+------------------------+
| Market_Name             | Currency | Market_Cap_in_trillion | Number_Of_Stock_Symbols |
+-------------------------+----------+---------------------+------------------------+
| Euronext                | EUR      |                4.52 |                   1462 |
| NASDAQ                  | USD      |                1.72 |                   8100 |
| Shanghai Stock Exchange | CNY      |                5.01 |                   1041 |
| Tadawul                 | SAR      |                2.19 |                    202 |
| Tokyo Stock Exchange    | JPY      |                5.67 |                   2292 |
+-------------------------+----------+---------------------+------------------------+
5 rows in set (0.00 sec)

mysql> select * from stock;
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
| Stock_Symbol | Number_Of_Public_Stocks_in_thousand | Stock_Price | Market_Name             | Commercial_Registration_Number |
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
| 2010         |                              660000 |       96.00 | Tadawul                 | 8857232768                     |
| 2222         |                              940699 |       35.90 | Tadawul                 | 5315073274                     |
| 4001         |                              215350 |     7250.00 | Tokyo Stock Exchange    | 4001894494                     |
| 4161         |                              297472 |     7301.00 | Tokyo Stock Exchange    | 6229087803                     |
| AMZN         |                              500890 |     3185.00 | NASDAQ                  | 4457756495                     |
| GOOGL        |                              289886 |     1787.00 | NASDAQ                  | 8643657928                     |
| HKG          |                              274500 |      269.00 | Shanghai Stock Exchange | 6713620014                     |
| NOKIA        |                              988089 |        3.42 | Euronext                | 1792169223                     |
| SPC          |                                1501 |      301.00 | Shanghai Stock Exchange | 5098220895                     |
| VOW3         |                              295089 |      149.08 | Euronext                | 9598342161                     |
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
10 rows in set (0.00 sec)

mysql> select * from owns;
+--------------+----------------------------+------------------+
| Stock_Symbol | IBAN_number                | Number_Of_Shares |
+--------------+----------------------------+------------------+
| 2010         | CH4250514369317289437157   |               39 |
| 2010         | CH7550515162589388976886   |              504 |
| 2222         | CH7550515162589388976886   |               48 |
| 2222         | DE16500105174529546245     |               91 |
| 2222         | SA2125267688145539388743   |                1 |
| 4001         | JP821756900040913954463245 |               73 |
| 4001         | NL12RAB0813971873          |              163 |
| 4001         | US341922553675553244       |               16 |
| 4161         | CH4250514369317289437157   |             1323 |
| 4161         | JP821756900040913954463245 |               99 |
| 4161         | SA2125267688145539388743   |                2 |
| AMZN         | NL12RAB0813971873          |               40 |
| AMZN         | US281264541519999339       |              420 |
| AMZN         | US341922553675553244       |              321 |
| GOOGL        | NL12RAB0813971873          |              861 |
| GOOGL        | SA4038369116113433969462   |               34 |
| GOOGL        | US341922553675553244       |               26 |
```



```
mysql> update stock_market set Market_Name="Saudi_Tadawul" where Market_Name="Tadawul";
Query OK, 1 row affected (0.01 sec)
Rows matched: 1  Changed: 1  Warnings: 0

mysql> update stock set Stock_Symbol="1111" where Stock_Symbol="2222";
Query OK, 1 row affected (0.01 sec)
Rows matched: 1  Changed: 1  Warnings: 0
```

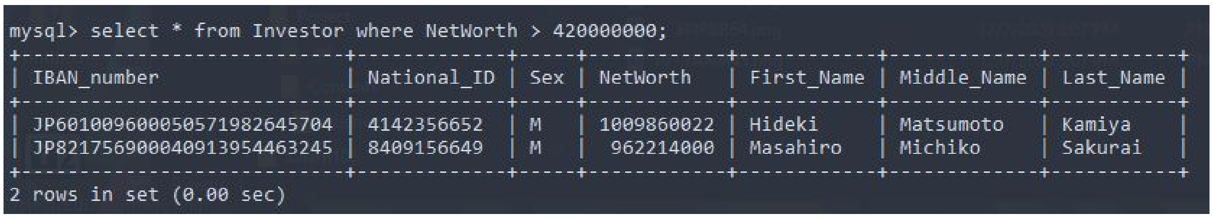
We can see that the database preformed cascade update successfully



```
mysql> select * from stock_market;
+-------------------------+----------+------------------------+--------------------------+
| Market_Name             | Currency | Market_Cap_in_trillion | Number_Of_Stock_Symbols  |
+-------------------------+----------+------------------------+--------------------------+
| Euronext                | EUR      |                   4.52 |                     1462 |
| NASDAQ                  | USD      |                   1.72 |                     8100 |
| Saudi_Tadawul           | SAR      |                   2.19 |                      202 |
| Shanghai Stock Exchange | CNY      |                   5.01 |                     1041 |
| Tokyo Stock Exchange    | JPY      |                   5.67 |                     2292 |
+-------------------------+----------+------------------------+--------------------------+
5 rows in set (0.00 sec)

mysql> select * from stock;
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
| Stock_Symbol | Number_Of_Public_Stocks_in_thousand | Stock_Price | Market_Name             | Commercial_Registration_Number |
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
| 1111         |                              940699 |       35.90 | Saudi_Tadawul           | 5315073274                     |
| 2010         |                              660000 |       96.00 | Saudi_Tadawul           | 8857232768                     |
| 4001         |                              215350 |     7250.00 | Tokyo Stock Exchange    | 4001894494                     |
| 4161         |                              297472 |     7301.00 | Tokyo Stock Exchange    | 6229087803                     |
| AMZN         |                              500890 |     3185.00 | NASDAQ                  | 4457756495                     |
| GOOGL        |                              289886 |     1787.00 | NASDAQ                  | 8643657928                     |
| HKG          |                              274500 |      269.00 | Shanghai Stock Exchange | 6713620014                     |
| NOKIA        |                              988089 |        3.42 | Euronext                | 1792169223                     |
| SPC          |                                1501 |      301.00 | Shanghai Stock Exchange | 5098220895                     |
| VOW3         |                              295089 |      149.08 | Euronext                | 9598342161                     |
+--------------+-------------------------------------+-------------+-------------------------+--------------------------------+
10 rows in set (0.00 sec)

mysql> select * from owns;
+--------------+----------------------------+------------------+
| Stock_Symbol | IBAN_number                | Number_Of_Shares |
+--------------+----------------------------+------------------+
| 1111         | CH7550515162589388976886   |               48 |
| 1111         | DE16500105174529546245     |               91 |
| 1111         | SA2125267688145539388743   |                1 |
| 2010         | CH4250514369317289437157   |               39 |
| 2010         | CH7550515162589388976886   |              504 |
| 4001         | JP821756900040913954463245 |               73 |
| 4001         | NL12RAB0813971873          |              163 |
| 4001         | US341922553675553244       |               16 |
| 4161         | CH4250514369317289437157   |             1323 |
| 4161         | JP821756900040913954463245 |               99 |
| 4161         | SA2125267688145539388743   |                2 |
| AMZN         | NL12RAB0813971873          |               40 |
| AMZN         | US281264541519999339       |              420 |
| AMZN         | US341922553675553244       |              321 |
| GOOGL        | NL12RAB0813971873          |              861 |
| GOOGL        | SA4038369116113433969462   |               34 |
| GOOGL        | US341922553675553244       |               26 |
```

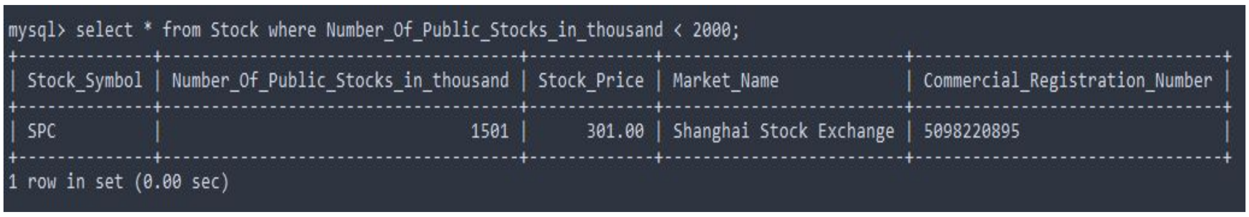
Queries Implementation in SQL

1



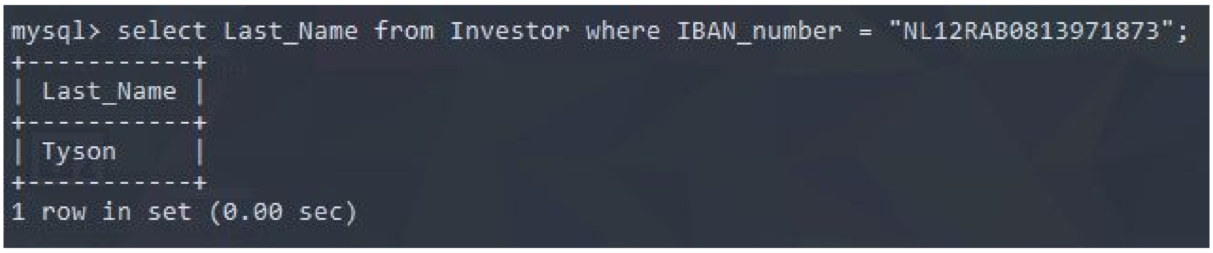
```
mysql> select * from Investor where NetWorth > 420000000;
+----------------------------+-------------+-----+------------+------------+-------------+-----------+
| IBAN_number                | National_ID | Sex | NetWorth   | First_Name | Middle_Name | Last_Name |
+----------------------------+-------------+-----+------------+------------+-------------+-----------+
| JP601009600050571982645704 | 4142356652  | M   | 1009860022 | Hideki     | Matsumoto   | Kamiya    |
| JP821756900040913954463245 | 8409156649  | M   |  962214000 | Masahiro   | Michiko     | Sakurai   |
+----------------------------+-------------+-----+------------+------------+-------------+-----------+
2 rows in set (0.00 sec)
```

2



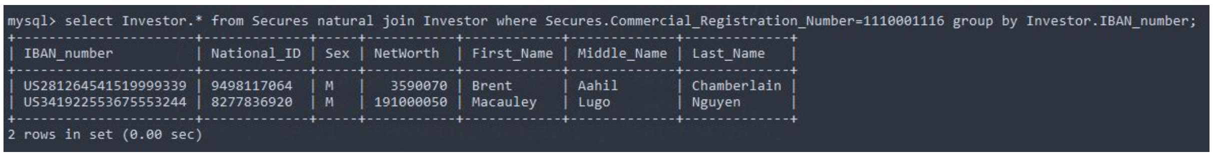
```
mysql> select * from Stock where Number_Of_Public_Stocks_in_thousand < 2000;
+--------------+-------------------------------------+-------------+------------------------+--------------------------------+
| Stock_Symbol | Number_Of_Public_Stocks_in_thousand | Stock_Price | Market_Name            | Commercial_Registration_Number |
+--------------+-------------------------------------+-------------+------------------------+--------------------------------+
| SPC          |                                1501 |      301.00 | Shanghai Stock Exchange | 5098220895                    |
+--------------+-------------------------------------+-------------+------------------------+--------------------------------+
1 row in set (0.00 sec)
```

3



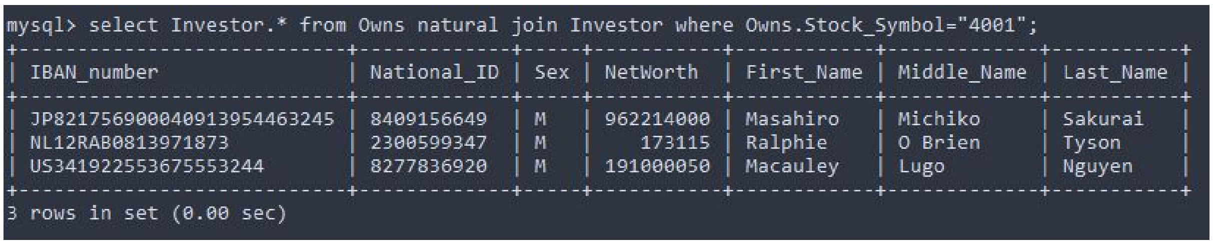
```
mysql> select Last_Name from Investor where IBAN_number = "NL12RAB0813971873";
+-----------+
| Last_Name |
+-----------+
| Tyson     |
+-----------+
1 row in set (0.00 sec)
```

4



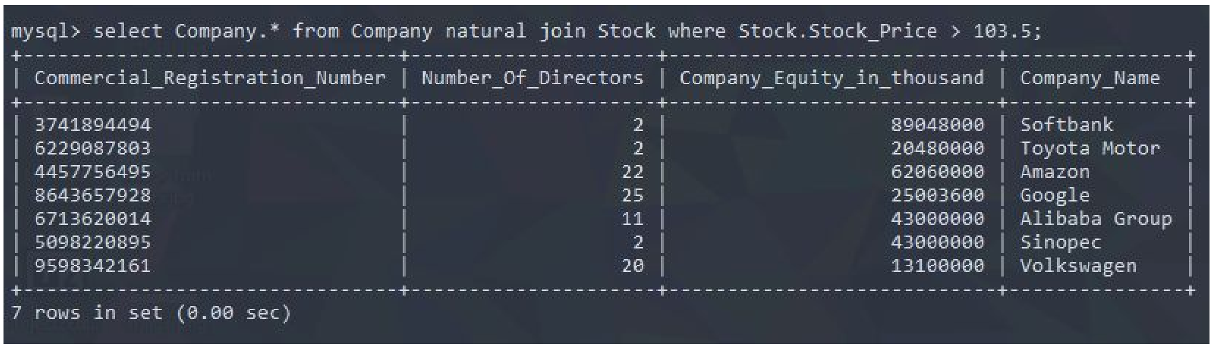
```
mysql> select Investor.* from Secures natural join Investor where Secures.Commercial_Registration_Number=1110001116 group by Investor.IBAN_number;
+----------------------+-------------+-----+-----------+------------+-------------+------------+
| IBAN_number          | National_ID | Sex | NetWorth  | First_Name | Middle_Name | Last_Name  |
+----------------------+-------------+-----+-----------+------------+-------------+------------+
| US281264541519999339 | 9498117064  | M   |   3590070 | Brent      | Aahil       | Chamberlain |
| US341922553675553244 | 8277836920  | M   | 191000050 | Macauley   | Lugo        | Nguyen     |
+----------------------+-------------+-----+-----------+------------+-------------+------------+
2 rows in set (0.00 sec)
```

5



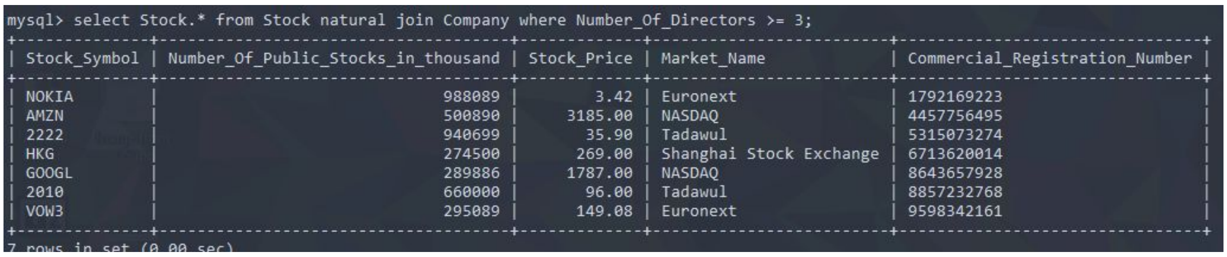
```
mysql> select Investor.* from Owns natural join Investor where Owns.Stock_Symbol="4001";
+----------------------------+-------------+-----+-----------+------------+-------------+-----------+
| IBAN_number                | National_ID | Sex | NetWorth  | First_Name | Middle_Name | Last_Name |
+----------------------------+-------------+-----+-----------+------------+-------------+-----------+
| JP821756900040913954463245 | 8409156649  | M   | 962214000 | Masahiro   | Michiko     | Sakurai   |
| NL12RAB0813971873          | 2300599347  | M   |    173115 | Ralphie    | O Brien     | Tyson     |
| US341922553675553244       | 8277836920  | M   | 191000050 | Macauley   | Lugo        | Nguyen    |
+----------------------------+-------------+-----+-----------+------------+-------------+-----------+
3 rows in set (0.00 sec)
```

6



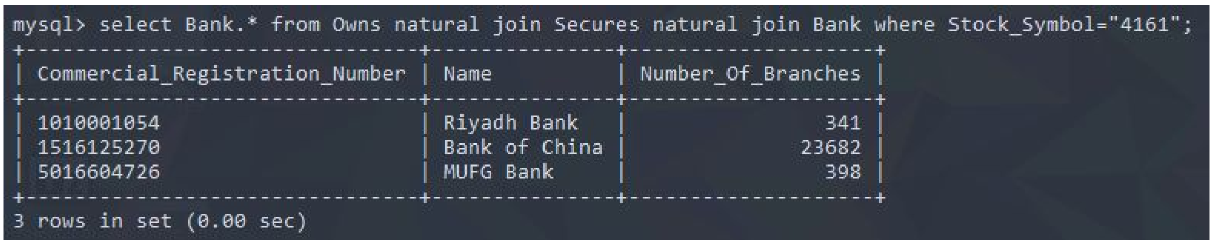
```
mysql> select Company.* from Company natural join Stock where Stock.Stock_Price > 103.5;
+--------------------------------+---------------------+------------------------------+---------------+
| Commercial_Registration_Number | Number_Of_Directors | Company_Equity_in_thousand   | Company_Name  |
+--------------------------------+---------------------+------------------------------+---------------+
| 3741894494                     |                   2 |                     89048000 | Softbank      |
| 6229087803                     |                   2 |                     20480000 | Toyota Motor  |
| 4457756495                     |                  22 |                     62060000 | Amazon        |
| 8643657928                     |                  25 |                     25003600 | Google        |
| 6713620014                     |                  11 |                     43000000 | Alibaba Group |
| 5098220895                     |                   2 |                     43000000 | Sinopec       |
| 9598342161                     |                  20 |                     13100000 | Volkswagen    |
+--------------------------------+---------------------+------------------------------+---------------+
7 rows in set (0.00 sec)
```

7



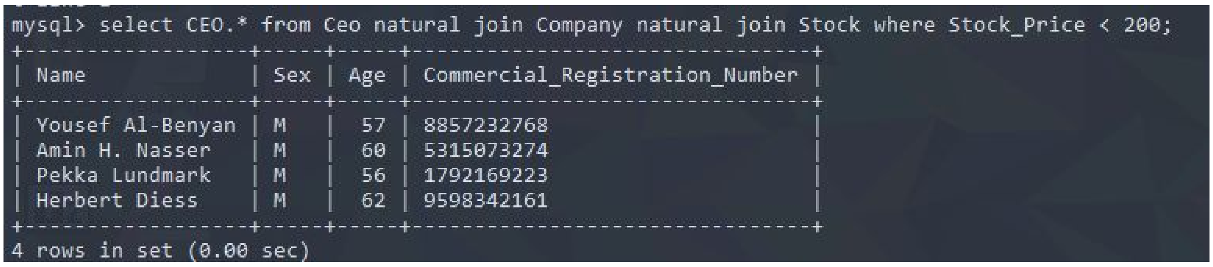
```
mysql> select Stock.* from Stock natural join Company where Number_Of_Directors >= 3;
+--------------+-----------------------------------+-------------+--------------------------+-------------------------------+
| Stock_Symbol | Number_Of_Public_Stocks_in_thousand | Stock_Price | Market_Name              | Commercial_Registration_Number |
+--------------+-----------------------------------+-------------+--------------------------+-------------------------------+
| NOKIA        |                            988089 |        3.42 | Euronext                 | 1792169223                    |
| AMZN         |                            500890 |     3185.00 | NASDAQ                   | 4457756495                    |
| 2222         |                            940699 |       35.90 | Tadawul                  | 5315073274                    |
| HKG          |                            274500 |      269.00 | Shanghai Stock Exchange  | 6713620014                    |
| GOOGL        |                            289886 |     1787.00 | NASDAQ                   | 8643657928                    |
| 2010         |                            660000 |       96.00 | Tadawul                  | 8857232768                    |
| VOW3         |                            295089 |      149.08 | Euronext                 | 9598342161                    |
+--------------+-----------------------------------+-------------+--------------------------+-------------------------------+
7 rows in set (0.00 sec)
```

8



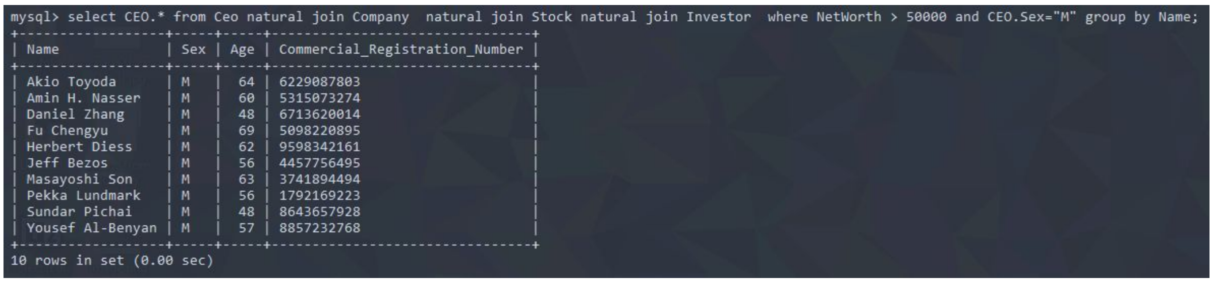
```
mysql> select Bank.* from Owns natural join Secures natural join Bank where Stock_Symbol="4161";
+--------------------------------+---------------+--------------------+
| Commercial_Registration_Number | Name          | Number_Of_Branches |
+--------------------------------+---------------+--------------------+
| 1010001054                     | Riyadh Bank   |                341 |
| 1516125270                     | Bank of China |              23682 |
| 5016604726                     | MUFG Bank     |                398 |
+--------------------------------+---------------+--------------------+
3 rows in set (0.00 sec)
```

9



```
mysql> select CEO.* from Ceo natural join Company natural join Stock where Stock_Price < 200;
+-----------------+-----+-----+--------------------------------+
| Name            | Sex | Age | Commercial_Registration_Number |
+-----------------+-----+-----+--------------------------------+
| Yousef Al-Benyan | M   |  57 | 8857232768                     |
| Amin H. Nasser  | M   |  60 | 5315073274                     |
| Pekka Lundmark  | M   |  56 | 1792169223                     |
| Herbert Diess   | M   |  62 | 9598342161                     |
+-----------------+-----+-----+--------------------------------+
4 rows in set (0.00 sec)
```

10



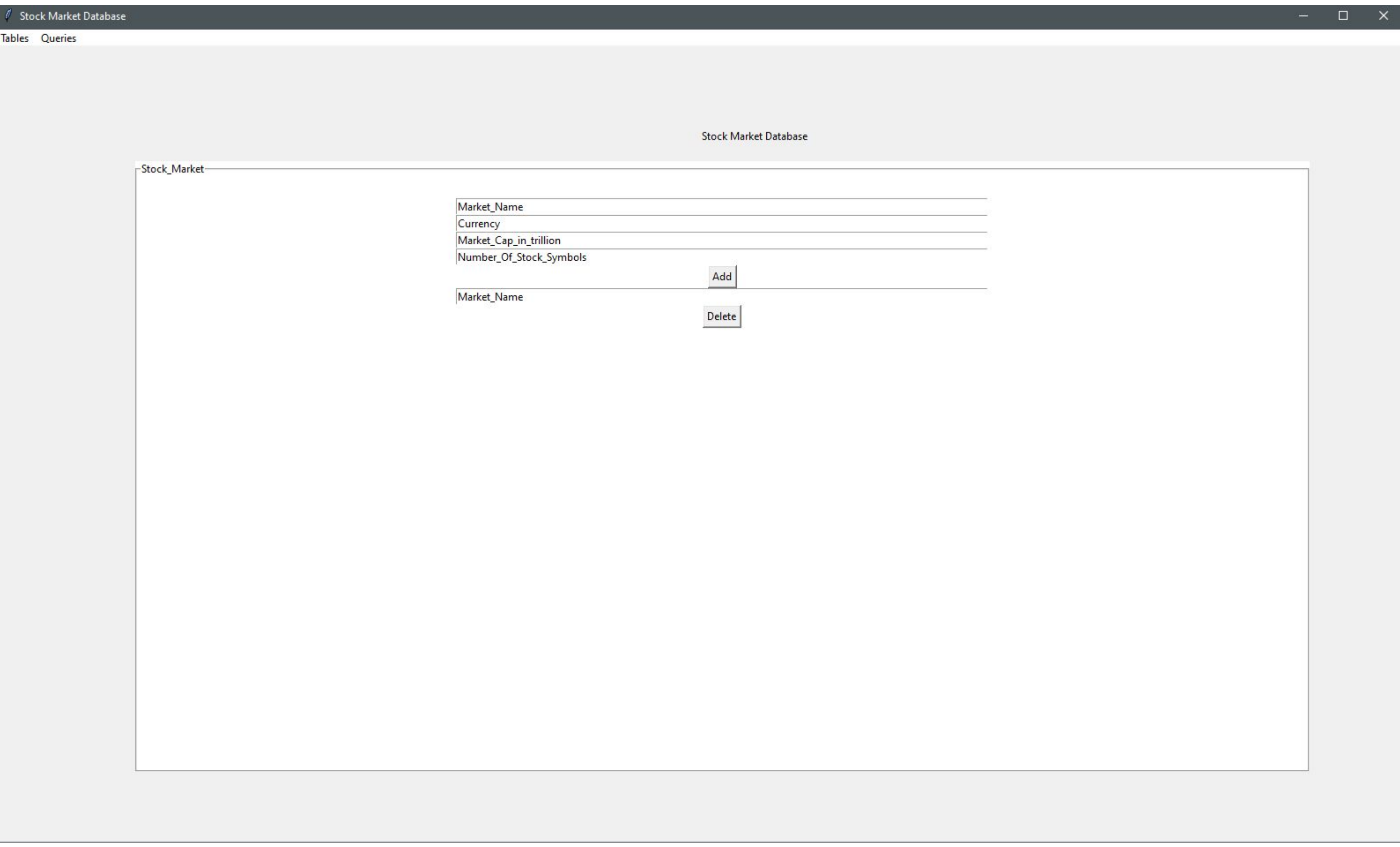
```
mysql> select CEO.* from Ceo natural join Company  natural join Stock natural join Investor  where NetWorth > 50000 and CEO.Sex="M" group by Name;
+------------------+-----+-----+--------------------------------+
| Name             | Sex | Age | Commercial_Registration_Number |
+------------------+-----+-----+--------------------------------+
| Akio Toyoda      | M   |  64 | 6229087803                     |
| Amin H. Nasser   | M   |  60 | 5315073274                     |
| Daniel Zhang     | M   |  48 | 6713620014                     |
| Fu Chengyu       | M   |  69 | 5098220895                     |
| Herbert Diess    | M   |  62 | 9598342161                     |
| Jeff Bezos       | M   |  56 | 4457756495                     |
| Masayoshi Son    | M   |  63 | 3741894494                     |
| Pekka Lundmark   | M   |  56 | 1792169223                     |
| Sundar Pichai    | M   |  48 | 8643657928                     |
| Yousef Al-Benyan | M   |  57 | 8857232768                     |
+------------------+-----+-----+--------------------------------+
10 rows in set (0.00 sec)
```

SQL Code

```sql
create database Stock_Exchange;

        use Stock_Exchange;

        create table Stock_Market(
                Market_Name varchar(100),
                Currency char(3) not null,
                Market_Cap_in_trillion decimal(3,2),
                Number_Of_Stock_Symbols int,

                constraint Market_Name_PK primary key(Market_Name),
                constraint Currency_Check check(Currency like "___")
                );

        create table Company(
                Commercial_Registration_Number varchar(100),
                Number_Of_Directors int,
                Company_Equity_in_thousand int,
                Company_Name varchar(50) not null,

                constraint Commercial_Registration_Number_PK primary key(Commercial_Registration_Number),
                constraint Number_Of_Directors_Check check(Number_Of_Directors >= 1)
                );

        create table Investor(
                IBAN_number varchar(100),
                National_ID varchar(50) not null,
                Sex char(1) not null,
                NetWorth int,
                First_Name varchar(20) not null,
                Middle_Name varchar(20) not null,
                Last_Name varchar(20) not null,

                constraint IBAN_number_PK primary key(IBAN_number)
                );

        create table Bank(
                Commercial_Registration_Number varchar(100),
                Name varchar(50) not null,
                Number_Of_Branches int,

                constraint Commercial_Registration_Number_PK primary key(Commercial_Registration_Number),
                constraint Number_Of_Branches_Check check(Number_Of_Branches >= 1)
                );

        create table Stock(
                Stock_Symbol varchar(10),
                Number_Of_Public_Stocks_in_thousand int,
                Stock_Price decimal(8,2),
                Market_Name varchar(100),
                Commercial_Registration_Number varchar(100),

                constraint Stock_Symbol_PK primary key(Stock_Symbol),
                constraint Market_Name_FK foreign key(Market_Name) references Stock_Market(Market_Name) on
delete cascade on update cascade,
                constraint Commercial_Registration_Number_FK1 foreign key(Commercial_Registration_Number)
references Company(Commercial_Registration_Number) on delete cascade on update cascade
                );

        create table CEO(
                Name varchar(100),
                Sex char(1) not null,
                Age int not null,
                Commercial_Registration_Number varchar(100),

                constraint Compound_PK primary key(Name , Commercial_Registration_Number),
                constraint Commercial_Registration_Number_FK2 foreign key(Commercial_Registration_Number)
references Company(Commercial_Registration_Number) on update cascade on delete cascade,
                constraint Age_Check check(Age >= 23)
                );

        create table Secures(
                Stock_Symbol varchar(10),
                IBAN_number varchar(100),
                Commercial_Registration_Number varchar(100),

                constraint Compound_PK primary key(Stock_Symbol , IBAN_number ,
Commercial_Registration_Number),
                constraint Stock_Symbol_FK foreign key(Stock_Symbol) references Stock(Stock_Symbol) on update
cascade on delete cascade,
                constraint IBAN_number_FK foreign key(IBAN_number) references Investor(IBAN_number) on update
cascade on delete cascade,
                constraint Commercial_Registration_Number_FK3 foreign key(Commercial_Registration_Number)
references Bank(Commercial_Registration_Number) on update cascade on delete cascade
                );

        create table Owns(
                Stock_Symbol varchar(10),
                IBAN_number varchar(100),
                Number_Of_Shares int,

                constraint Compound_PK primary key(Stock_Symbol , IBAN_number),
                constraint Stock_Symbol_FK2 foreign key(Stock_Symbol) references Stock(Stock_Symbol) on update
cascade on delete cascade,
                constraint IBAN_number_FK2 foreign key(IBAN_number) references Investor(IBAN_number) on update
cascade on delete cascade
                );

        insert into Stock_Market(
                Market_Name,
                Currency,
                Market_Cap_in_trillion,
                Number_Of_Stock_Symbols
                ) values
                ("NASDAQ", "USD",  1.72,  8100),
                ("Tadawul", "SAR",  2.19,  202),
                ("Tokyo Stock Exchange", "JPY",  5.67,  2292),
                ("Euronext", "EUR",  4.52,  1462),
                ("Shanghai Stock Exchange", "CNY",  5.01,  1041);

        insert into Investor(
                IBAN_number,
                National_ID,
                Sex,
                NetWorth,
                First_Name,
                Middle_Name,
                Last_Name
                ) values
                ('US281264541519999339','9498117064','M',3590070,'Brent','Aahil','Chamberlain'),
                ('DE16500105174529546245','2126117000','M',99801000,'Andreas ','Sheikh ','Perez'),
                ('US341922553675553244','8277836920','M',191000050,'Macauley','Lugo','Nguyen'),
                ('JP821756900040913954463245','8409156649','M',962214000,'Masahiro ','Michiko ','Sakurai'),
                ('JP601009600050571982645704','4142356652','M',1009860022,'Hideki','Matsumoto','Kamiya'),
                ('CH4250514369317289437157','7734693388','M',5156,'Li','Dong','Brody'),
                ('CH7550515162589388976886','4992719807','M',39059,'Bo','Zhou','Galindo'),
                ('SA2125267688145539388743','1304026480','M',358630,'Abdo','Saad','Husain'),
                ('SA4038369116113433969462','1011353190','M',459174,'Abdullah','Mohammed','Hamed'),
                ('NL12RAB0813971873','2300599347','M',173115,'Ralphie','O Brien','Tyson');


        insert into Bank(
                Commercial_Registration_Number,
                Name,
                Number_Of_Branches
                ) values
                ('1110001116','New York Community Bank',255),
                ('1010001054','Riyadh Bank',341),
                ('5016604726','MUFG Bank',398),
                ('2311911035','HSBC',4000),
                ('1516125270','Bank of China',23682);
```

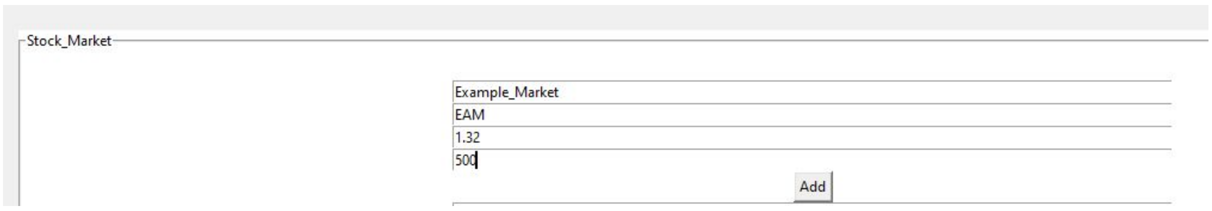
```sql
insert into Company(
         Commercial_Registration_Number,
         Number_Of_Directors,
         Company_Equity_in_thousand,
         Company_Name
         ) values
         ('4457756495',22,62060000,'Amazon'),
         ('5315073274',11,39800000,'Saudi Aramco'),
         ('6229087803',2,20480000,'Toyota Motor'),
         ('9598342161',20,13100000,'Volkswagen'),
         ('6713620014',11,43000000,'Alibaba Group'),
         ('8643657928',25,25003600,'Google'),
         ('8857232768',13,70000000,'SABIC'),
         ('1792169223',17,30310000,'Nokia'),
         ('5098220895',2,43000000,'Sinopec'),
         ('4001894494',2,89048000,'Softbank');


insert into CEO(
         Name,
         Sex,
         Age,
         Commercial_Registration_Number
         ) values
         ('Jeff Bezos','M',56,'4457756495'),
         ('Amin H. Nasser','M',60,'5315073274'),
         ('Akio Toyoda','M',64,'6229087803'),
         ('Herbert Diess','M',62,'9598342161'),
         ('Daniel Zhang','M',48,'6713620014'),
         ('Sundar Pichai','M',48,'8643657928'),
         ('Yousef Al-Benyan','M',57,'8857232768'),
         ('Pekka Lundmark','M',56,'1792169223'),
         ('Fu Chengyu','M',69,'5098220895'),
         ('Masayoshi Son','M',63,'4001894494');


insert into Stock(
         Stock_Symbol,
         Number_Of_Public_Stocks_in_thousand,
         Stock_Price,
         Market_Name,
         Commercial_Registration_Number
         ) values
         ('AMZN',500890,3185,'NASDAQ','4457756495'),
         ('2222',940699,35.9,'Tadawul','5315073274'),
         ('4161',297472,7301,'Tokyo Stock Exchange','6229087803'),
         ('VOW3',295089,149.08,'Euronext','9598342161'),
         ('HKG',274500,269,'Shanghai Stock Exchange','6713620014'),
         ('GOOGL',289886,1787,'NASDAQ','8643657928'),
         ('2010',660000,96,'Tadawul','8857232768'),
         ('4001',215350,7250,'Tokyo Stock Exchange','4001894494'),
         ('NOKIA',988089,3.42,'Euronext','1792169223'),
         ('SPC',1501,301,'Shanghai Stock Exchange','5098220895');

insert into Owns(
         Stock_Symbol,
         IBAN_number,
         Number_Of_Shares
         ) values
         ("AMZN", "US281264541519999339",  420),
         ("AMZN", "US341922553675553244",  321),
         ("AMZN", "NL12RAB0813971873",  40),
         ("2222", "SA2125267688145539388743",  1),
         ("2222", "DE16500105174529546245",  91),
         ("2222", "CH7550515162589388976886",  48),
         ("4161", "SA2125267688145539388743",  2),
         ("4161", "CH4250514369317289437157",  1323),
         ("4161", "JP821756900040913954463245",  99),
         ("VOW3", "CH7550515162589388976886",  123),
         ("VOW3", "US341922553675553244",  2311),
         ("VOW3", "DE16500105174529546245",  1053),
         ("HKG", "JP6010096000505719826457O4",  9),
          ("HKG", "SA4038369116113433969462",  32),
          ("HKG", "JP82175690004091395446 3245",  1942),
          ("GOOGL", "US341922553675553244",  26),
          ("GOOGL", "NL12RAB0813971873",  861),
          ("GOOGL", "SA4038369116113433969462",  34),
          ("2010", "CH4250514369317289437157",  39),
          ("2010", "CH7550515162589388976886",  504),
          ("4001", "JP8217569000409139544632 45",  73),
          ("4001", "NL12RAB0813971873",  163),
          ("4001", "US341922553675553244",  16),
          ("NOKIA", "JP6010096000505719826457 04",  19),
          ("NOKIA", "SA2125267688145539388743",  3),
          ("NOKIA", "DE16500105174529546245",  51),
          ("SPC", "CH7550515162589388976886",  342),
          ("SPC", "DE16500105174529546245",  4),
          ("SPC", "SA2125267688145539388743",  999);


insert into Secures(
          Stock_Symbol,
          IBAN_number,
          Commercial_Registration_Number
          ) values
          ("AMZN", "US281264541519999339", "1110001116"),
          ("AMZN", "US341922553675553244", "1110001116"),
          ("AMZN", "NL12RAB0813971873", "2311911035"),
          ("2222", "SA2125267688145539388743", "1010001054"),
          ("2222", "DE16500105174529546245", "2311911035"),
          ("2222", "CH7550515162589388976886", "1516125270"),
          ("4161", "SA2125267688145539388743", "1010001054"),
          ("4161", "CH4250514369317289437157", "1516125270"),
          ("4161", "JP8217569000409139544632 45", "5016604726"),
          ("VOW3", "CH7550515162589388976886", "1516125270"),
          ("VOW3", "US341922553675553244", "1110001116"),
          ("VOW3", "DE16500105174529546245", "2311911035"),
          ("HKG", "JP6010096000505719826457 04", "5016604726"),
          ("HKG", "SA4038369116113433969462", "1010001054"),
          ("HKG", "JP8217569000409139544632 45", "5016604726"),
          ("GOOGL", "US341922553675553244", "1110001116"),
          ("GOOGL", "NL12RAB0813971873", "1010001054"),
          ("GOOGL", "SA4038369116113433969462", "2311911035"),
          ("2010", "CH4250514369317289437157", "5016604726"),
          ("2010", "CH7550515162589388976886", "1516125270"),
          ("4001", "JP8217569000409139544632 45", "1010001054"),
          ("4001", "NL12RAB0813971873", "2311911035"),
          ("4001", "US341922553675553244", "5016604726"),
          ("NOKIA", "JP6010096000505719826457 04", "2311911035"),
          ("NOKIA", "SA2125267688145539388743", "1010001054"),
          ("NOKIA", "DE16500105174529546245", "2311911035"),
          ("SPC", "CH7550515162589388976886", "1516125270"),
          ("SPC", "DE16500105174529546245", "1010001054"),
          ("SPC", "SA2125267688145539388743", "1010001054");

-- Querie
 select * from Investor where NetWorth > 420000000;
select * from Stock where Number_Of_Public_Stocks_in_thousand < 2000;
select Last_Name from Investor where IBAN_number = "NL12RAB0813971873";
select Investor.* from Secures natural join Investor
  where Secures.Commercial_Registration_Number=1110001116 group by Investor.IBAN_number;
select Investor.* from Owns natural join Investor where Owns.Stock_Symbol="4001";
select Company.* from Company natural join Stock where Stock.Stock_Price > 103.5;
select Stock.* from Stock natural join Company where Number_Of_Directors >= 3;
select Bank.* from Owns natural join Secures natural join Bank where Stock_Symbol="4161";
select CEO.* from CEO natural join Company natural join Stock where Stock_Price < 200;
select CEO.* from CEO natural join Company
  natural join Stock natural join Investor
  where NetWorth > 50000 and CEO.Sex="M" group by Name;
```

Graphical User Interface (GUI)



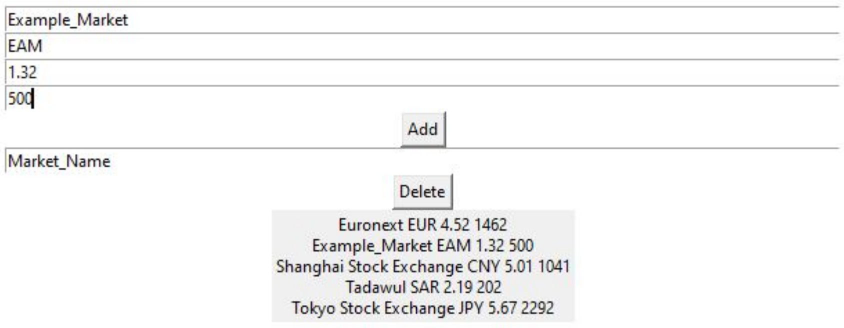
Addition And Deletion

We can add and delete using the GUI, for example we will be adding a new *Stock_Market* tuple



Example_Market
EAM
1.32
500

After pressing `Add` the GUI displays our results (our tuple is the second one)

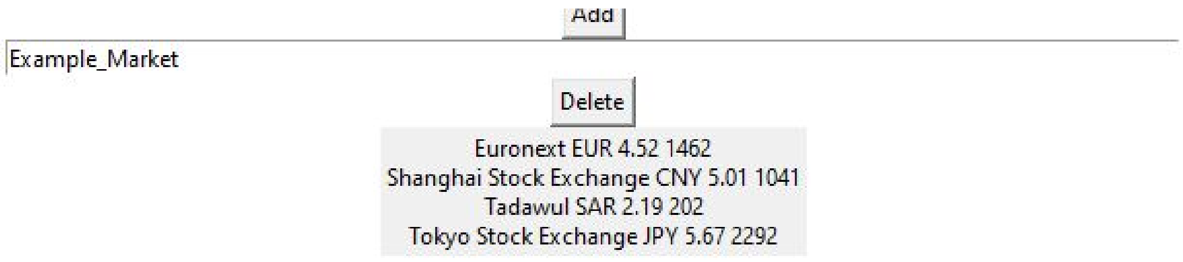


Example_Market
EAM
1.32
500

Market_Name

```
Euronext EUR 4.52 1462
Example_Market EAM 1.32 500
Shanghai Stock Exchange CNY 5.01 1041
Tadawul SAR 2.19 202
Tokyo Stock Exchange JPY 5.67 2292
```

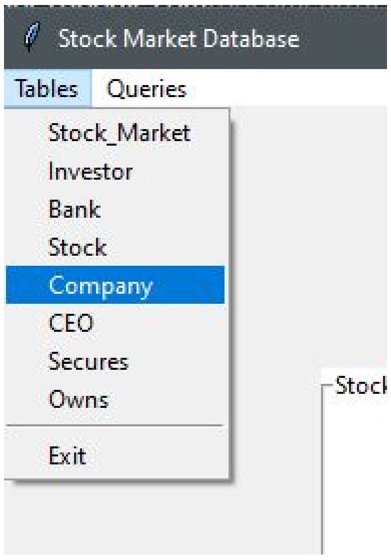
We can also delete the tuple by entering the Primary key of the tuple (*Market_Name*) and then clicking delete and seeing the results (The example market has been deleted!)



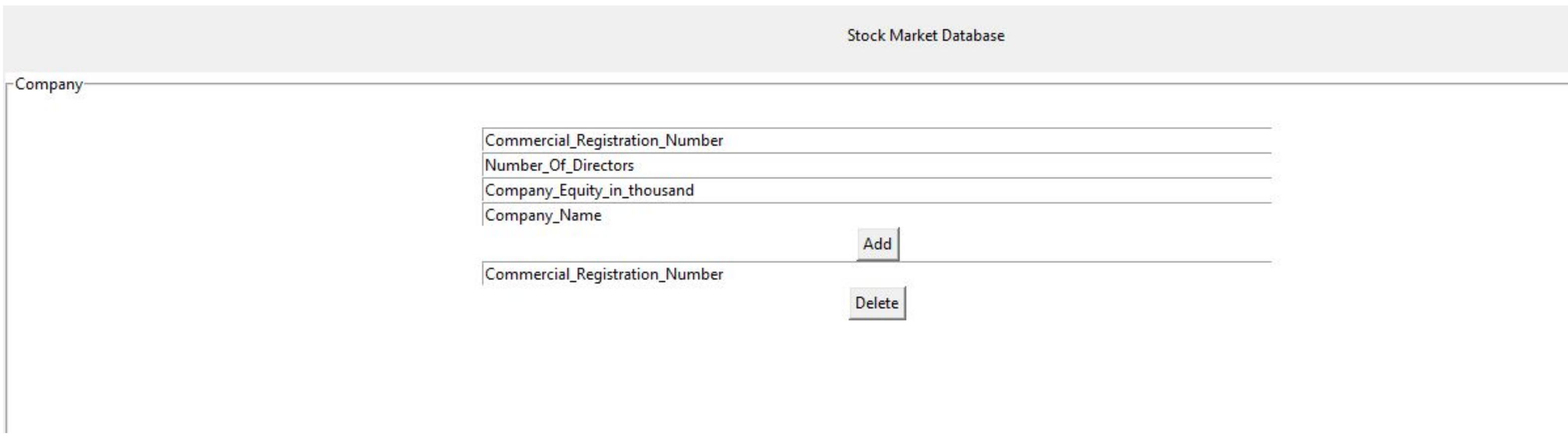
Example_Market

```
Euronext EUR 4.52 1462
Shanghai Stock Exchange CNY 5.01 1041
Tadawul SAR 2.19 202
Tokyo Stock Exchange JPY 5.67 2292
```

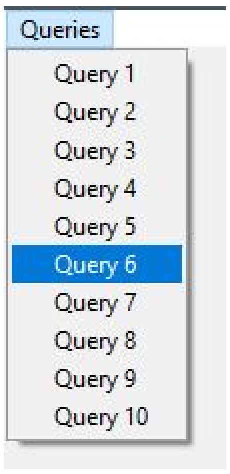
We can Add and delete for all tables, in the upper left corner we can change tables (Let’s choose *Company*)



We can see that the GUI has updated to *Company*'s attributes. From there we can also add and delete

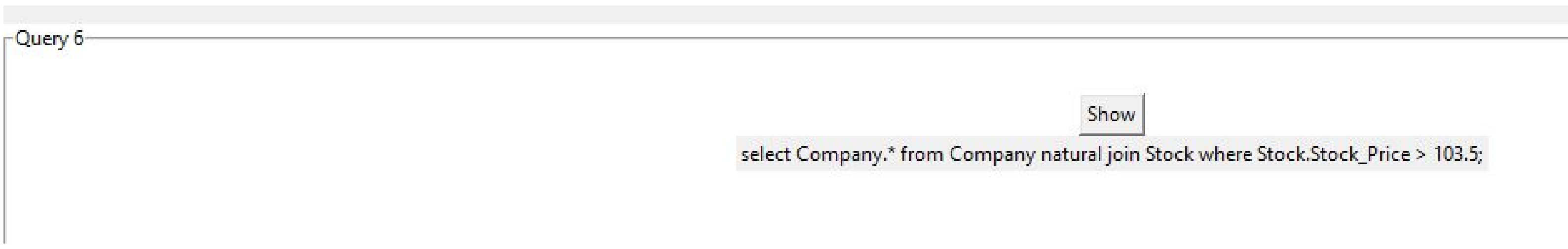

Stock Market Database
Company
Commercial_Registration_Number
Number_Of_Directors
Company_Equity_in_thousand
Company_Name
Add
Commercial_Registration_Number
Delete

Preset Queries



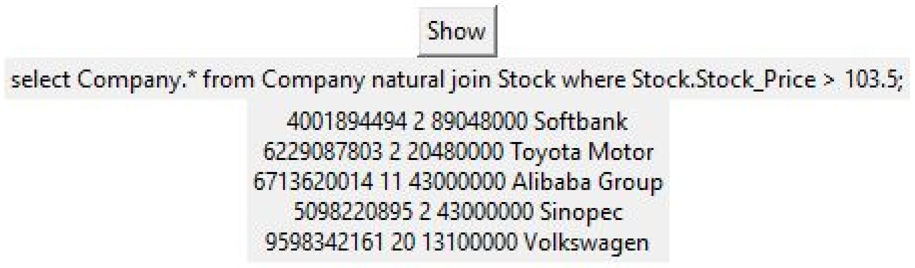
From the upper left corner we can choose preset queries (these ten are the ones we included above in the document). Let's click Query 6

We can see Query 6's command. Let's click show (which will fetch results from out DB)



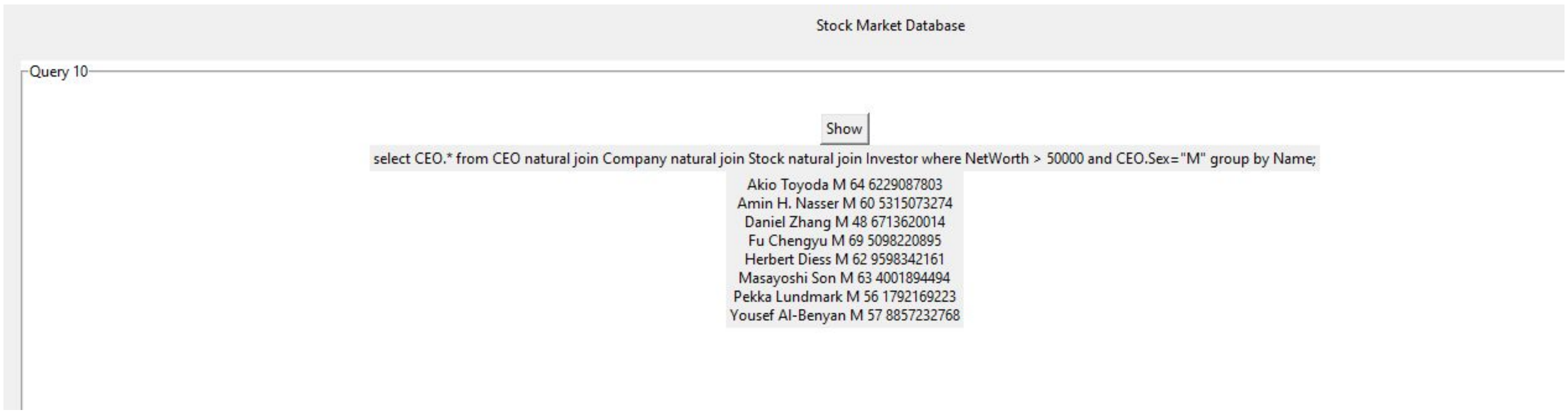
```
select Company.* from Company natural join Stock where Stock.Stock_Price > 103.5;
```

We can see that the GUI shows the results of executing this command



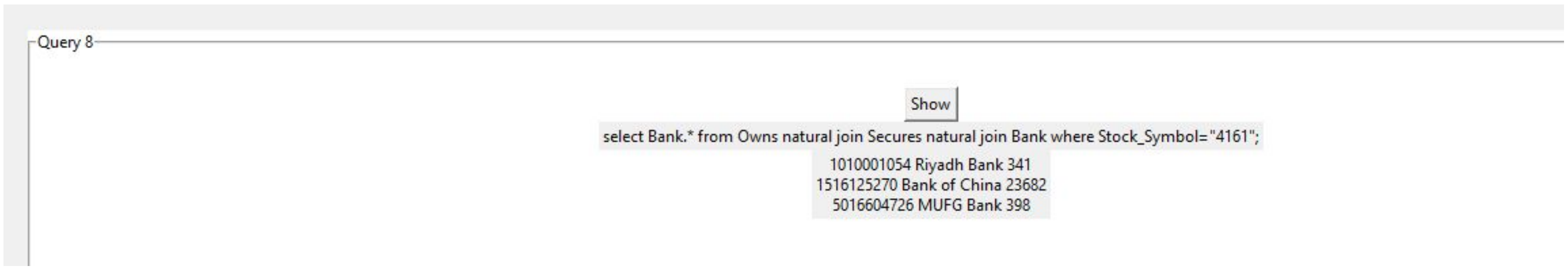
```
select Company.* from Company natural join Stock where Stock.Stock_Price > 103.5;
4001894494 2 89048000 Softbank
6229087803 2 20480000 Toyota Motor
6713620014 11 43000000 Alibaba Group
5098220895 2 43000000 Sinopec
9598342161 20 13100000 Volkswagen
```

Lets repeat the same thing for Query 10



```
select CEO.* from CEO natural join Company natural join Stock natural join Investor where NetWorth > 50000 and CEO.Sex="M" group by Name;
Akio Toyoda M 64 6229087803
Amin H. Nasser M 60 5315073274
Daniel Zhang M 48 6713620014
Fu Chengyu M 69 5098220895
Herbert Diess M 62 9598342161
Masayoshi Son M 63 4001894494
Pekka Lundmark M 56 1792169223
Yousef Al-Benyan M 57 8857232768
```

And Query 8



```
select Bank.* from Owns natural join Secures natural join Bank where Stock_Symbol="4161";
1010001054 Riyadh Bank 341
1516125270 Bank of China 23682
5016604726 MUFG Bank 398
```