Dynamic Relation System & Persistent Storage Manager

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Pages (4)

Home
- Development Log
- Design Document

Key Terms

- **Relation** - also known as a table in SQL.
- **Relation Object** - a relation, but loaded in memory and represented by a C++ object.
- **Tuple** - also known as a row (single entry of data) in SQL.

Section 1 – State the purpose of your project/sub-system

The purpose of this portion of the system is to serve two primary functions, 1) Provide a set of publicly accessible functions for creating, loading, manipulating and storing data, 2) Provide a system that is capable of persisting aforementioned data between sessions. For sake of naming conventions the first system shall be known as the **Dynamic Relation System (DRS)** and the second shall be known as the **Persistent Storage Manager (PSM)**. This system is not capable of directly handling SQL queries, it is however capable of mimicking them through a series of function calls. More on this will be covered in a section outlining testing.

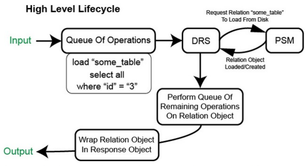
Dynamic Relation System (DRS)

As mentioned above, this system is capable of emulating all the operations available by a typical SQL query. This is done through a series of function calls that will later be initiated by the actual SQL parser (outlined in a later document). This system shall create a base data type for each known data type in SQL, and represent it as a sole object. Within each of these objects there lies a conversion from a known C++ data type to SQL data type so that it may be manipulated by the engine. From there we define a relation (table) object. Each relation can contain any number of aforementioned SQL data objects. This will allow each table loaded into memory to be evaluated using a set of core function calls from counting rows, searching (WHERE), deleting rows, updating rows, etc. This system shall also interface with a system for loading and saving this data to disk (Persistent Storage Manager).

Persistent Storage Manager (PSM)

This system is designed to manage the storage and retrieval process of relations (tables) from memory. This system shall be designed such that the structure of each relation is unknown until the relation is loaded from memory and constructed into a relation object. Each relation shall be stored in an individual file where the name of the file is also the name of the table. When a file is loaded from disk the first section of the document will outline the structure of the given relation (table) so that the relation object can be allocated. The remainder of the document will be structured in a way that allows each row (tuple) to be read into the corresponding data object originally allocated when the relation object was created. This not only allows for the database files to be well structured and dynamic but for debugging purposes will make them easier to understand and read. After the given relation is loaded into memory as an object the DRS will then be able to manipulate the object as described above. When all operations have been completed the DRS will respond with either an error or desired result and the PSM will save the relation object back to disk (if a save is necessary).

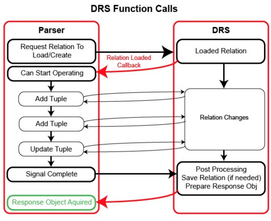
Section 2 – Define the high level entities in your design



As shown in the above graphic this system takes care of loading a necessary relation, performing some list or sequence of operations on the relation, then returning the new relation (and saving it back to disk if also needed). The idea here is that once the system loads or creates a relation, any number of functions can then be used on the specific relation. Tuples can be updated, added, truncated, counted, along with any number of relational algebraic operations. If any of these operations changes the structure of the relation, for instance an update, a save operation will be flagged and executed when all operations are complete. These post processing routines (like save) will be executed when a final callback is executed by the parsing system. With this system there will also exist a response object that will encompass all data output by the DRS. This object will contain a flag that lets the parser know if any errors occurred during operation and will also contain a list of error messages that can be output if so desired. Typically the parser will get back a response object and check if any errors have occurred before further manipulating the data.

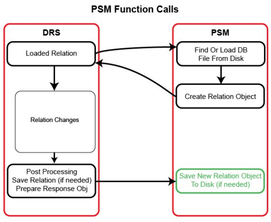
Section 3 – For each entity, define the low level design

Dynamic Relation System (DRS)



As seen in the above diagram the main goal of the DRS is to allow the parser to initiate any number of operations on the the relation object once the relation is loaded into memory. In this particular example the system is adding two rows and performing an update. This loose style of implementation is intended to remain stateless so that any each operation exists in its own space. Essentially the imposed SQL grammar and resulting order of operations will fall on the parser. The DRS is merely a medium for operating on the data to achieve the intended result as intended by any SQL query. By allowing any sequence of operations to take place on a relation object, the DRS remains ambiguous and open to other language implementations in the future.

Persistent Storage Manager (PSM)



The PSM is a little less complicated in terms of functionality when compared to the DRS. This system is designed to turn a stored file on disk and turn it into a relation object. The same applies for the saving process as well. Each relation object, no matter its size, construction or affiliated data types can be converted into a savable file and created from a file stored on disk. The markup for these files shall be JSON and will contain three major sections, **table**, **definitions** and **data**. Wherein the definition portion will contain the necessary markup to create any type of relation object with any varying number of columns and data types. The data portion will contain structured segments corresponding to each and every tuple in the relation. Lastly, the table portion will contain any information relating directly to the table, such as the current index for the auto_increment of the primary key.

Sample Database File For PSM (in JSON)

This relation has three tuples (rows) and four attributes (columns).

```
{
  "table": {
    "auto_increment": 3,
    "last_edited": 1423163442
  },
  "definitions": [
    {
      "name": "id",
      "kind": "INT",
      "length": 0,
      "default": "NONE",
      "index": "PRIMARY",
      "auto_increment": true
    },
    {
      "name": "username",
      "kind": "VARCHAR",
      "length": 25,
      "default": "NONE",
      "index": "UNIQUE",
      "auto_increment": false
    },
    {
      "name": "name_last",
      "kind": "VARCHAR",
      "length": 25,
      "default": "NONE",
      "index": "NONE",
      "auto_increment": false
    },
    {
      "name": "name_first",
      "kind": "VARCHAR",
      "length": 25,
      "default": "NONE",
      "index": "NONE",
      "auto_increment": false
    }
  ],
  "data": [
    {
      "id": 0,
      "username": "Beat-O",
      "name_first": "Kenny",
      "name_last": "Hill"
    },
    {
      "id": 1,
      "username": "12thApple",
      "name_first": "Neville",
      "name_last": "18"
    },
    {
      "id": 2,
      "username": "I_Like_Cheese",
      "name_first": "Bbb",
      "name_last": "Secret"
    }
  ]
}
```

Section 4 – Benefits, assumptions, risks/issues

Benefits

- Structured database files will aid in readability and debugging. Since these documents will be more readable than comma delimited files.
- A system that can initiate any sequence of operations on the relation object will impose less restrictions on the parser and grammar interpretations.
- Simple response object will create better error handling and reporting, even after many operations take place on a relation.

Risks

- Have never used JSON combined with C++ before, though have used extensively with Java.
- DRS may take extra time to develop.

Assumptions

(none at the moment)

Application Testing

For application testing we will construct a series of unit tests that creates and manipulates the relation object in a variety of ways. Many of these operations will mimic those required by the final application, such as adding tuples, updating tuples and selecting tuples within varying algebraic conditions. Starting with each individual operation, the system will test each function on the relation object and continue to increase in capacity until we as a team feel that the system is capable of handling any realistic SQL scenario. While unit testing takes place we will also be monitoring the status of the database files to ensure that there are no storage limitations, or other document processing discrepancies.

Team #6