DB101:
Graefe 1995 “…Cascades…”

Goetz Graefe – Madison, Wis.

Agenda

- Context
- Extensibility
  - Logical & physical operators & properties
  - Transformation & implementation rules, enforcers
  - Search algorithm & data structures: memo, tasks
- Prototypes: Open OODB, scientific computations
- Derivatives
  - Microsoft SQL Server
  - GP Orca, Apache Calcite

Context

- Extensibility: Postgres, Starburst, Exodus
- Starburst: “lolepops” = low-level plan operators
- Exodus: operators, properties, rules
- Volcano optimizer generator: better search
- Cascades: contract work for & with Tandem NonStop SQL

Extensibility: operators

- Logical: defining correctness of transformations
- Physical: algorithms and data representations
- Both (e.g., a logical operation with a default algorithm)
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- No operators prescribed or provided

Extensibility: properties

Properties of intermediate results, not of computations

- Logical: ⇐ logical operators & logical inputs
  Arity, cardinality, integrity constraints, etc.
- Physical: ⇐ algorithms and data representations
  Order, partitioning, compression, …
- Anticipated execution cost

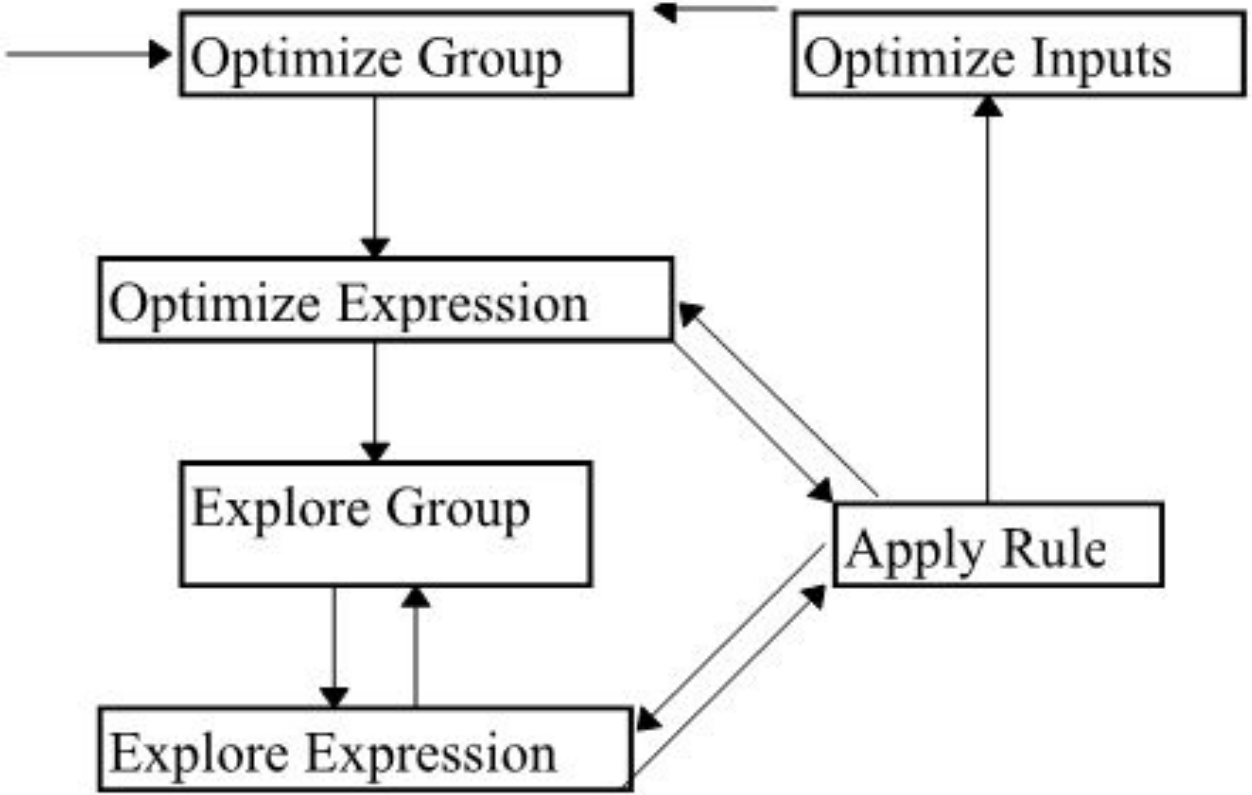
Extensibility: rules

- Transformation rules: logical → logical
- Implementation rules: logical → physical
- Enforcer rules: logical no-ops: sorting, partitioning, …

Algorithms & data structures: memo & tasks

- Memo: a set of groups
- Group: equivalent logical “queries” & physical “plans” + logical properties
- Query: a logical operator + logical inputs
- Logical input: a pointer to a group
- Plan: a physical operator + phys inputs + phys properties
- Physical input: a pointer to a group + required phys props
- Task: rule + root of matching expression

Tasks as data structures



Microsoft SQL Server

- Adopted in 1994, shipping since 1998
- Now ~50 physical operators in query optimization and iterators in query execution
- Now ~230 transformation & implementation rules

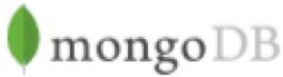
A “complex beast” few engineers dare touch

Further derivatives

- Microsoft
  - Data warehouse
  - Dryad
  - …
- Greenplum ORCA
- Apache Calcite

Used by

Connects to



Cascades future

- Alternative search strategy, e.g., for joins?
- Automatic “explain” – final output, derivation
- Built-in foundation?
  - select, project, join, grouping, set operations
  - sorting, partitioning, compression…
  - materialized views creation, maintenance, queries
- ?