LABORATOIRE DE RECHERCHE EN INFORMATIQUE

Deep specification and verification of SQL compilation chain

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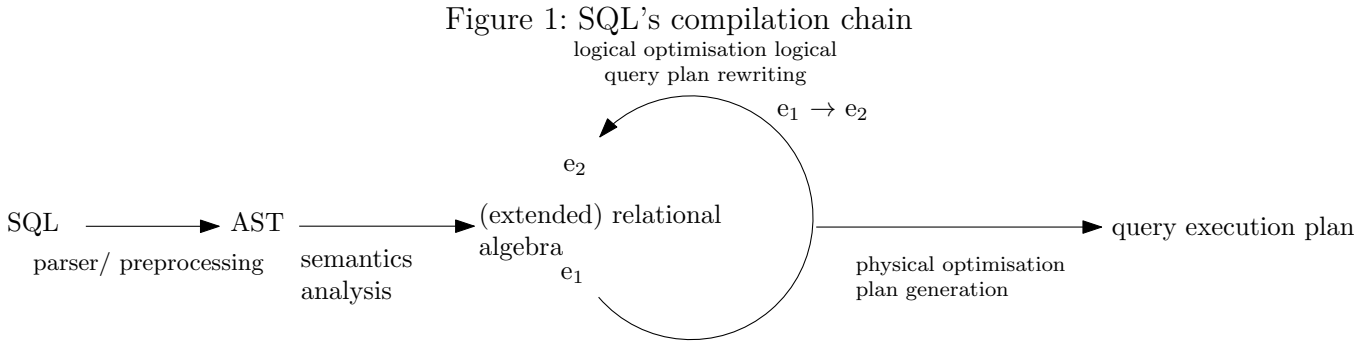
Data systems and languages, proofs

Until now there have been little usages of formal methods towards SQL and DBMS, yet, the compilation chain of SQL queries is complex.

Figure 1: SQL's compilation chain



Certified parsing, from SQL to SQLCoq

```
SELECT s.sname FROM sailors s WHERE EXISTS (SELECT * FROM reserves r WHERE
↪  r.bid = 103 AND s.sid = r.sid);
```

- SQL parser in menhir/OCamllex
- certified using the CompCert parser generator
- automatic translation into SQLCoq (in OCaml)

Involving DBMS, from SQL to unified execution plan

- PostgreSQL and Oracle query execution plan parser
- both translated to our own unified plan format

From unified plan to Extended Algebra

```
<Plan>
  <Node-Type>Hash Join</Node-Type>
  <Join-Type>Inner</Join-Type>
  <Hash-Cond>(s.sid = r.sid)</Hash-Cond>
  <Plans>
    <Plan>
      <Node-Type>Seq Scan</Node-Type>
      <Parent-Relationship>Outer</Parent-Relation
      ↪  ship>
      <Relation-Name>sailors</Relation-Name>
      <Alias>s</Alias>
    </Plan>
    ...
```

- Extended Algebra (ExtAlg) is similar to Relationnal Algebra but more powerful
- translation from an unified plan to an ExtAlg expression
- automatic annotation of ExtAlg expression with algorithms
- ability to execute our Coq version of those algorithms

```
Omega {
  _ Fine
  _ r.dday  r.dday, r.bid  r.bid, r.sid  r.sid,
  ↪  s.age  s.age, s.rating  s.rating, s.sname
  ↪  s.sname, s.sid  s.sid
  _ x_0.s.sid = x_0.r.sid
  _ {
      Omega {
        _ Fine
        _ sid  s.sid, sname  s.sname, rating
        ↪  s.rating, age  s.age
        _
        _ {
          Seq Scan on sailors
        }
      }
      X (DependentJoin) (Hash Join)
      ...
```

Equivalence of two ExtAlg queries

- translation from SQLCoq to ExtAlg
- two ExtAlg expressions, one from the DBMS, one from the SQL query/SQLCoq
- proof that two ExtAlg expression have the same semantic
- strong guarantees about the fact that the DBMS kept the semantic of the SQL query
- algorithms used by the DBMS have not been proved yet
- Coq version of some algorithms