Nested Queries in SQL

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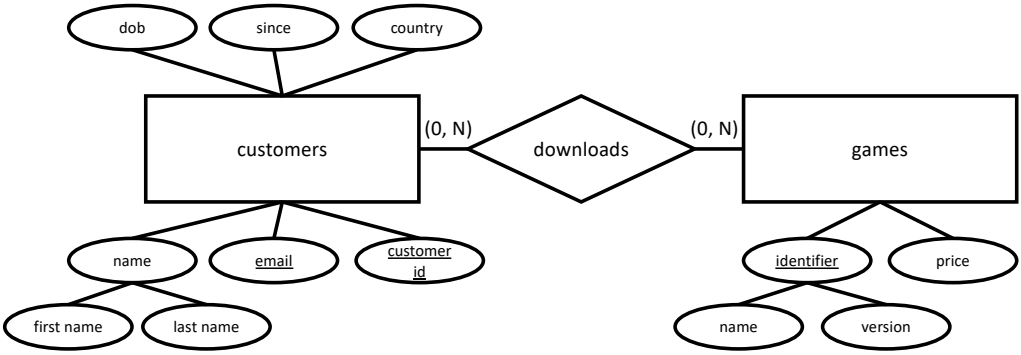
We want to develop an application for managing the data of our online app store. We would like to store several items of information about our customers such as their first name, last name, date of birth, e-mail, date and country of registration to our online sales service and the customer identifier that they have chosen . We also want to manage the list of our products, games, their name, their version and their price. The price is fixed for each version of each game. Finally, our customers buy and download games. So we must remember which version of which game each customer has downloaded. It is not important to keep the download date for this application.


dob
since
country
customers
(0, N)
downloads
(0, N)
games
name
email
customer id
first name
last name
identifier
price
name
version

This is the complete schema for our example

```
1  CREATE TABLE IF NOT EXISTS customers (
2   first_name VARCHAR(64) NOT NULL,
3   last_name VARCHAR(64) NOT NULL,
4   email VARCHAR(64) UNIQUE NOT NULL,
5   dob DATE NOT NULL,
6   since DATE NOT NULL,
7   customerid VARCHAR(16) PRIMARY KEY,
8   country VARCHAR(16) NOT NULL);
9
10 CREATE TABLE IF NOT EXISTS games(
11  name VARCHAR(32),
12  version CHAR(3),
13  price NUMERIC NOT NULL,
14  PRIMARY KEY (name, version));
15
16  CREATE TABLE downloads(
17  customerid VARCHAR(16) REFERENCES customers(customerid)
18     ON UPDATE CASCADE ON DELETE CASCADE
19     DEFERRABLE INITIALLY DEFERRED,
20  name VARCHAR(32),
21  version CHAR(3),
22  PRIMARY KEY (customerid, name, version),
23  FOREIGN KEY (name, version) REFERENCES games(name, version)
24     ON UPDATE CASCADE ON DELETE CASCADE
25     DEFERRABLE INITIALLY DEFERRED);
```

We can use subqueries in the FROM clause.

```
1 SELECT cs.last_name, d.name
2 FROM   (SELECT *
3         FROM customers c
4         WHERE c.country = 'Singapore') AS cs, downloads d
5 WHERE cs.customerid = d.customerid;
```

last_name	name
"Green"	"Biodex"
"Green"	"Domainer"
"Green"	"Subin"
...	

It is rarely a good idea. Most of the time the same query can written as a simple query.

```
1 SELECT c.last_name, d.name
2 FROM   customers c, downloads d
3 WHERE c.country = 'Singapore'
4 AND c.customerid = d.customerid;
```

We can use subqueries in the WHERE clause.

```
1 SELECT d.name
2 FROM   downloads d
3 WHERE d.customerid IN (
4     SELECT c.customerid
5     FROM customers c
6     WHERE c.country = 'Singapore');
```

name
"Biodex"
"Domainer"
"Subin"
...

Most of the time the same query can written as a simple query.

```
1 SELECT d.name
2 FROM   customers c, downloads d
3 WHERE c.country = 'Singapore'
4 AND c.customerid = d.customerid;
```

The queries below are the same.

```sql
SELECT d.name
FROM   downloads d
WHERE d.customerid IN (
    SELECT c.customerid
    FROM customers c
    WHERE c.country = 'Singapore');
```

```sql
SELECT d.name
FROM   downloads d
WHERE d.customerid = ANY (
    SELECT c.customerid
    FROM customers c
    WHERE c.country = 'Singapore');
```

Never use a comparison to a subquery without specifiying the quantifier `ALL or ANY`.

The query below finds the names and versions and the price of the most expensive games.

```
1 SELECT g1.name, g1.version, g1.price
2 FROM   games g1
3 WHERE g1.price >= ALL (
4     SELECT g2.price
5     FROM   games g2);
```

name	version	price
"Aerified"	"1.0"	12
"Aerified"	"2.1"	12
"Alpha"	"1.0"	12
...		

`ALL` adds expressive power similar to that of `OUTER JOIN`, `EXCEPT` and aggregate functions.

If we change `ALL` to `ANY`, we print all the games.

```
1  SELECT g1.name, g1.version, g1.price
2  FROM   games g1
3  WHERE g1.price >= ANY (
4  SELECT g2.price
5  FROM   games g2);
6
```

The following queries do not work.

```
1 SELECT g.name, g.version, g.price
2 FROM   games g
3 HAVING g.price= MAX(g.price);
```

```
1 ERROR:  column "g.name" must appear in the GROUP BY clause or be used in an aggregate function
2 LINE 1: SELECT g.name, g.version, g.price
3                ^
4 SQL state: 42803
5 Character: 8
```

```
1 SELECT g1.name, g1.version, g1.price
2 FROM   games g1
3 WHERE g1.price = MAX(SELECT g2.price FROM games g2);
```

```
1 ERROR:  syntax error at or near "SELECT"
2 LINE 3: WHERE g1.price = MAX(SELECT g2.price FROM game g2);
3                              ^
4 SQL state: 42601
5 Character: 73
```

But we could write the following nested query.

```
1 SELECT g1.name, g1.version, g1.price
2 FROM   games g1
3 WHERE g1.price = ALL (
4   SELECT MAX(g2.price)
5   FROM games g2);
```

`EXISTS` evaluates to true if the subquery has some results.
It evaluates to false if the subquery has no result.

```
1 SELECT d.name
2 FROM   downloads d
3 WHERE EXISTS (
4     SELECT c.customerid
5     FROM customers c
6     WHERE d.customerid = c.customerid
7     AND c.country = 'Singapore');
```

name
"Biodex"
"Domainer"
"Subin"
...

The subquery is correlated to the query.
The column `d.customerid` of the `customer` table of the outer query appears in the WHERE clause of the inner query.

All subqueries can be correlated.

```
1 SELECT g1.name, g1.version, g1.price
2 FROM   games g1
3 WHERE g1.price >= ALL (
4       SELECT g2.price
5       FROM   games g2
6       WHERE g1.name = g2.name);
```

name	version	price
...		
"Fintone"	"1.0"	12
"Fintone"	"1.2"	12
"Fix San"	"1.1"	5.0
...		

The above query finds the names, versions and prices of the games that are the most expensive among the games of the same name.

You can always use a column from an outer table in an inner query but not the other way around.

```
1 SELECT c.customerid, d.name
2 FROM   downloads d
3 WHERE d.customerid IN (
4     SELECT c.customerid
5     FROM customers c
6     WHERE c.country = 'Singapore');
```

```
1 ERROR:  missing FROM-clause entry for table "c"
2 LINE 1: SELECT c.customerid, d.name
3                ^
4 SQL state: 42P01
5 Character: 8
```

Nested queries are most powerful when combined with negation.

```
1 SELECT c.customerid
2 FROM   customers c
3 WHERE c.customerid NOT IN (
4     SELECT d.customerid
5     FROM downloads d);
```

```
1 SELECT c.customerid
2 FROM   customers c
3 WHERE c.customerid <> ALL (
4     SELECT d.customerid
5     FROM downloads d);
```

```
1 SELECT c.customerid
2 FROM   customers c
3 WHERE NOT EXISTS (
4     SELECT d.customerid
5     FROM downloads d
6     WHERE c.customerid = d.customerid);
```

The three queries above find the 22 customers who never downloaded a game.

The following query finds the countries with the largest number of customers.

```
1 SELECT c1.country
2 FROM customers c1
3 GROUP BY c1.country
4 HAVING COUNT(*) >= ALL (
5     SELECT COUNT(*)
6     FROM customers c2
7     GROUP BY c2.country);
```

country
"Singapore"

Who are our best customers in each country (those who spend the most money among all the customers in their country)?

customerid	country
"TheresaB81"	"Thailand"
"Ashley1991"	"Vietnam"
"Amy1990"	"Malaysia"
"Helen1992"	"Singapore"
"RandyK86"	"Indonesia"

What does this query find?

```
1  SELECT c.first_name, c.last_name
2  FROM customers c
3  WHERE NOT EXISTS(
4      SELECT *
5      FROM games g
6      WHERE g.name ='Aerified'
7      AND NOT EXISTS (
8          SELECT *
9          FROM downloads d
10         WHERE d.customerid = c.customerid
11         AND d.name = g.name
12         AND d.version = g.version));
```