Q*cert

A platform for specifying and verifying query compilers

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Challenges?
Precise Language Semantics
Long Compilation Pipeline
Query Optimizer

What for?
Correctness guarantees
New Languages (e.g., DSLs)
Education

How?
Formal Specification
Mechanized Proof
Code Extraction

Algebraic Equivalence

```
(* Selection distributes over union *)
Lemma select_union_distr q0 q1 q2 :
    σ⟨ q0 ⟩(q1 ∪ q2) ≡ σ⟨ q0 ⟩(q1) ∪ σ⟨ q0 ⟩(q2).
Proof.
  … (* proof omitted *)
Qed.
```

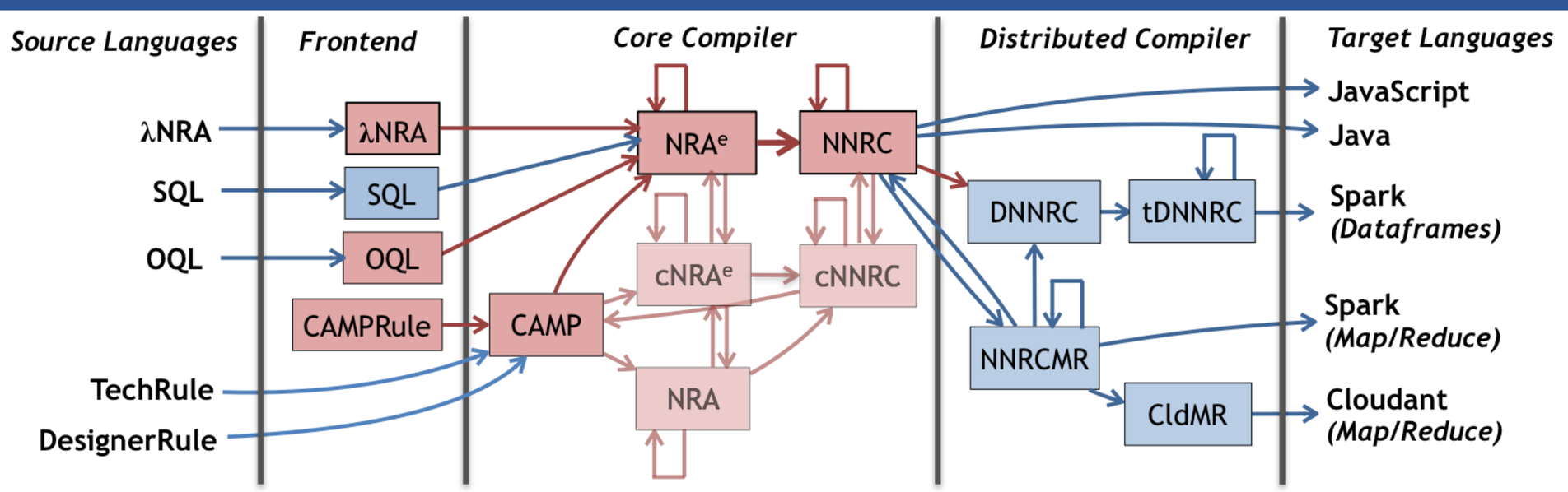
Functional Rewrite

```
(* Selection over union push-down *)
Definition select_union_distr_fun q :=
  match q with
  | NRAEnvSelect q0 (NRAEnvBinop AUnion q1 q2) =>
      NRAEnvBinop AUnion
        (NRAEnvSelect q0 q1) (NRAEnvSelect q0 q2)
  | _ => q
end.
```

Correctness Proof

```
(* Selection over union push-down is correct *)
Property select_union_distr_fun_correctness q0 q1 q2 :
 select_union_distr_fun q ≡ q.
Proof.
 Hint Rewrite select_union_distr : envmap_eqs.
 prove_correctness q.
 Qed.
```

Compilation Pipeline



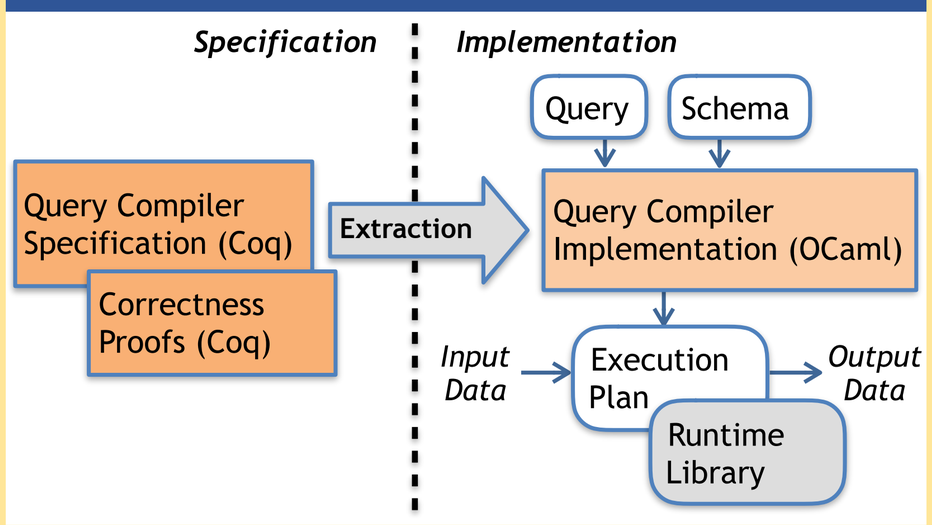
SQL: Structured Query Language
OQL: Object Query Language
λNRA: NRA with Lambdas
CAMPRule: Rule Macros for CAMP
TechRule: ODM technical rules
DesignerRule: ODM designer rules

NRA: Nested Relational Algebra
NRA^e: NRA with Environments
cNRA^e: Core NRA^e
NNRC: Named Nested Relational Calculus
cNNRC: Core NNRC
CAMP: Calculus of Aggregating Matching Patterns

DNNRC: Distributed NNRC
tDNNRC: Typed DNNRC
NNRCMR: NNRC + Map/Reduce
CldMR: NNRC + Cloudant Map/Reduce

Features
Nested Data Model with Objects
Type Checking
Aggregate Queries
External Types and Functions
JSON Support

Compiler Extraction



The Coq Proof Assistant

https://github.com/querycert