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HYRISE Deep Dive

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Agenda

- Architecture
- Implementation
- Tasks

Status Quo

HYRISE is a prototype

- no transactions
- no guarantees
- plenty of fun!

Basic Features

- Vertical Partitioning
- Early / Late Materialization
- Compression

Architecture

- most important parts of HYRISE are a colleciton of shared libraries that provide database engine features exposed via an API
- infrastructure code for parallelization and remote access
- protocol is HTTP

Basic Modules

- **IO** - Loading data from disc, catalog management
- **Storage** - Table, data types, compression, met data
- **Access** - Query operators, predicates
- **Net** - communication
- **Helper** - Memory manegement, logging, tracing, …

Installation

- User Guide (HPI network) – http://goo.gl/47qc8
- Ubuntu fast install – http://goo.gl/I2Msh

Installation

```
$ cp settings.mk.default settings.mk
```

```
$ make
touch settings.mk
make --no-print-directory -s  --directory=build/jsoncpp
CC third_party/jsoncpp/json_writer.cpp
LINK build/libjson.dylib
ld: warning: directory not found for option '-L/usr/lib64'
make --no-print-directory -s  --directory=build/lib/helper
DEPEND trace.d
DEPEND Settings.d
DEPEND RetainCountingObject.d
DEPEND prefetching.d
DEPEND logger.d
DEPEND HttpHelper.d
DEPEND hash.d
DEPEND GroupValue.d
DEPEND demangle.d
DEPEND ConfigFile.d
```

Developing With HYRISE

Where to Start?

- All (most) features are **tested**
  - `src/bin/units_access`
  - `src/bin/units_storage`

HYRISE Data Format

- CSV data + Header
- Header consists out of 4 rows
  - Name
  - Data Type
  - Grouping
  - Separator

HYRISE Data Format

```
int|float|string
INTEGER | FLOAT | STRING
0_R | 1_R | 1_R
===
3|3.1|null
0|0.1|zwei
2|2.1|vier
5|5.1|doppelt
7|7.1|acht
```

HYRISE Data Format

- Grouping defines vertical partitioning
- `0_R` defines an identifier (*0*) and group type *R* (currently only R)
- Group identifiers must increase
- `0_R | 1_R | 1_R` defines a two container table with thre attributes

Loading Data

- **Loader** - construction/combination of loaders

```
namespace Loader
  class params {
  private:
nclude "parameters.inc"
      param_ref_member(AbstractInput, Input);
      param_ref_member(AbstractHeader, Header);
      param_member(AbstractTableFactory*, Factory);
      param_member(string, BasePath);
      param_member(bool, InsertOnly);
  public:
      params();
      ~params();
      params* clone() const;
  };
  AbstractTable* load(const params& args);
```

Loader Shortcuts

- Provides predefined options for loading data, less flexible, less code

```
namespace Loader {
    namespace shortcuts {
        /*!
          Loads a table for a given filename,
    assuming it contains header and data in HYRISE format.
       \param filepath
         */
        AbstractTable* load(const string& filepath);
        /*!
          Load a table from a given filename,
    while supplying the header from another file.
          Must be HYRISE formatted.
          \param datafilepath
          \param headerfilepath
        */
        AbstractTable* loadWithHeader(const string& datafilepath,
   const string& headerfilepath);
    };
};
```

Storage Manager

- Provides catalog management for HYRISE (`src/lib/io/StorageManager.h`)
  - Encapsulates name, table mapping
  - Primarily used in plan operations
- Singleton class
- Support for binary dumps

Querying Data

The **easy** way:

```
SELECT a,b FROM table WHERE c = 9;
```

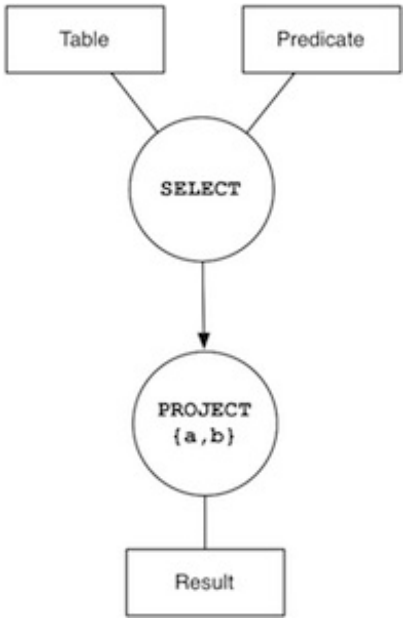
However, there is no easy way in HYRISE.

Querying Data

The original query

```
SELECT a,b FROM table WHERE c = 9;
```

becomes



Querying Data

```
SELECT a,b FROM table WHERE c = 9;
```

becomes

```
AbstractTable *table =
 Loader::shortcuts::loadWithHeader("data",
                                   "header");
EqualsExpression<int>* eq =
 new EqualsExpression<int>(table,
         table->numberOfColumn("c"), 9);

SimpleTableScan stc;
stc.setPredicate(eq);
stc.addInput(district);
stc.setProducesPositions(true);
AbstractTable *positions = stc.execute();

ProjectionScan ps;
ps.addInput(positions);
ps.addField(table->numberOfColumn("a"));
ps.addField(table->numberOfColumn("b"));
AbstractTable *result = ps.execute();
```

HYRISE Remote Access (a.k.a server)

- Build on the ideas of others
  - HTTP as database protocol
  - Queries as post requests with valid JSON
- Allows to use your favorite language to query HYRISE using HTTP

How things get done

- Smallest execution unit is a task – plan operations derive from tasks
- Task are ordered by their dependencies
- Tasks can form any cycle-free graph

Client - Bad Request

```
$ curl http://localhost:5000
```

Client - Bad Request

```
$ curl http://localhost:5000 -d "query=`cat test
```

Server - Answer

```
$ ./build/hyrise_server 5000
Warning: no body received!
127.0.0.1 [2011-11-10 11:08:31 +0100] GET / (0.0
```

Client - Good Request

```
curl http://localhost:5000 -d "query=`cat test/autojson/howto.jso

"header" : [ "col_0", "col_1" ],
"message_handling" :
{
 "parse_request" : 1999,
 "respond_request" : 116
},
"performanceData" :
[

 {
  "data" : 0,
  "duration" : 2415,
  "name" : "TableLoad",
  "papi_event" : "PAPI_TOT_INS"
 },
 {
  "data" : 0,
  "duration" : 26,
  "name" : "ProjectionScan",
  "papi_event" : "PAPI_TOT_INS"
 }
],
"rows" :
[
 [ 0, 1 ],
 [ 200, 300 ],
 [ 400, 500 ],
```

Server - Answer

```
$ HYRISE_DB_PATH=`pwd`/test ./build/hyrise_server
2011-11-10 11:29:20,136 [0x102281000] INFO  hyrise.net - Json recei
{
 "edges" :
 [
  [ "0", "1" ]
 ],
 "operators" :
  "-1" :
  {
   "filename" : "lin_xxxs.tbl",
   "table" : "reference",
   "type" : "TableLoad"
  },
  "0" :
  {
   "filename" : "lin_xxxs.tbl",
   "table" : "lin_xxs",
   "type" : "TableLoad"
  },
  "1" :
  {
   "fields" : [ 0, 1 ],
   "type" : "ProjectionScan
} } }
2011-11-10 11:29:20,137 [0x102304000] DEBUG access.plan._PlanOperat
2011-11-10 11:29:20,138 [0x102387000] DEBUG access.plan._PlanOperat
```

Behind The Curtains

Raw Data Access

- Every data container in HYRISE implements the *AbstractTable* interface * only 1 container actually stores data

```
class Table{}
```

- `Table` is the base container type, no further decomposition

Raw Data Access - Type Handling

- Type handling is deferred to C++ templates
- However, template methods cannot be overloaded
  - Compression helps
  - Typical operations work with value ids

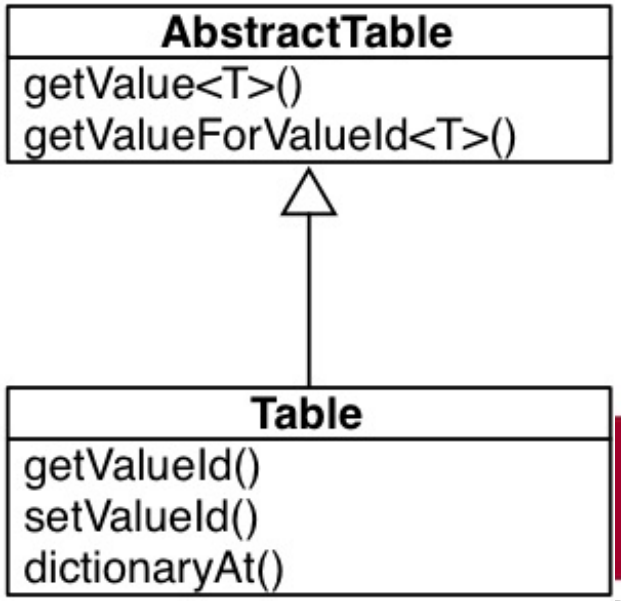


Table Composition

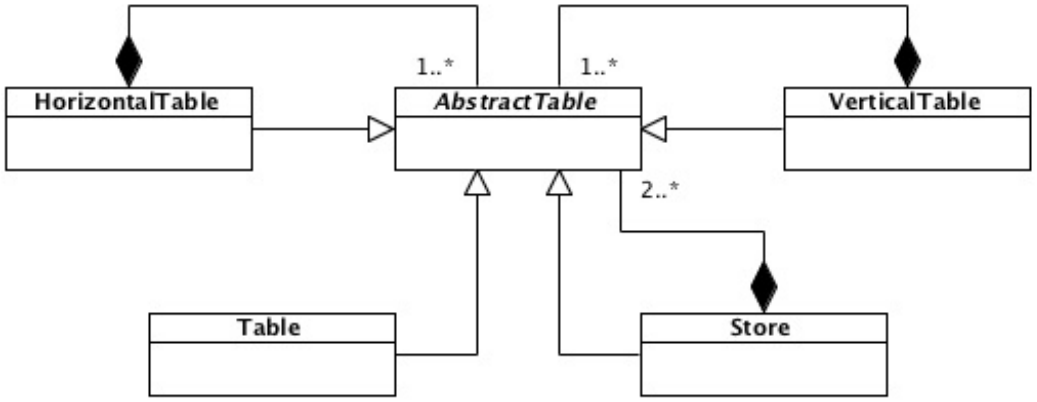


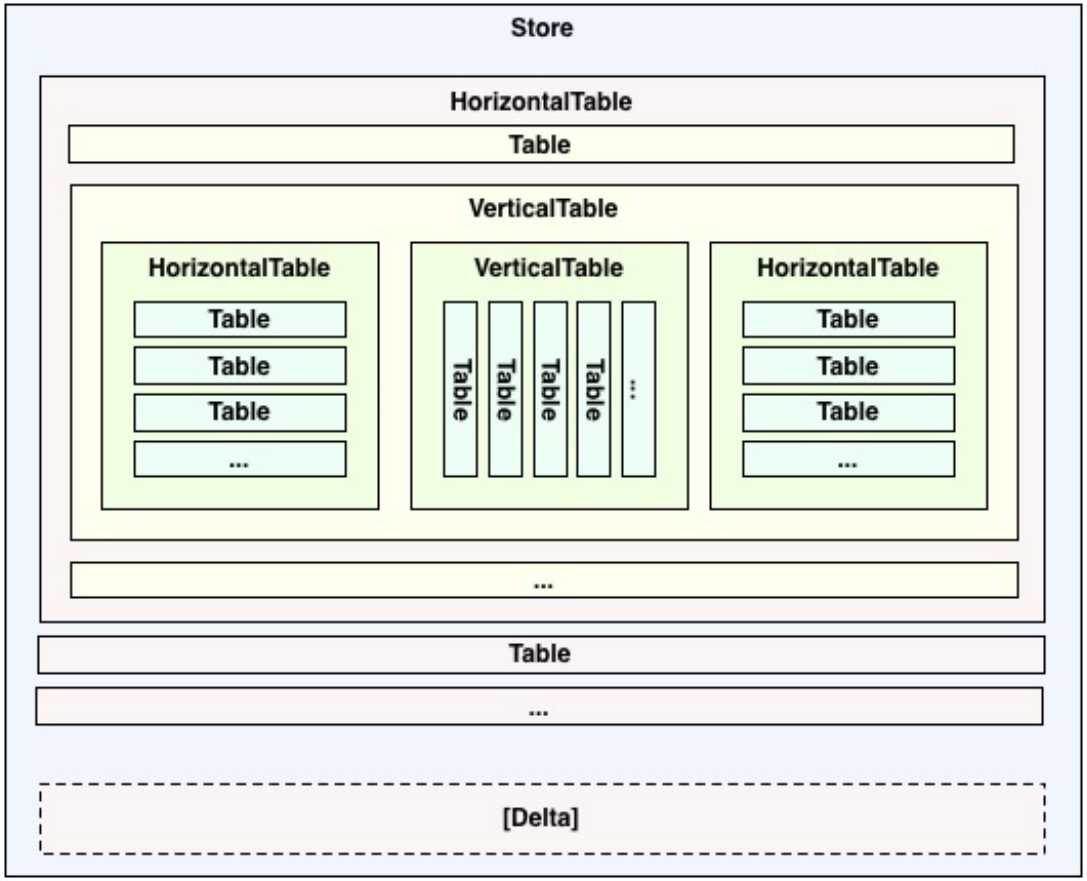
Table Composition

- **AbstractTable** is the magic base class for all data storages, it is used in many different ways, in containers, plain tables, intermediate results and more.
- **Table** is the innermost entity in the table structure. It stores the actual values like a regular table and cannot be split further.
- **VerticalTable** implements a vertical table layout. It is organized into one or more vertical entities spreading over a distinct number of columns. The entities can be any subclass of AbstractTable.

Table Composition (II)

- **HorizontalTable** implements a horizontal table layout. It is organized into one or more horizontal subtables spreading over a distinct number of rows. The subtables can be any subclass of AbstractTable.
- **Store** consists of one or more main tables and a delta store and is the only entity capable of modifying the content of the table(s) after initialization via the delta store. It can be merged into the main tables using a to-be-set merger which defines the merge strategy.

Table Composition



Compression

- Dictionary compression is always enabled, immutable tied to the storage system
- Infrastructure makes it easy to plug other compression algorithms easily

Memory Management

- C++ provides no easy way out (compared to C++11)
- Manual retain counting (thread-safe, `src/lib/helper/RetainCountingObject.h`)

Memory Management

```
struct Test
{
    AbstractTable* table;

    void setTable(AbstractTable* t)
    {
        table = t;
        table->retain();
    }

    ~Test()
    {
        table->release();
    }
};
```

New Plan Operators

- Operators can perform any action, as long as they implement `_PlanOperation`
- Use existing unit tests and other plan operatos as template

```
class _PlanOperation : public OutputTask
{

protected:

    virtual void setupPlanOperation();
    virtual void executePlanOperation() = 0;
    virtual void teardownPlanOperation();

public:

    void setLimit(unsigned long l);
    void setProducesPositions(bool p);
    void setFields(field_list_t *fields);
    void addField(field_t field);
    void addInput(AbstractTable *input);
    void addInput(vector<AbstractTable *>* input_list);
}


// Implement own operation
class MyOperation : public _PlanOperation
{
    void executePlanOperation()
 {
  /* ... */
  addResult(myTable);
 }
}
```