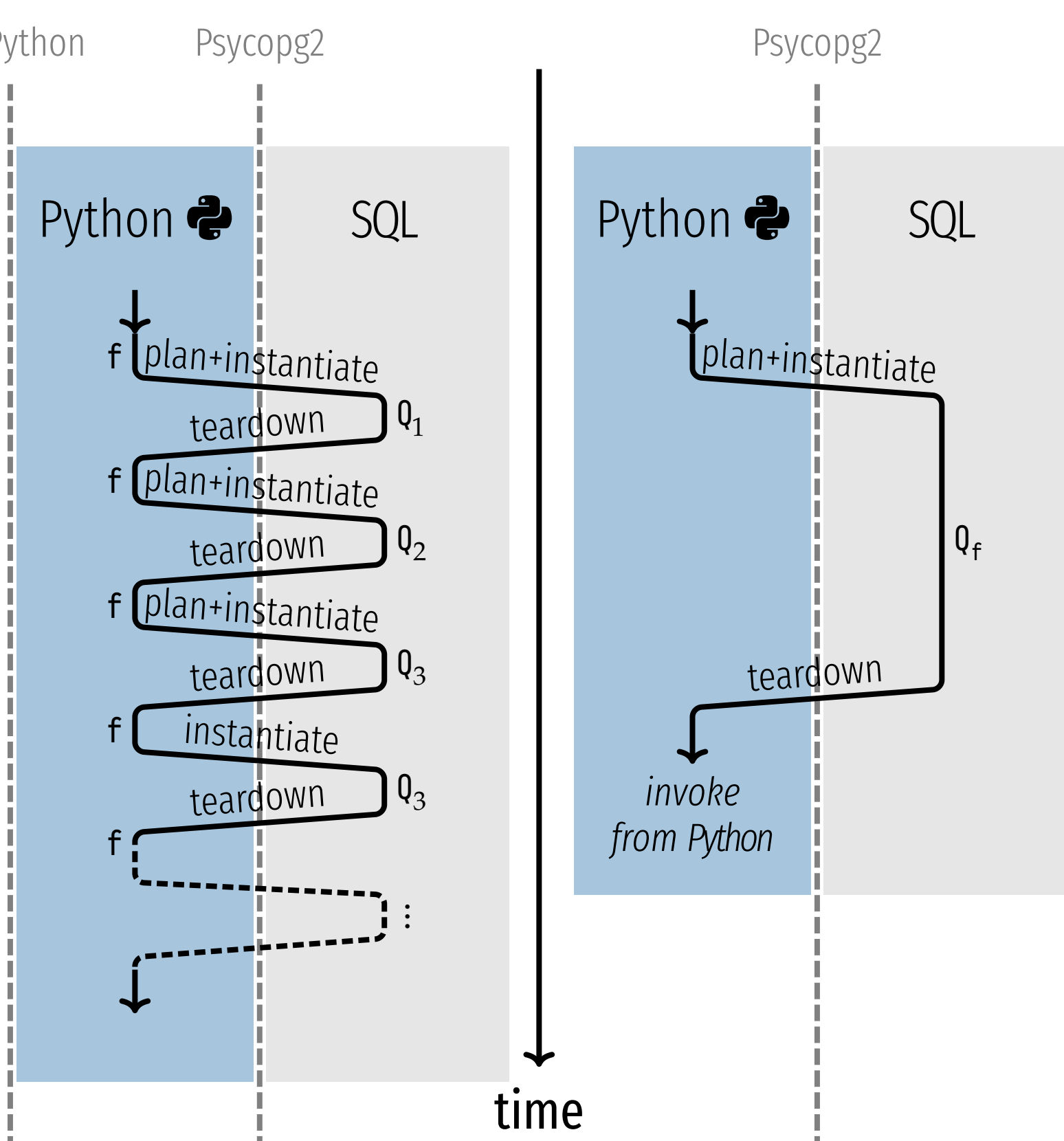


### Python Subset Understood by ByePy

- looping and iteration (`while`, `for v in range/array`)
- flow control statements (`continue`, `break`, `return`),
- conditional statements (`if`, `elif`, `else`) as well as expressions (`e1 if e2 else e3`),
- variable assignment (`v=e`, `v+=e`, `v[e1]=e2`) and reference,
- lists (`[e1, ..., en]`), indexed access and slicing (`e1[e2]`, `e1[e2:e3]`), stateful list methods (`e.pop`, `e.append`, `e.extend`),
- a large range of builtin operators and functions (`+`, `%`, `**`, `&`, `~`, `<<`, `<=`, `==`, `and`, `...`, `len`, `max`, `ceil`, `sqrt`, `coalesce`, ...),
- embedded read-only queries (`SQL(q, [e1, ..., en])`)

### Interplay of the Python Interpreter and SQL Engine



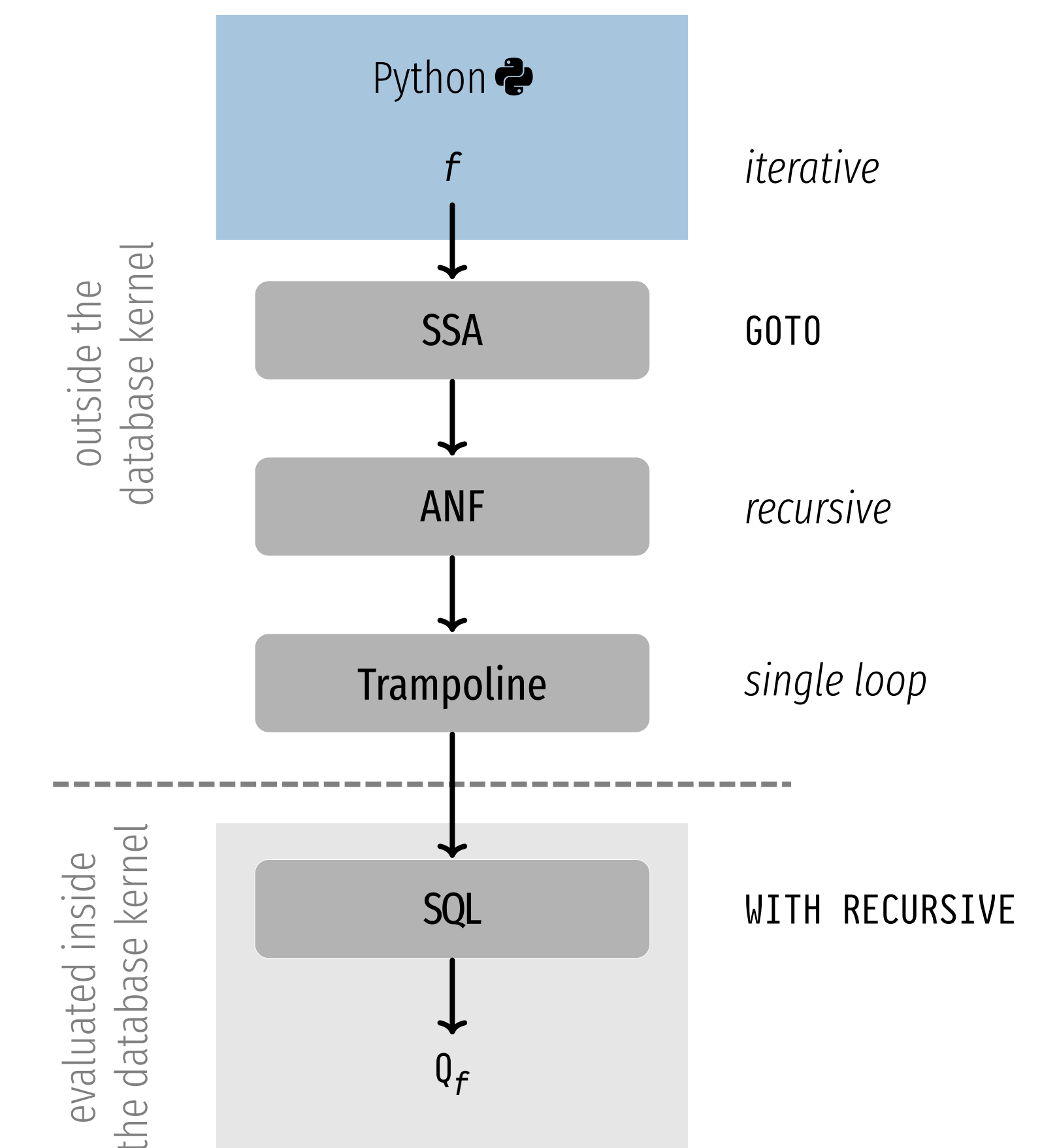
# Snakes on a Plan – ByePy

# Bye, Python! – How we compile UDFs with complex control flow into one recursive SQL CTE.

### Compiling UDF $f$ : Intermediate Program Forms

1. Bring  $f$  into SSA form in which iterative as well as conditional control flow is *exclusively* expressed in terms of **GOTO**,
2. translate the resulting *graph of SSA blocks* into a bundle of tail-recursive functions in ANF,
3. form a central **trampoline** function which dispatches to the functions in the bundle, then loops back to itself, and
4. **inline** the functions into the trampoline, after which the recursive CTE  $Q_f$  can be read off this final intermediate form.

### Compiler Stages



### A Collection of Compiled Python UDFs

UDF	Description	Speedup
force	$n$ -body simulation (Barnes-Hut quad tree)	5.7x
march	track border of 2D object (Marching Squares)	10.0x
margin	buy/sell TPC-H orders to maximize margin	4.7x
markov	Markov-chain based robot control	3.6x
packing	pack TPC-H lineitems tightly into containers	16.0x
savings	optimize supply chain of a TPC-H order	31.0x
vm	execute program on a simple virtual machine	24.0x



Try the demo

<https://apfel-db.informatik.uni-tuebingen.de>



Download the full paper

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