Query Processing for Non-traditional Applications

CS848 Spring 2013

Cheriton School of CS

Updating Data

Plan

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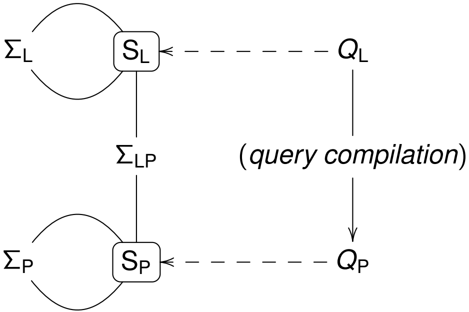
    - updates and logical relations
    - updates and constraints
    - updates and access paths
3. Difficulties on the way
    - sequencing updates
    - value invention

Physical Design and Query Compilation: Overview



UPDATES IN NUTSHELL

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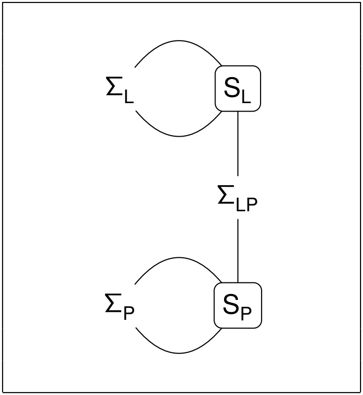
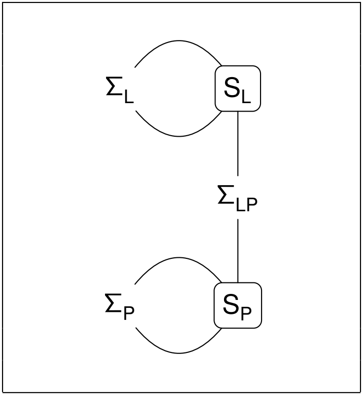


old instance



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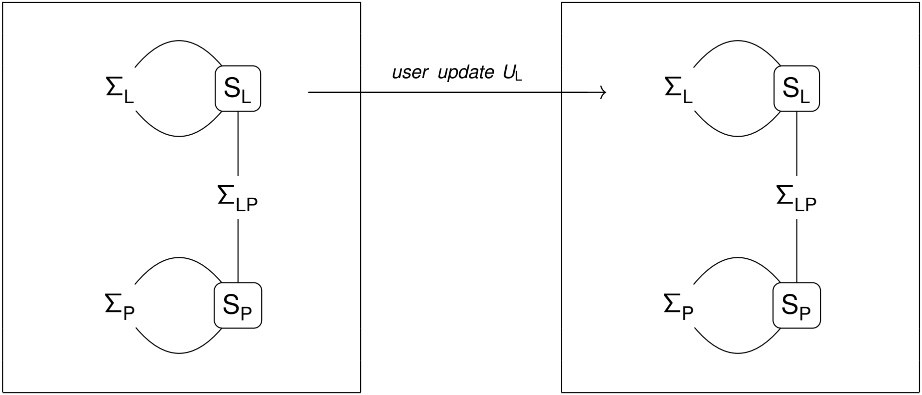

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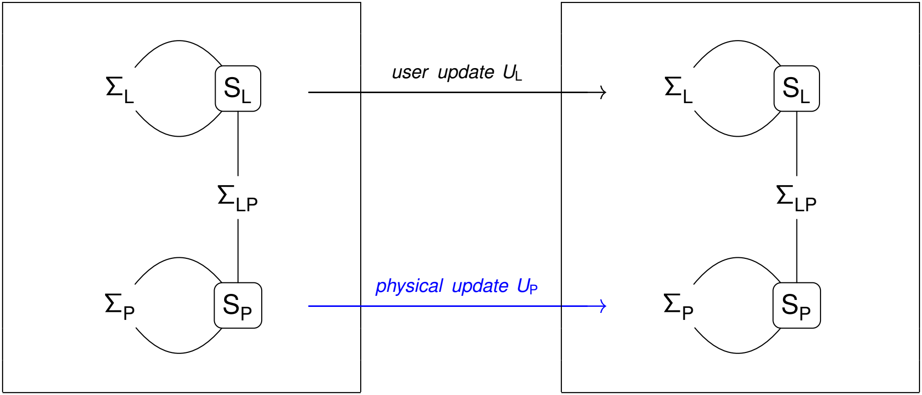

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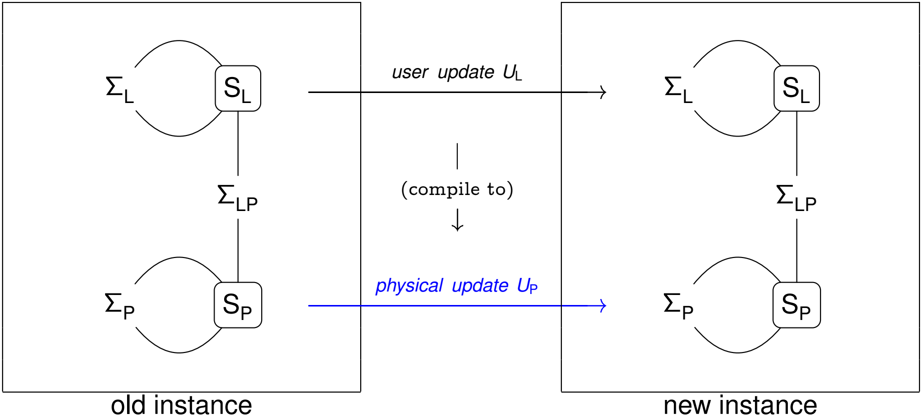

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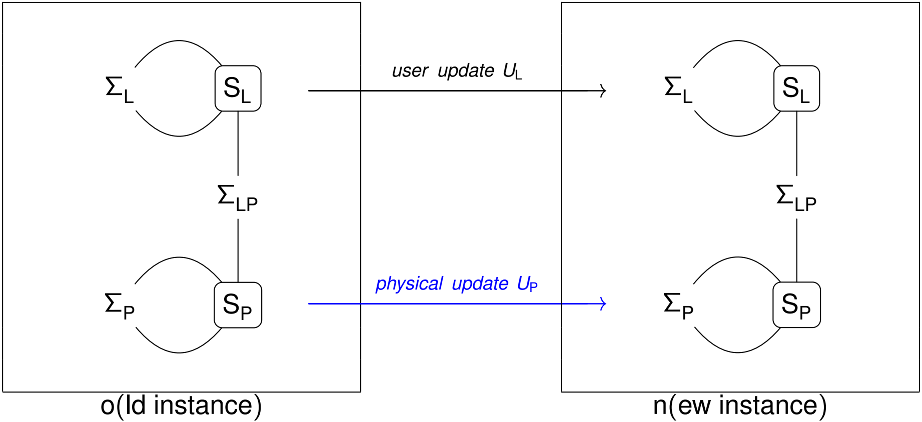

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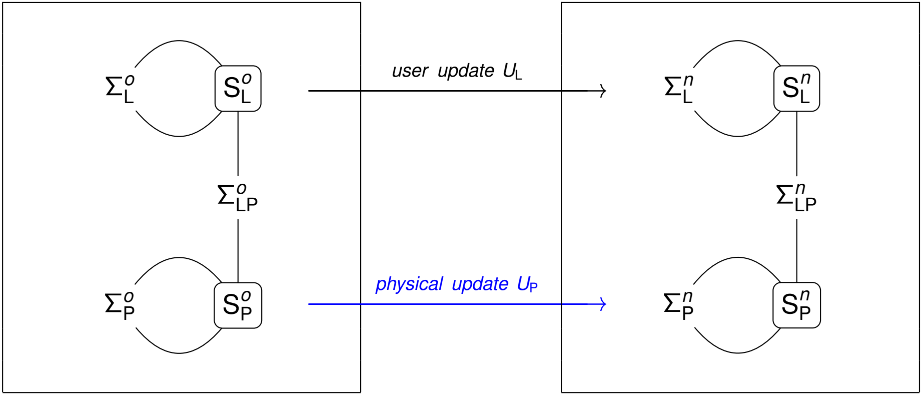

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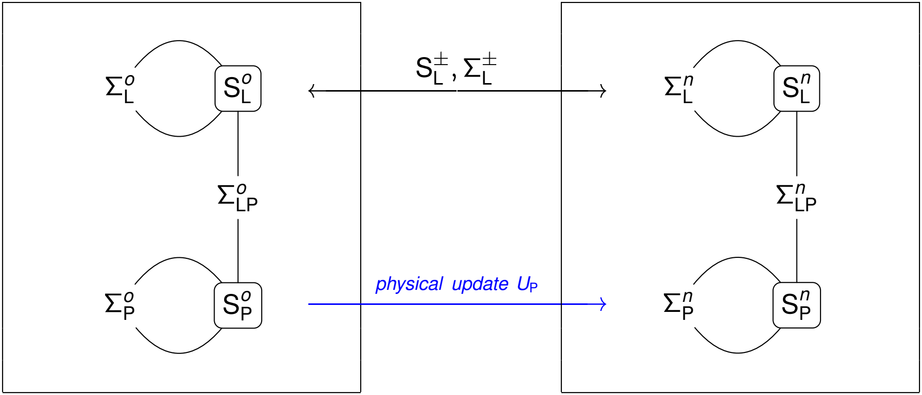

Σ^o_L
S^o_L
Σ^o_LP
Σ^o_P
S^o_P
$\mathsf{S}^\pm_\mathsf{L}, \Sigma^\pm_\mathsf{L}$
physical update U_P
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$$\mathsf{S}^\pm_\mathsf{L} = \{P^+, P^- \mid P \in \mathsf{S}_\mathsf{L}\},$$
$$\Sigma^\pm_\mathsf{L} = \{\forall\bar{x}.(P^o(\bar{x}) \vee P^+(\bar{x})) \leftrightarrow (P^n(\bar{x}) \vee P^-(\bar{x})) \mid P \in \mathsf{S}_\mathsf{L}\}$$

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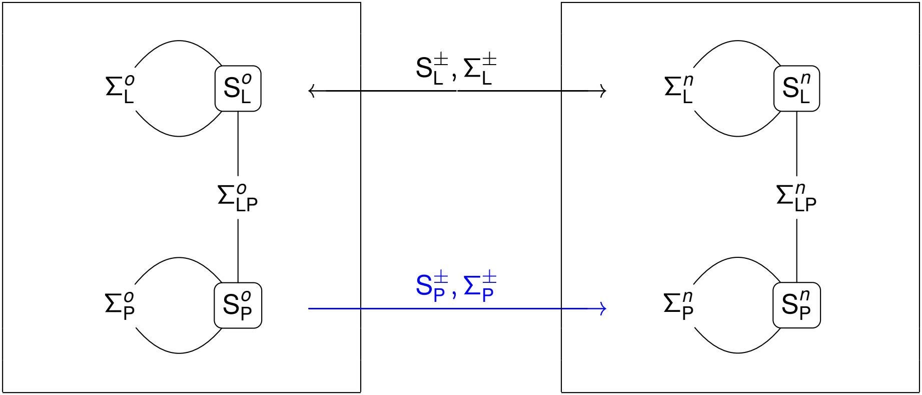

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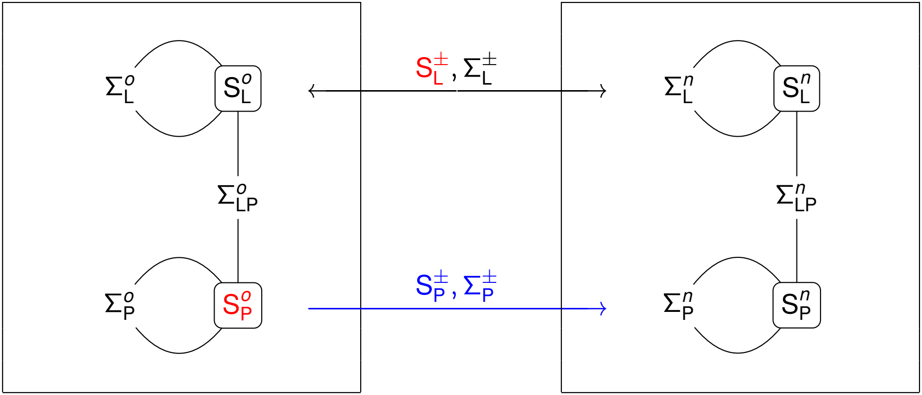

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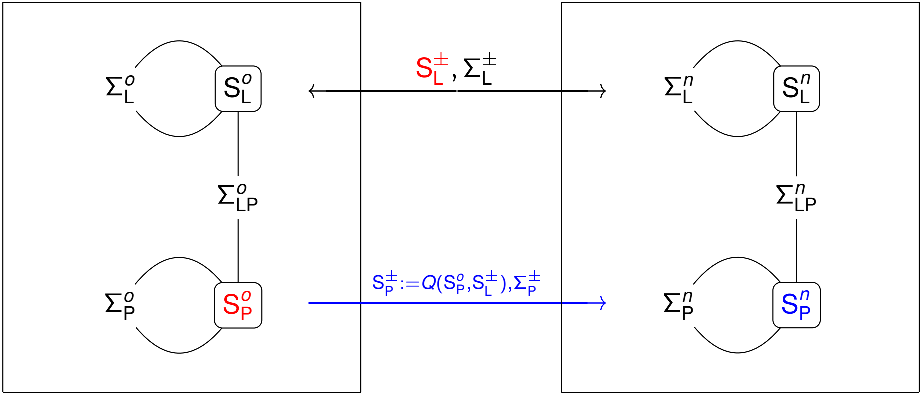
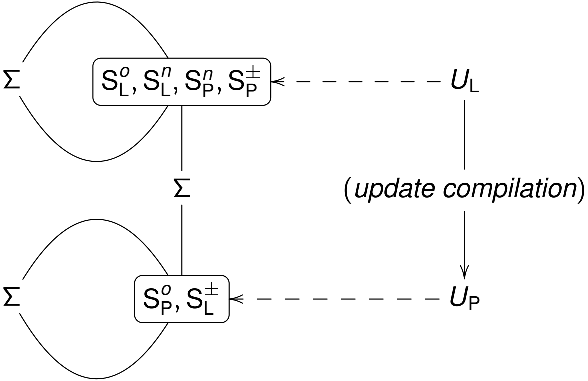


Physical Design and Update Compilation



Σ

$S_L^o, S_L^n, S_P^n, S_P^\pm$

U_L

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(*update compilation*)

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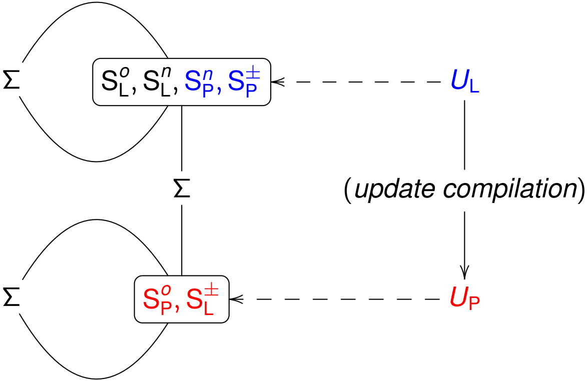

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Physical Design and Update Compilation

$$\begin{tikzcd}
\boxed{S_L^o, S_L^n, S_P^n, S_P^\pm} \arrow[loop left, "\Sigma"] \arrow[d, dash, "\Sigma"] & & U_L \arrow[ll, dashed] \arrow[d, "(\textit{update compilation})"] \\
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- U_L is a *user query* $P^+(\bar{x})$ $(P^-(\bar{x}))$ for $P \in S_A$;

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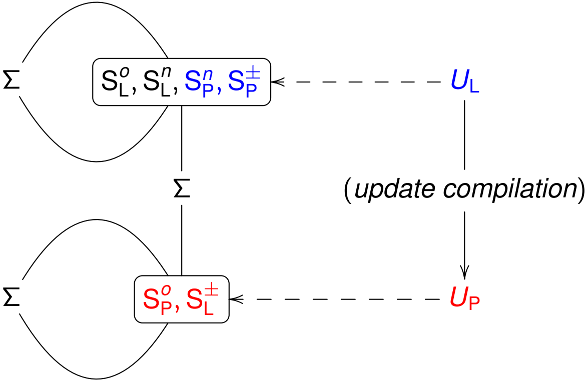

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$(\textit{update compilation})$

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- U_L is a *user query* $P^+(\bar{x})$ $(P^-(\bar{x}))$ for $P \in S_A$;
- U_P is a *plan* for the user query $P^+(\bar{x})$ $(P^-(\bar{x}))$ for $P \in S_A$
  $\Rightarrow$ w.r.t. the access paths $S_A \cup S_L^\pm$, and
  $\Rightarrow$ aux code that inserts (deletes) the result of the plan into (from) P.

Example

Setup: standard relational design for `Employee(id,name,salary)`

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Logical Schema:

$$\mathsf{S_L} = \{\texttt{Employee}/3\}, \Sigma_\mathsf{L} = \{\text{“}\texttt{id}\text{ is a key”}\}$$

Physical Schema:

$$\mathsf{S_P} = \mathsf{S_A} = \{\texttt{empfile}/3/0, \texttt{emp-id}/3/1, \texttt{emp-name}/2/1\}$$

$$\Sigma_\mathsf{LP} = \left\{ \begin{array}{l} \forall x,y,z.\texttt{Employee}(x,y,z) \leftrightarrow \texttt{empfile}(x,y,z) \\ \forall x,y,z.\texttt{Employee}(x,y,z) \leftrightarrow \texttt{emp-id}(x,y,z) \\ \forall x,y,z.\texttt{Employee}(x,y,z) \leftrightarrow \texttt{emp-name}(y,x) \end{array} \right\}$$

Logical Update Schema: (just the signature)

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. . . similar for `emp-name`, no-op for `emp-id` (why?)

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Additional information ⇒ additional constraints:

1. $P^- = \emptyset$ for the “insert-only” relation P,
2. $P^+ = P^- = \emptyset$ for unmodified relations.
3. ...

The View Update Problem

Classical View Update Problem

Given a relational view

$$\forall \bar{x}. V(\bar{x}) \leftrightarrow Q(\bar{x})$$

with Q expressed over $\mathsf{S_L}$, is it possible to update the content of V by appropriately modifying the interpretation of the $\mathsf{S_L}$ symbols?

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Answer

Define *update schema* for V and $\mathrm{S_L}$ (where every symbol is also an access path). Then V is

- *insertable* if P^n is definable w.r.t. the update design with $V^- = \emptyset$,
- *deletable* if P^n is definable w.r.t. the update design with $V^+ = \emptyset$, and
- *updatable* if P^n and V^- are definable w.r.t. the update design

for all $P \in \mathrm{S_L}$.

⇒ when the answer is positive, we construct a corresponding *update* queries.

ADVANCED ISSUES IN UPDATE COMPILATION

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3. evolving physical schema one AP at a time

   ⇒ sequence of update schemas with a subset of S_A "updated",
   ⇒ subsequent updates compiled w.r.t. partially updated schema.

Value Invention

Setup: advanced relational design for `Employee(id,name,salary)`

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$\Rightarrow$ no update query, e.g., for $\texttt{empfile}^{+}(r, x, y, z)$: no "source" of `RId`s!

(due to: $\forall x, y, z.\texttt{Employee}(x, y, z) \leftrightarrow (\exists r.\texttt{empfile}(r, x, y, z))$)

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- a separate access path (may need to "remember" all allocated records!)
- a part of the record insertion code (AP^+ doesn't have the attribute)
  ⇒ update query for `emp-name`$^+$ must execute *after* `empfile`$^+$.

Value Invention and Schematic Cycles

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IDEA: reify (one of) the AP (we have done that already in our example) and then interleave updates to the reified relations.

1. insert an employee’s `Id` into `emp-id` AP (yields address of `emp`);
2. insert department record (the above value used for the manager field; yields address of `dept`);
3. insert the same employee into `emp-dept` AP using the `dept` address.

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- How to determine the *ordering* of the individual AP updates?
- How to identify when *reification* is needed?
- How to determine if the user update preserves *consistency*?

  ⇒ guaranteed by the user (e.g., extra user queries to make sure)

  ⇒ system-generated checks—HARD!