**GOAL AND APPROACH**

**Goal:** Reduction of temporal operators to nontemporal operators using adjustment of timestamps.

**Problem Definition:** Given a temporal operator \( \psi^T \), and input relations \( r_1, \ldots, r_n \), our goal is to express \( \psi^T(r_1, \ldots, r_n) \) as follows:

\[
\psi^T(r_1, \ldots, r_n) = \phi^T(\psi^T(r_1, \ldots, r_n)) \quad (\text{reduction})
\]

where \( \psi \) is the nontemporal operator corresponding to \( \psi^T \), and \( \phi^T \) is a temporal primitive.

**Solution:**
- Two new algebra operators (primitives) for the adjustment of timestamps:
  - Temporal Splitter \( \mathcal{N} \)
  - Temporal Aligner \( \phi^T \)
- Reduction rules for usage within nontemporal RA.
- Timestamp propagation for accessing original timestamps.

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**EXAMPLE**

**Input:** Manager \( M \) manages, employee \( N \) employed at department \( D \) during time \( T \).

**Query:** Which employees has a manager been managing who have a shorter contract period than the manager?

**Result:** Temporal Left Outer Join

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**IMPLEMENTATION**

<table>
<thead>
<tr>
<th>Operator</th>
<th>Reduction</th>
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<tr>
<td>( \sigma_{(r)} )</td>
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<tr>
<td>( \pi_{B}(r) )</td>
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<tr>
<td>( \rho_{T}^{\geq}(r) )</td>
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**SUMMARY**

- Algebraic basis for temporal operators.
- Reduction of temporal operators to nontemporal operators.
- Deep integration into PostgreSQL kernel.

**Future Work**

- Optimization/equivalence rules for temporal primitives.
- Extensions towards time depended (malleable) quantities.
- Extension to bag algebra.

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