

Bachelor Proposals

Logic and Semantics & Programming Languages

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LS & PL Members

Logic and Semantics



Programming Languages



All Things Programming Languages, Analysis and Verification

- Programming languages
- Logic, compilers
- Type systems, type inference
- Security, Coq
- ...
- Automata and formal languages
- Algorithmic verification
- Static program analysis
- Testing
- ...

Property Based Testing

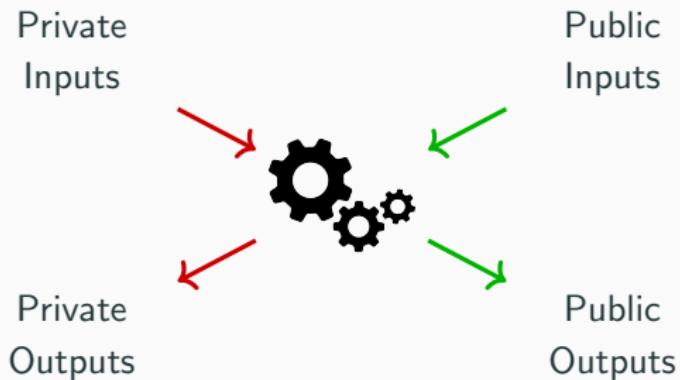
```
// Transitivity
def LessThan(x:a, y:b): Bool = {
  ...
}
```

$$\text{LessThan}(x, y) \wedge \text{LessThan}(y, z) \implies \text{LessThan}(x, z)$$

Property Based Testing – in Troupe



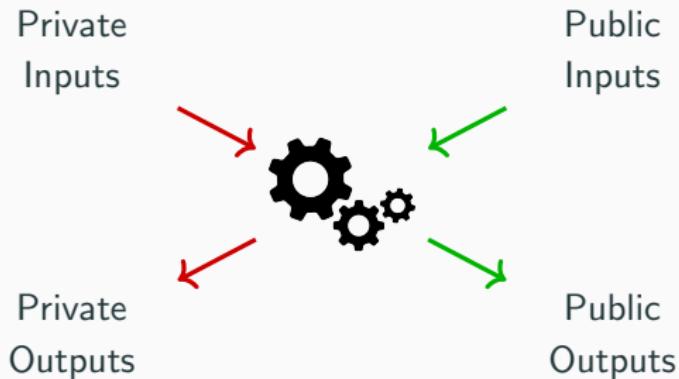
A language with runtime security monitoring



Property Based Testing – in Troupe



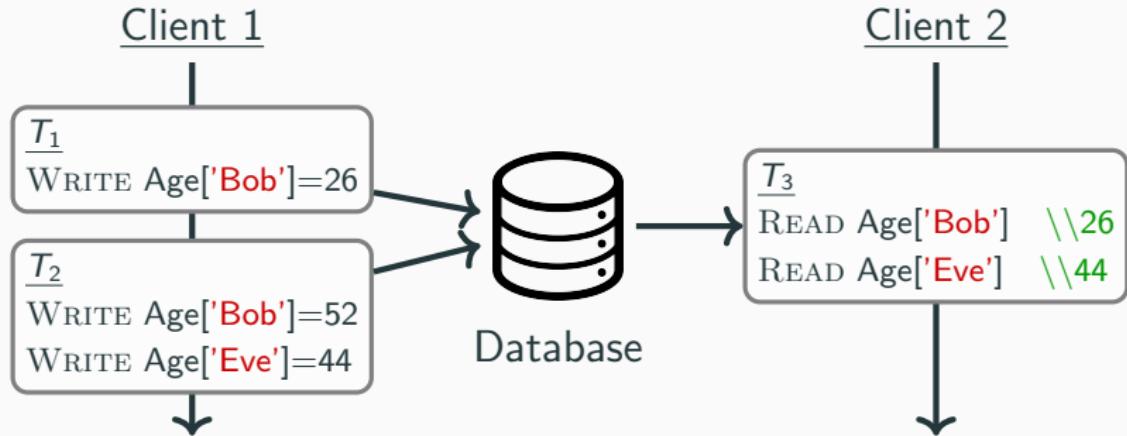
A language with runtime security monitoring



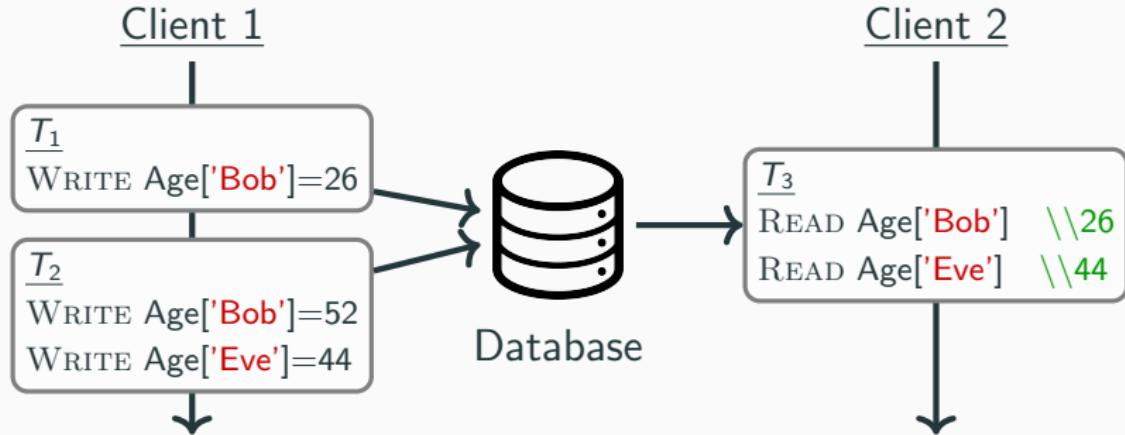
Non-interference

$$\forall x, y : (x.\text{public} = y.\text{public}) \implies (\text{gear}(x).\text{public} = \text{gear}(y).\text{public})$$

Database Isolation Testing



Database Isolation Testing

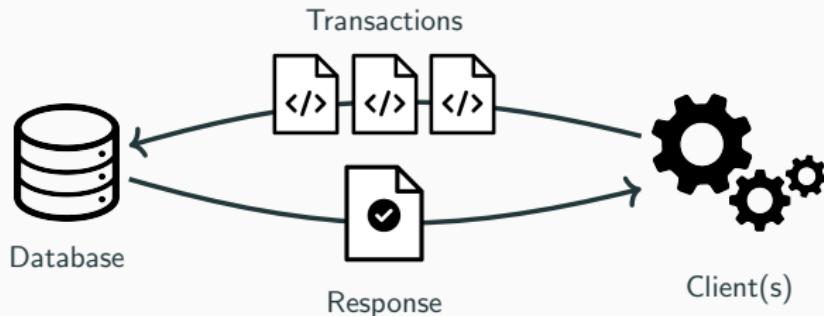


Isolation: a contract of “how atomically” each transaction executes

Database Isolation Testing



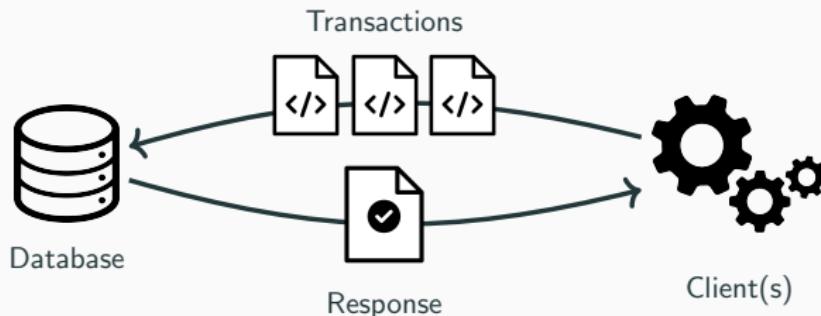
- Databases often break their isolation guarantees!
- How do we test them?



Database Isolation Testing



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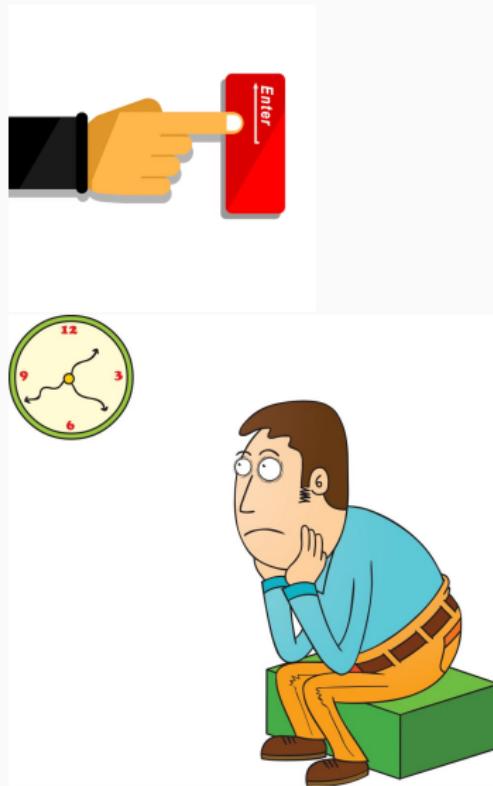
- Formalization of isolation levels?
- Algorithmic complexity of testing?
- Tooling?



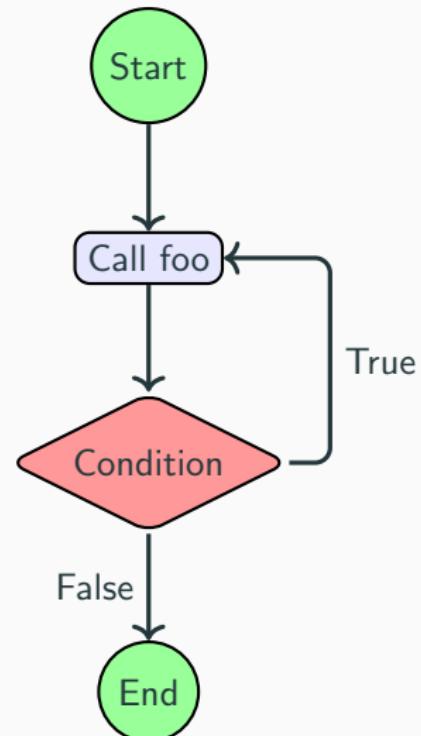
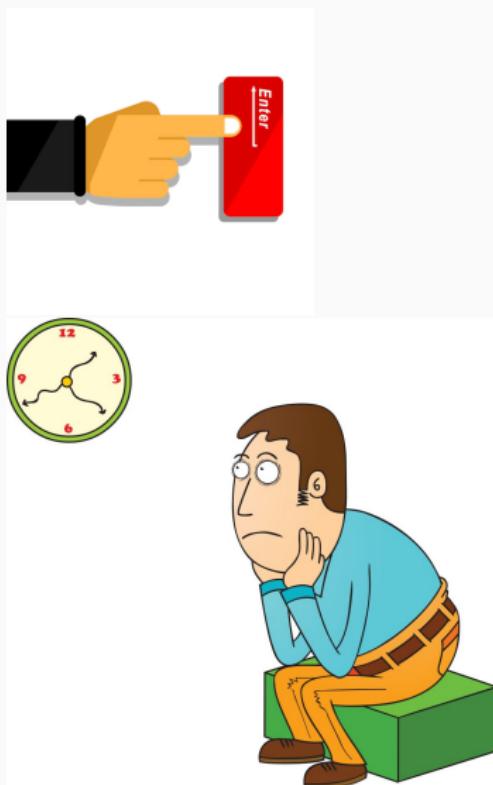
Termination Analysis



Termination Analysis



Termination Analysis



Termination Analysis



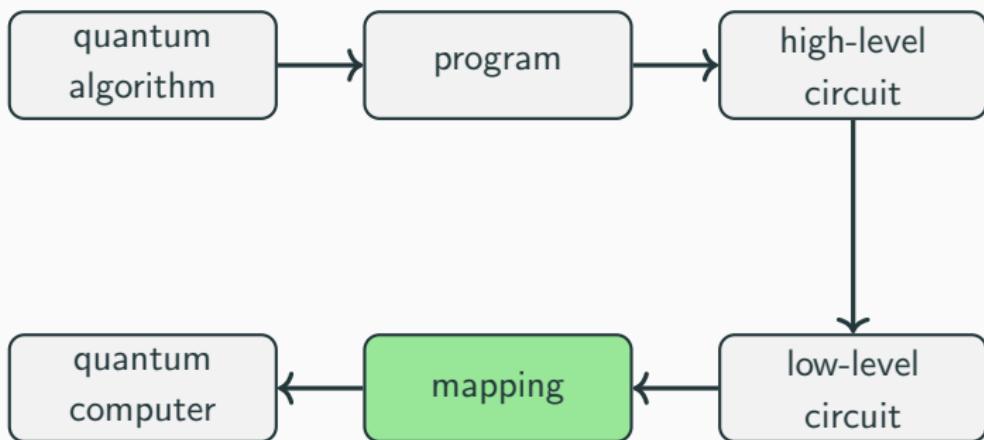
- Algebraic data types
- Type inference
- Polymorphic effects
- First-class Datalog constraints

```
// Termination via recursion on structurally smaller data
def map(f: a->b, l: List[a]): List[b] =
    match l {
        case Nil      => Nil
        case x :: xs => f(x) :: map(f, xs)
    }
```

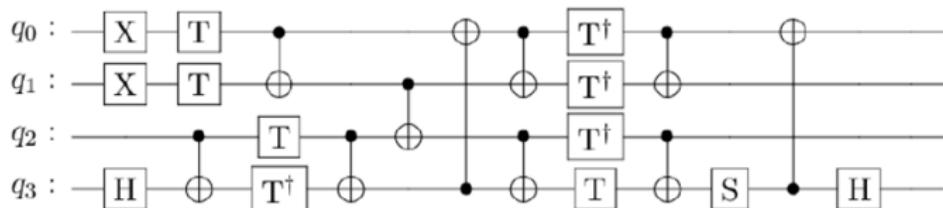
- What methods exist for termination checking?
- How to implement in the Flix compiler?



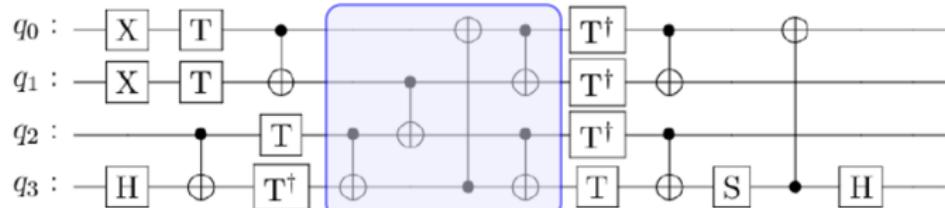
Quantum Circuit Synthesis



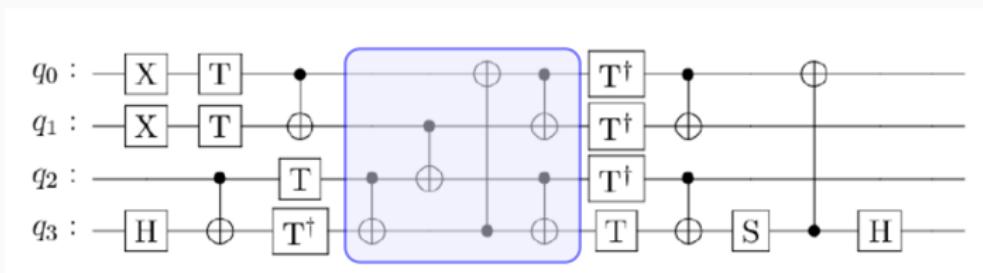
Quantum Circuit Synthesis



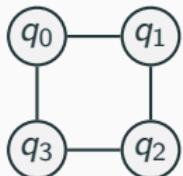
Quantum Circuit Synthesis



Quantum Circuit Synthesis



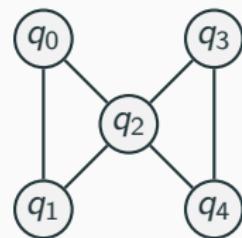
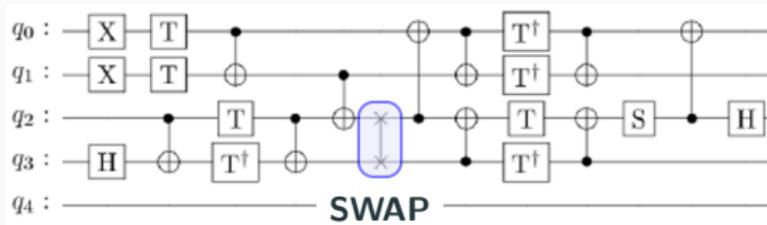
Requires



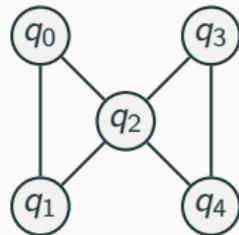
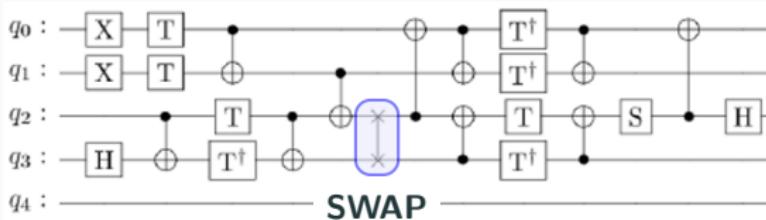
What if we only have?



Quantum Circuit Synthesis



Quantum Circuit Synthesis



- Can a topology support a quantum circuit?
- What is the minimal number of **SWAPs** needed?
- What is the optimal circuit for a given topology?



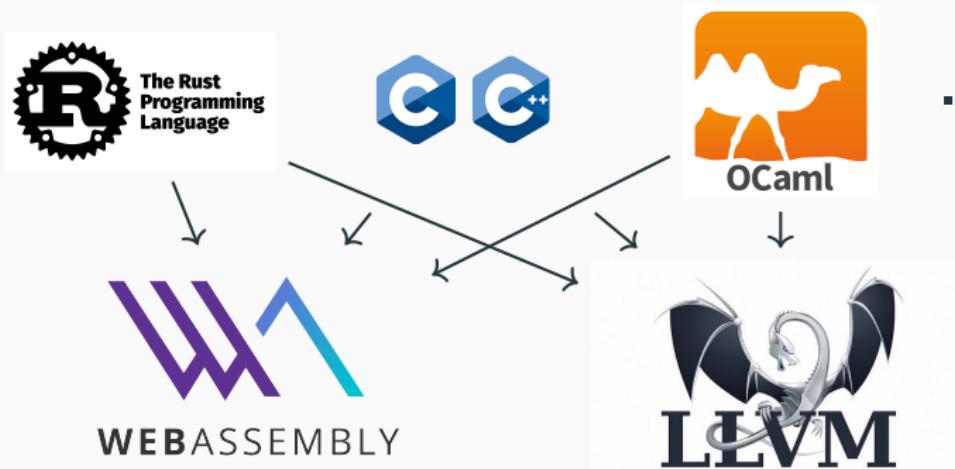
Safe Compilation to WebAssembly and LLVM



Safe Compilation to WebAssembly and LLVM



Safe Compilation to WebAssembly and LLVM



- How do I compile between mainstream languages?
- How do I prove that my compilation is correct?
 - Property based testing
 - Mechanization
 - ...

