A genetic and source-to-source approach to iterative compilation

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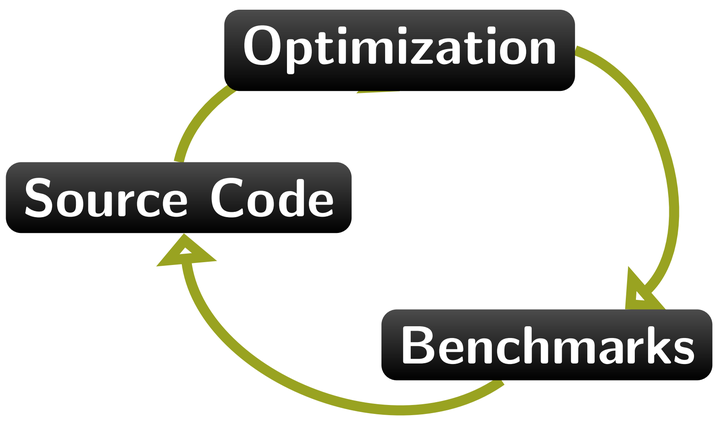
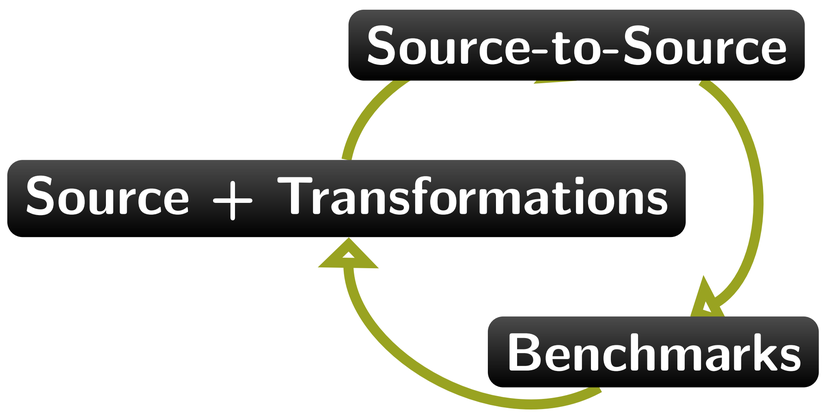
Classical optimization Cycle



With Source-to-source compilers

- PIPS – OSS from Mines ParisTech, 21 years old, 550 KLOC
- 242 transformations/phases
- ODL ⇒ introspection, persistence . . .
- *à la* `make` phase chaining engine
- Linear Algebra-based analysis

Enhanced optimization Cycle



Automation through Python

Automatically chain Transformations

```
from pyps import * # tool namespace
w = workspace("test.c") # load files
foo=w["foo"] # per function selection
bar=w["bar"] # bar as a 'module' type
bar.unroll(FACTOR=4) # call transformations on module
foo.inlining(CALLERS="bar",PURGE_LABELS=True)
bar.display() # display module content on stdout
w.save(indir="sample") # save transformed files
w.compile(outdir="sample",link=False) # compile them
```

Various Approaches

- Transverse $\mathbb{T}$, the source-to-source transformation set
  ⇒ *unrolling*, *inlining*, *loop distribution*, *scalarization* . . .
- K is a selection factor ⇒ control the greedy complexity

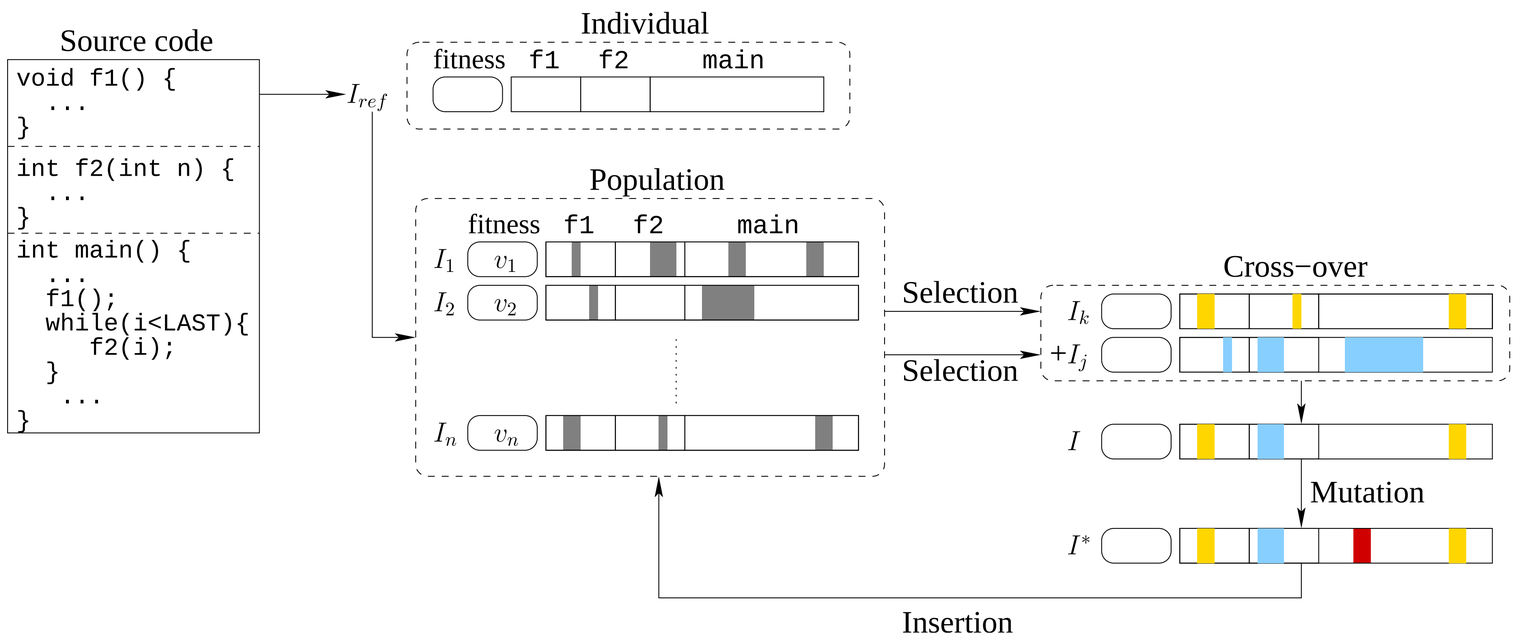
Full: $\mathcal{O}(|\mathbb{T}|!)$

Greedy: $\mathcal{O}(K * |\mathbb{T}|^2)$

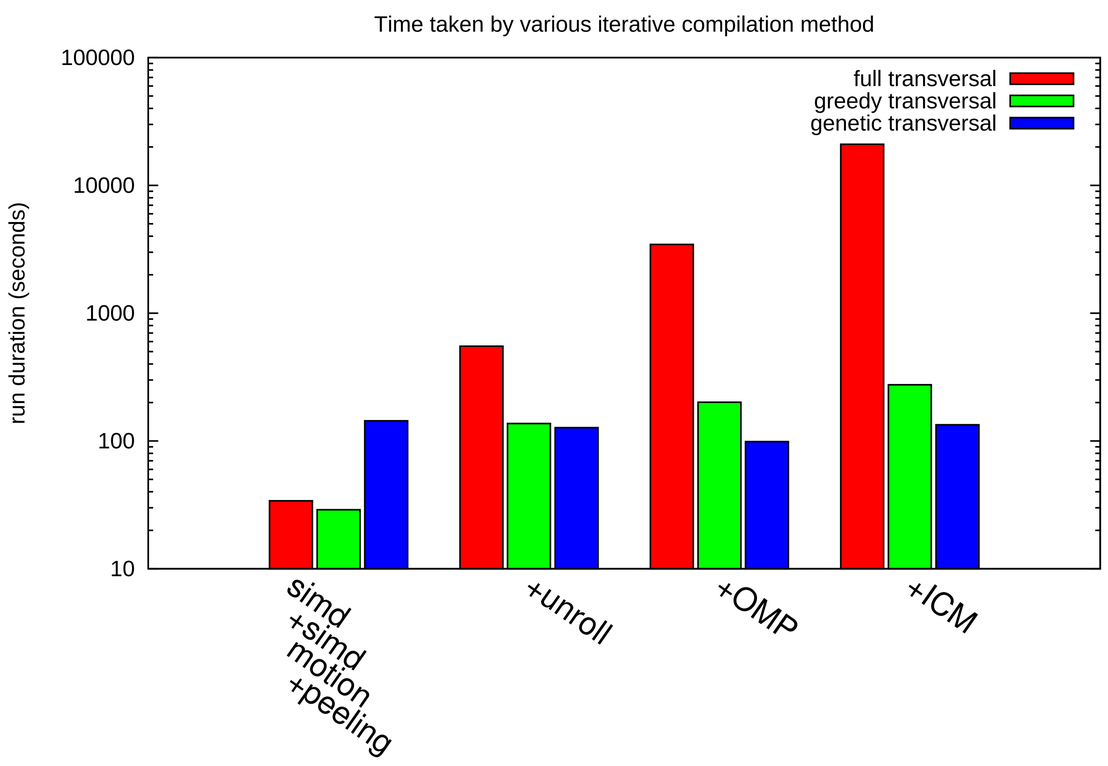
⇒ Either too costly or too naive !

Genetic Algorithm Based Transformation space exploration

- Search heuristic based on biological evolution
- Individual: source code
- Mutation: code transformation
- Fitness: execution time
- Configurable Complexity
- Avoid Greedy algorithm problem
- ± Random behavior
- Parallelization opportunity ?



Time performance



On an inner product

```
float inner_product(float b[SIZE], float c[SIZE]) {
 int i;
 float a = 0;
 for(i = 0; i < SIZE; i++)
  a += b[i]*c[i];
 return a;
}
```

Best Element

	ref	full	greedy	genetic
execution time (clock)	11435	8641	9870	8673

Best transformation

simdization + simd constant motion + unrolling + omp // for

this work was supervised by **Sébastien Varrette** from the University of Luxembourg