PDQ: A PLATFORM FOR REFORMULATING QUERIES

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Problem statement

Given a conjunctive query

$$Q :- \exists x_1 \ldots x_k \bigwedge_i R_i$$

over a schema with **access restrictions** over the schema relations and **integrity constraints Σ** and a **cost function C** find a plan that **minimises the cost to answer Q under C**.

Access restrictions over relations require values of certain attributes to be given as inputs to access relations.

The integrity constraints **Σ** are given by tuple-generating dependencies (TGDs):

$$\forall x_1,\ldots, x_k \bigwedge_i A_i \rightarrow \exists y_1,\ldots, y_l \bigwedge_j B_j$$

Example

Relations

Customer(cid)
CustomerDetails(cid,cname,cphone)
Product(pid,pname,pprice)
Item(itemid,pid)
Bought(cid,itemid)

Constraints

Customer(cid) → CustomerDetails(cid,cname,cphone)
CustomerDetails(cid,cname,cphone) → Customer(cid)

Access methods

Customer$^{\emptyset}$: ∅ → cid
Product$^{\emptyset}$: ∅ → pid, pname, pprice
Bought^{cid}: cid → itemid
Item^{pid}: itemid → pid

Query

SELECT CustomerDetails.cid, Product.pprice
FROM CustomerDetails, Product, Item, Bought
WHERE CustomerDetails.cid = HasBought.cid
AND Item.itemid = HasBought.itemid
AND Product.pid = Item.pid

Q:- ∃ pid, pname,itemid CustomerDetails(cid,cname,cphone), Bought(cid,itemid), Product(pid, pname, pprice), Item(itemid,pid)

Q*:- CustomerDetails(cid_0,$cname_0$, $cphone_0$), Bought(cid_0, $itemid_0$), Product(pid_0, $pname_0$, $pprice_0$), Item($itemid_0$, pid_0)

Hidden database: CustomerDetails(cid_0,$cname_0$, $cphone_0$), Bought(cid_0, $itemid_0$), Product(pid_0, $pname_0$, $pprice_0$), Item($itemid_0$, pid_0), Customer(cid_0)

Accessibility axioms

Customer(cid) → InferredAccessibleCustomer(cid) ∧ Accessible(cid)

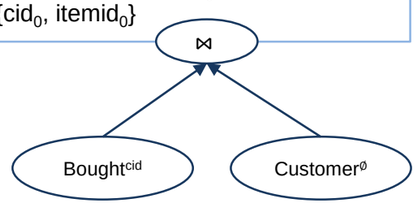
Product(pid,pname,pprice) → InferredAccessibleProduct(pid,pname,pprice) ∧ Accessible(pid) ∧ Accessible(pname) ∧ Accessible(pprice)

Accessible(pid) ∧ Item(itemid,pid) → InferredAccessibleItem(itemid,pid) ∧ Accessible(itemid)

Accessible(cid) ∧ Bought(cid,itemid) → InferredAccessibleBought(cid,itemid) ∧ Accessible(itemid)

Status: Unsuccessful, closed
Inputs: ∅
Implicit information: Customer(cid_0), CustomerDetails(cid_0,$cname_0$, $cphone_0$), InferredAccessibleCustomer(cid_0), Accessible={cid_0}

Status: Unsuccessful, open
Inputs: cid↦cid_0
Implicit information: Bought(cid_0, $itemid_0$), Customer(cid_0), CustomerDetails(cid_0,$cname_0$, $cphone_0$), InferredAccessibleBought(cid_0, $itemid_0$), InferredAccessibleCustomer(cid_0), Accessible={cid_0, $itemid_0$}



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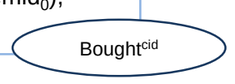
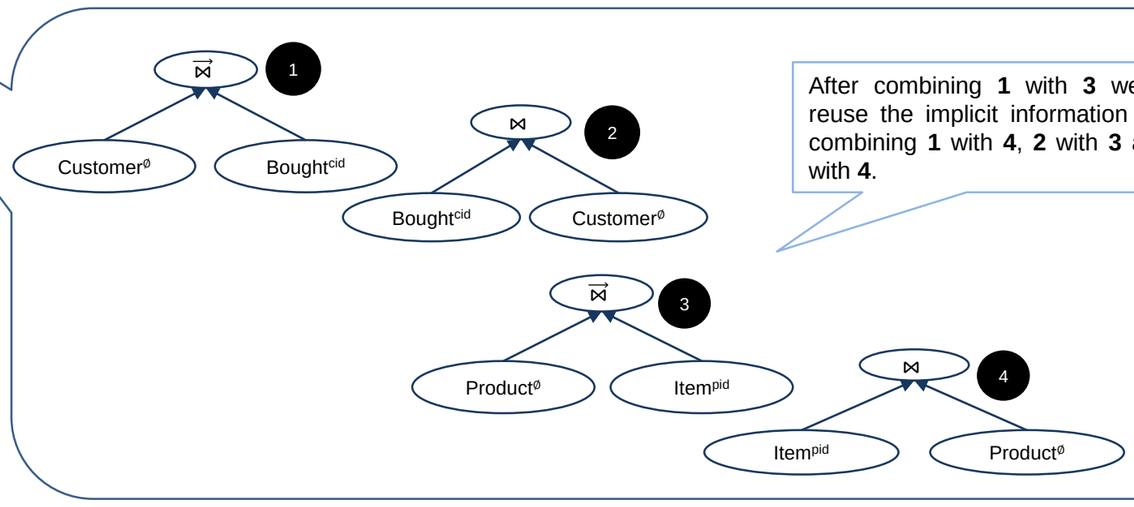




Building up plans

Access plans

Plan language
- ❑ **Access operators**
- ❑ **Dependent join operators**
- ❑ **Joins, selections and projections**

Each plan is associated with
- ❑ **the inputs required to perform the plan**
- ❑ **implicit information** found through **reasoning**

A plan can be
- ❑ **Open** (requires inputs to run) or **closed** (can be run stand alone)
- ❑ **Successful** (equivalent to query) or **unsuccessful**

Deriving implicit information

Preprocessing step
- ❑ Create "hidden database" of facts by forming canonical database of **Q Q*** and taking consequences under **Σ**.
- ❑ Augment **Σ** with accessibility axioms and inferred accessible copies of the constraints in **Σ**.

Implicit information of accesses
- ❑ consequences of hidden facts exposed by operators

Implicit information of BinaryOperator(Plan$_1$,Plan$_2$)
- ❑ consequences of [implicit information of Plan$_1$ ∪ implicit information of Plan$_2$] under augmented **Σ**

Pruning out sub-plans

Keep the best plan within some class
- ❑ group plans by input and by implicit information
- ❑ discard plans with the same or less implicit information and higher cost

Prune out unpromising sub-plans
- ❑ prune out plans with cost higher than the best closed and successful plan found

Speeding-up planning

- ❑ Search the plan space in parallel
- ❑ Speeding up reasoning
  - group plans based on their implicit information
  - when combining plans from two groups reason only the first time a composite plan is created from these two groups
- ❑ Prune out plans with cost higher than the best plan prior to reasoning

Prototype with LogicBlox

LogicBlox is a relational database geared toward analytics and predictions.

LogicBlox programs are implemented in the proprietary language LogicQL, derived from Datalog.

A PDQ server instance is started upon the creation or opening of an LB workspace.

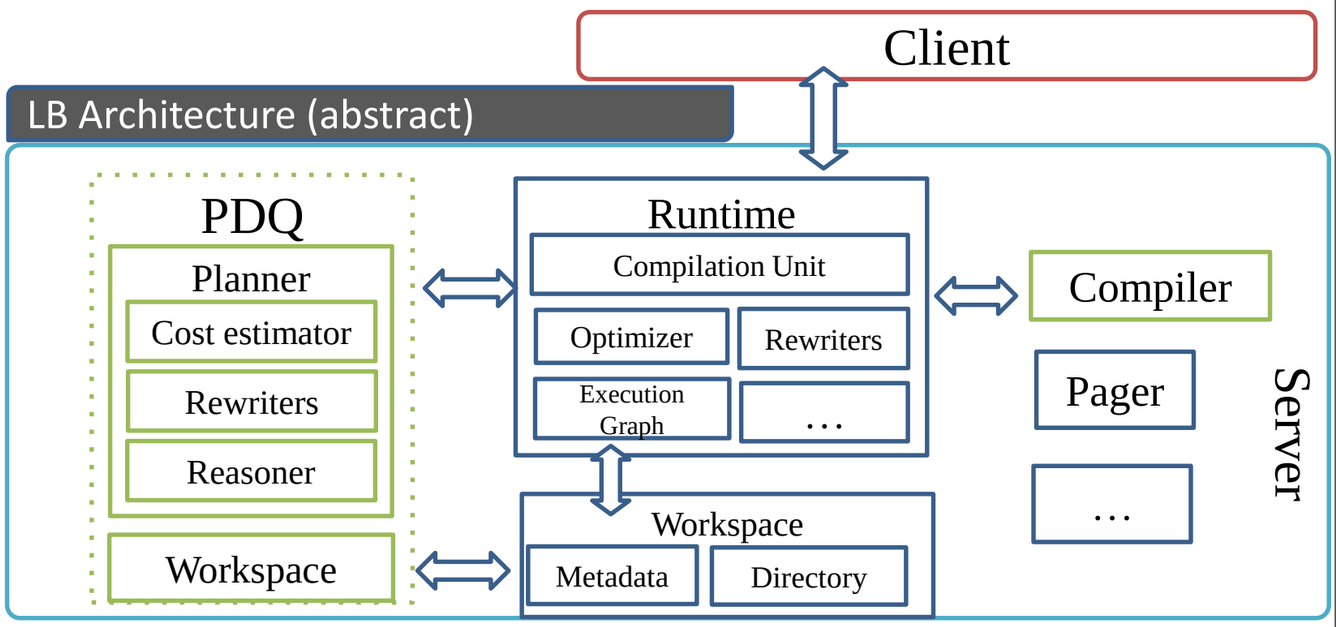
PDQ is initialized with all relevant information from the workspace such as **views** and **constraints**.

PDQ **optimizes** LB rules, by offering equivalent rewritings with different cost.

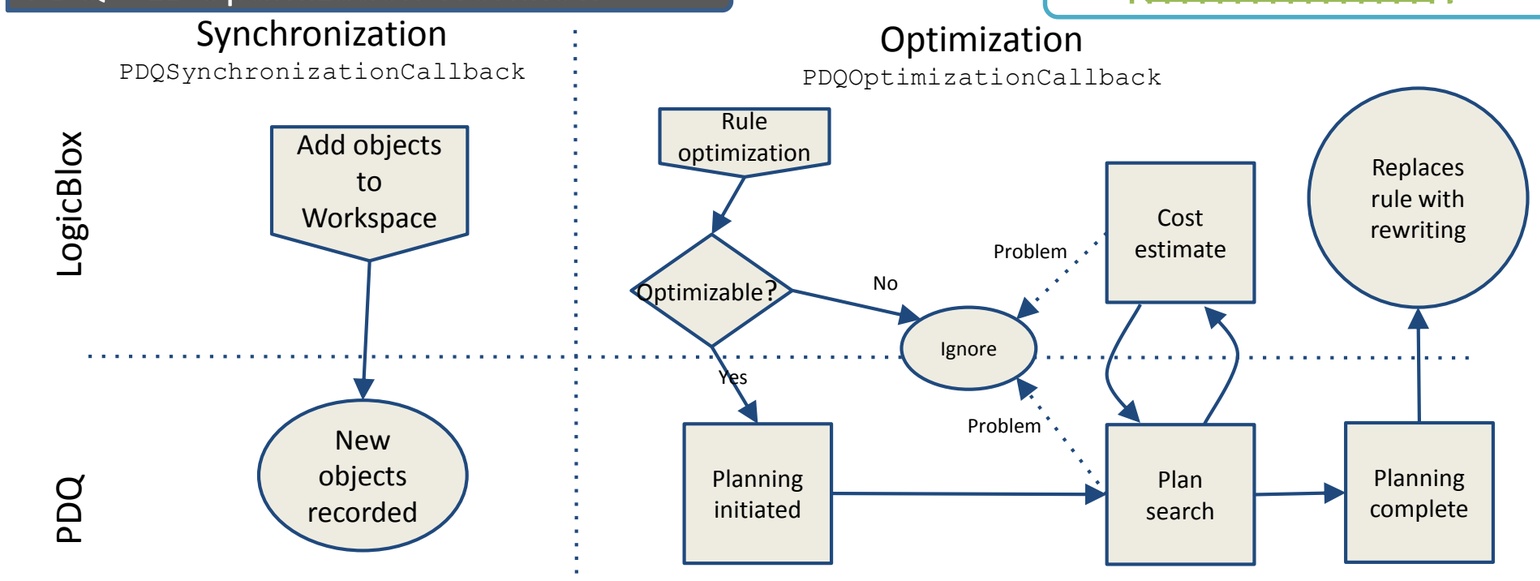
During planning **PDQ asks LB** for its estimation about the **cost** of a specific subplan.

When a transaction ends successfully, PDQ is updated to account for the objects that have been created or destroyed.

LB Architecture (abstract)



PDQ – LB Optimization Workflow



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