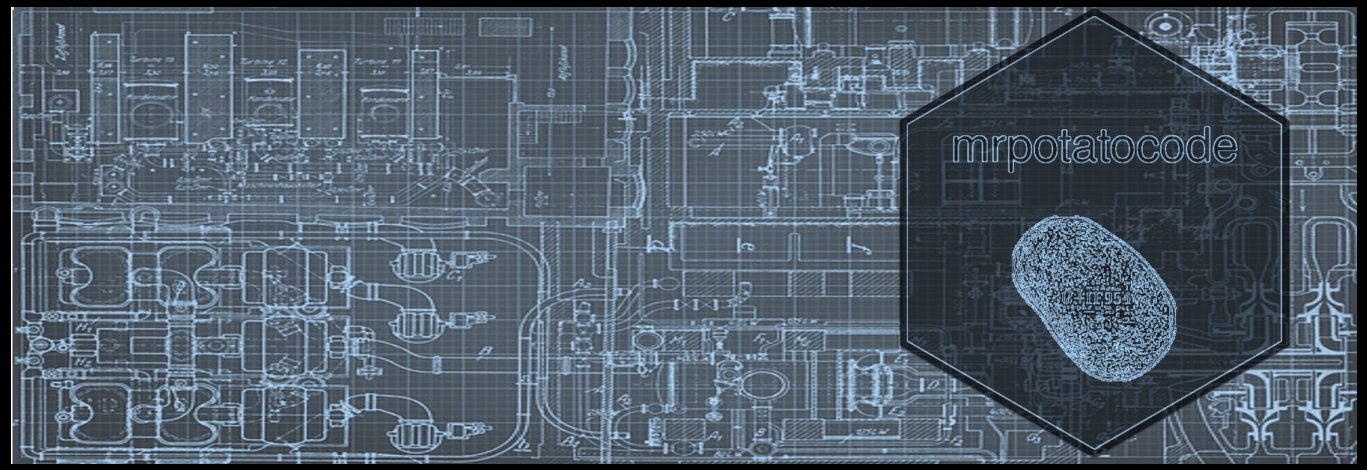


Introduction to Data Access and Storage

Thomas Rosenthal - DSI @ UofT

Module 05

Expanding your Database:

INSERT, UPDATE, DELETE

Importing and Exporting Data

Normal Forms

Views

Expanding your Database:

INSERT, UPDATE, DELETE

Importing and Exporting Data

Normal Forms

Views

INSERT, UPDATE, DELETE

Prior to this, we've focused solely on retrieving values from tables:

- Tables can also be manipulated with `INSERT`, `UPDATE`, and/or `DELETE`
- *A word of warning...these commands are PERMANENT* 😱
    - Generally, follow a policy that avoids altering data
    - Make backups of tables before you run a query
    - Never hurts to test on a temporary table first!
- But they are useful, and sometimes the correct solution
- There is no `SELECT` statement for these types of queries

INSERT, UPDATE, DELETE

INSERT

- `INSERT` allows you to add a record
- Specify where you want to add:
  - `INSERT INTO [some_table_name]`
- ...and what you want to add:
  - `VALUES(column_one_value, column_two_value)`
- `VALUES` come in the order of the columns within the tables
- `VALUES` must respect table constraints
  - e.g. NULLs, UNIQUE, data types, etc
- `INSERT` can help create small helper tables
  - Can we think of any scenarios?

INSERT, UPDATE, DELETE

UPDATE

- `UPDATE` allows you to change a record
- Specify where you are making your change:
  - `UPDATE [some_table_name]`
- ...and what you want to change:
  - `SET column_one = value1, column_one = value2`
- *SPECIFY A* `WHERE` *CONDITION*
  - `WHERE condition`
- You can change a single column, a few columns, all the columns, etc
  - (Respecting table constraints)
- **What happens if you don't specify a WHERE condition?**

INSERT, UPDATE, DELETE

DELETE

- `DELETE` allows you to remove a record
- Specify where you want to delete:
  - `DELETE FROM [some_table_name]`
- *SPECIFY A* `WHERE` *CONDITION*
  - `WHERE condition`
- **What happens if you don't specify a WHERE condition?!?**
- `DELETE` doesn't *remove* a table from a database
  - Instead it removes the data from it, leaving the table structure and constraints in place

INSERT, UPDATE, DELETE

(`INSERT`, `UPDATE`, `DELETE` live coding with a TEMP TABLE)

Any Questions?

What happens if you don't specify a `WHERE` condition

Expanding your Database:

INSERT, UPDATE, DELETE

Importing and Exporting Data

Normal Forms

Views

Importing and Exporting Data

Import & Export

CSV

JSON

Importing and Exporting Data

Import & Export

CSV

JSON

Import & Export

- RDBMs allow data to flow into and out of them
  - Some processes are easy:
    - e.g. exporting a table as a CSV file
  - ...while others are complex
    - e.g. writing a CRM to a normalized data warehouse on a nightly basis

- In DB Browser for SQLite, we can make use of the following:
  - Import and export CSV files
  - Manipulate and export JSON files
- SQLite more broadly can:
  - Produce CSVs from queries (using the command line, which we won't do)
  - Connect to other programming languages

Importing and Exporting Data

Import & Export

CSV

JSON

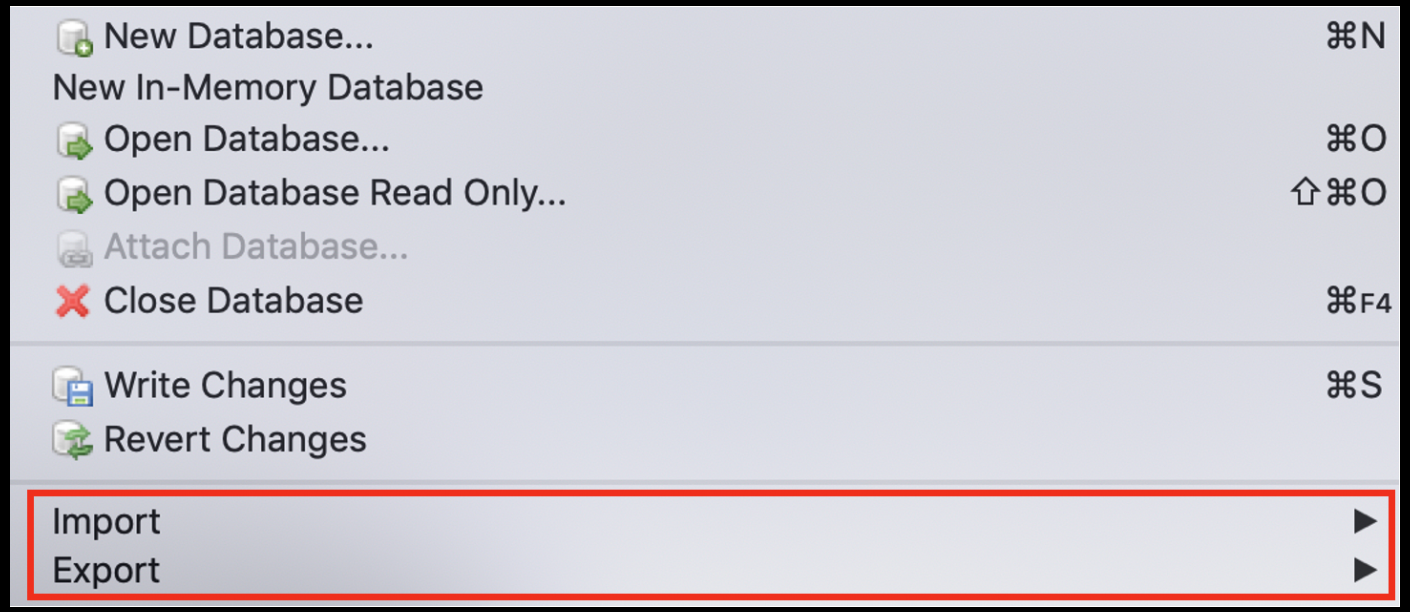
CSV

- CSV stands for "Comma Separated Values"
- CSVs are file formats well designed to store SQL tables
    - The values of each row are separated by commas
        - Sometimes it makes more sense to use a "|" (pipe), if there is complex text data stored, which might be more sensitive to the presence of commas and/or line breaks

- They are a common file format for transporting structured data
- CSVs can be opened by:
    - Excel
    - Simple text editors (e.g. notepad++, sublime)
    - Programming languages (e.g. python, R)

CSV

DB Browser for SQLite natively supports CSV importing and exporting for tables:



You can also export queries if they are stored in Temporary Tables

CSV

DB Browser for SQLite allows us to extract a query result in a somewhat roundabout method:

- First, write a query

```
SELECT * FROM product p
JOIN product_category pc ON p.product_category_id = pc.product_category_id
```

- Second, right click the results, and select "Copy as SQL"
- Third, instantiate a table with `CREATE`

```
CREATE TABLE "example" ("product_id", "product_name", "product_size",
"product_category_id", "product_qty_type", "product_category_name") ;
```

- Fourth, paste the results from your clipboard

```
INSERT INTO "example" ("product_id", "product_name", "product_size",
"product_category_id", "product_qty_type", "product_category_name")
VALUES ('1', 'Habanero Peppers - Organic', 'medium', '1', 'lbs', 'Fresh Fruits & Vegetables');
...etc for each row
```

- Finally, export the table to CSV

CSV

(CSV live importing/exporting)

Importing and Exporting Data

Import & Export

CSV

JSON

JSON

- JSON stands for "JavaScript Object Notation"
- JSONs are file formats well designed to store tables, lists, arrays, and nested objects
  - Their syntax follows specific rules:
    - Data is in name/value pairs
    - Data is separated by columns
    - Curly brackets '{ }' hold objects
    - Square brackets '[ ]' hold arrays
  - e.g. `{"first_name":"Thomas", "last_name":"Rosenthal"}`
  - or for tables:

```
[ {"first_name":"A", "last_name":"Mahfouz"}
{"first_name":"Thomas", "last_name":"Rosenthal"} ]
```

- JSON can be opened by:
  - Web browsers
  - Simple text editors (e.g. notepad++, sublime)
  - Programming languages (e.g. python, R)
- SQLite also provides support for JSON value query and manipulation

JSON

DB Browser for SQLite supports a lot of JSON functions:

- Some are helper functions:
  - `JSON` and `JSON_VALID`, which confirm whether or not a string is JSON and/or in a valid JSON format
  - `JSON_TYPE`
    - When using extracting, type will help to inform column types that SQL will assume, based on the JSON

- Other functions can be used for manipulation or extraction:
- `JSON_EXTRACT` will allow you to return the values of a well-formed JSON string into desired parts
  - Importing JSON into SQL will use either `JSON_EXTRACT` or `JSON_EACH`
  - SQLite gives the following (fairly comprehensive) example set:
    - `json_extract('{"a":2,"c":[4,5,{"f":7}]}', '$')` → '{"a":2,"c":[4,5,{"f":7}]}'
    - `json_extract('{"a":2,"c":[4,5,{"f":7}]}', '$.c')` → '[4,5,{"f":7}]'
    - `json_extract('{"a":2,"c":[4,5,{"f":7}]}', '$.c[2]')` → '{"f":7}'
    - `json_extract('{"a":2,"c":[4,5,{"f":7}]}', '$.c[2].f')` → 7
    - `json_extract('{"a":2,"c":[4,5],"f":7}','$.c','$.a')` → '[[4,5],2]'
    - `json_extract('{"a":2,"c":[4,5],"f":7}','$.c[#-1]')` → 5
    - `json_extract('{"a":2,"c":[4,5,{"f":7}]}', '$.x')` → NULL
    - `json_extract('{"a":2,"c":[4,5,{"f":7}]}', '$.x', '$.a')` → '[null,2]'
    - `json_extract('{"a":"xyz"}', '$.a')` → 'xyz'
    - `json_extract('{"a":null}', '$.a')` → NULL

JSON

Importing a JSON array (table) into SQL with DB Browser for SQLite requires a bit more of nuanced approach:

- First copy and paste your JSON table array into SQLite, and put it in a temp table:

```
CREATE TEMP TABLE IF NOT EXISTS temp.[new_json]
(col BLOB);

INSERT INTO temp.[new_json](col)
VALUES('[{"a": 7, "b": "string"}]
```

- Second, use the `JSON_EACH` function as a table-valued function

```
SELECT key,value
FROM new_json,JSON_EACH(new_json.col, '$' )
```

- Third, use this previous query as a subquery and combine with `JSON_EXTRACT`, using the value column `JSON_EACH` generated

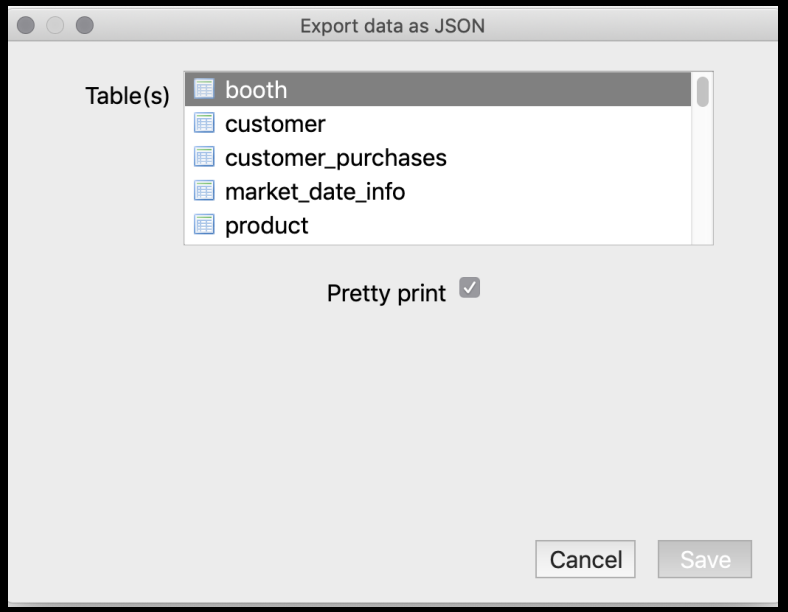
```
SELECT * ,
JSON_EXTRACT(value, '$.a') AS a,
JSON_EXTRACT(value, '$.b') AS b

FROM (...{subquery goes here}...)
```

- You now have a normal SQL table from a JSON array!

JSON

DB Browser for SQLite natively supports JSON exporting for tables:



This also works for Temporary Tables, so queries can be exported as well

JSON

(JSON live exporting)

Import/Export Questions?

Expanding your Database:

INSERT, UPDATE, DELETE

Importing and Exporting Data

Normal Forms

Views

Normal Forms

Purpose

First Normal Form

Second Normal Form

Third Normal Form

Normal Forms

Purpose

First Normal Form

Second Normal Form

Third Normal Form

Purpose

- Databases often become more useful if they are *normalized*
  - When a table is normalized, it splits complex data stored in single columns and stores them instead in many smaller tables
  - Our farmersmarket.db is normalized

- When a collection of databases is normalized we call this a data warehouse
- There's a fine balance between the number of tables created and what is stored in any single table
  - The degree of normalization is based on criteria defined by "forms"
  - e.g. our product table could be further normalized:
    - we could place product_qty_type into its own table and reference it with an id

Normal Forms

Purpose

First Normal Form

Second Normal Form

Third Normal Form

First Normal Form

- First Normal Form (1NF) requires that each column contain one single value
- Many tables are in 1NF by default

Consider a non-normalized table:

name	OS	software	supervisor
A	win	VSCode, MSSQL, RStudio	Eric Yu
Thomas	mac	Spyder, SQLite, RStudio	Rohan Alexander

We can shift it into 1NF by unpivoting the software column:

name	OS	software	supervisor
A	win	VSCode	Eric Yu
A	win	MSSQL	Eric Yu
A	win	RStudio	Eric Yu
Thomas	mac	Spyder	Rohan Alexander
Thomas	mac	SQLite	Rohan Alexander
Thomas	mac	RStudio	Rohan Alexander

(SQLite doesn't support `UNPIVOT`, so we'll use `SUBSTR` and `UNION` to create this)

Normal Forms

Purpose

First Normal Form

Second Normal Form

Third Normal Form

Second Normal Form

- Second Normal Form (2NF) requires that each non-key column is dependent on the primary key
  - Therefore, no row deletions can affect the integrity of another table
- Our farmersmarket.db is 2NF!

Our table is currently 1NF, which is required for 2NF:

name	OS	software	supervisor
A	win	VSCode	Eric Yu
A	win	MSSQL	Eric Yu
A	win	RStudio	Eric Yu
Thomas	mac	Spyder	Rohan Alexander
Thomas	mac	SQLite	Rohan Alexander
Thomas	mac	RStudio	Rohan Alexander

Second Normal Form

2NF requires that we prevent supervisors from being deleted, should A or myself leave the school.

Supervisors now becomes its own table:

id	name
1	Eric Yu
2	Rohan Alexander

Second Normal Form

We introduce a PK id and supervisor_id becomes our FK, replacing supervisor:

id	name	OS	supervisor_id
1	A	win	1
2	Thomas	mac	2

...and student_software now references that PK:

id	software
1	VSCode
1	MSSQL
1	RStudio
2	Spyder
2	SQLite
2	RStudio

Normal Forms

Purpose

First Normal Form

Second Normal Form

Third Normal Form

Third Normal Form

- Third Normal Form (3NF) requires that we replace any non-key transitive functional dependency
  - This means if any non-key column's value changed, and therefore another non-key value would be invalidated, we must replace this dependency with a table relationship instead

Our table is currently 2NF, which is required for 3NF:

id	name	OS	supervisor_id
1	A	win	1
2	Thomas	mac	2

Third Normal Form

Because MSSQL is only available on Windows, any change in OS will change whether MSSQL can be installed

OS must become its own table:

OS_id	OS	win_only
1	win	TRUE
2	mac	FALSE

...and we must create a software table referencing it

software_id	software	win_only
1	MSSQL	TRUE
2	RStudio	FALSE
3	VSCode	FALSE
4	SQLite	FALSE
5	Spyder	FALSE

Third Normal Form

At last, we have 3NF, for both our student_software table:

id	OS_id	software_id
1	1	1
1	1	2
1	1	3
2	2	2
2	2	4
2	2	5

...and our original table:

id	name	OS_id	supervisor_id
1	A	1	1
2	Thomas	2	2

Normal Forms

(Normal Forms live coding, putting the previous example into action!)

Pause for Questions about Normalization

Expanding your Database:

INSERT, UPDATE, DELETE

Importing and Exporting Data

Normal Forms

Views

Views

- Views instantiate a query result permanently
- They are particularly useful in highly normalized databases, where reproducing a query is tiresome or prone to query errors

- In databases that have live data flowing in:
  - Tables that are created from queries need to be continuously updated whenever there is new data
    - This requires either downtime where the table is empty
    - Or the chance of a "dirty read" (where a table is read before the data is fully updated)
  - Views, on the other hand, will always show the most up-to-date values!

- Views are created just like tables:

```
CREATE VIEW history AS
SELECT ...
```

Views

(Views live coding)

Lingering Questions?