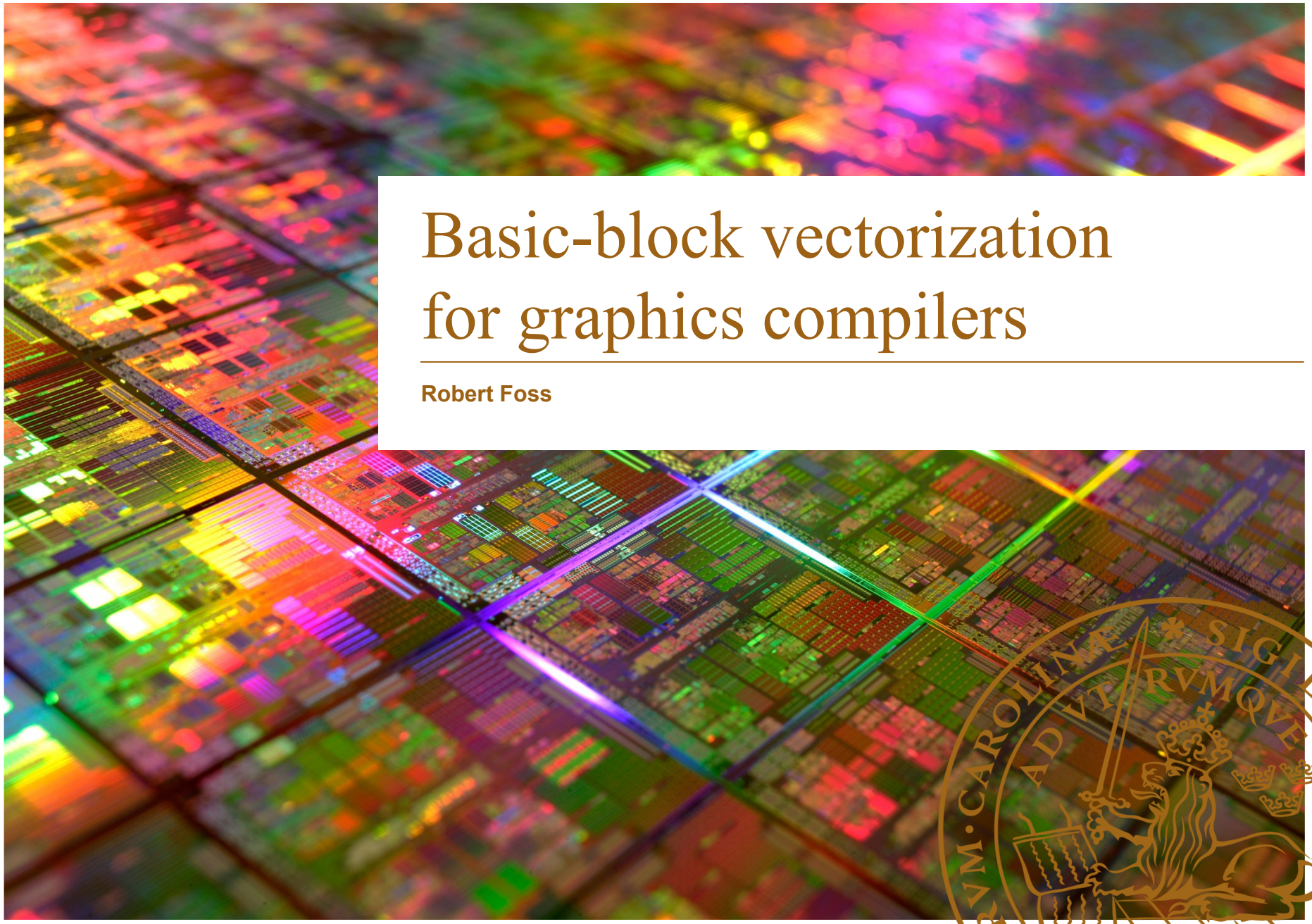
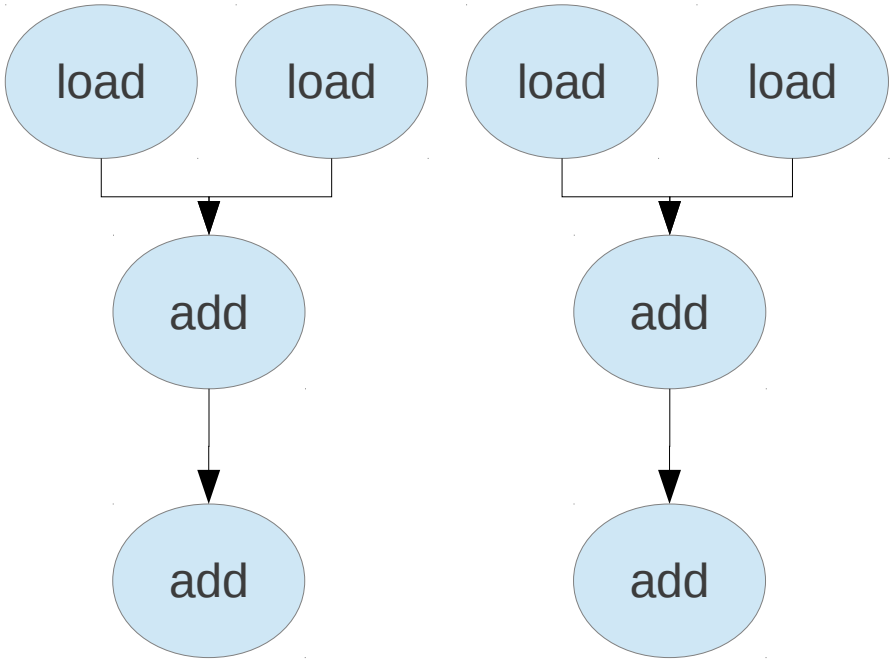


Basic-block vectorization for graphics compilers

Robert Foss

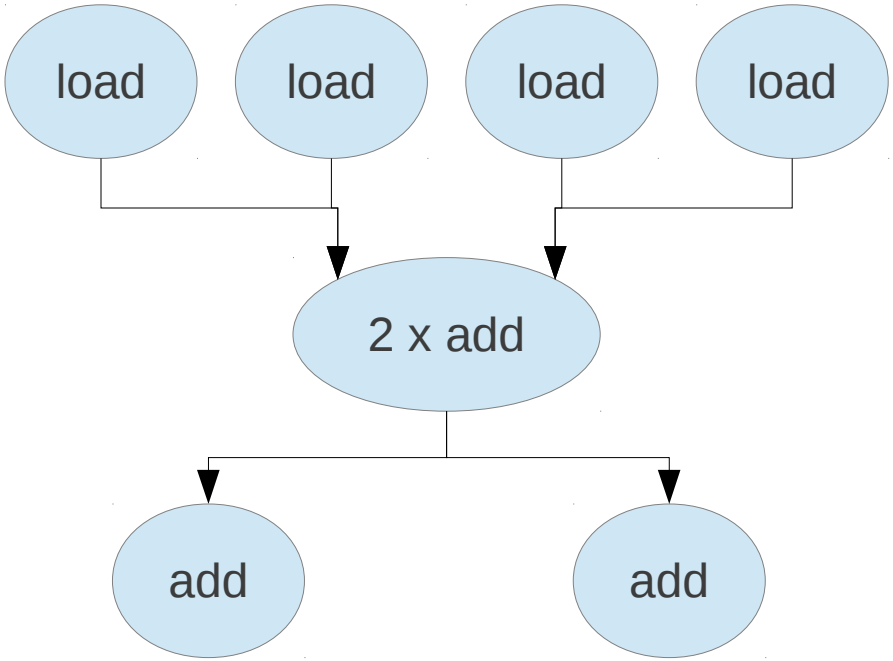
About vectorization

Vectorization 101



About vectorization

Vectorization 101



More about vectorization

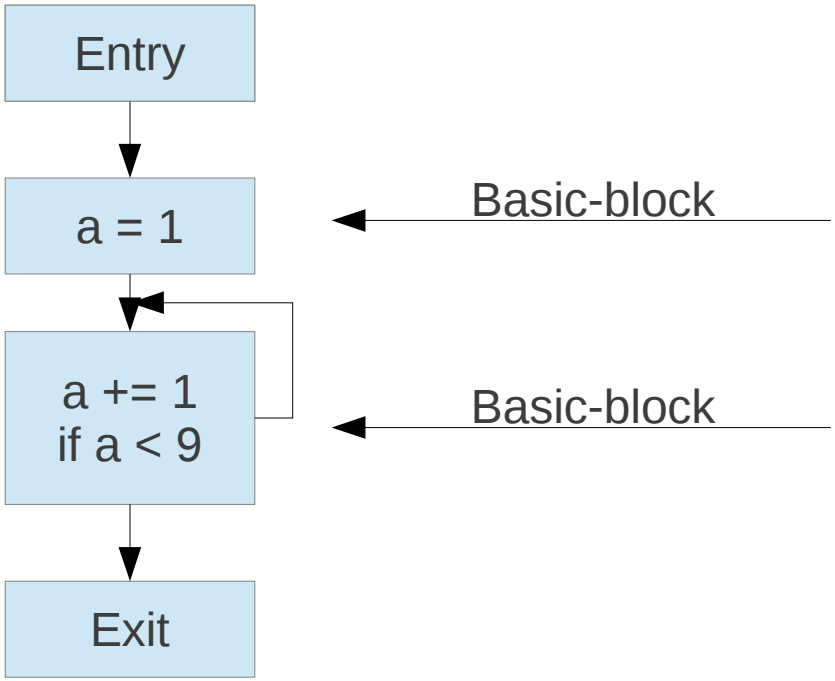
Techniques

Several techniques exist

- Loop-based vectorization
- Basic-block vectorization
- Superword Level Parallelism vectorization

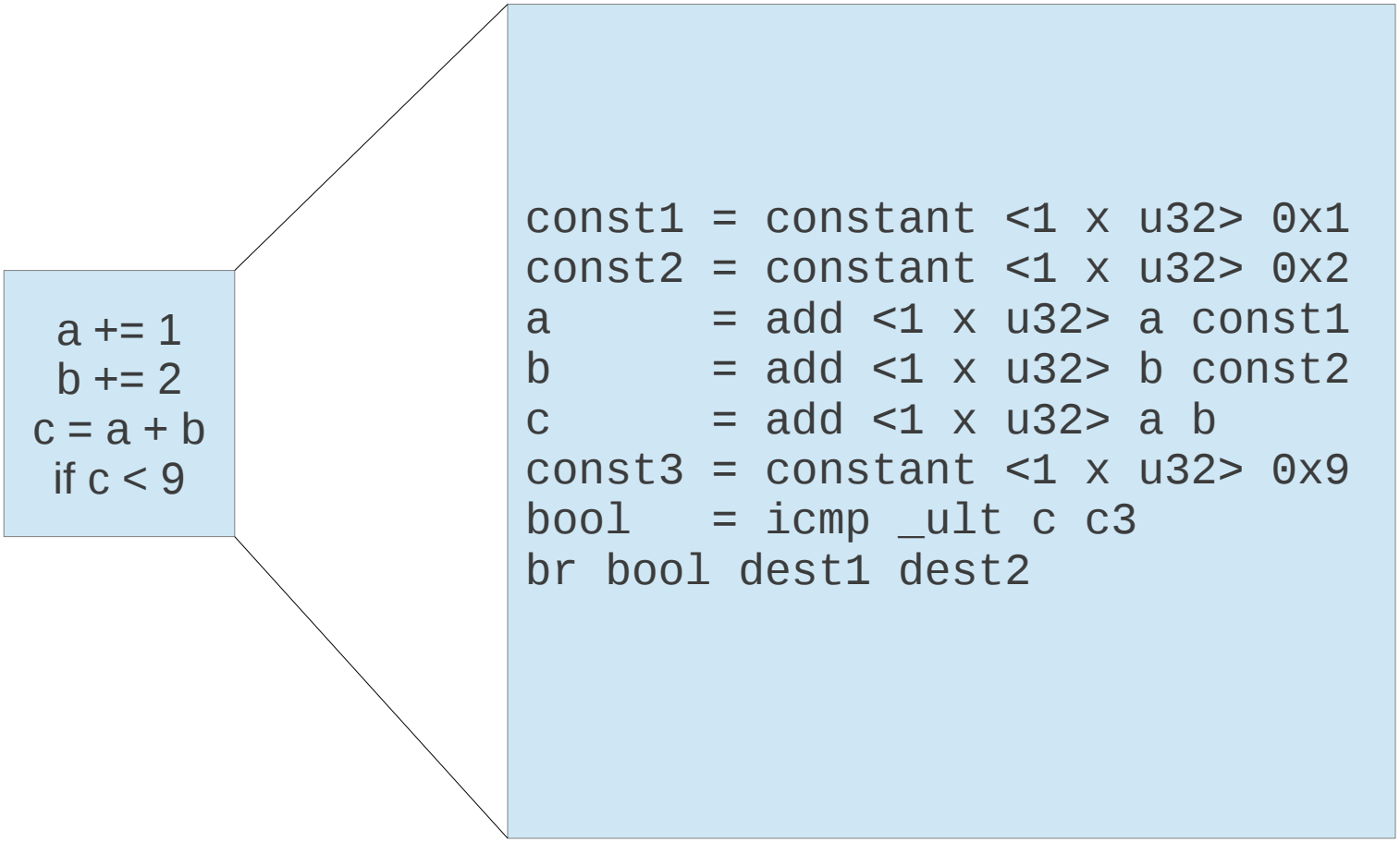
Basic-block vectorization

Control Flow Graph

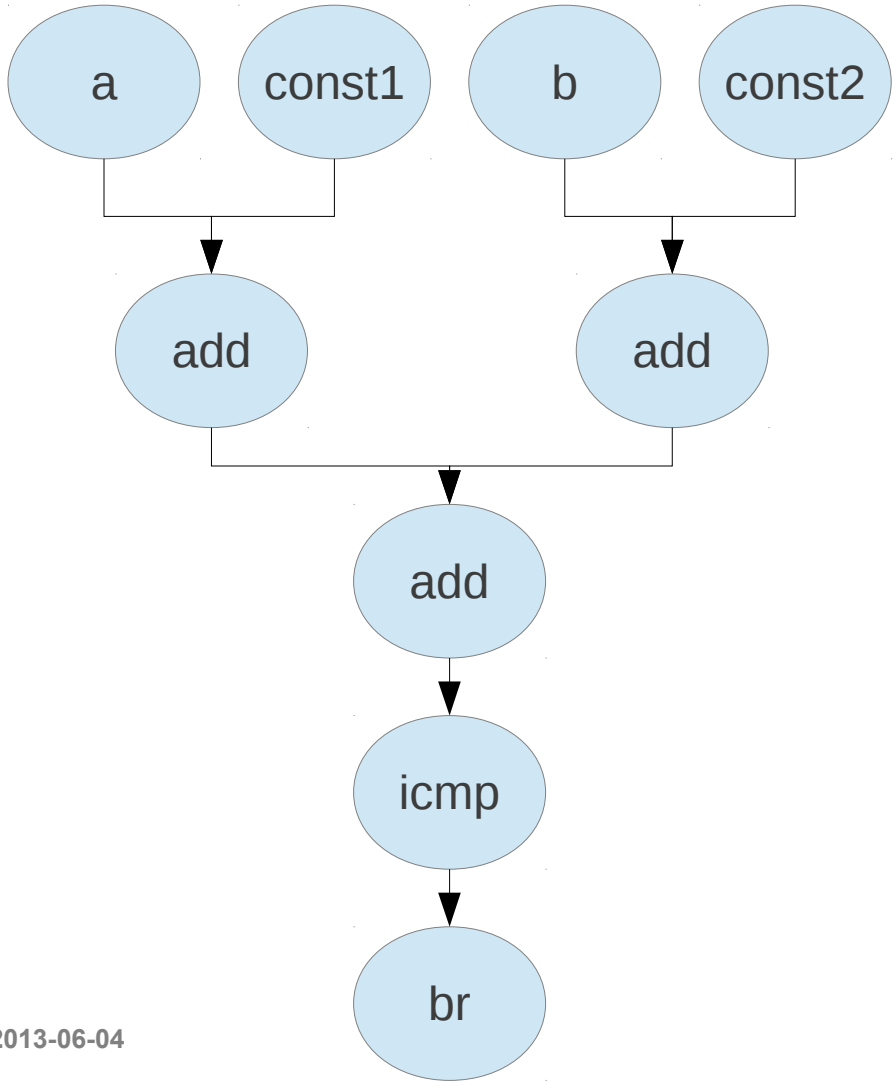


Basic-block vectorization

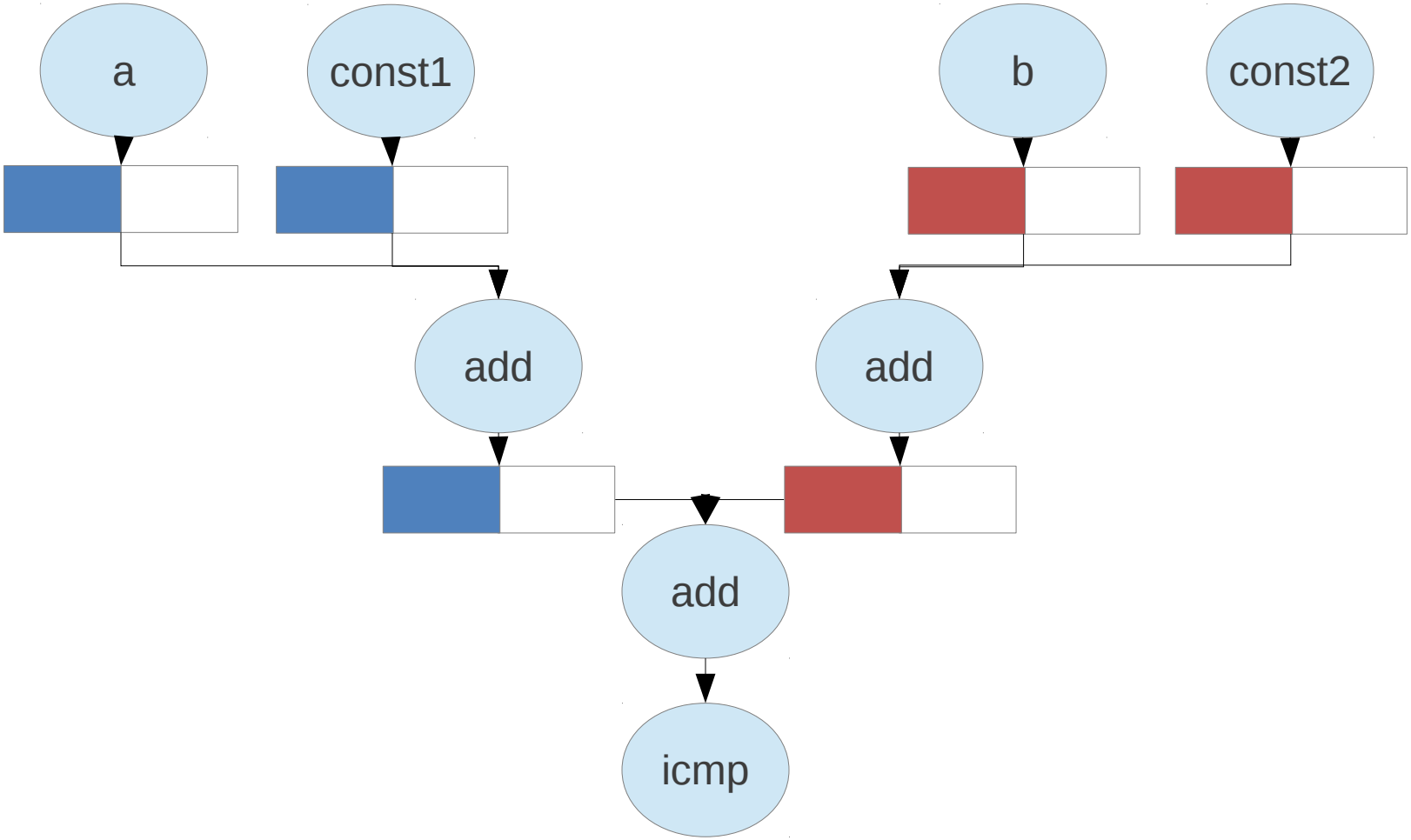
Basic-block



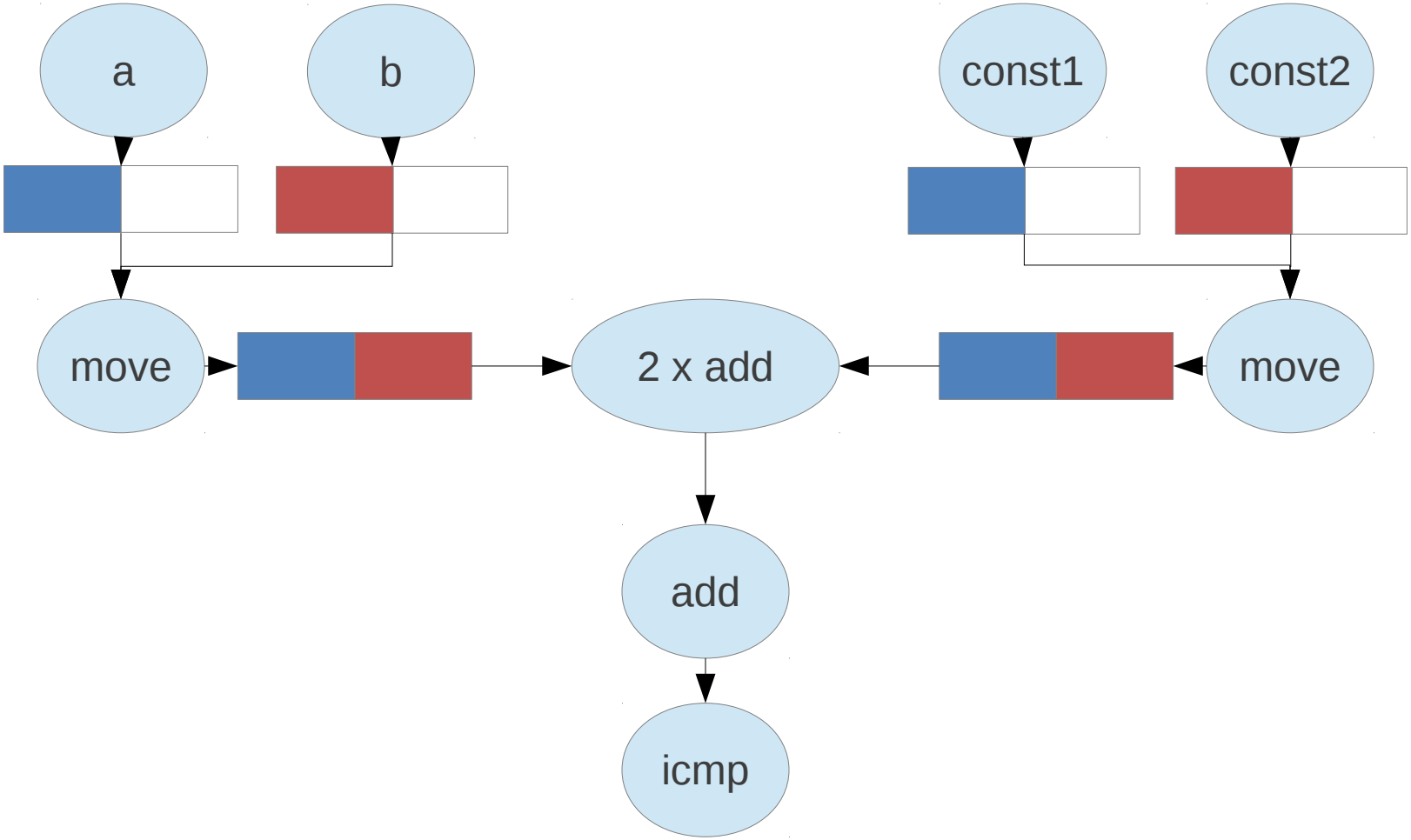
Basic-block vectorization



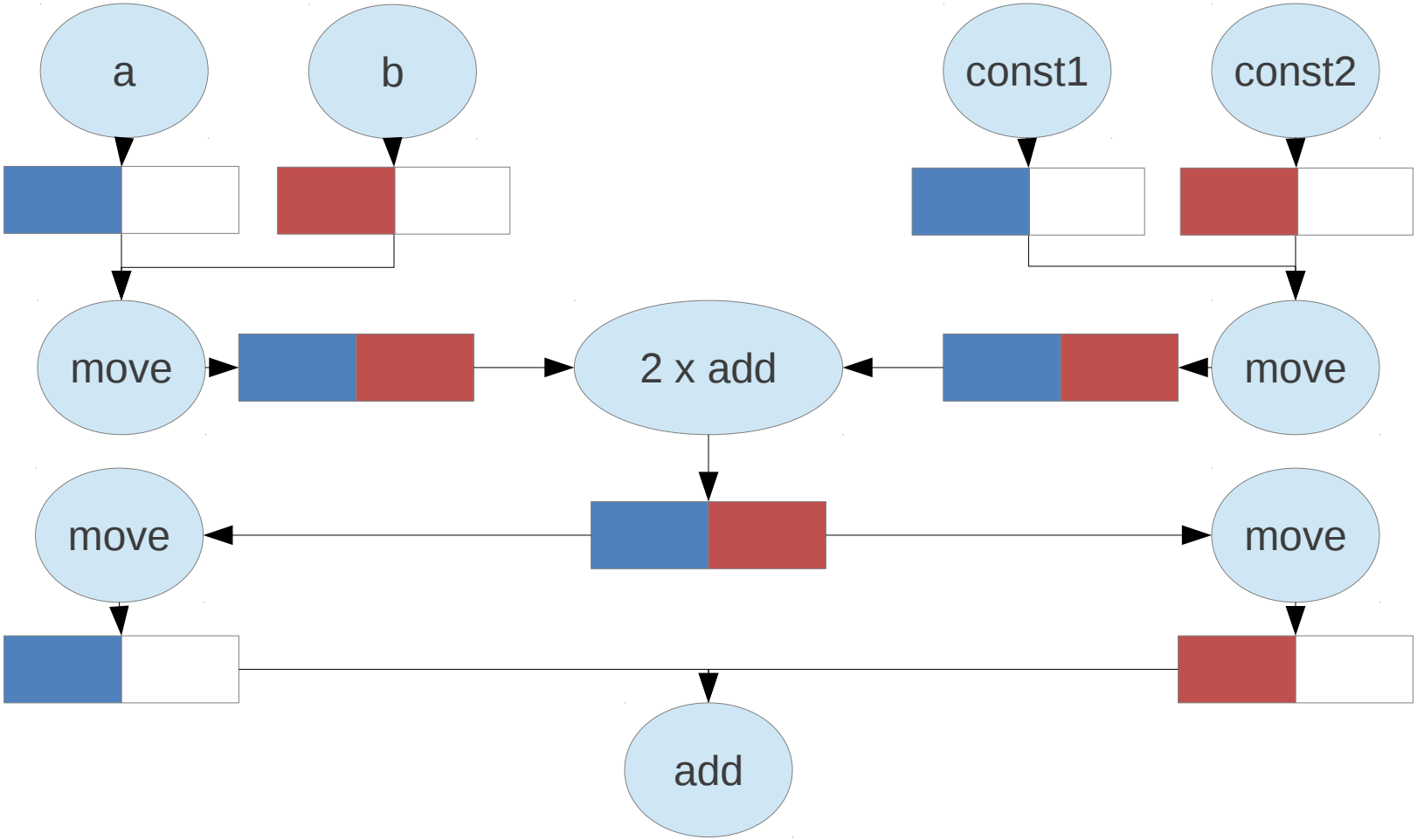
Basic-block vectorization



Basic-block vectorization



Basic-block vectorization



Basic-block vectorization

Alternatives

Two algorithms were implemented

- LLVM-based basic-block vectorization
- Pair-based basic-block vectorization

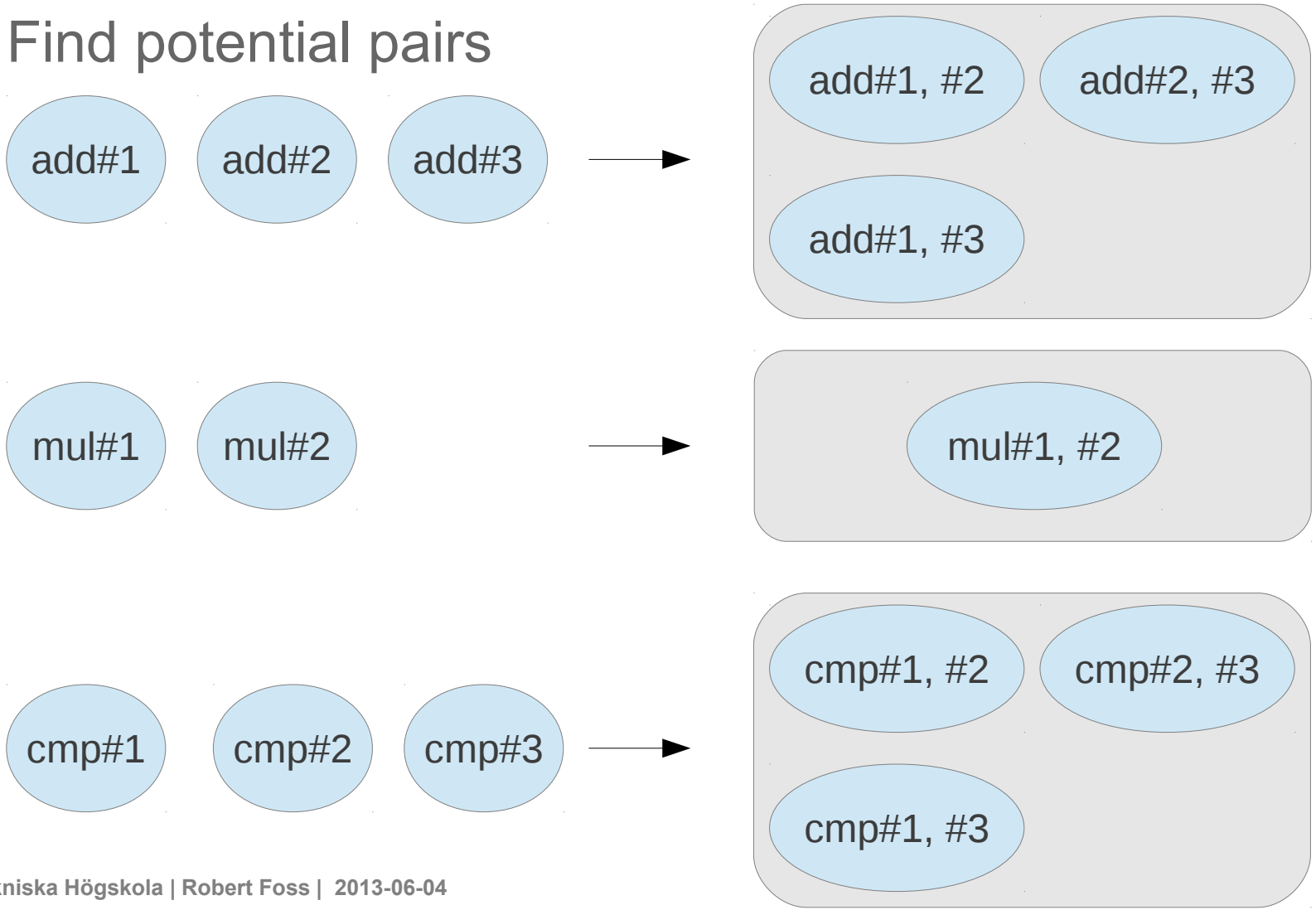
LLVM-based vectorization

Steps involved:

- Find potential pairs
- Find connections between pairs
- Pair selection
- Pair fusing
- Fixed-point iteration

LLVM-based vectorization

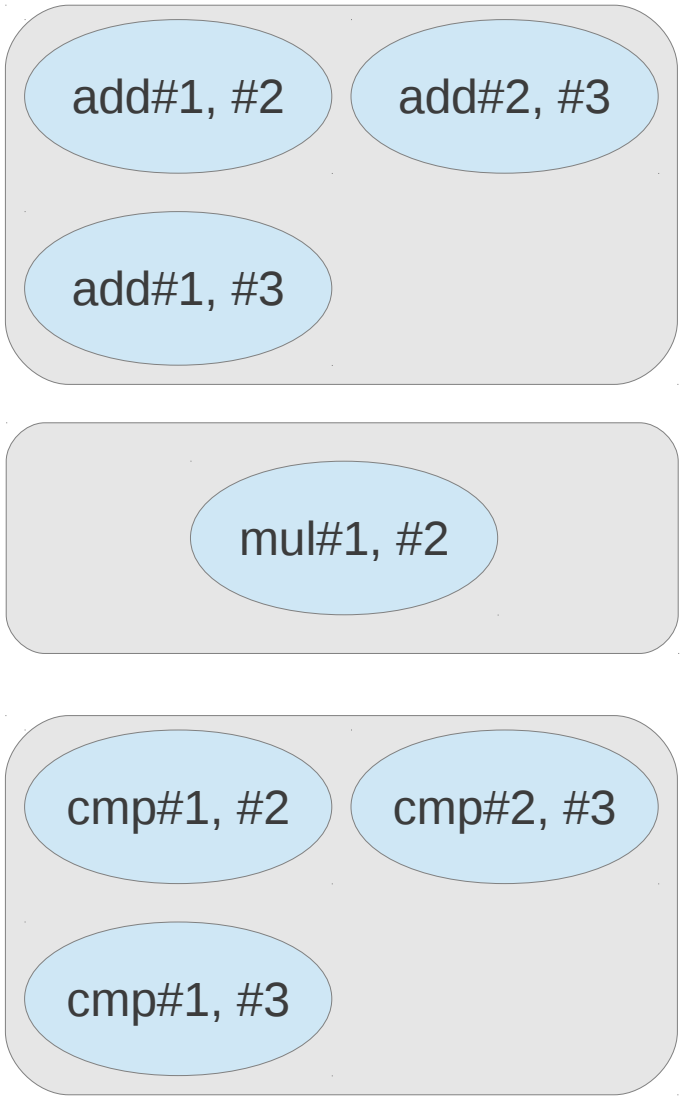
Find potential pairs



LLVM-based vectorization

Find potential pairs

Steps involved:

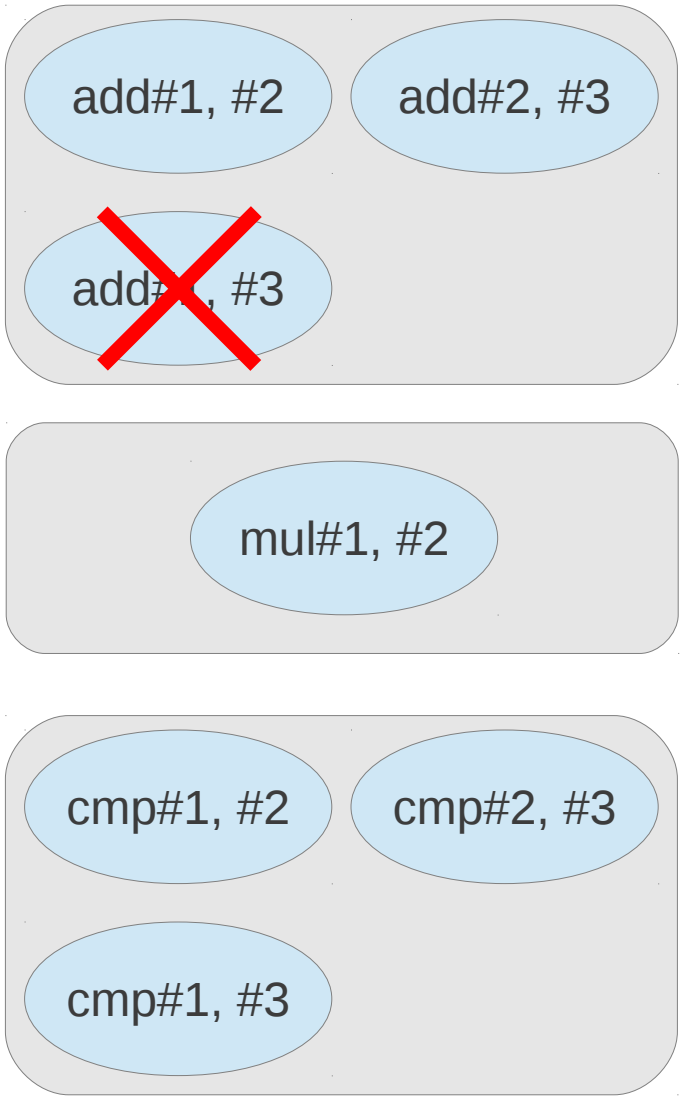


LLVM-based vectorization

Find potential pairs

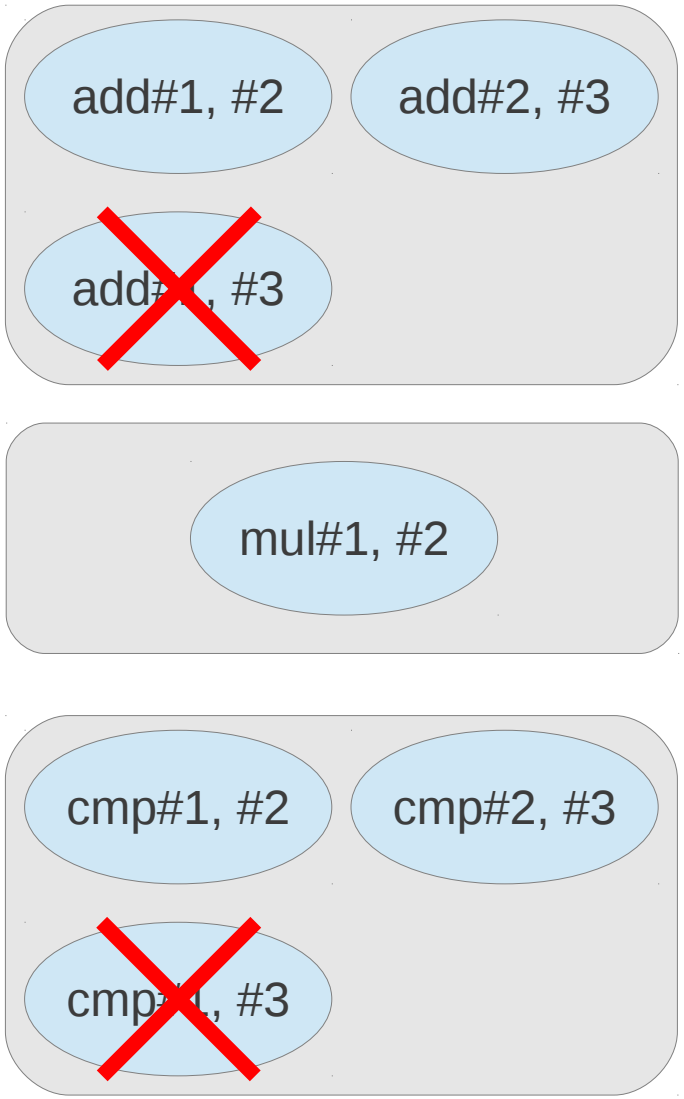
Steps involved:

- Remove intradependent pairs



LLVM-based vectorization

Find potential pairs

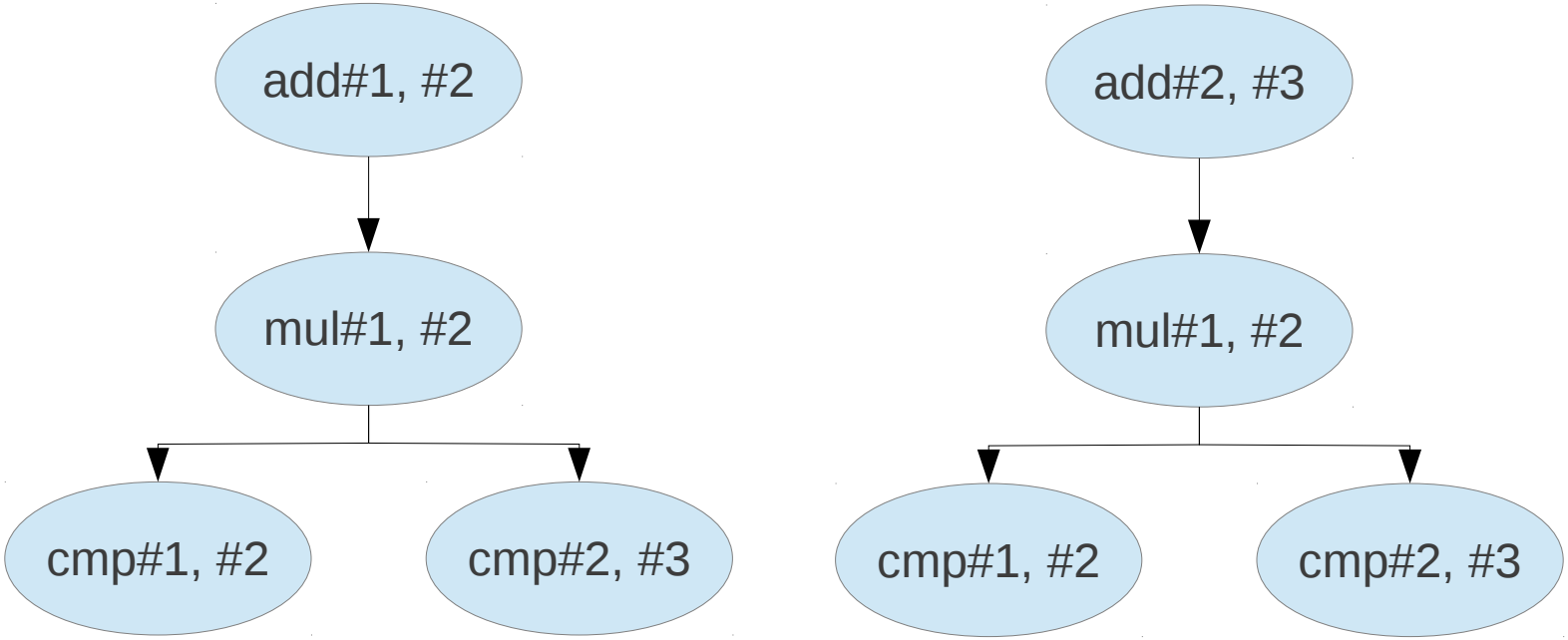


Steps involved:

- Remove intradependent pairs
- Remove illegal pairs

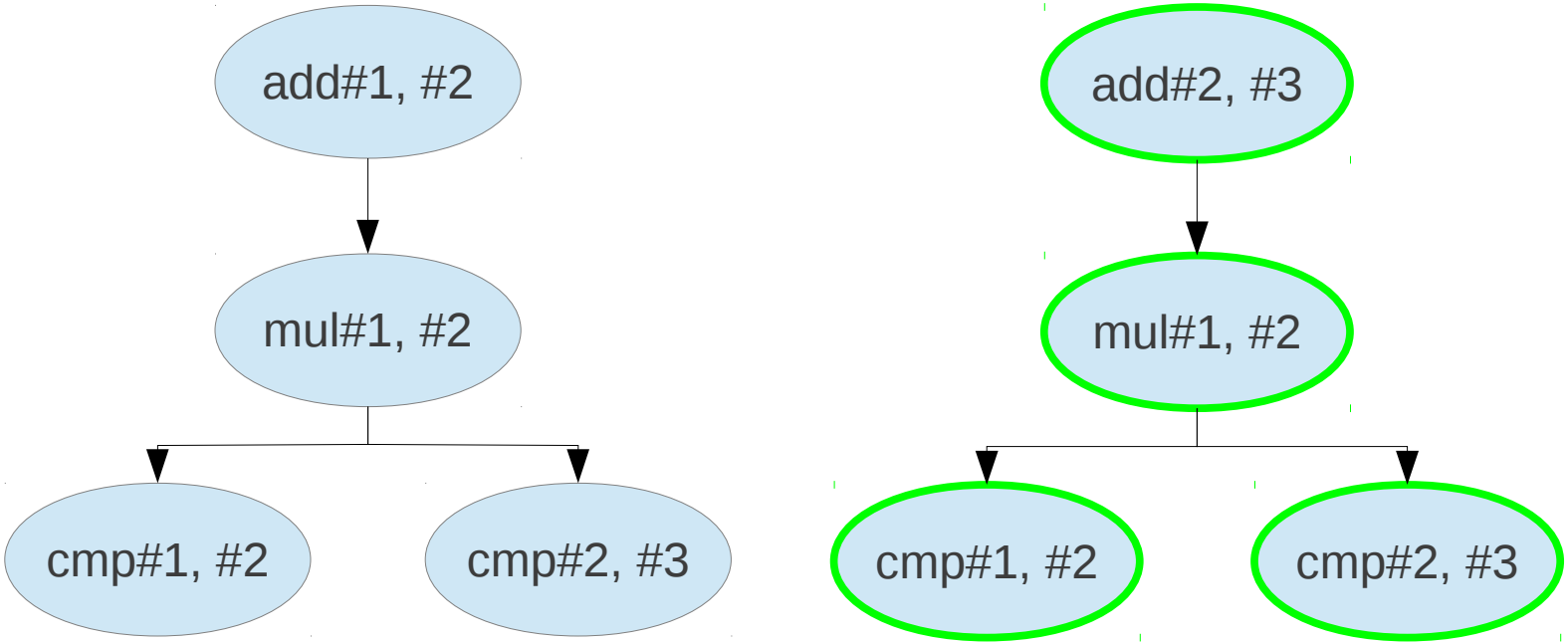
LLVM-based vectorization

Find pair connections



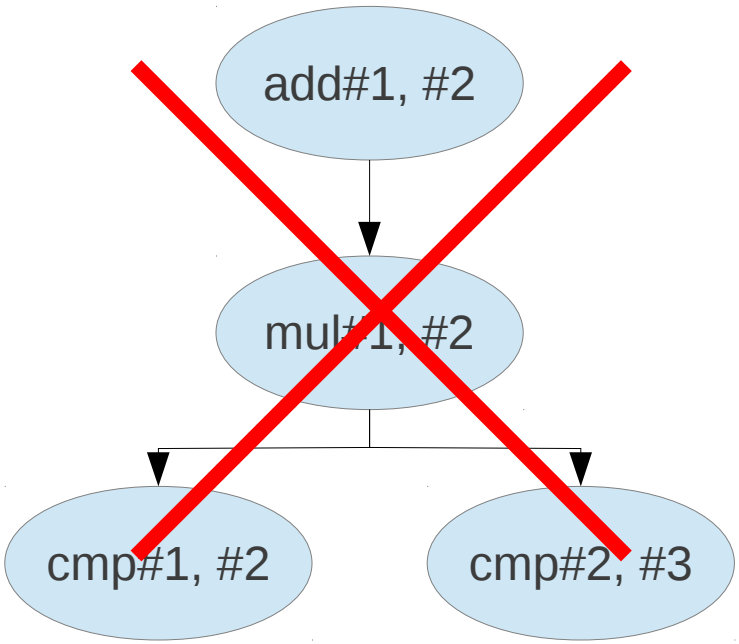
LLVM-based vectorization

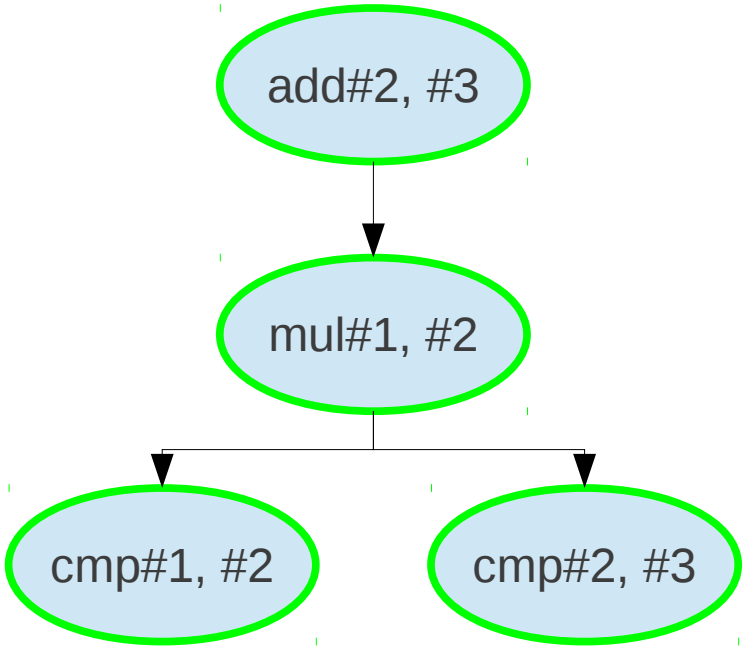
Pair selection



LLVM-based vectorization

Pair selection





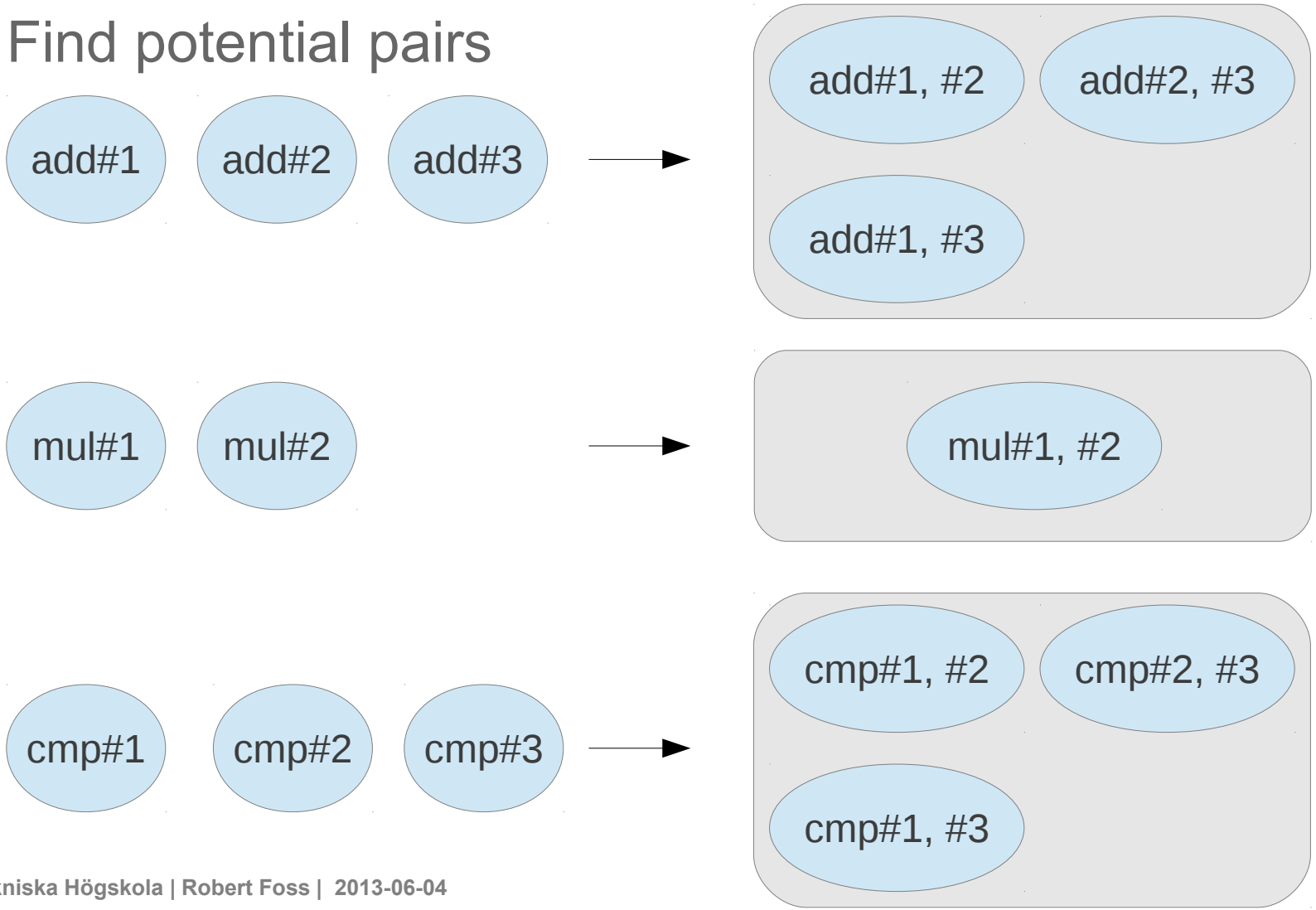
Pair-based vectorization

Steps involved:

- Find potential pairs
- Pair selection
- Pair fusing
- Fixed-point iteration

Pair-based vectorization

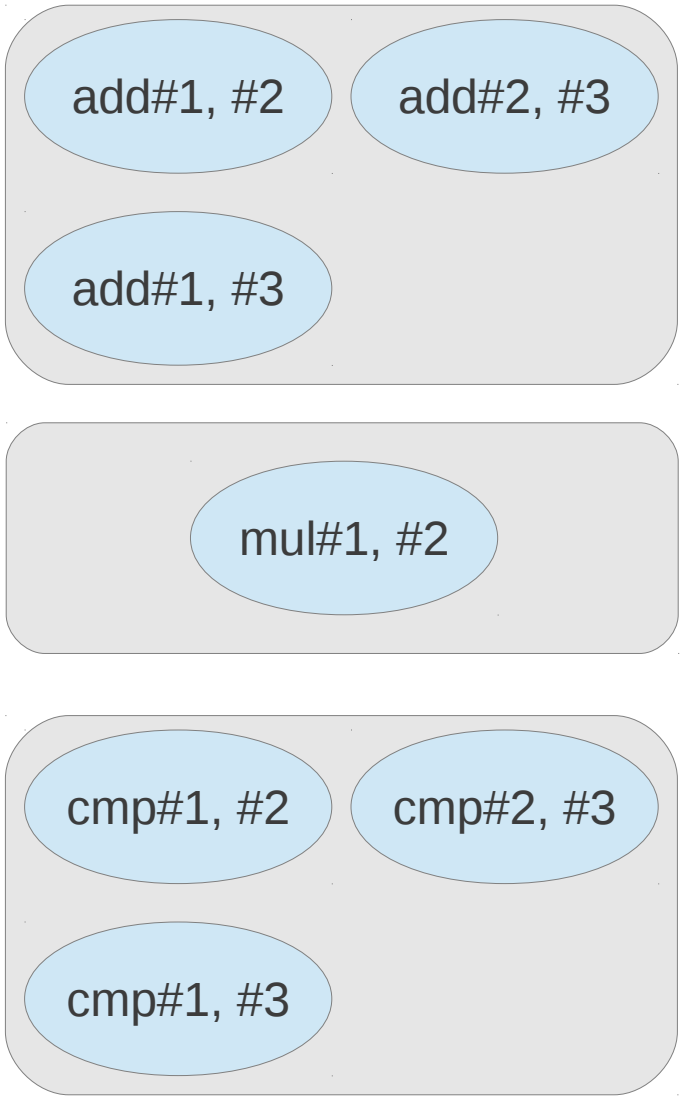
Find potential pairs



Pair-based vectorization

Find potential pairs

Steps involved:

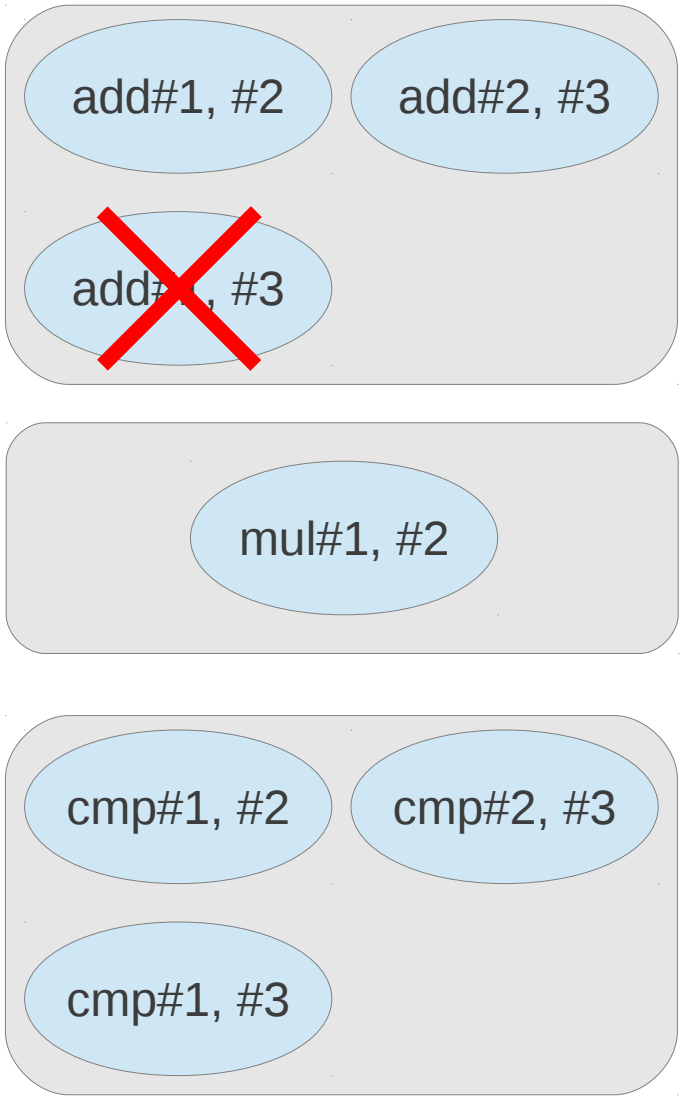


Pair-based vectorization

Find potential pairs

Steps involved:

- Remove intradependent pairs

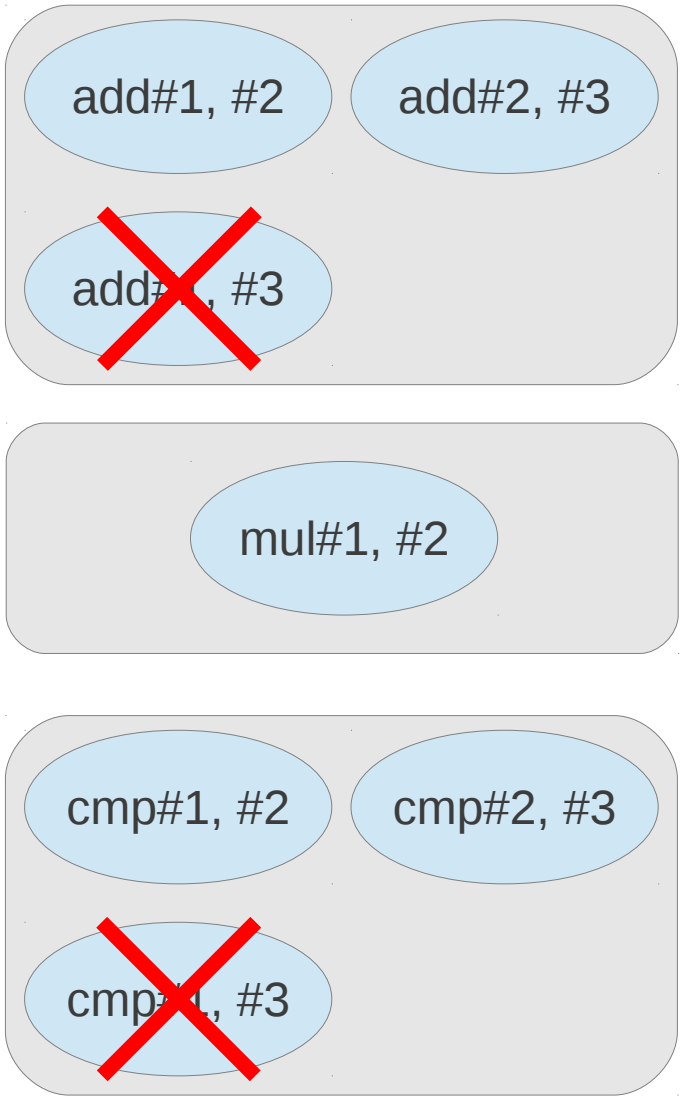


Pair-based vectorization

Find potential pairs

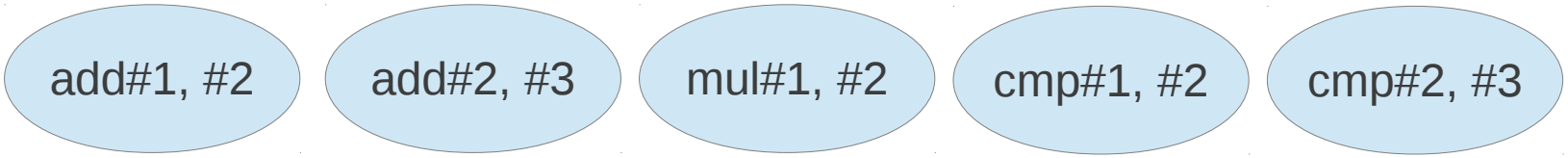
Steps involved:

- Remove intradependent pairs
- Remove illegal pairs



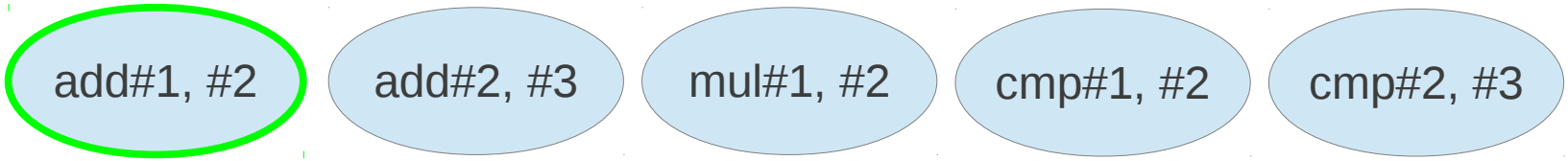
Pair-based vectorization

Pair selection



Pair-based vectorization

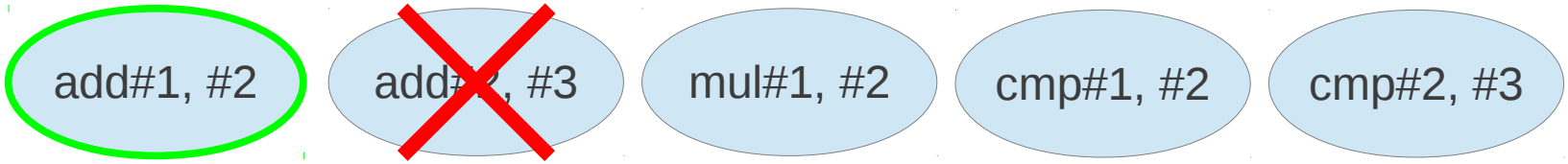
Pair selection



- Fuse most profitable pair

Pair-based vectorization

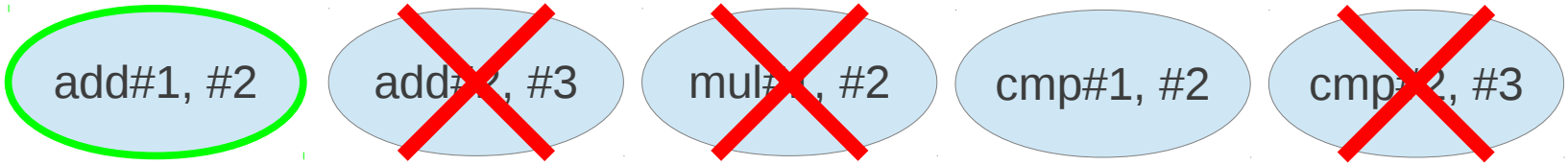
Pair selection



- Fuse most profitable pair
- Remove already fused operations

Pair-based vectorization

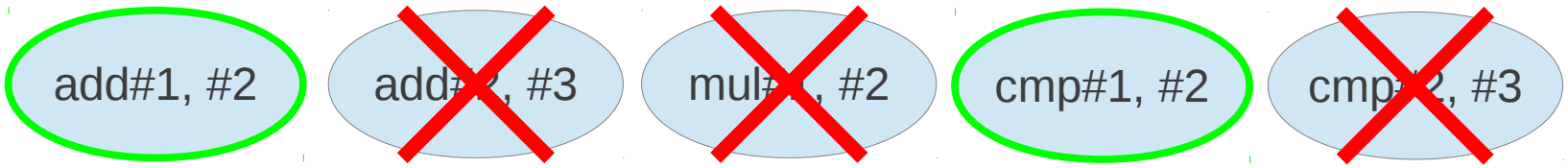
Pair selection



- Fuse most profitable pair
- Remove already fused operations
- Remove intradependent pairs

Pair-based vectorization

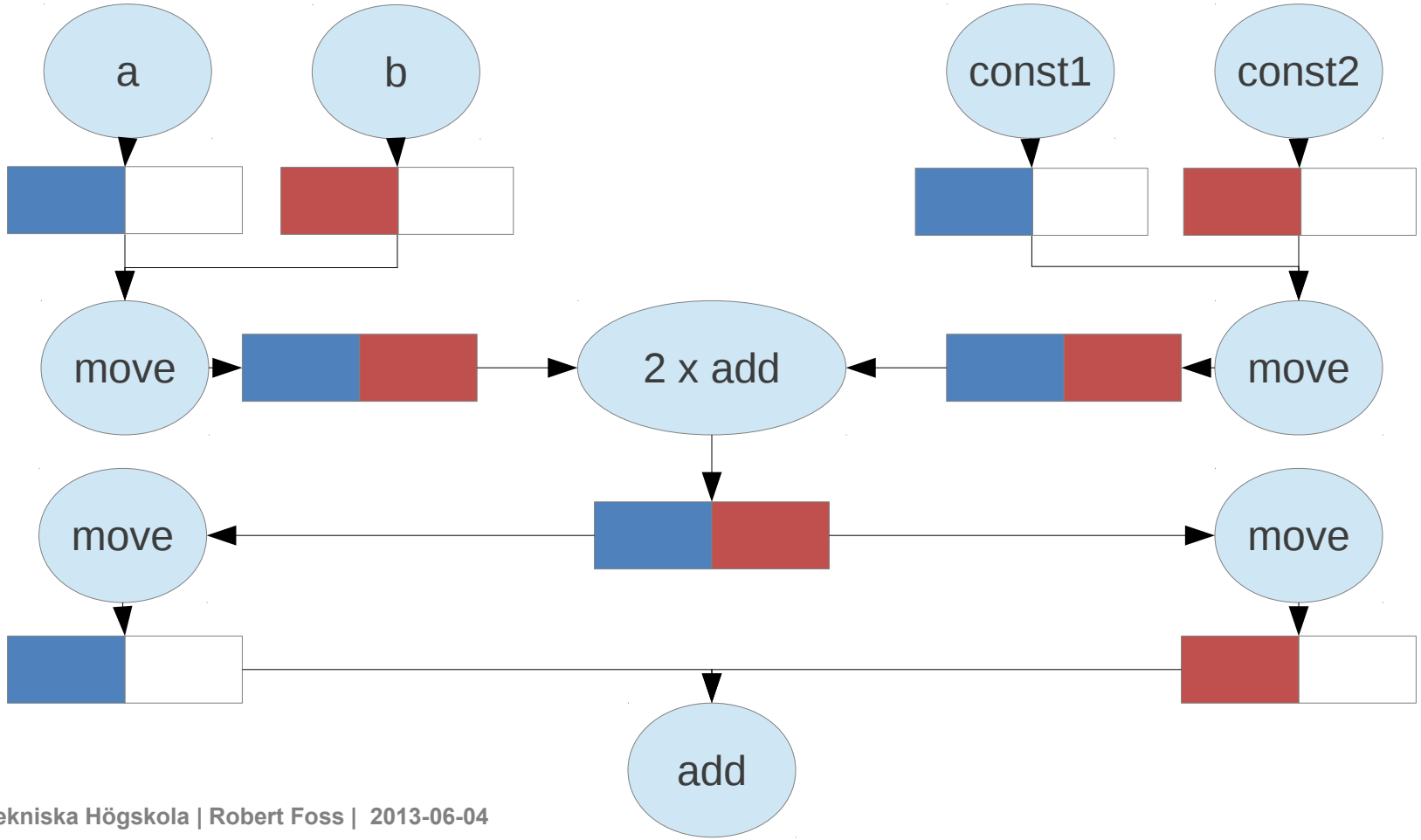
Pair selection



- Fuse most profitable pair
- Remove already fused operations
- Remove intradependent pairs
- Fixed-point iteration

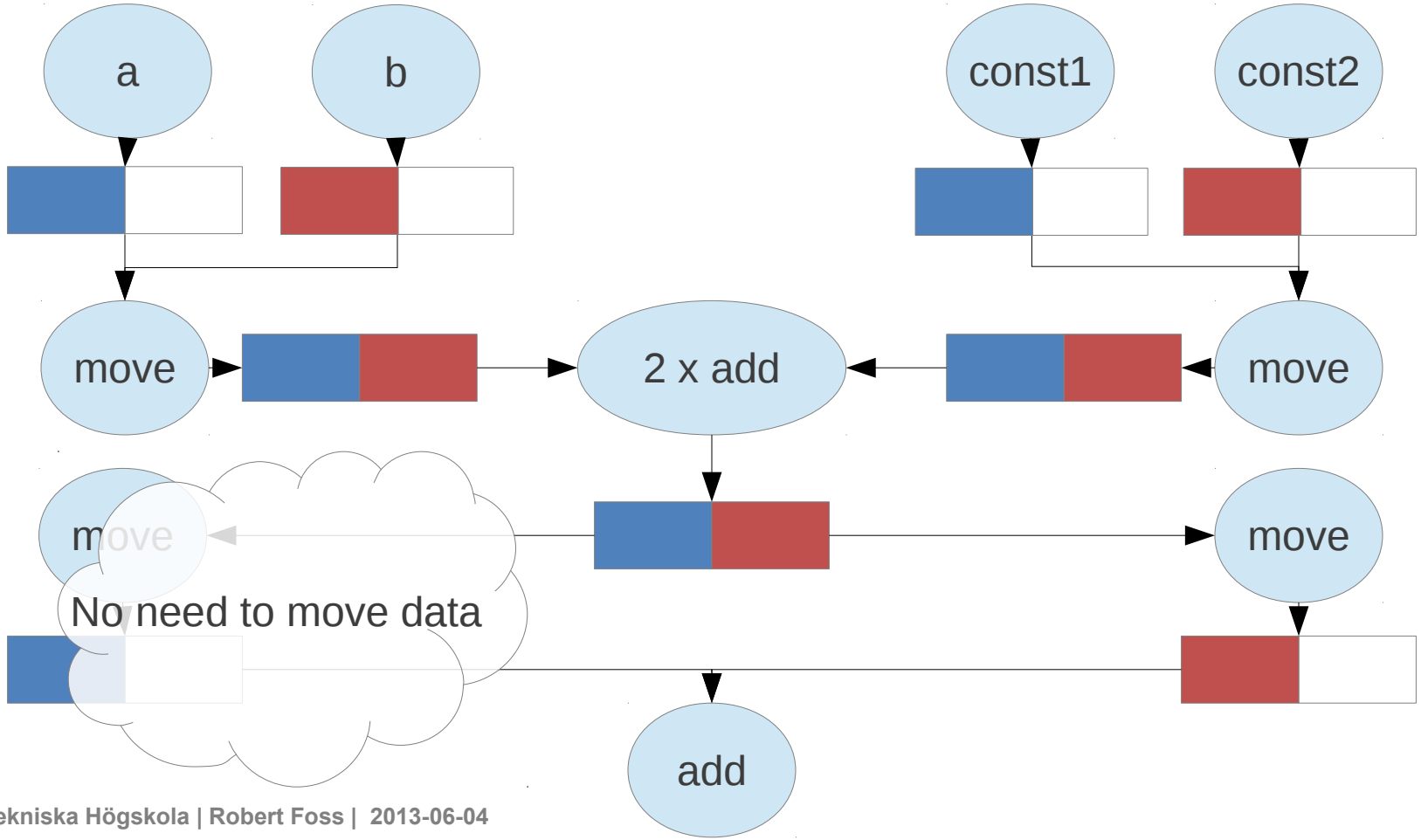
Heuristics

Which? How?



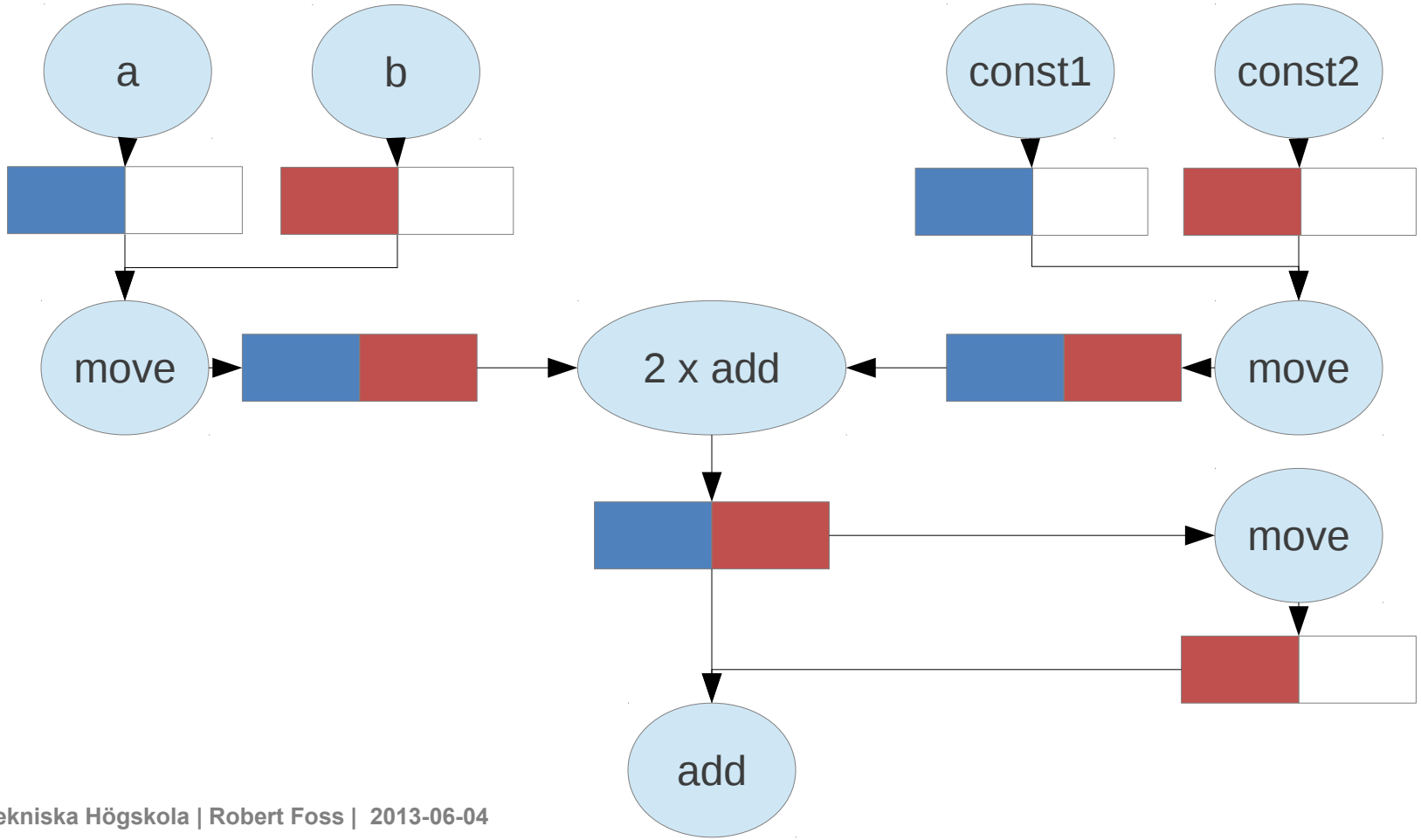
Heuristics

Which? How?



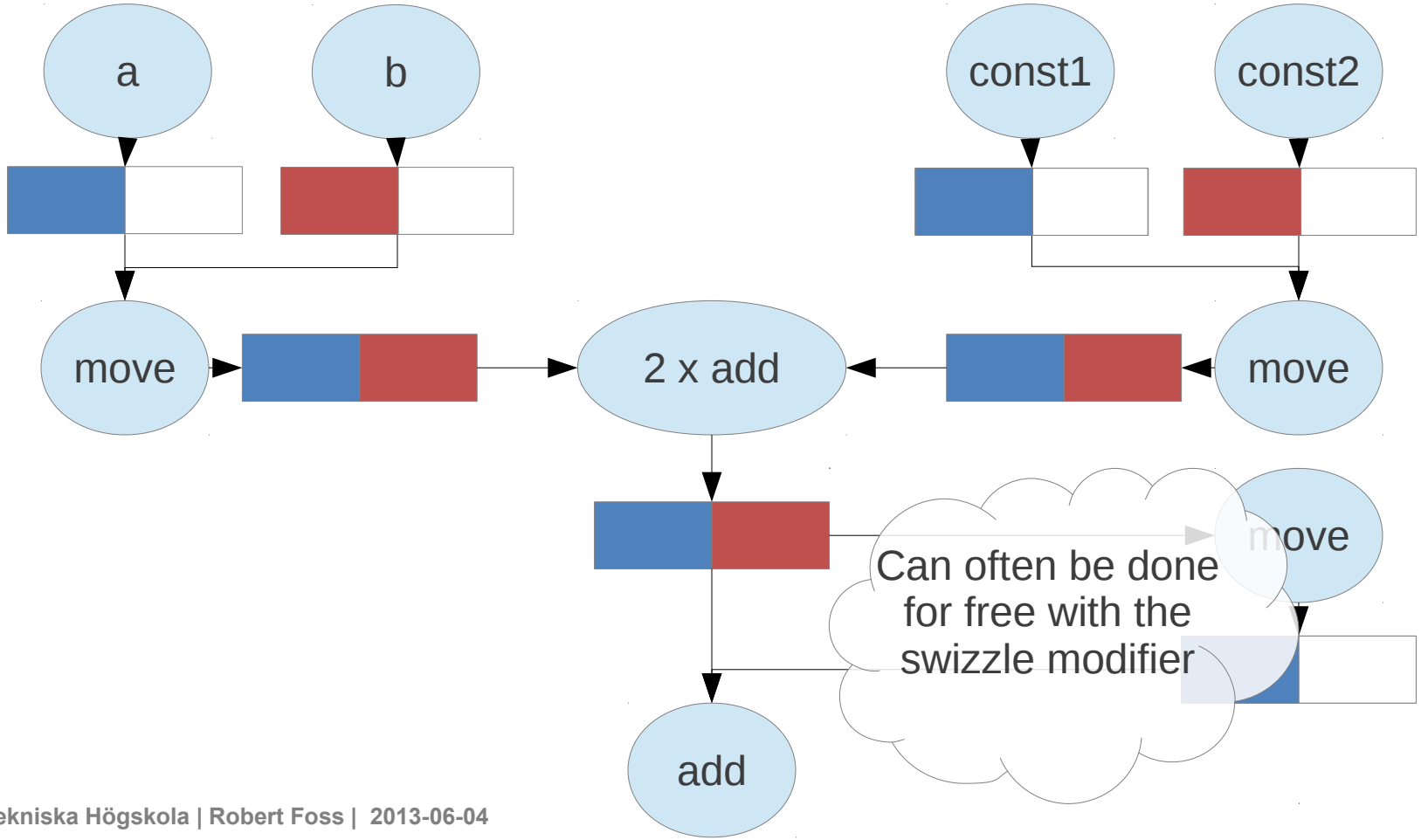
Heuristics

Which? How?



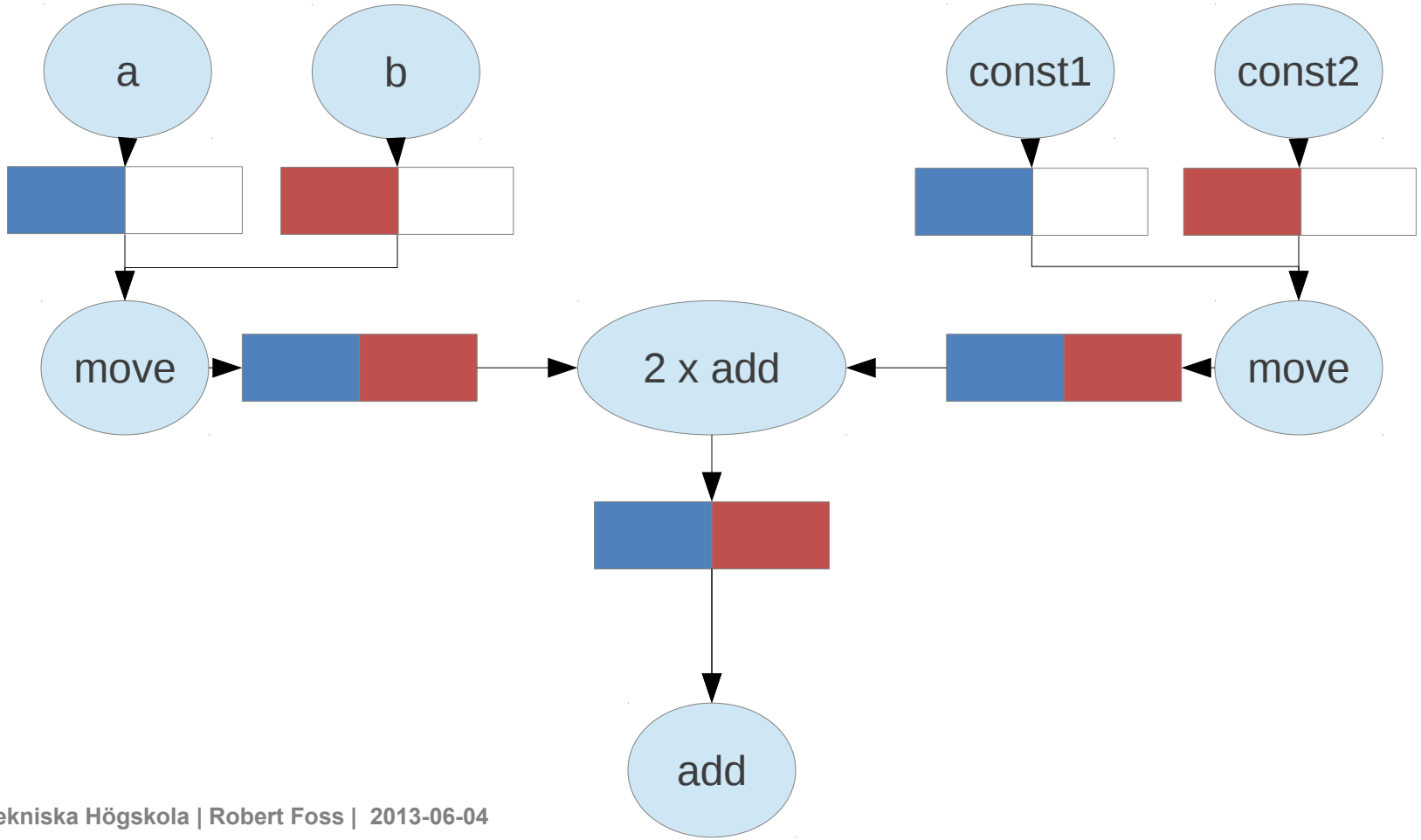
Heuristics

Which? How?



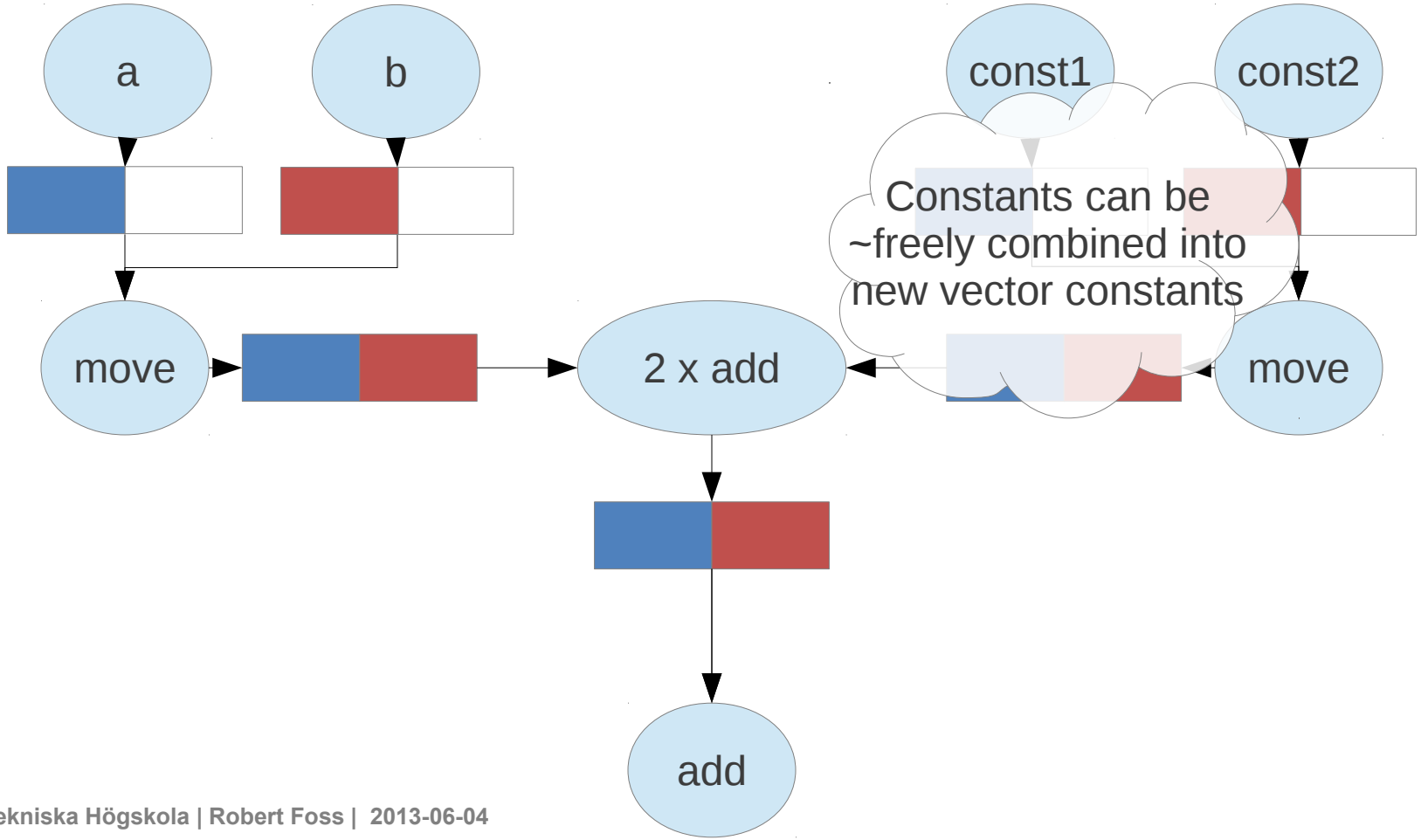
Heuristics

Which? How?



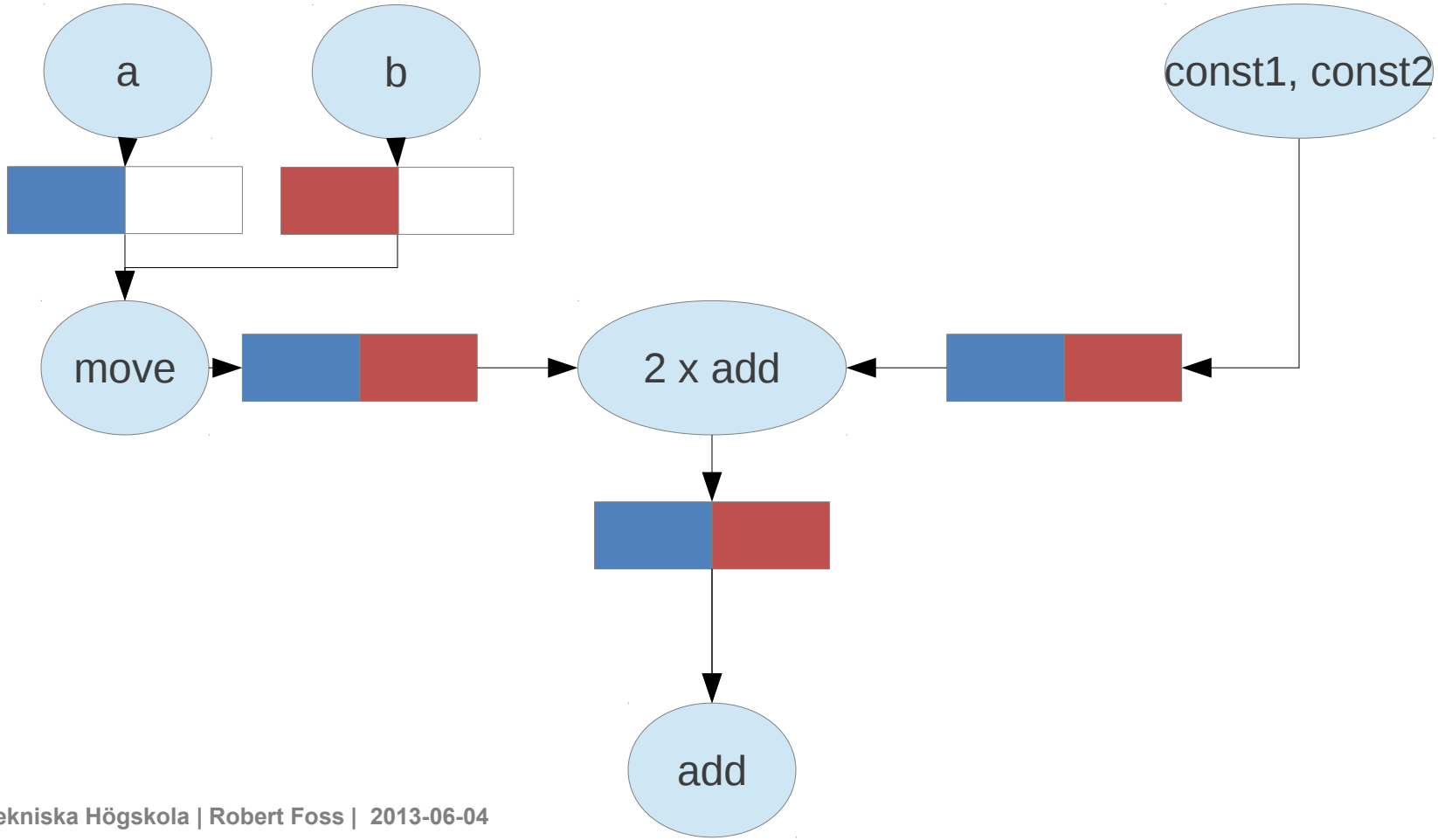
Heuristics

Which? How?



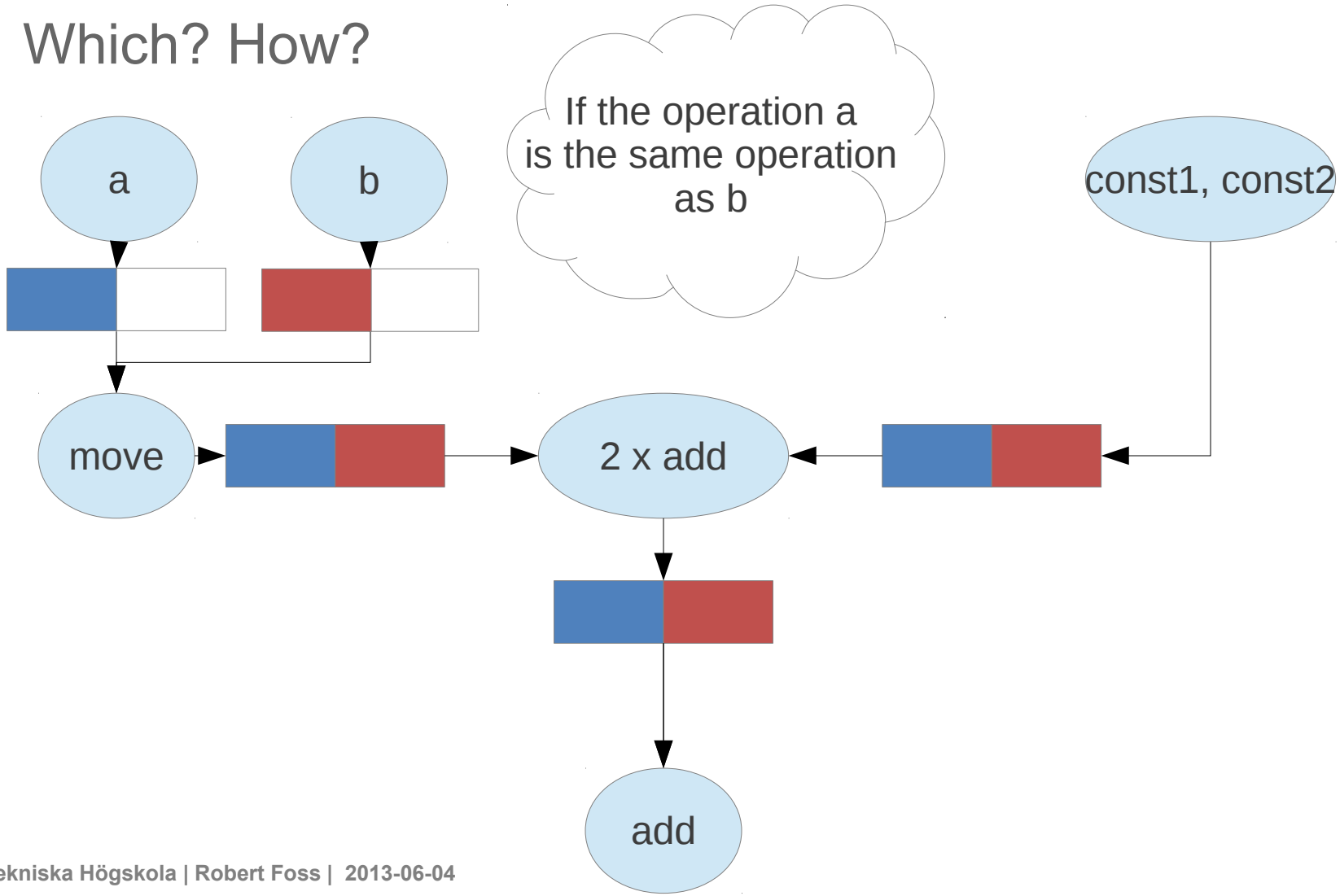
Heuristics

Which? How?



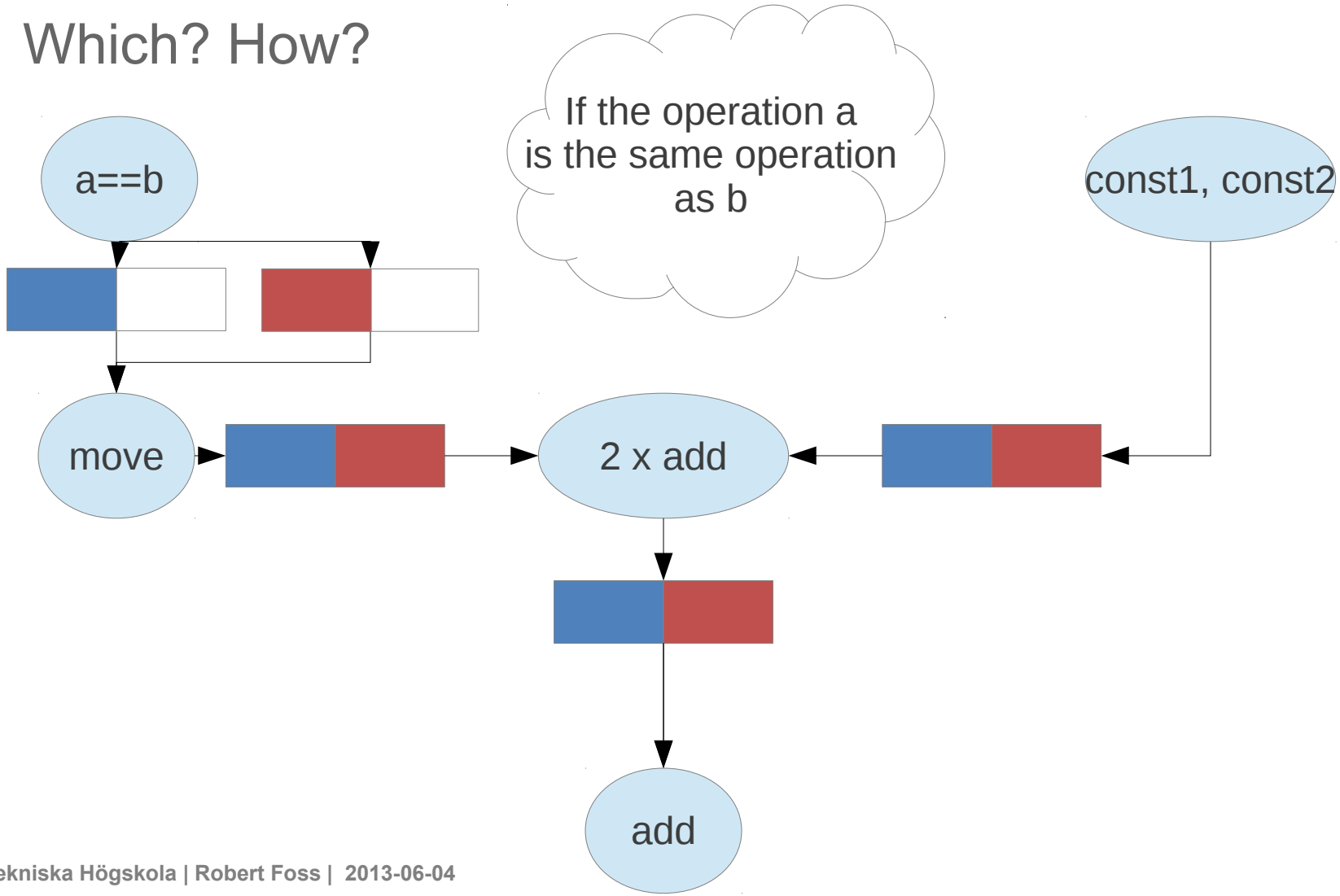
Heuristics

Which? How?



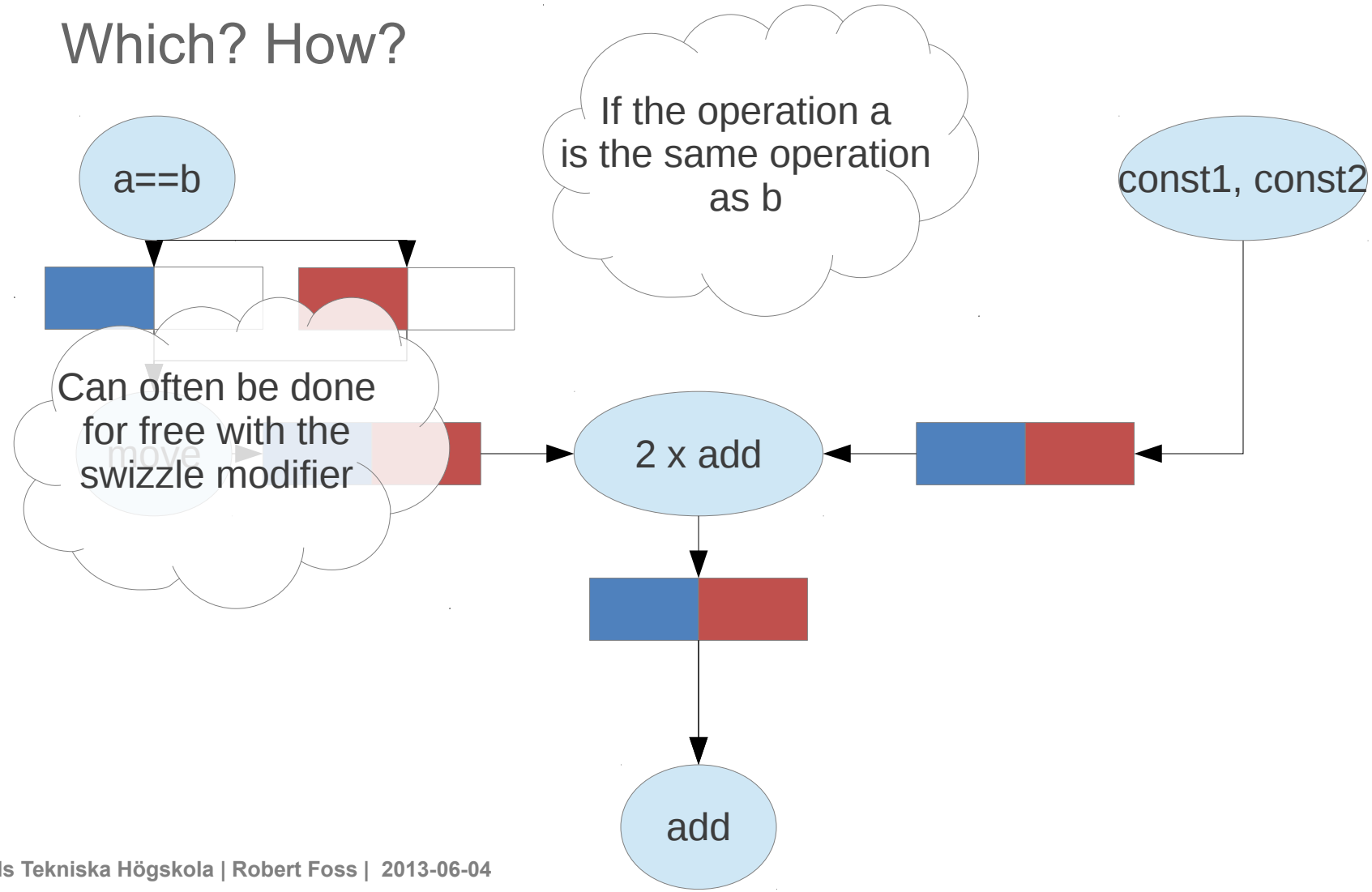
Heuristics

Which? How?



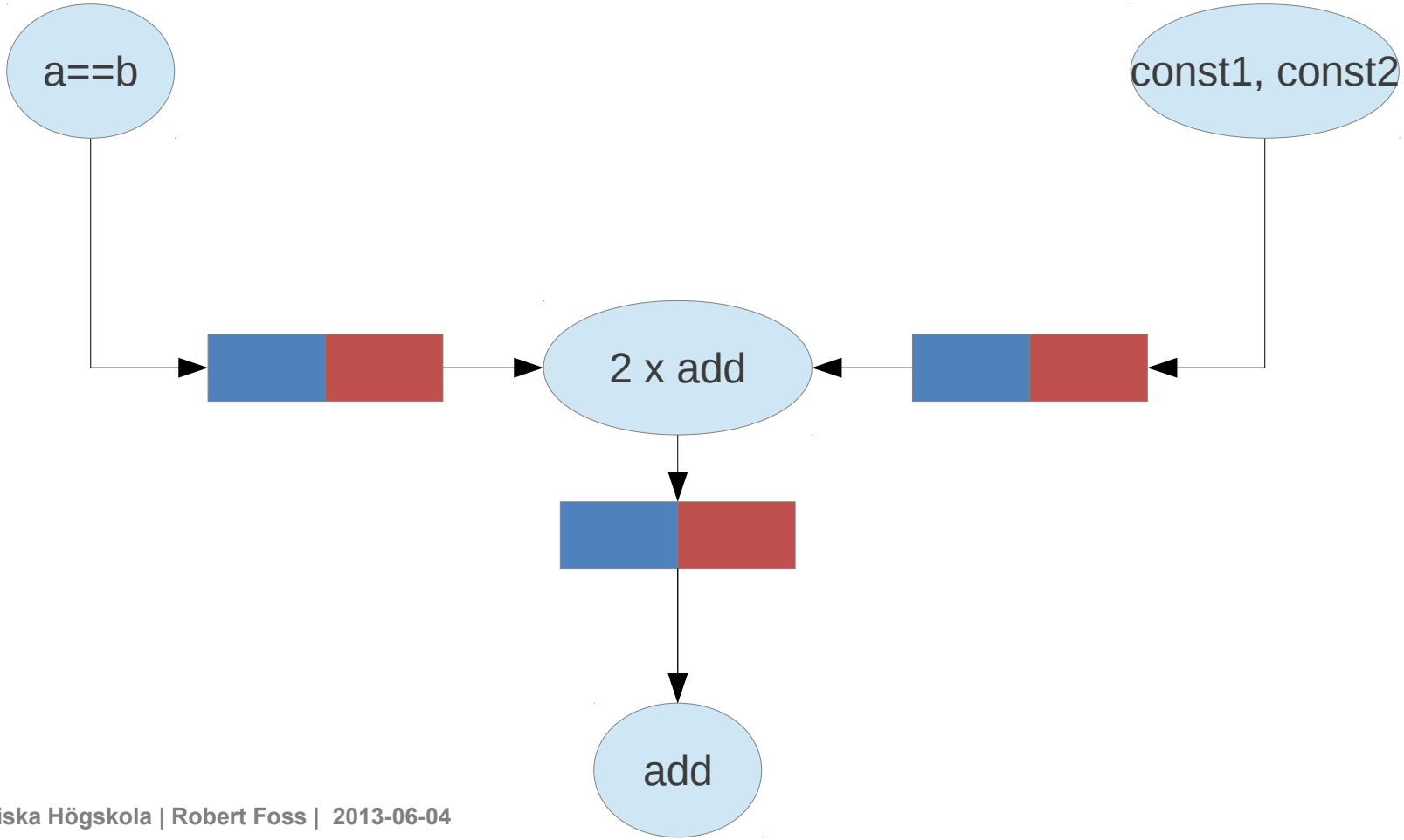
Heuristics

Which? How?



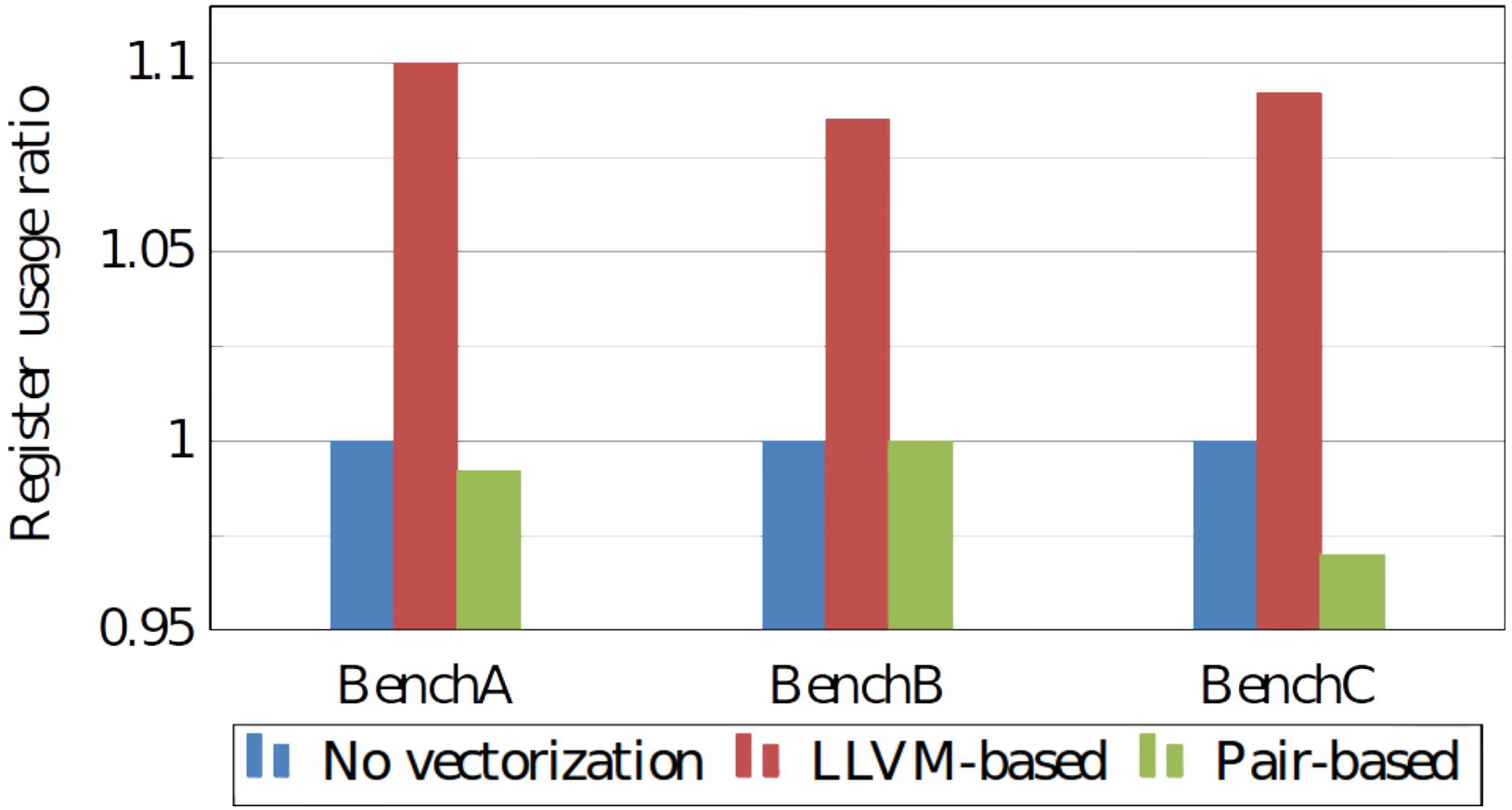
Heuristics

Which? How?



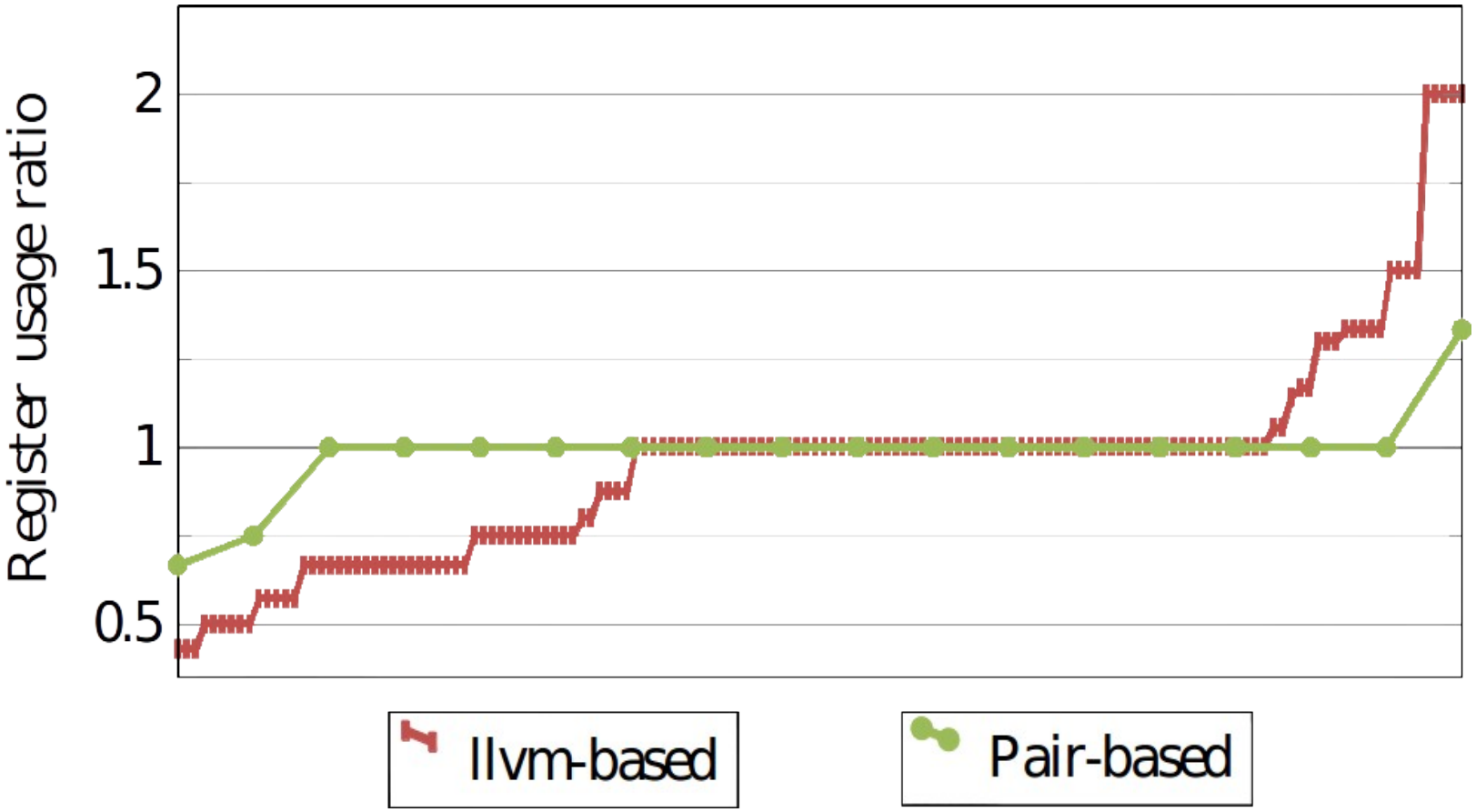
Results

Work Register Usage



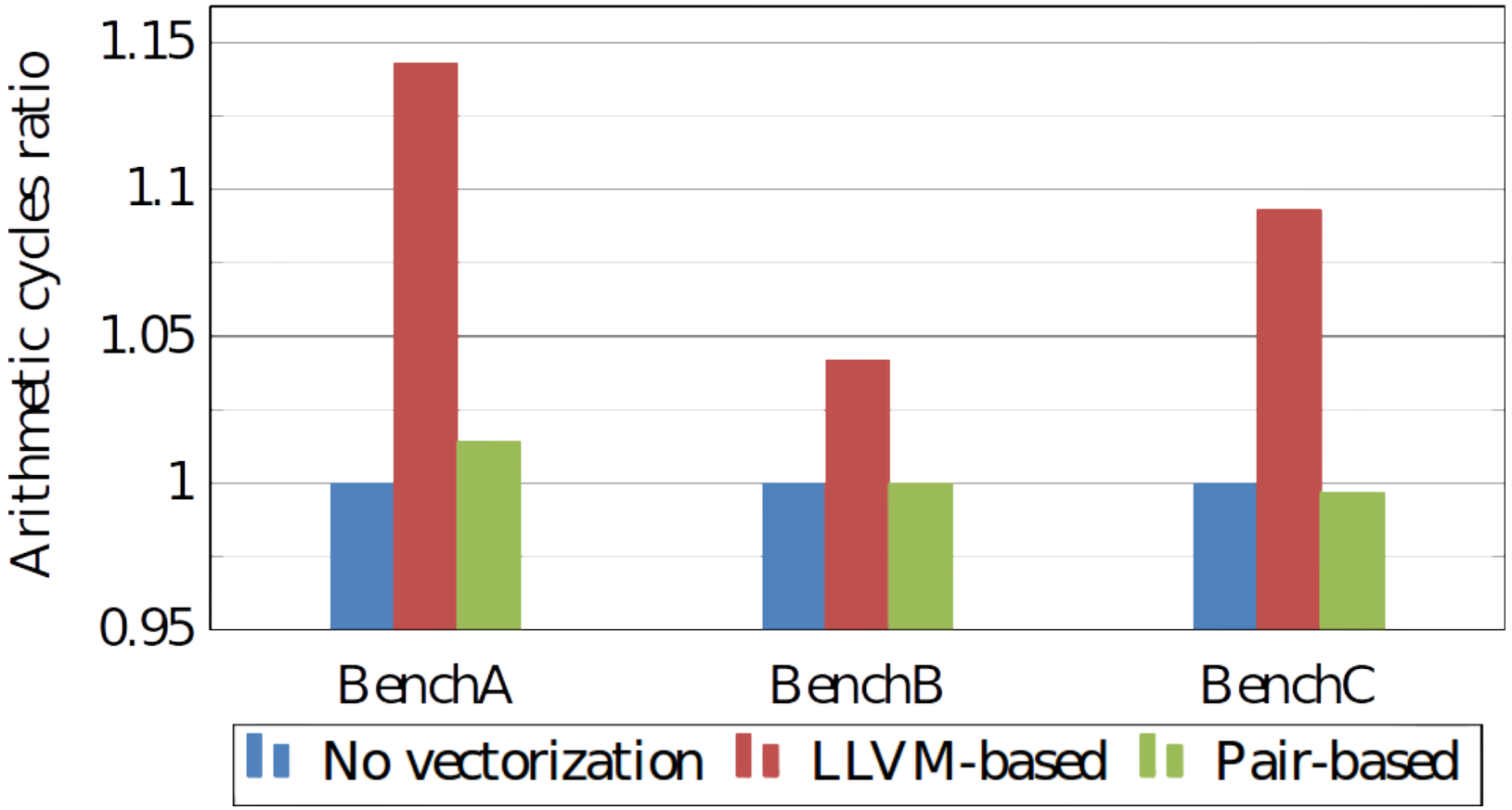
Results

Work Register Usage



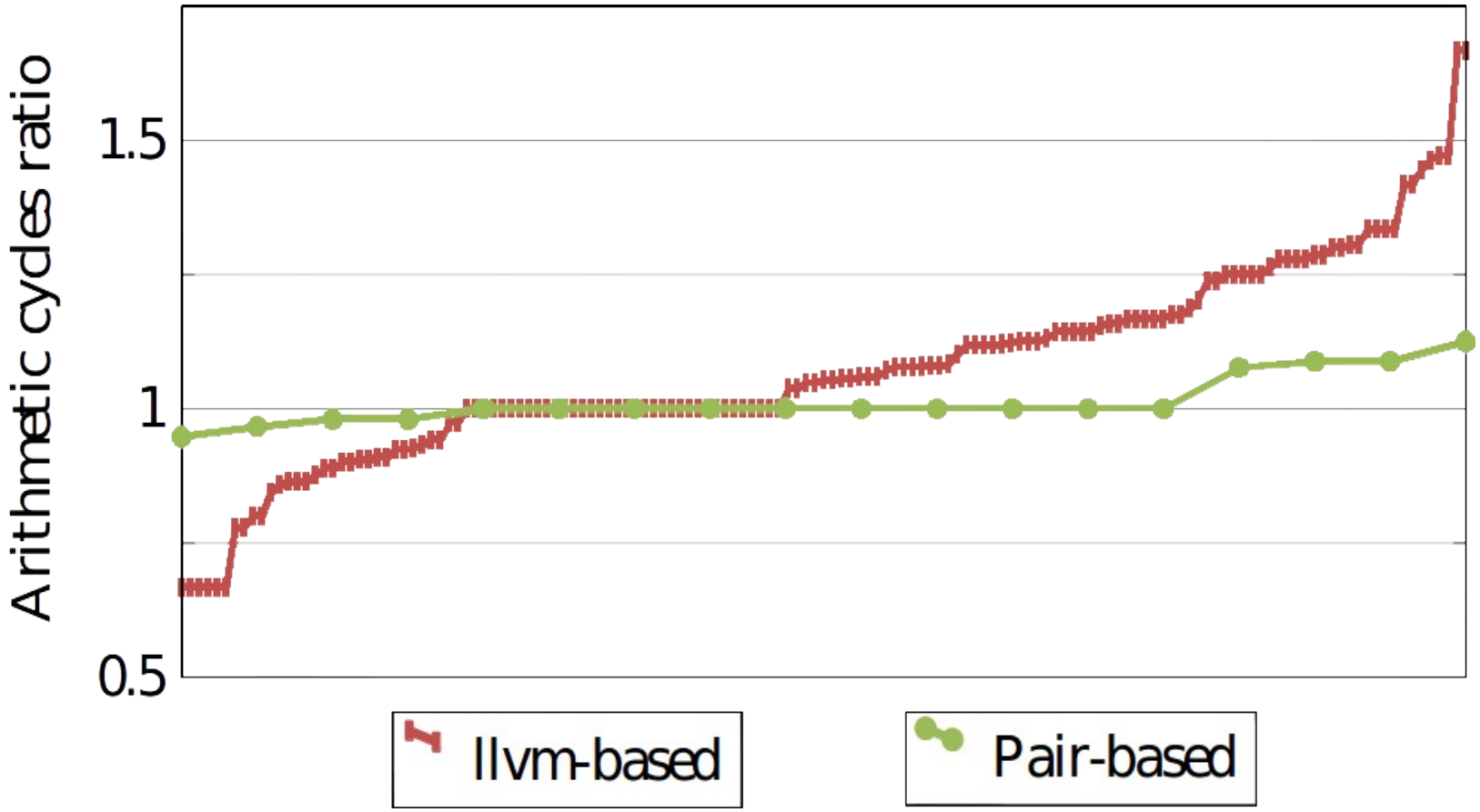
Results

Arithmetic Cycles



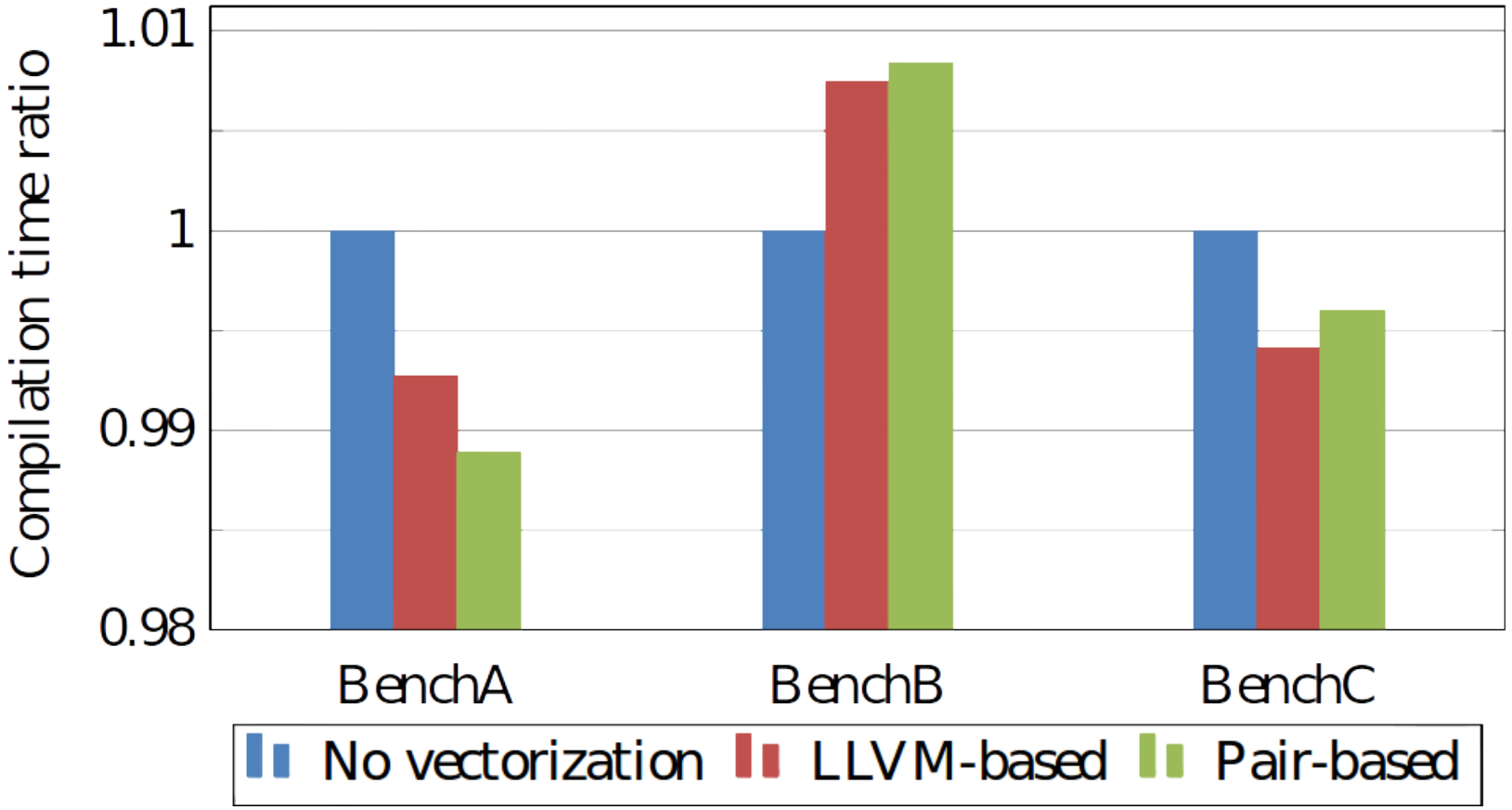
Results

Arithmetic Cycles



Results

Compilation Time



Results

Why?

Results

Why?

- Increased register pressure

Results

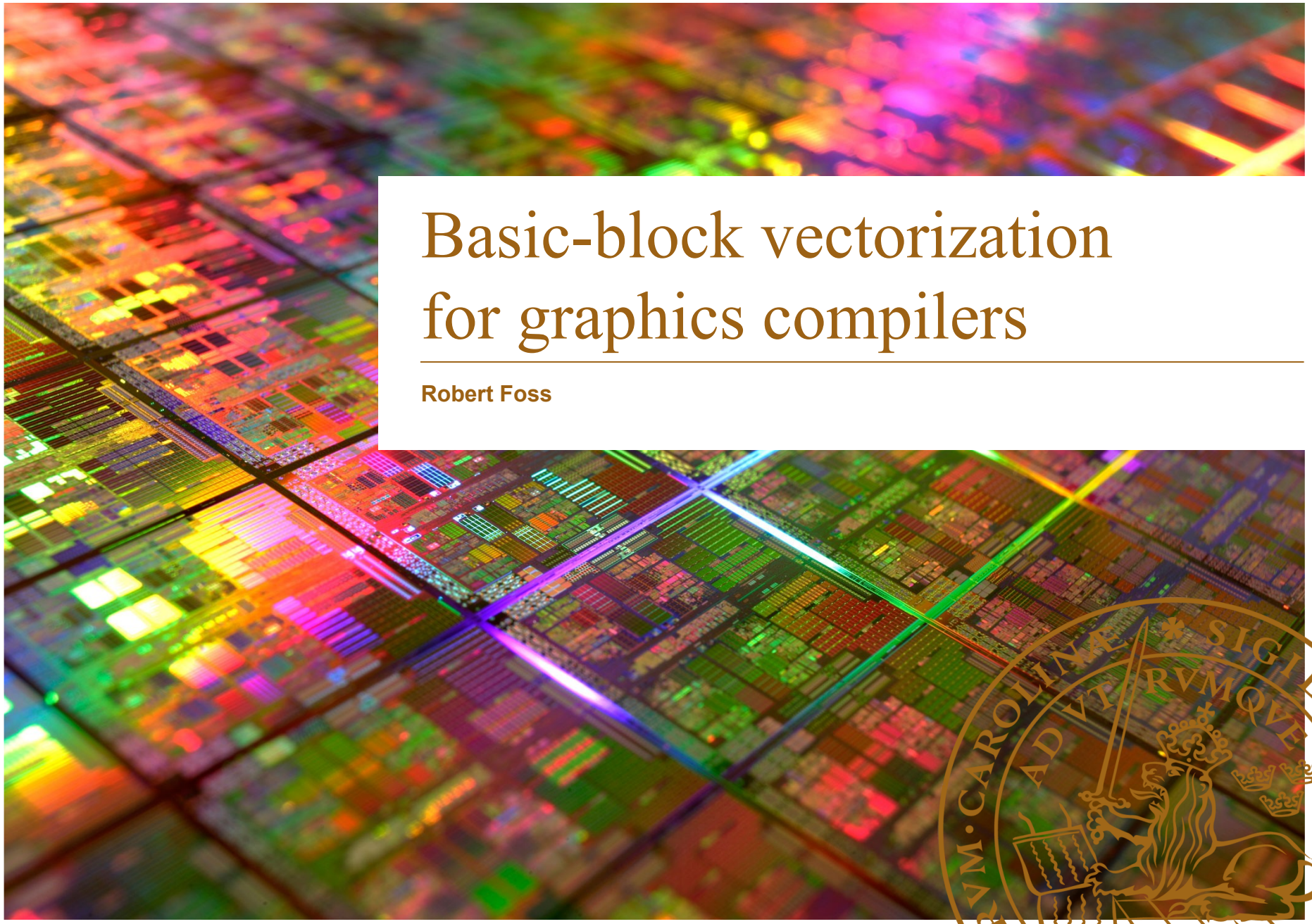
Why?

- Increased register pressure
- Increased scheduling tightness

Results

Why?

- Increased register pressure
- Increased scheduling tightness
- The cost of moving data around



Basic-block vectorization for graphics compilers

Robert Foss