To Iterate is Human, To Recurse is Divine

Mapping Iterative Python to Recursive SQL

Tim Fischer
✉ tim.fischer@uni-tuebingen.de

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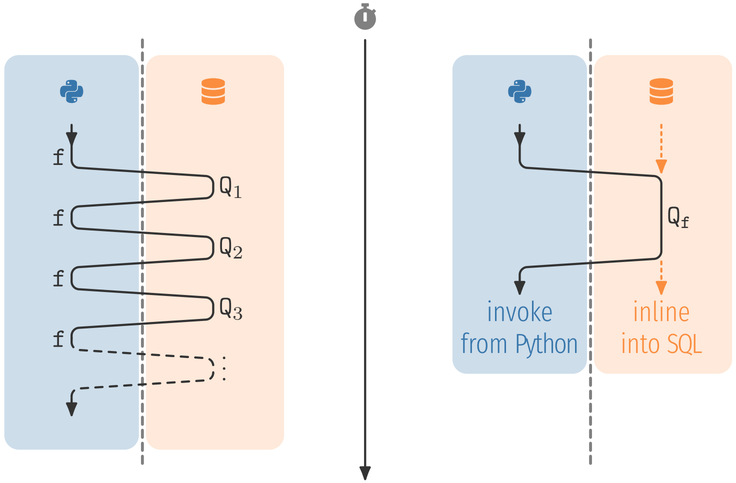
EBERHARD KARLS UNIVERSITÄT TÜBINGEN

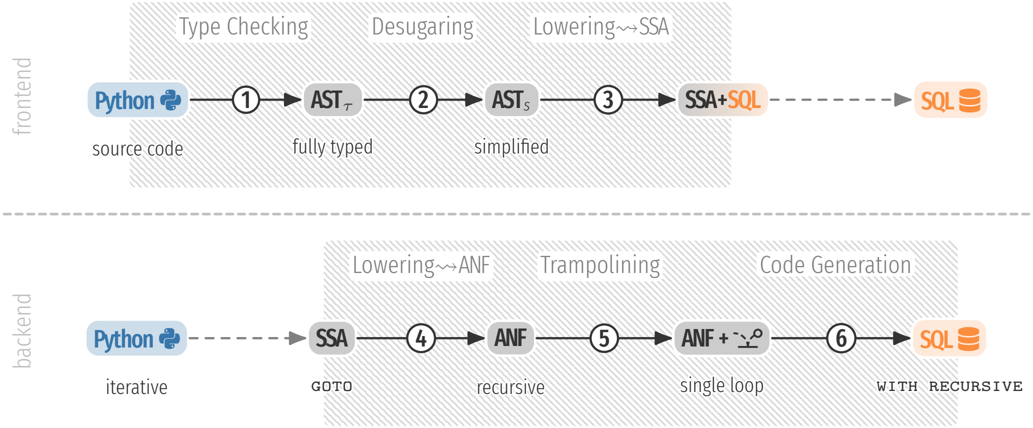
What’s the Problem?

```
def march(current: Point) -> list[Point]:
  goal : Point | None = None
  track: bool         = False
  march: list[Point]  = []

  while not track or current != goal:
    square: Squares = SQL(
        "SELECT s FROM squares AS s WHERE s.xy = $1",
        [current],
    )
    dir: Directions = SQL(
        """
        SELECT d
        FROM   directions AS d
        WHERE  (($1).ll, ($1).lr, ($1).ul, ($1).ur)
        =      (   d.ll,    d.lr,    d.ul,    d.ur)
        """,
        [square],
    )
    if not track and dir.track: track, goal = True, current
    if track:                   march.append(current)
    current += dir.dir

  return march
```

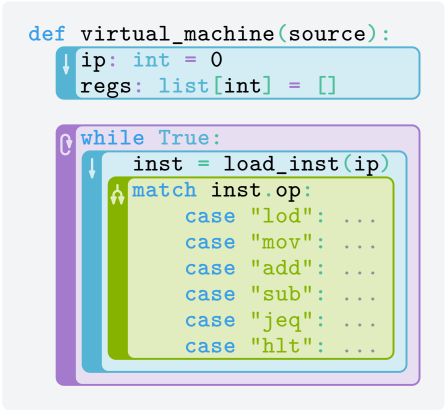
Too Many Round Trips!



Compiler Stages



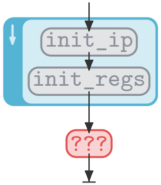
Types of Control Flow



```python
def virtual_machine(source):
    ip: int = 0
    regs: list[int] = []

    while True:
        inst = load_inst(ip)
        match inst.op:
            case "lod": ...
            case "mov": ...
            case "add": ...
            case "sub": ...
            case "jeq": ...
            case "hlt": ...
```

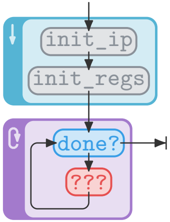
Non-Branching Linear Control Flow in SQL

```
SELECT ...
FROM   LATERAL (SELECT 1        :: int   ) AS let_1(ip),
       LATERAL (SELECT ARRAY[]  :: int[]) AS let_2(regs)
```



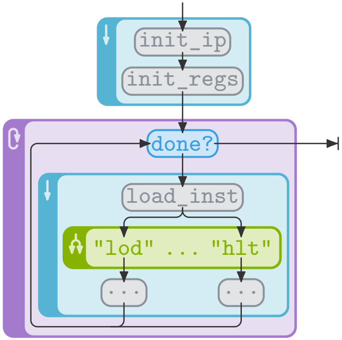
Non-Linear Control Flow in SQL

```
WITH RECURSIVE
  loop("done?", ...) AS (
    SELECT False, ...
      UNION
    SELECT ...
    FROM   loop AS state
    WHERE  NOT state."done?"
  )
SELECT ...
FROM   loop
WHERE  "done?"
```



Branching Linear Control Flow in SQL

```
SELECT next_state.*
FROM   loop AS state,
       LATERAL (SELECT load_inst(ip)) AS let_3(inst),
       LATERAL (
         SELECT ... WHERE inst.op = 'lod'
           UNION ALL
         SELECT ... WHERE inst.op = 'mov'
           UNION ALL
         SELECT ... WHERE inst.op = 'add'
           UNION ALL
         SELECT ... WHERE inst.op = 'sub'
           UNION ALL
         SELECT ... WHERE inst.op = 'jeq'
           UNION ALL
         SELECT ... WHERE inst.op = 'hlt'
       ) AS next_state
WHERE  NOT "done?"
```



Join us in our effort to
marry **complex computations** with **SQL**!

Fully-Funded PhD or Postdoc Position

Database Systems Group @ Uni Tübingen

Approach Torsten Grust, who is around this week.