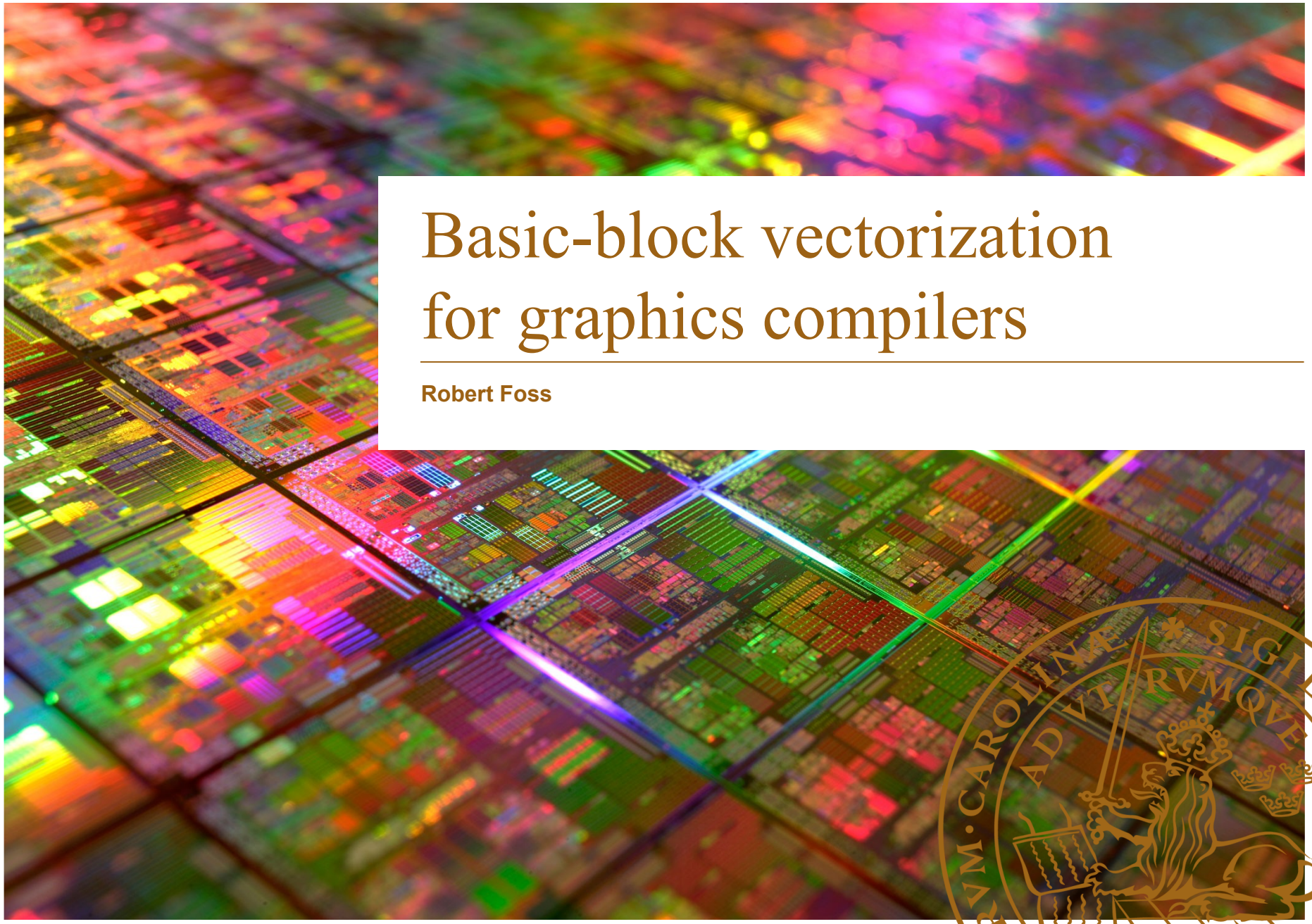
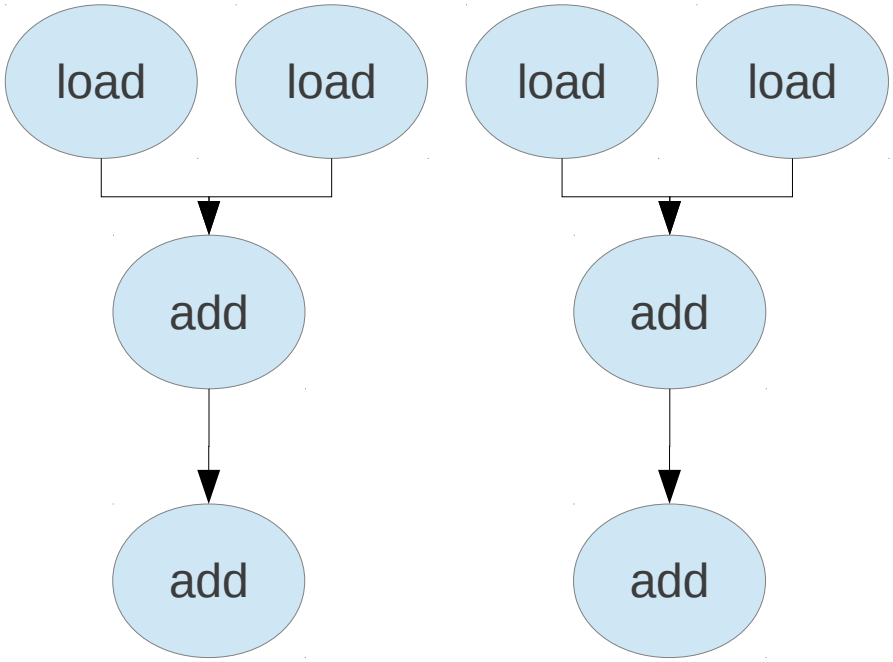


Basic-block vectorization for graphics compilers

Robert Foss

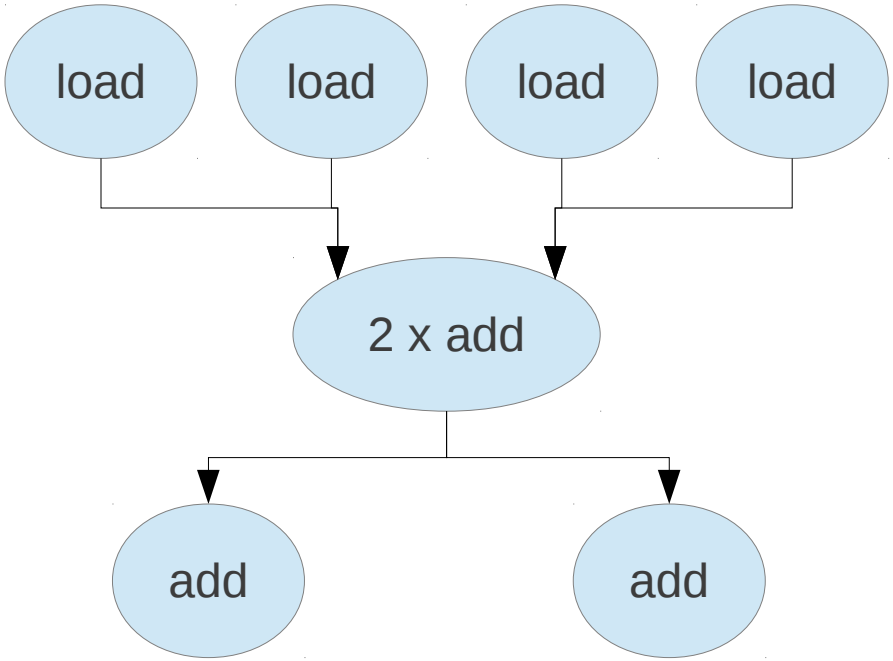
About vectorization

Vectorization 101



About vectorization

Vectorization 101



More about vectorization

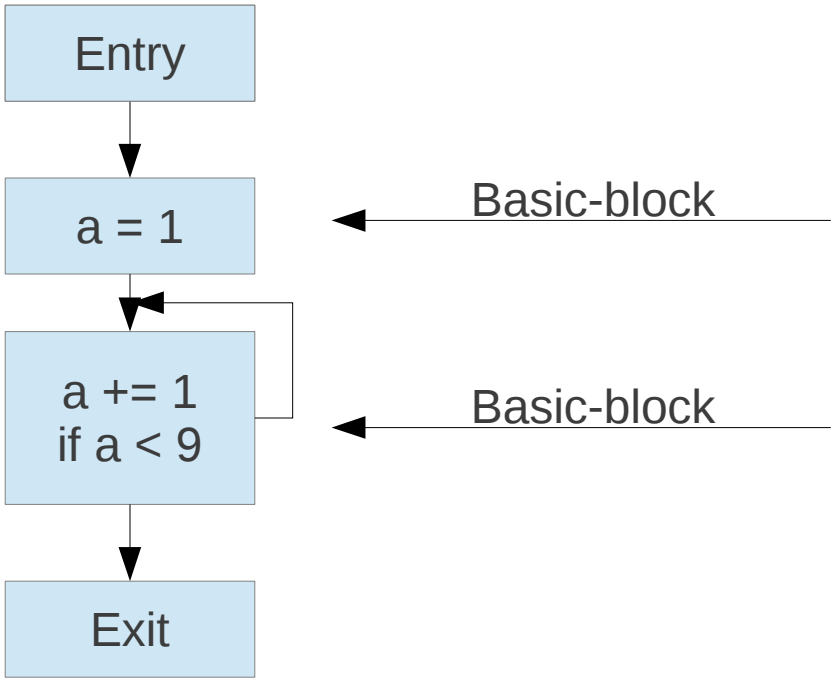
Techniques

Several techniques exist

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

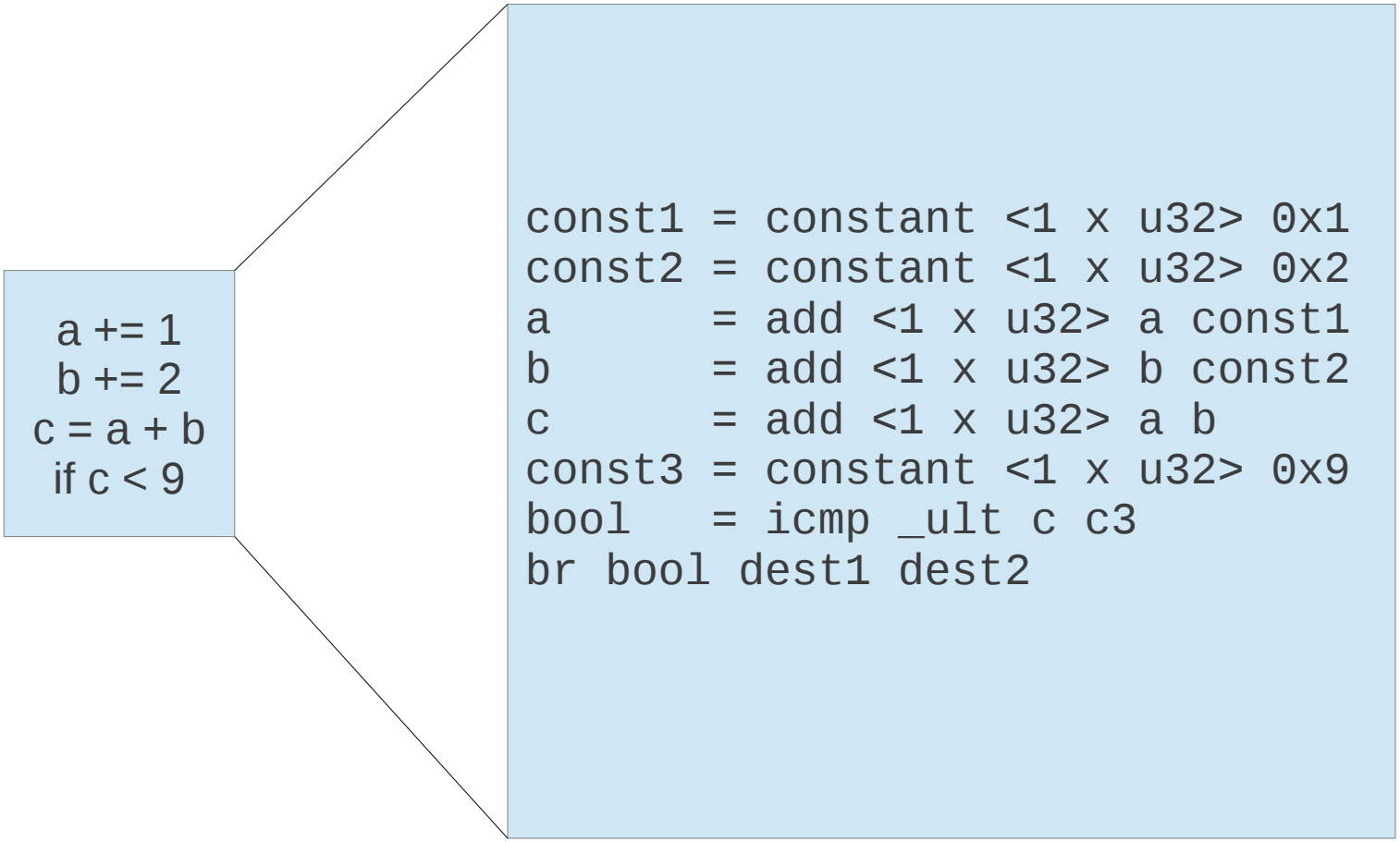
Basic-block vectorization

Control Flow Graph

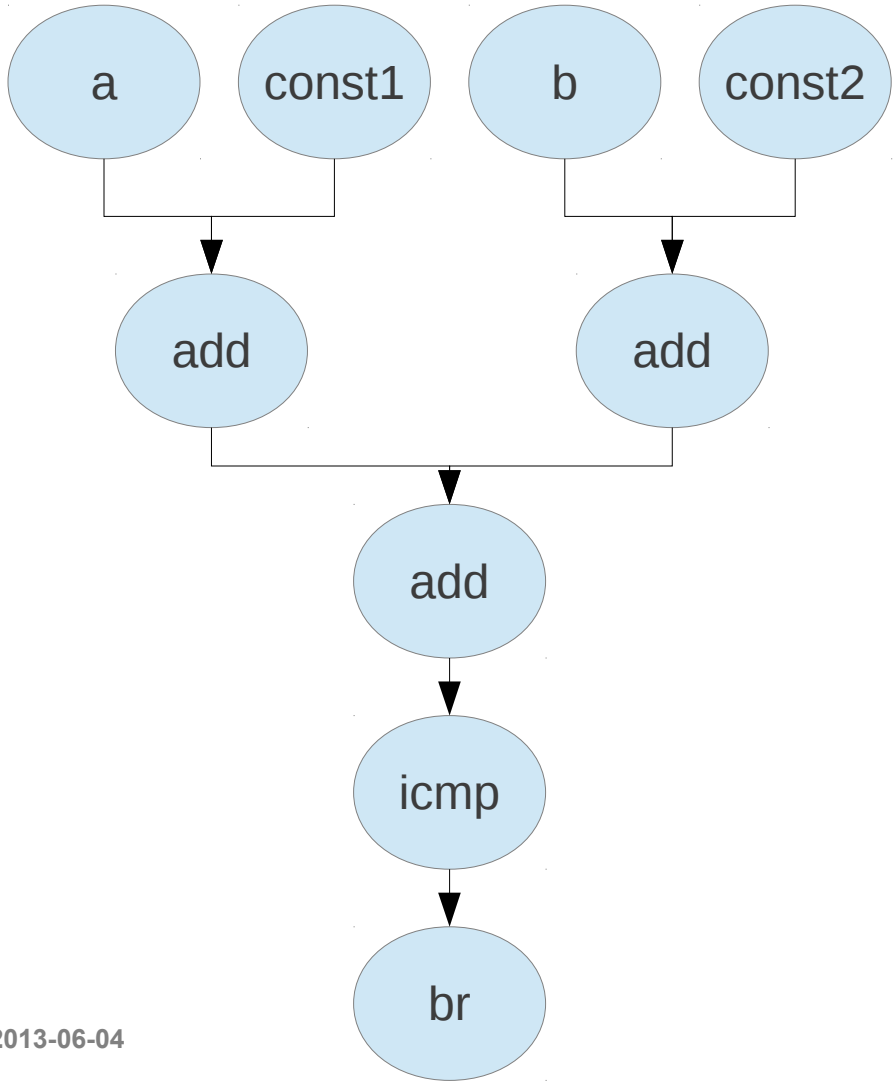


Basic-block vectorization

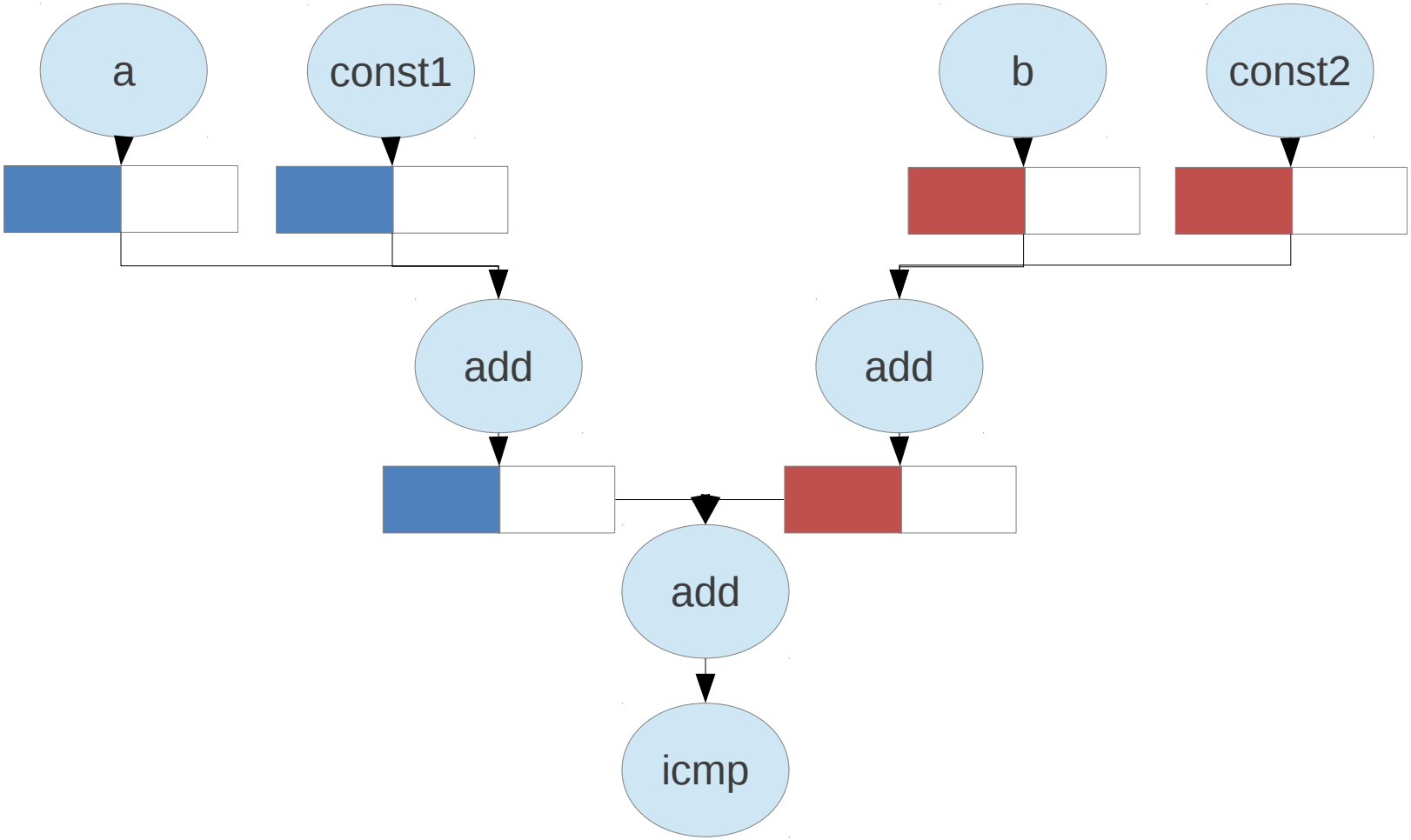
Basic-block



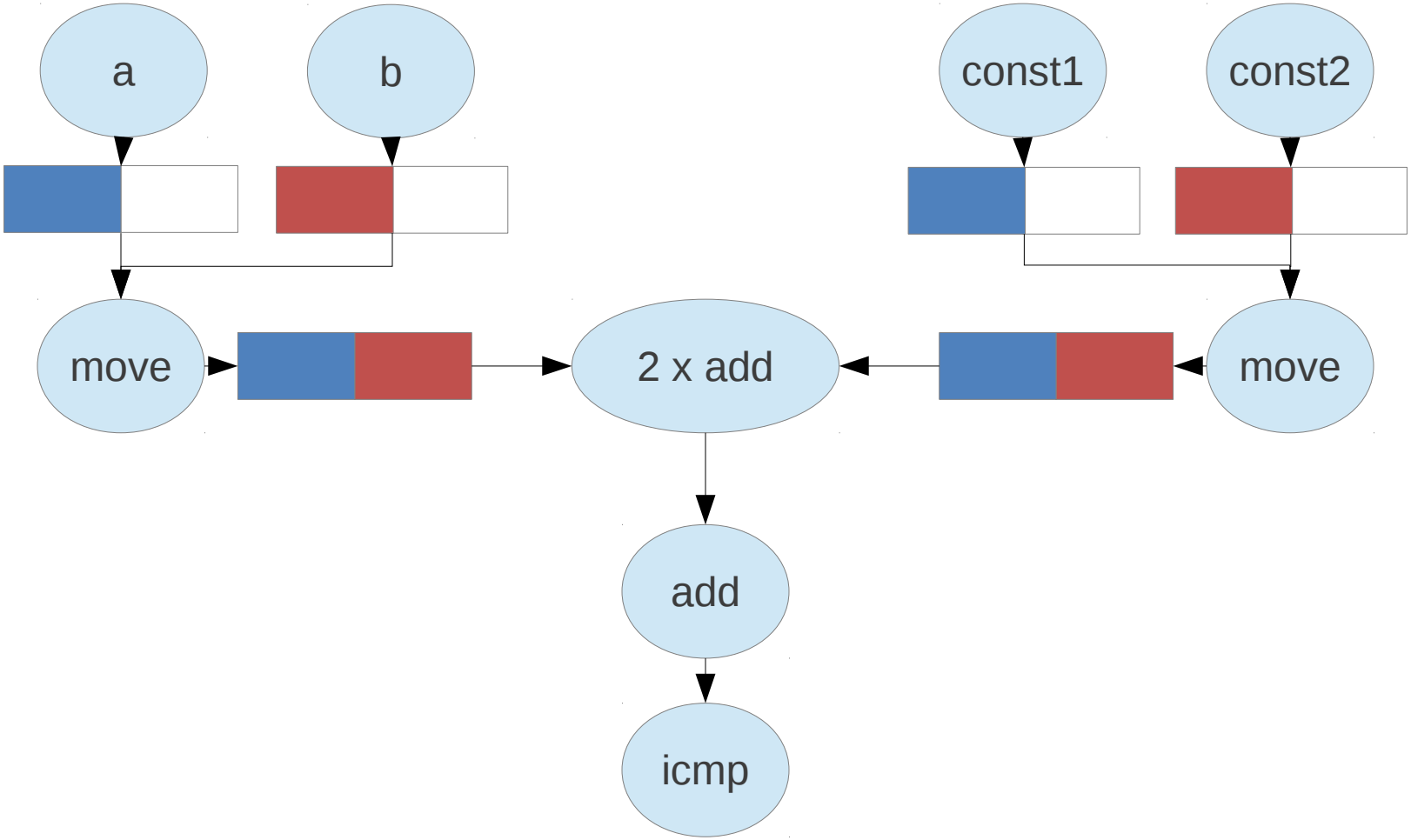
Basic-block vectorization



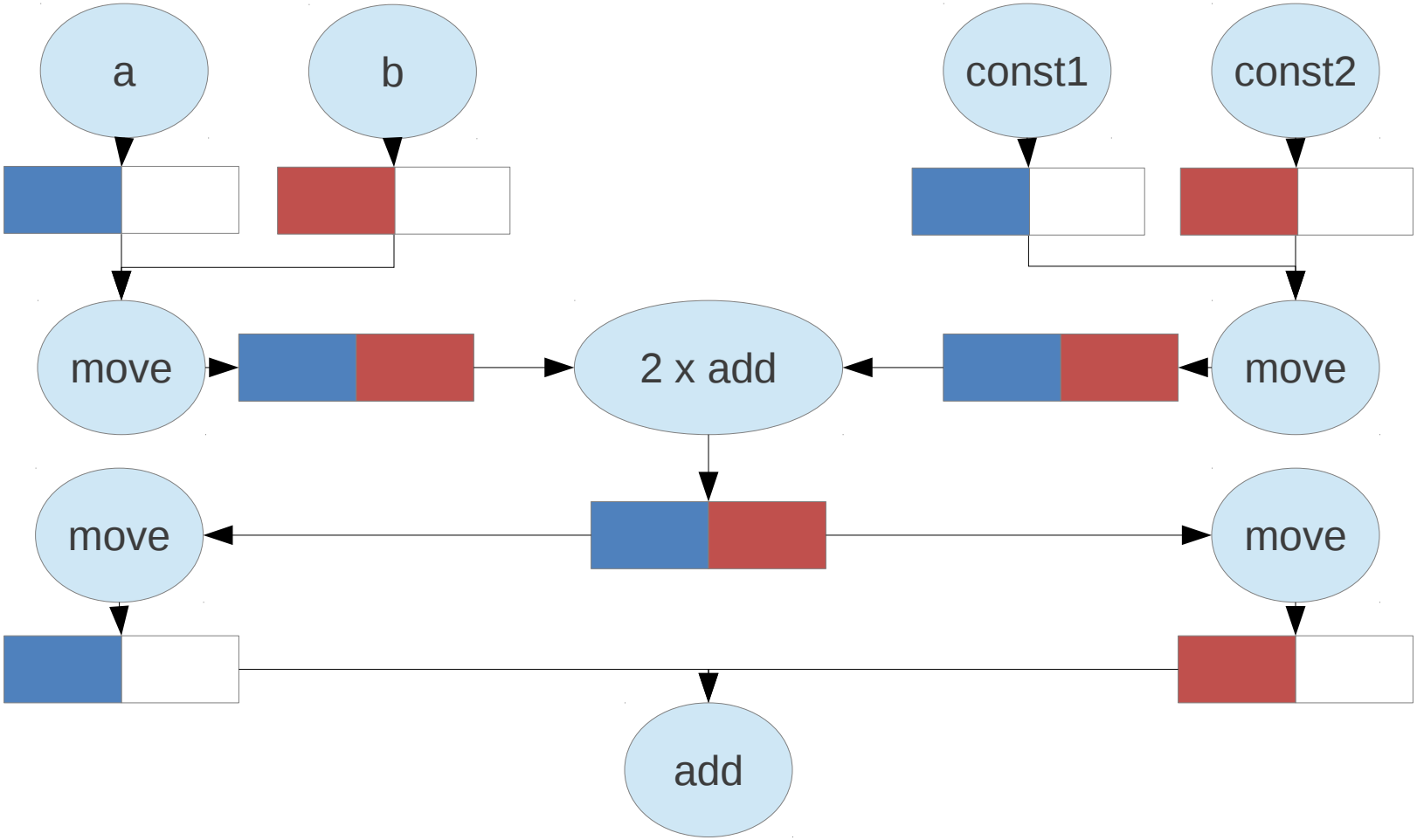
Basic-block vectorization



Basic-block vectorization



Basic-block vectorization



Basic-block vectorization

Alternatives

Two algorithms were implemented

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

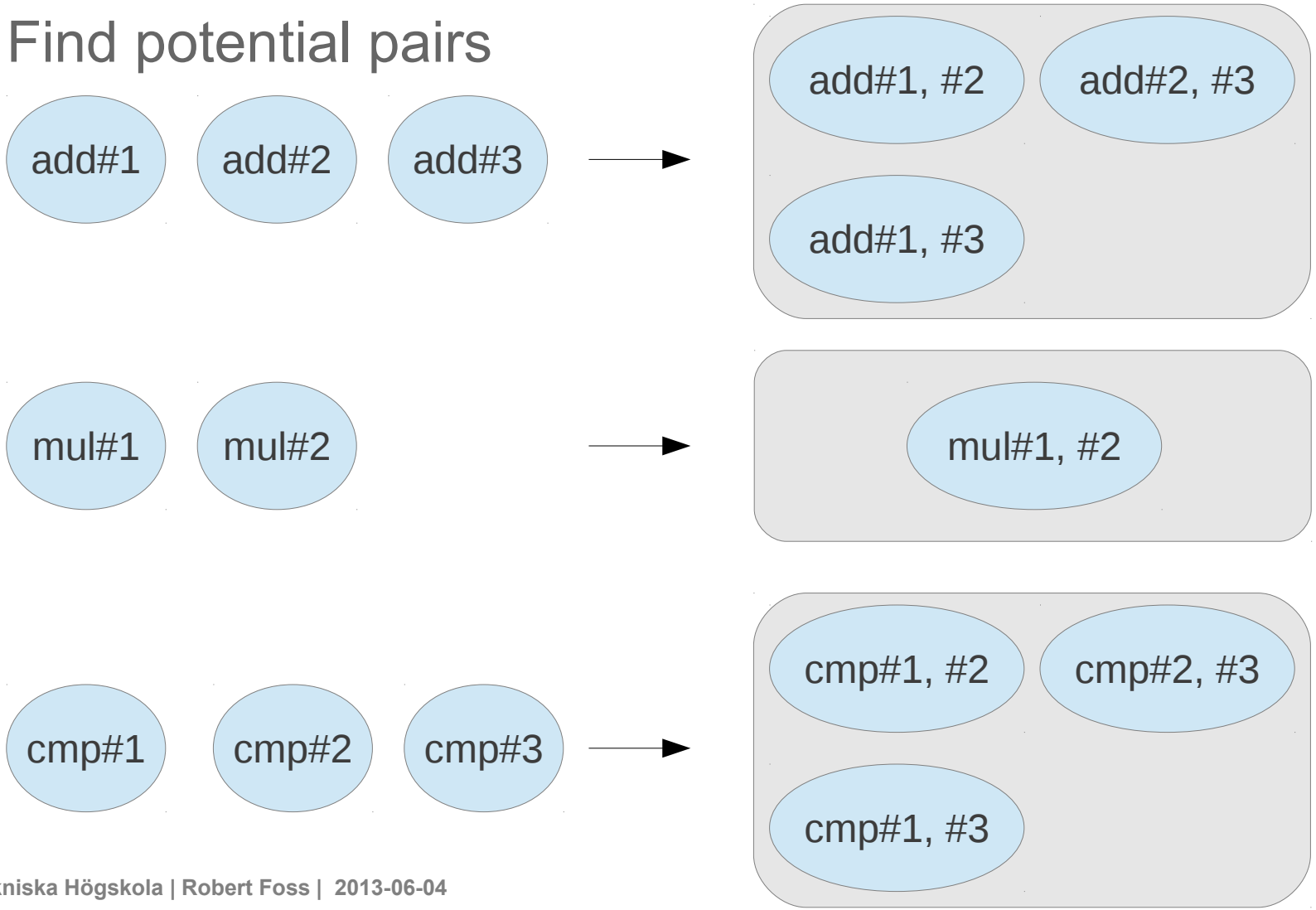
LLVM-based vectorization

Steps involved:

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

LLVM-based vectorization

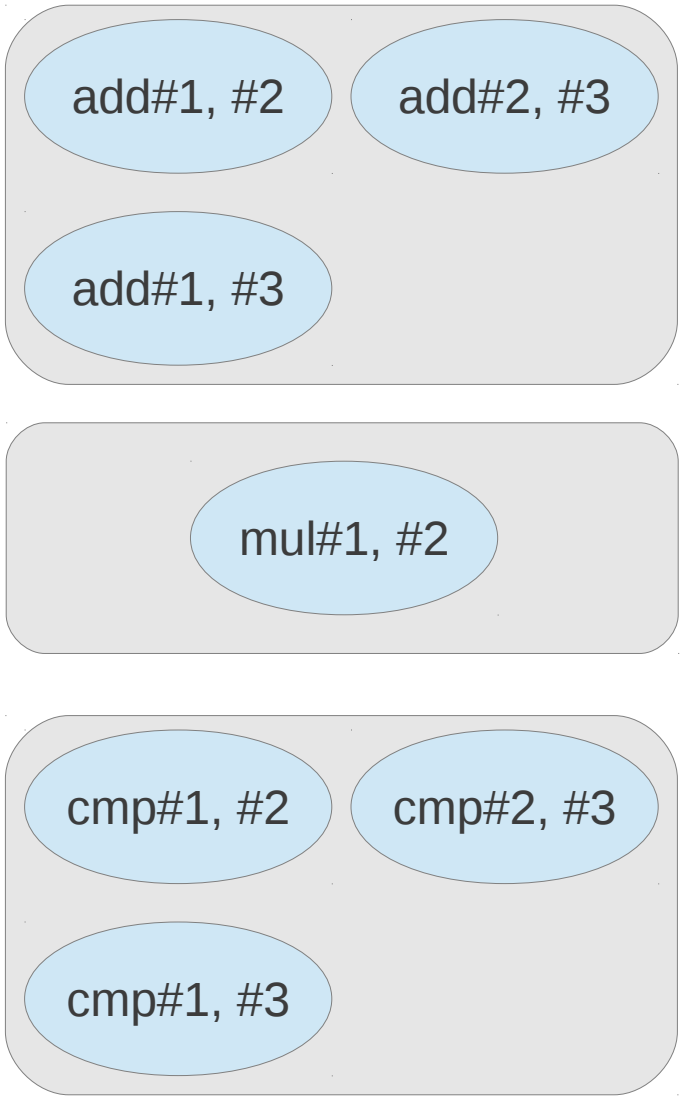
Find potential pairs



LLVM-based vectorization

Find potential pairs

Steps involved:

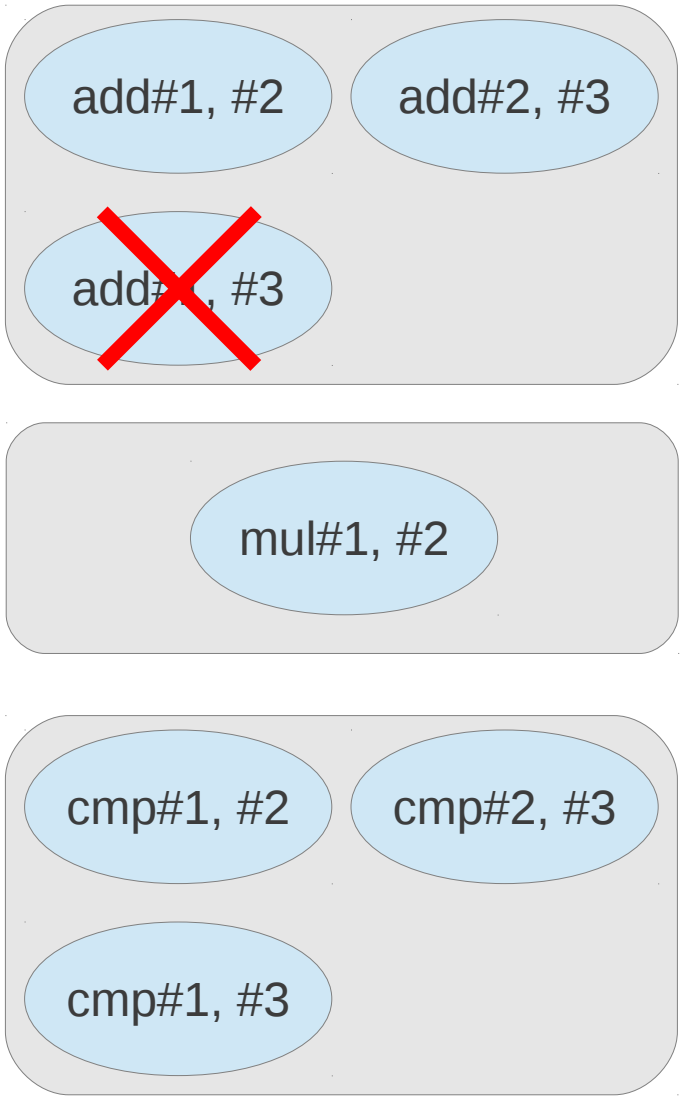


LLVM-based vectorization

Find potential pairs

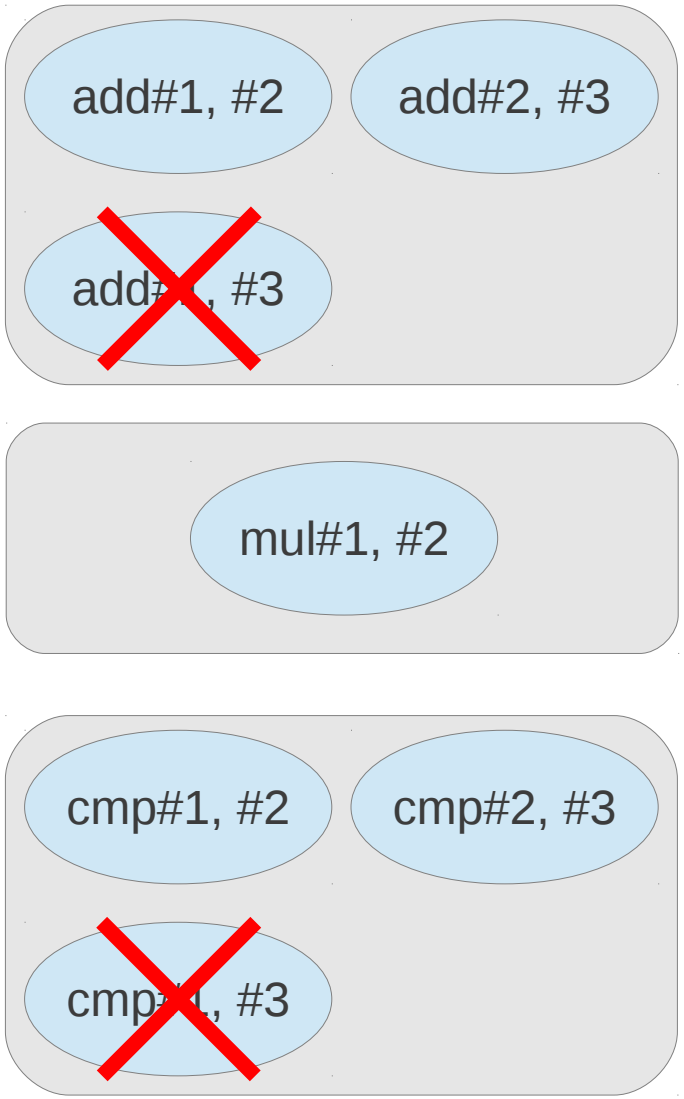
Steps involved:

- Remove intradependent pairs



LLVM-based vectorization

Find potential pairs

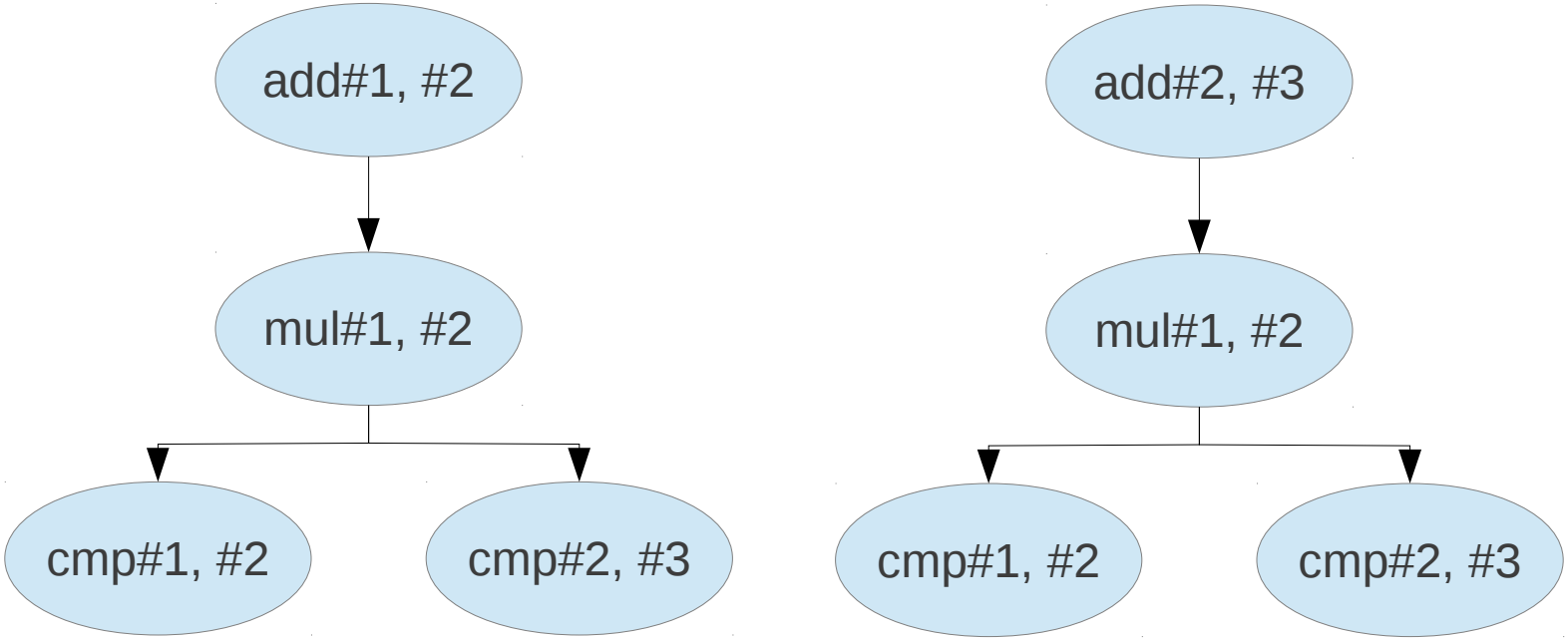


Steps involved:

- Remove intradependent pairs
- Remove illegal pairs

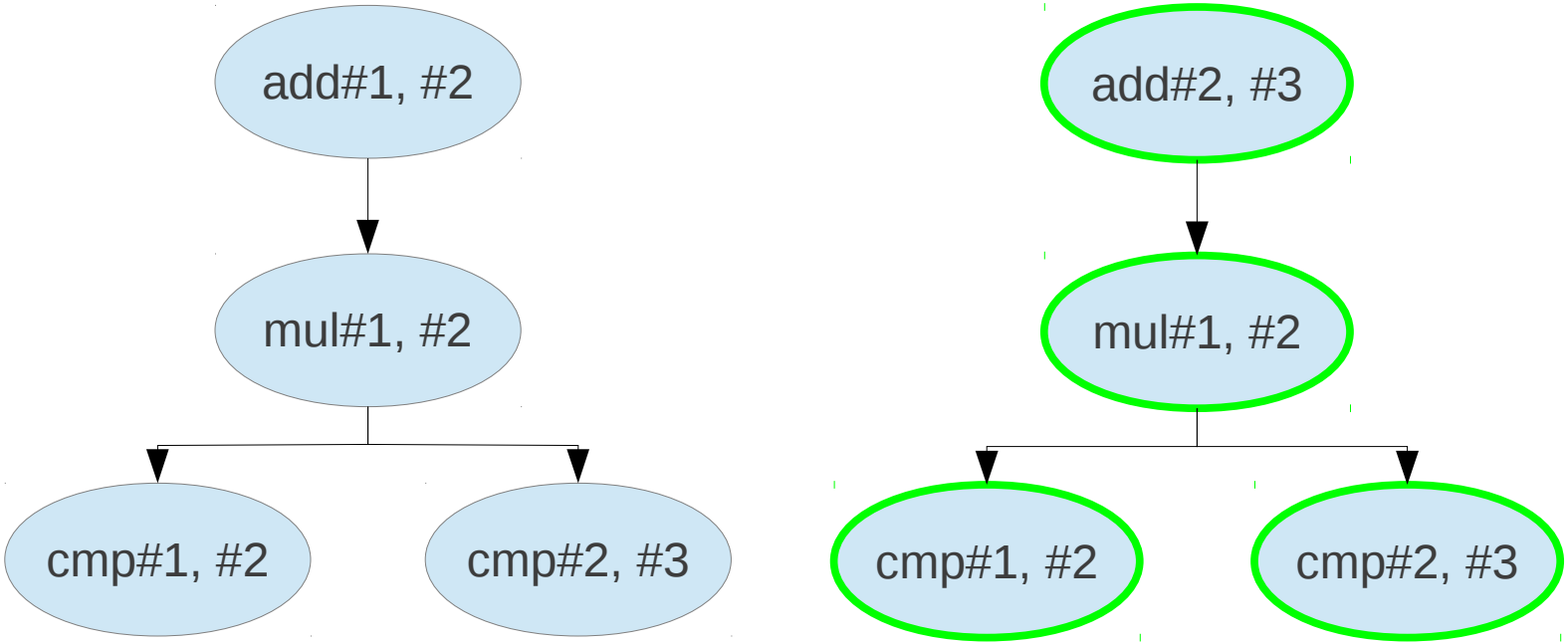
LLVM-based vectorization

Find pair connections



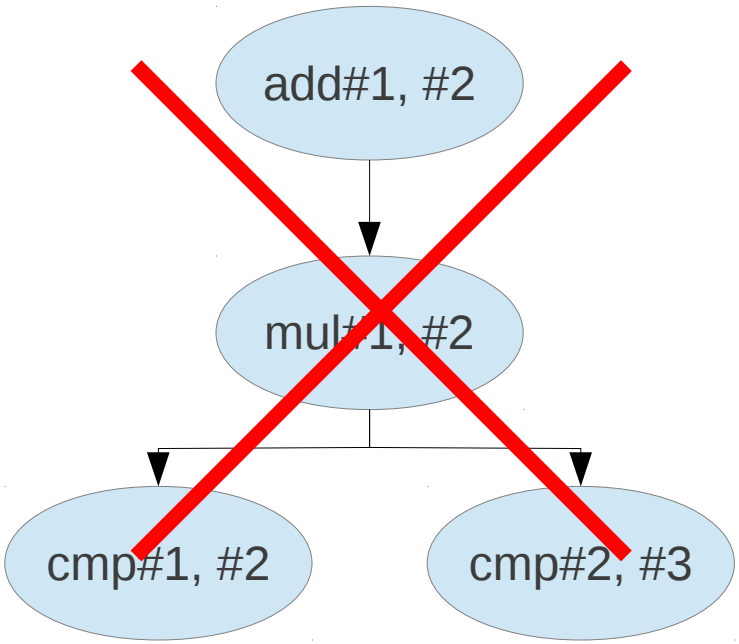
LLVM-based vectorization

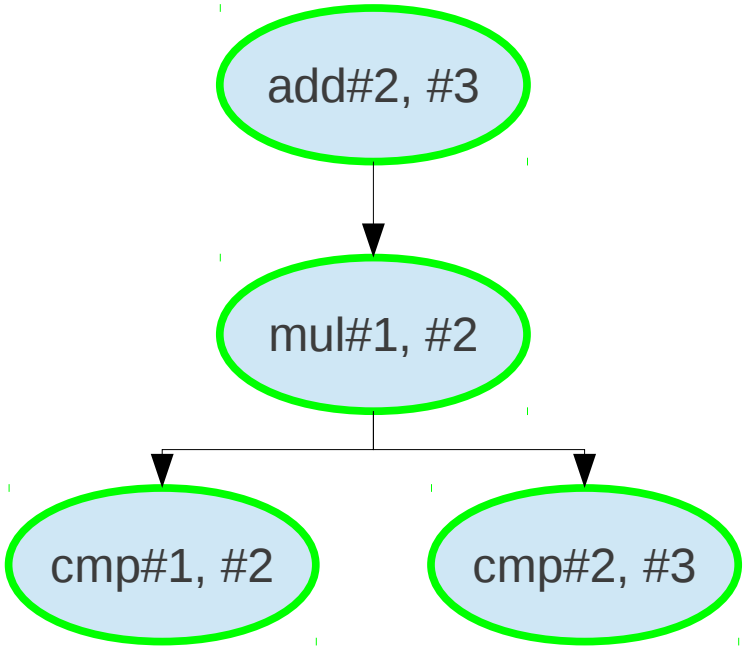
Pair selection



LLVM-based vectorization

Pair selection





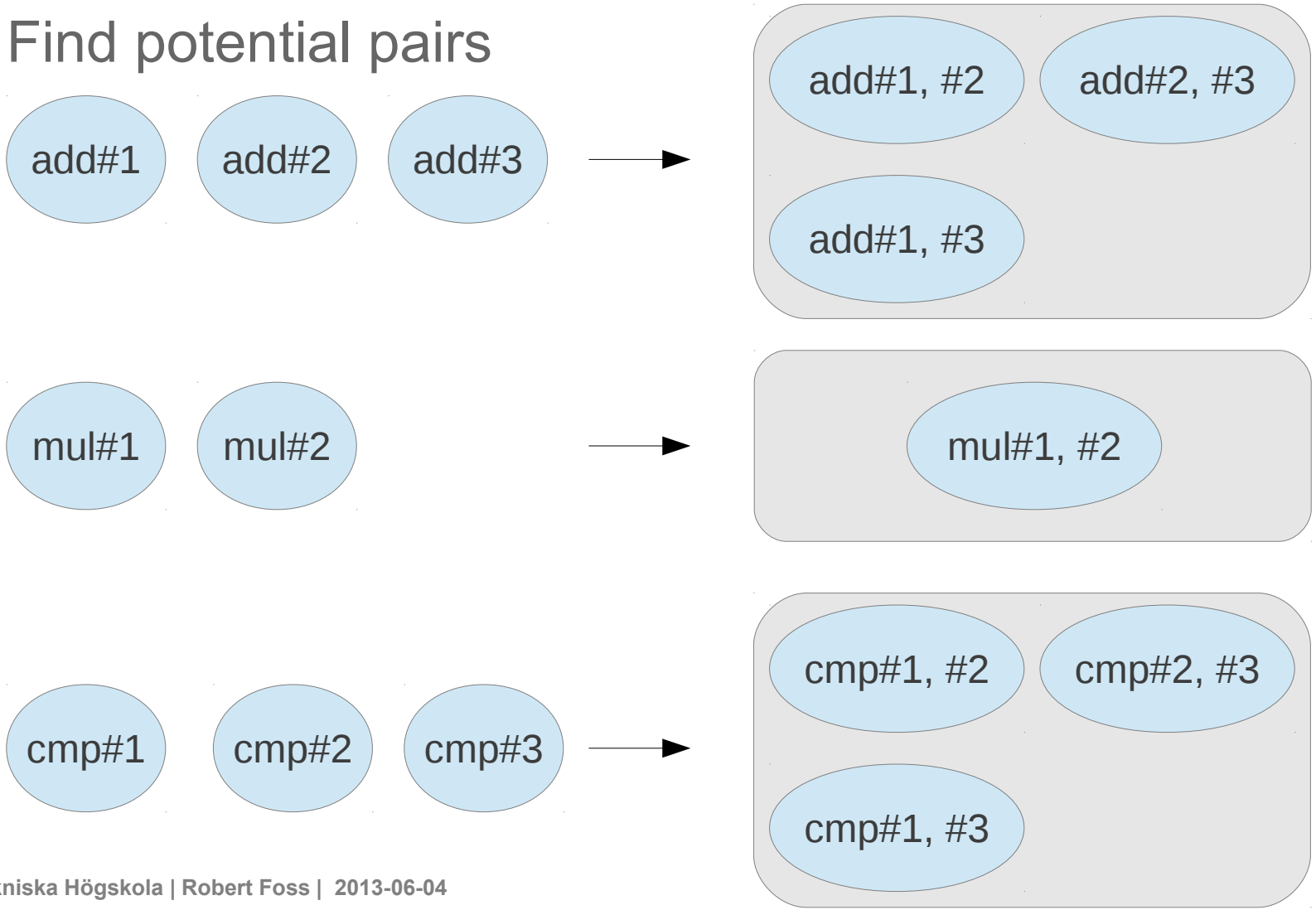
Pair-based vectorization

Steps involved:

- Find potential pairs
- Pair selection
- Pair fusing

LLVM-based vectorization

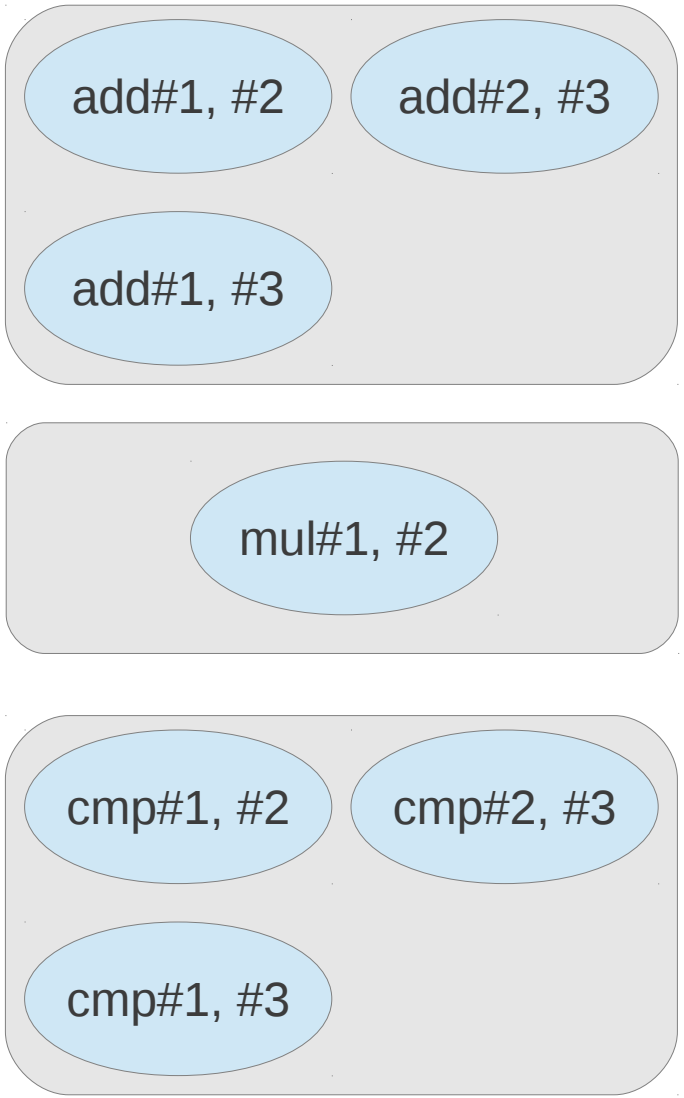
Find potential pairs



LLVM-based vectorization

Find potential pairs

Steps involved:

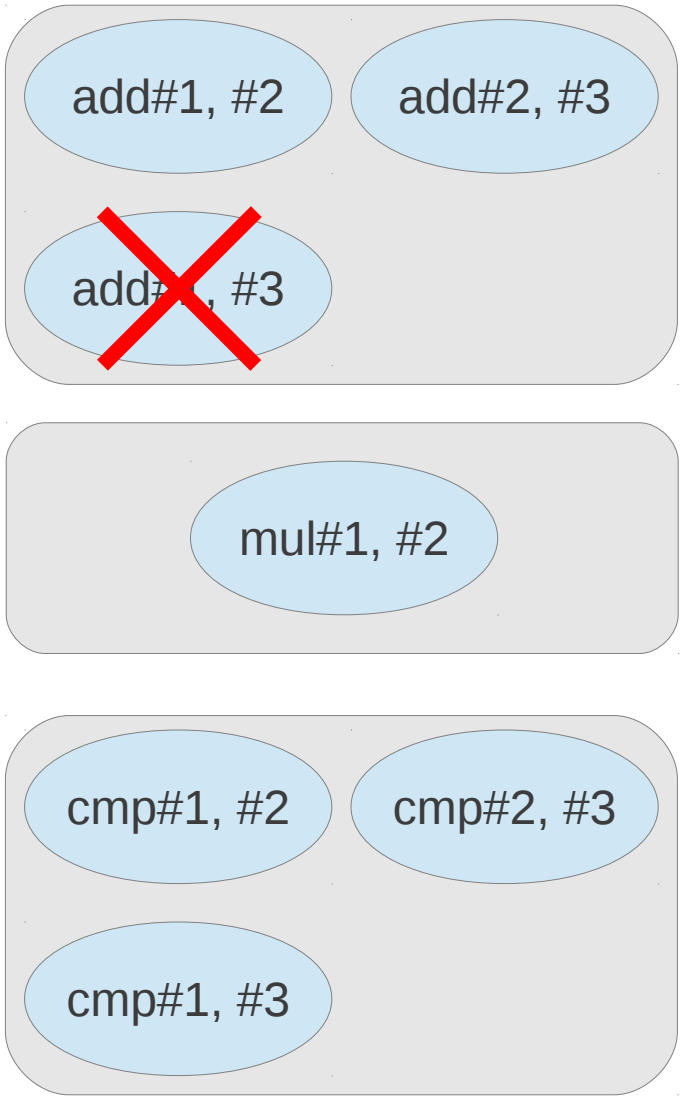


LLVM-based vectorization

Find potential pairs

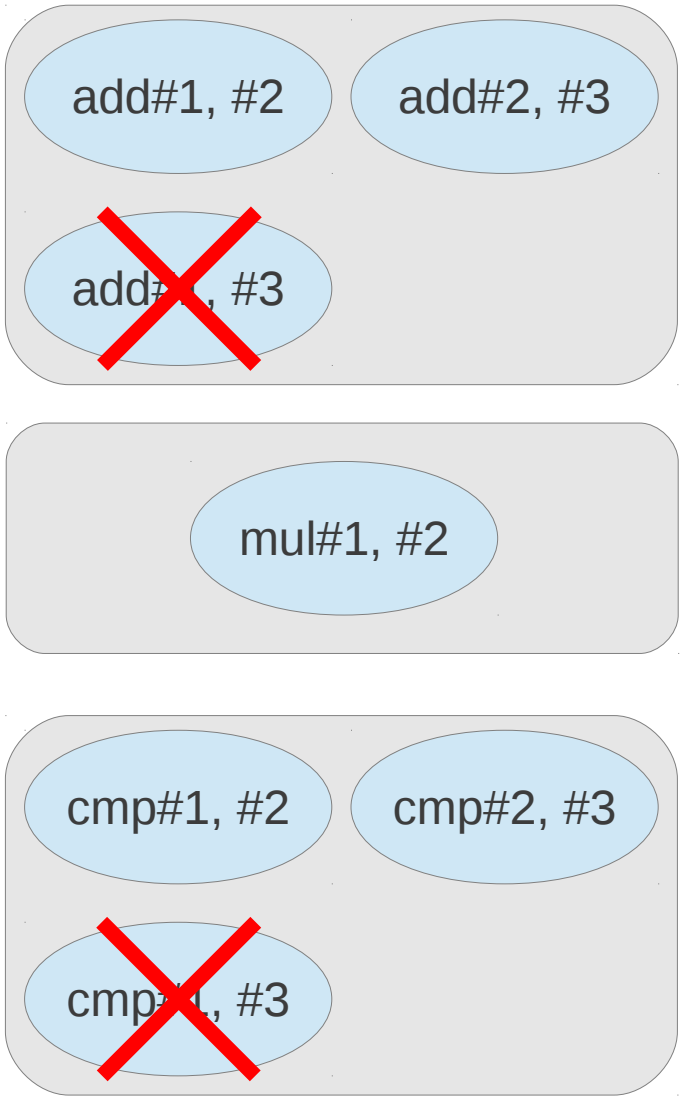
Steps involved:

- Remove intradependent pairs



LLVM-based vectorization

Find potential pairs

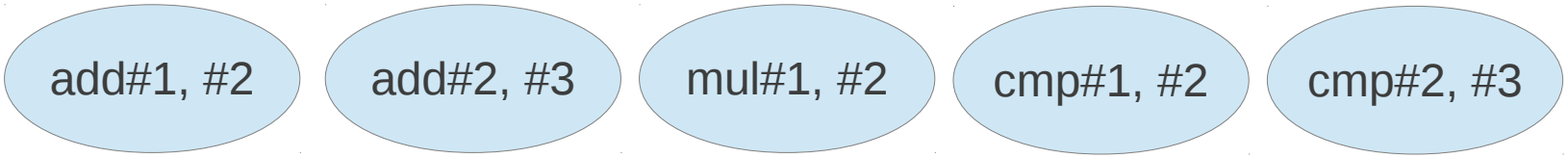


Steps involved:

- Remove intradependent pairs
- Remove illegal pairs

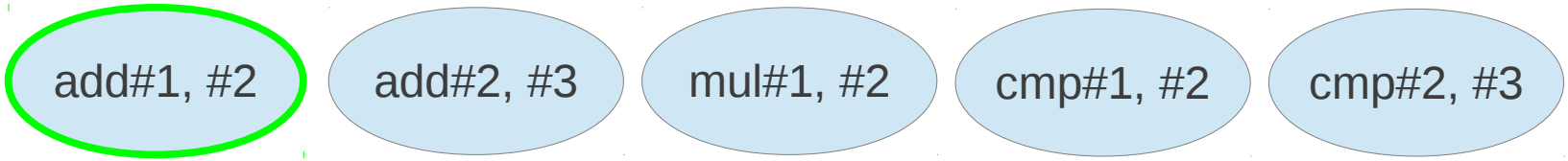
Pair-based vectorization

Pair selection



Pair-based vectorization

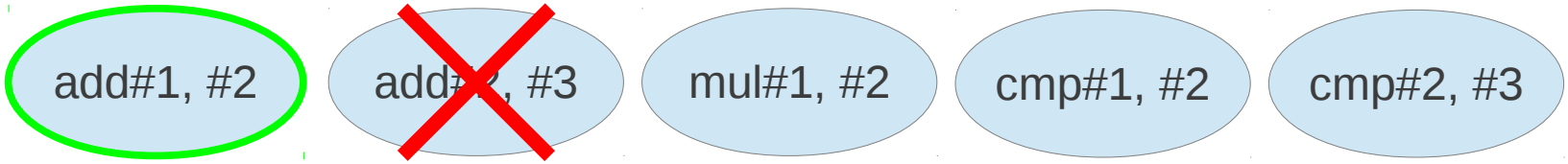
Pair selection



- Fuse most profitable pair

Pair-based vectorization

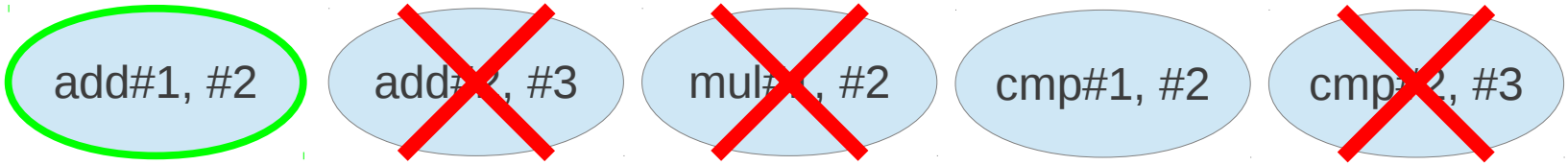
Pair selection



- Fuse most profitable pair
- Remove already fused operations

Pair-based vectorization

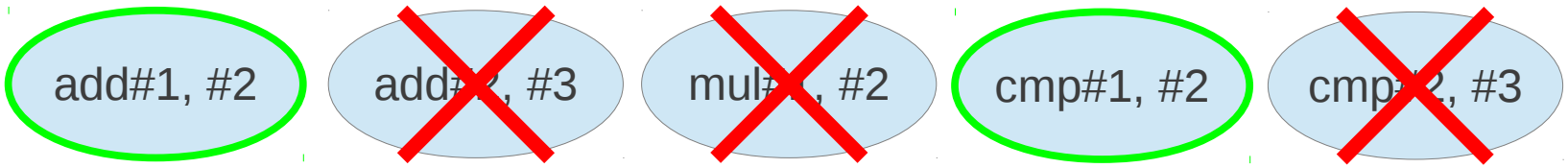
Pair selection



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

Pair-based vectorization

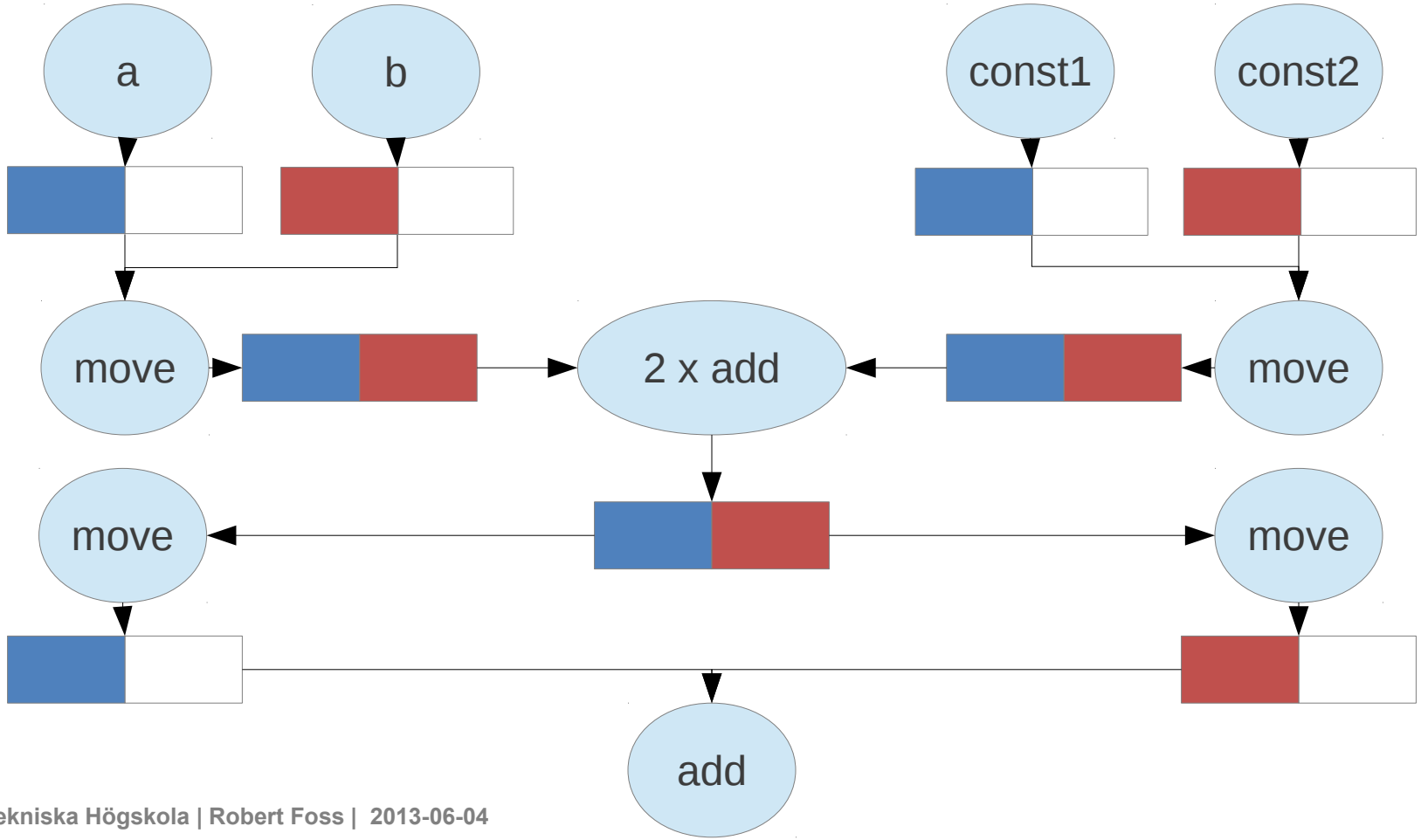
Pair selection



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

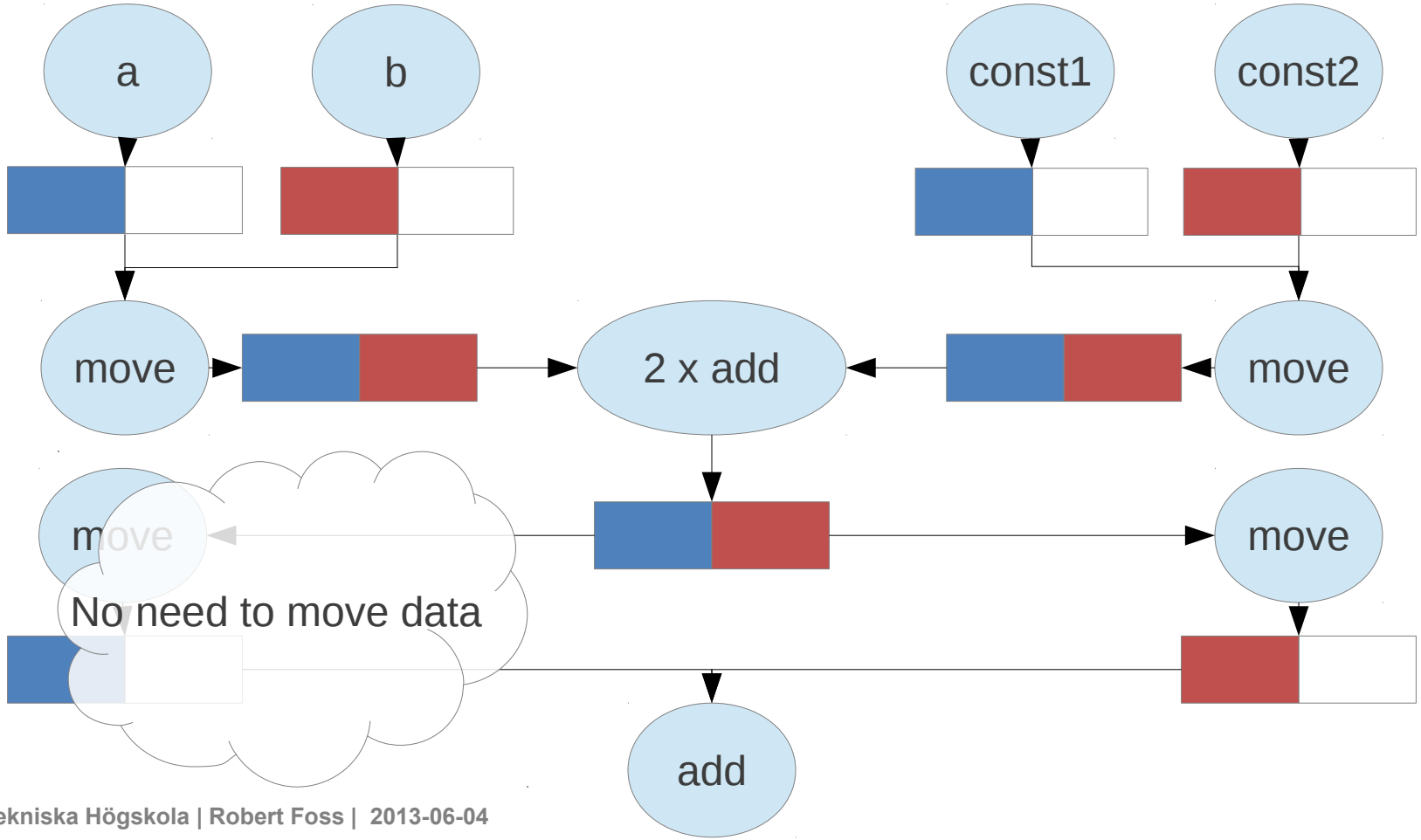
Heuristics

Which? How?



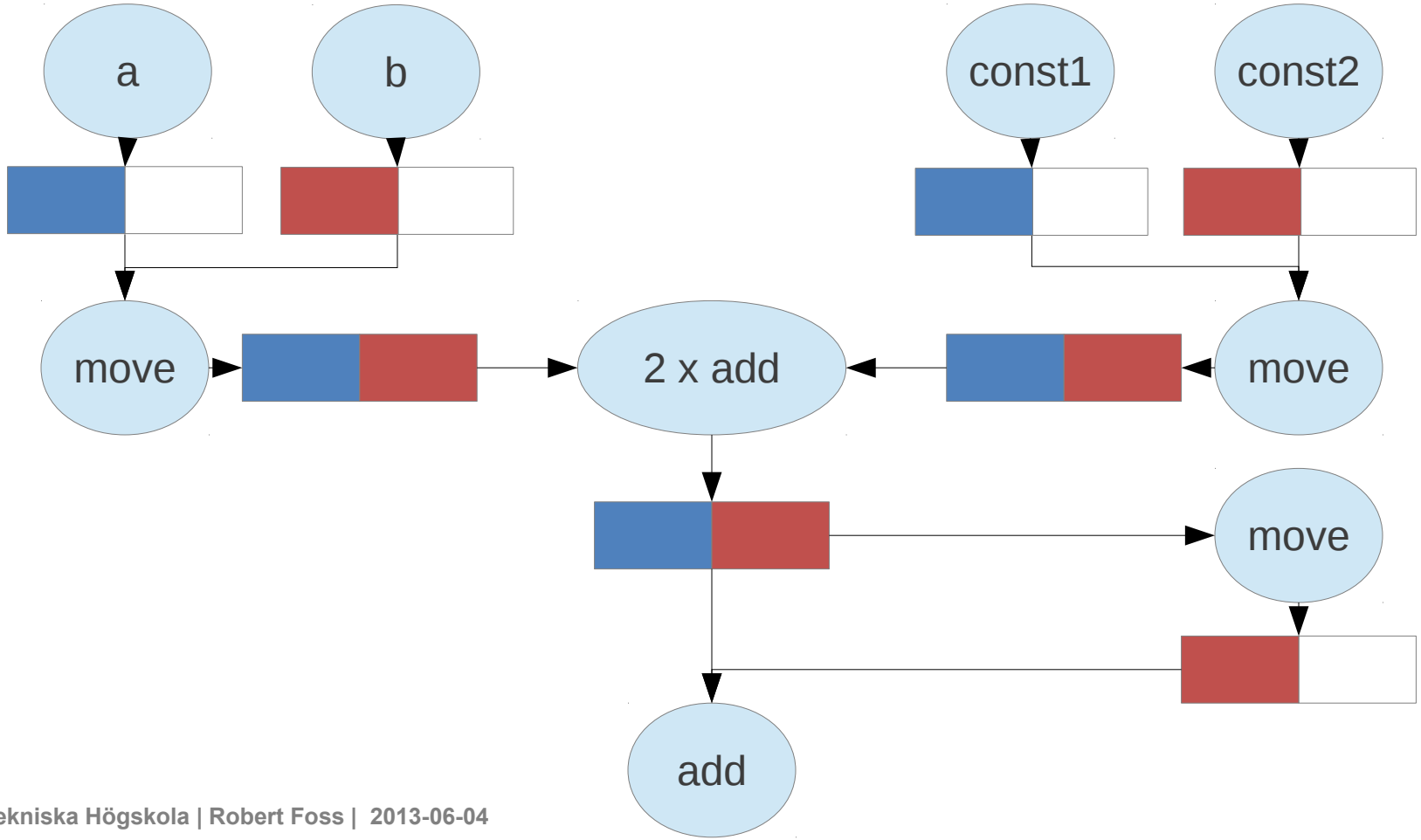
Heuristics

Which? How?



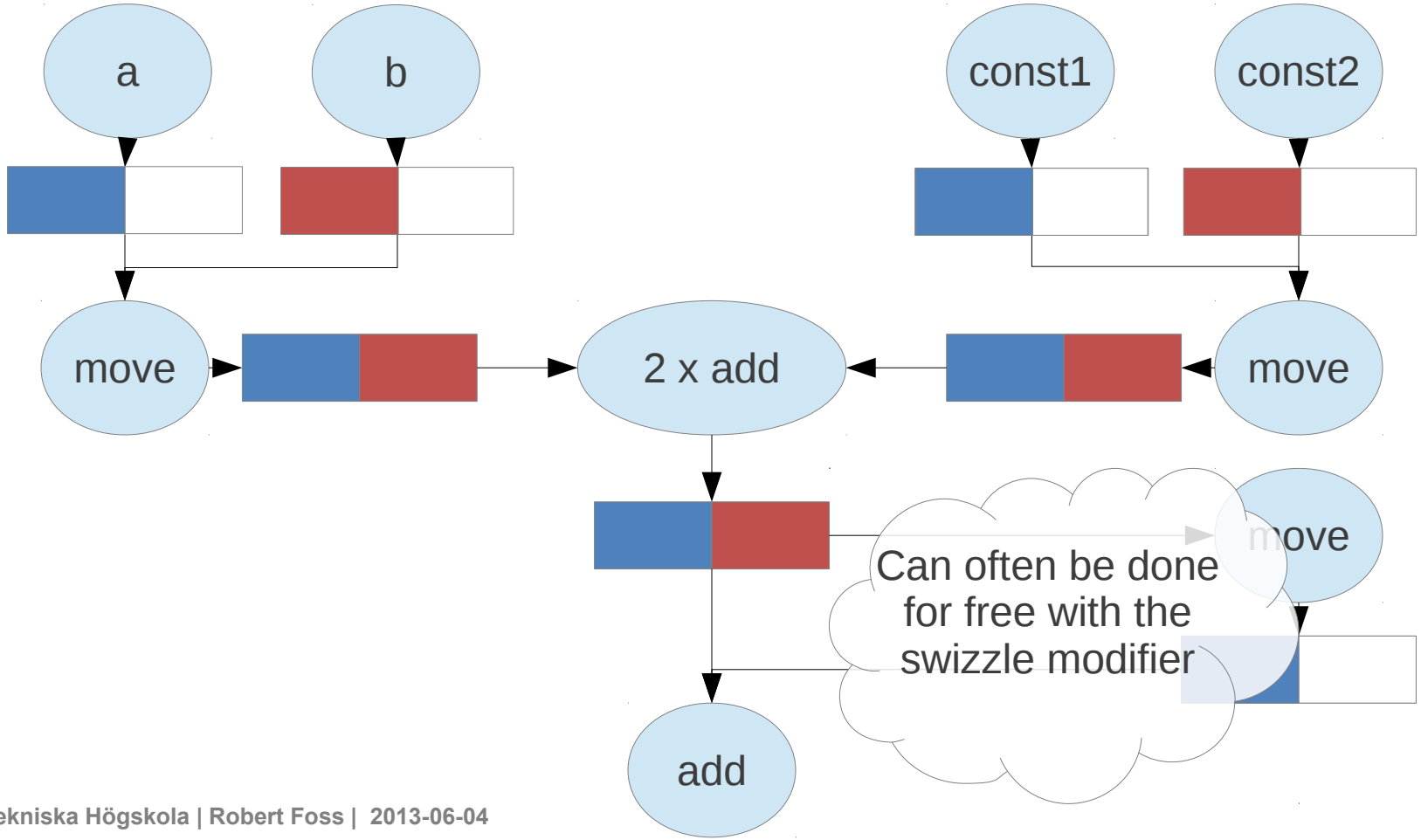
Heuristics

Which? How?



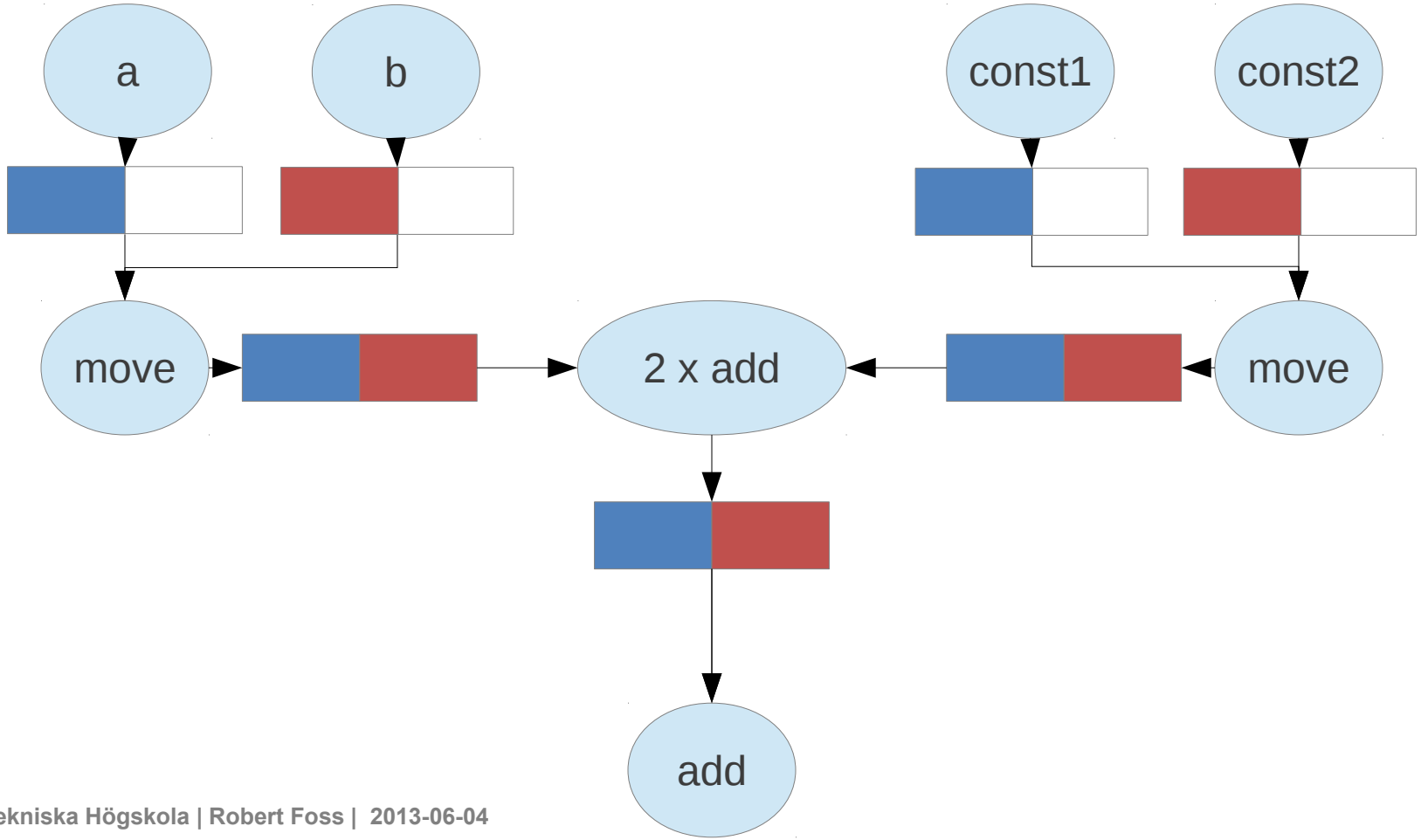
Heuristics

Which? How?



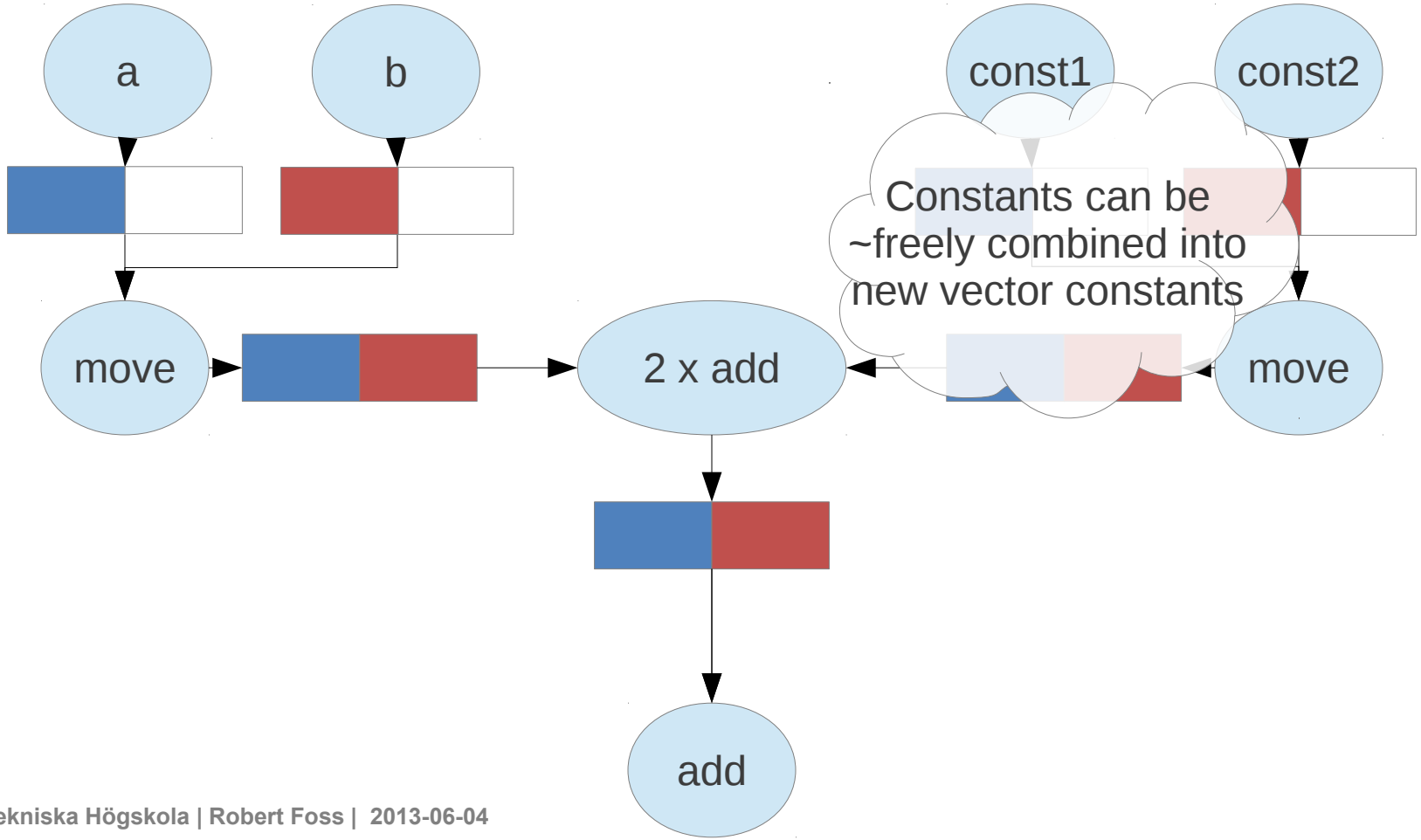
Heuristics

Which? How?



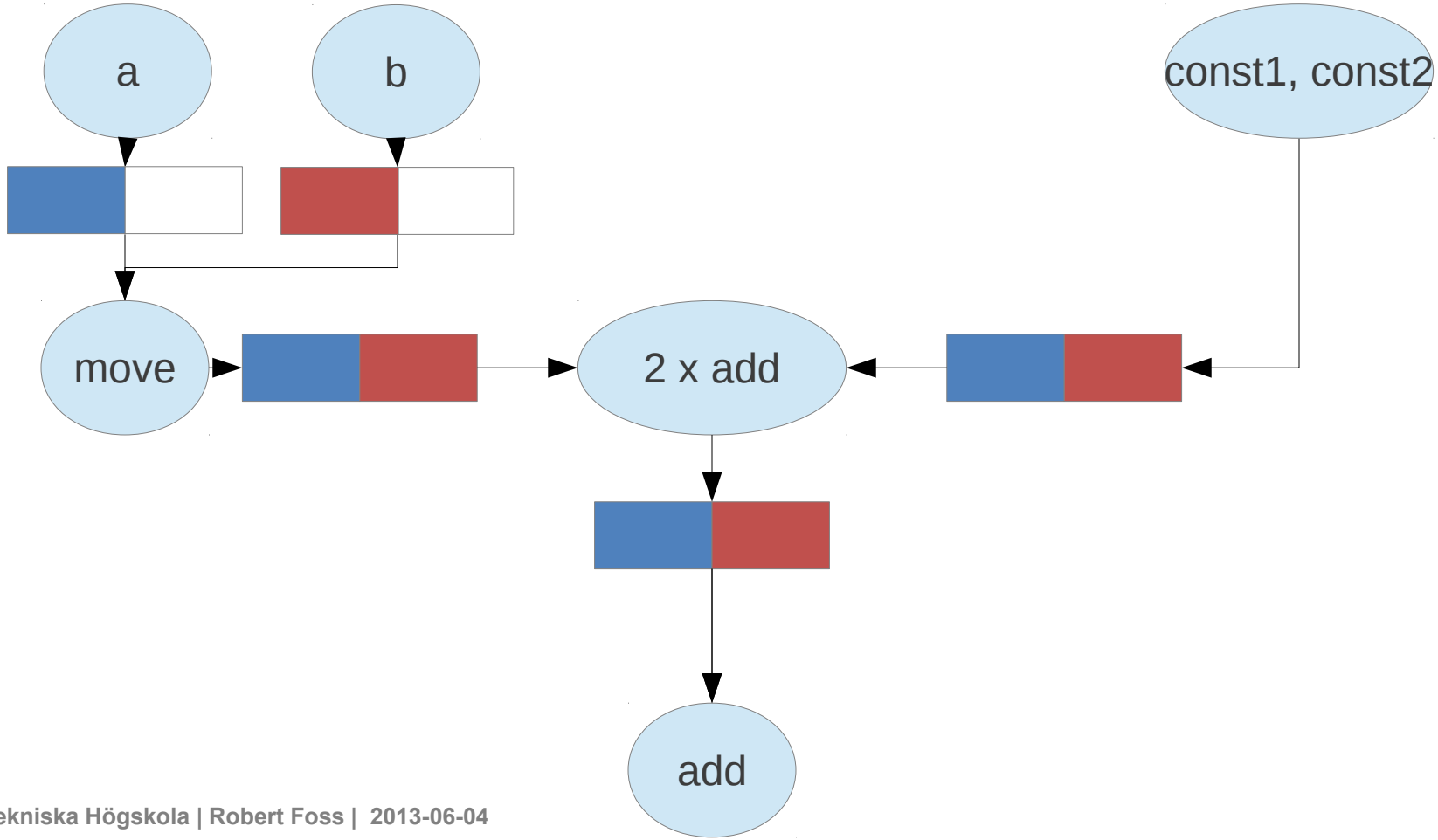
Heuristics

Which? How?



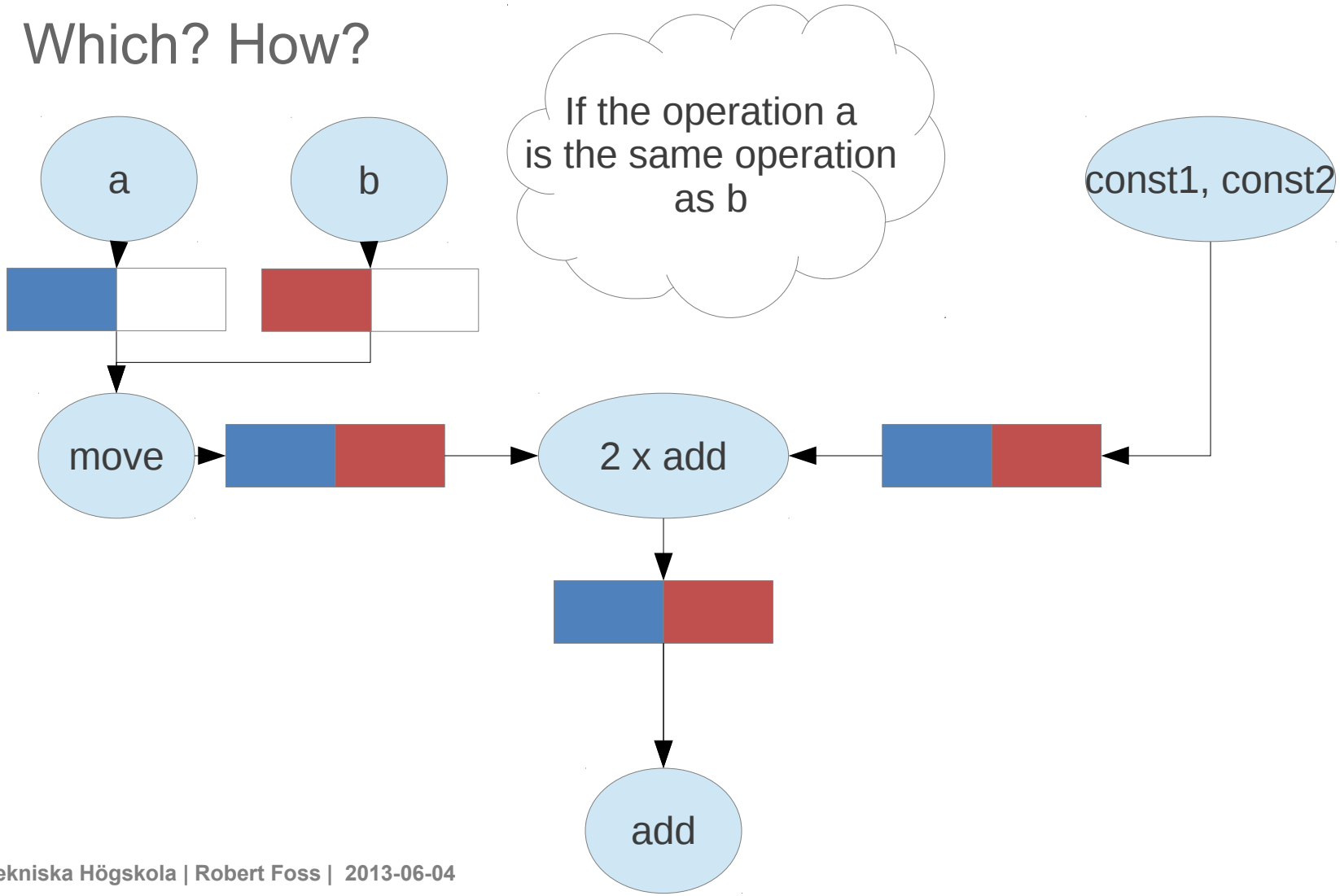
Heuristics

Which? How?



Heuristics

Which? How?



Heuristics

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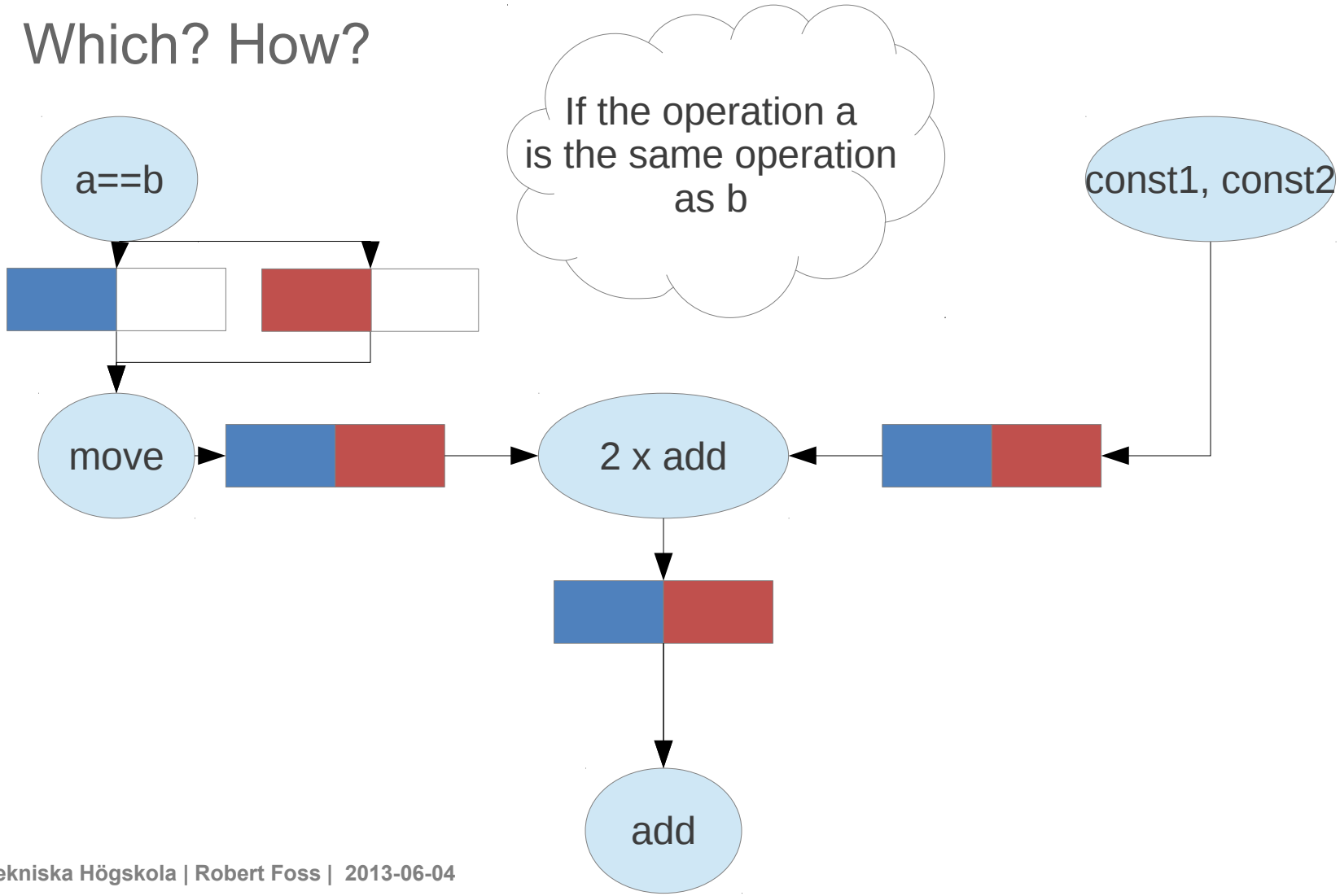
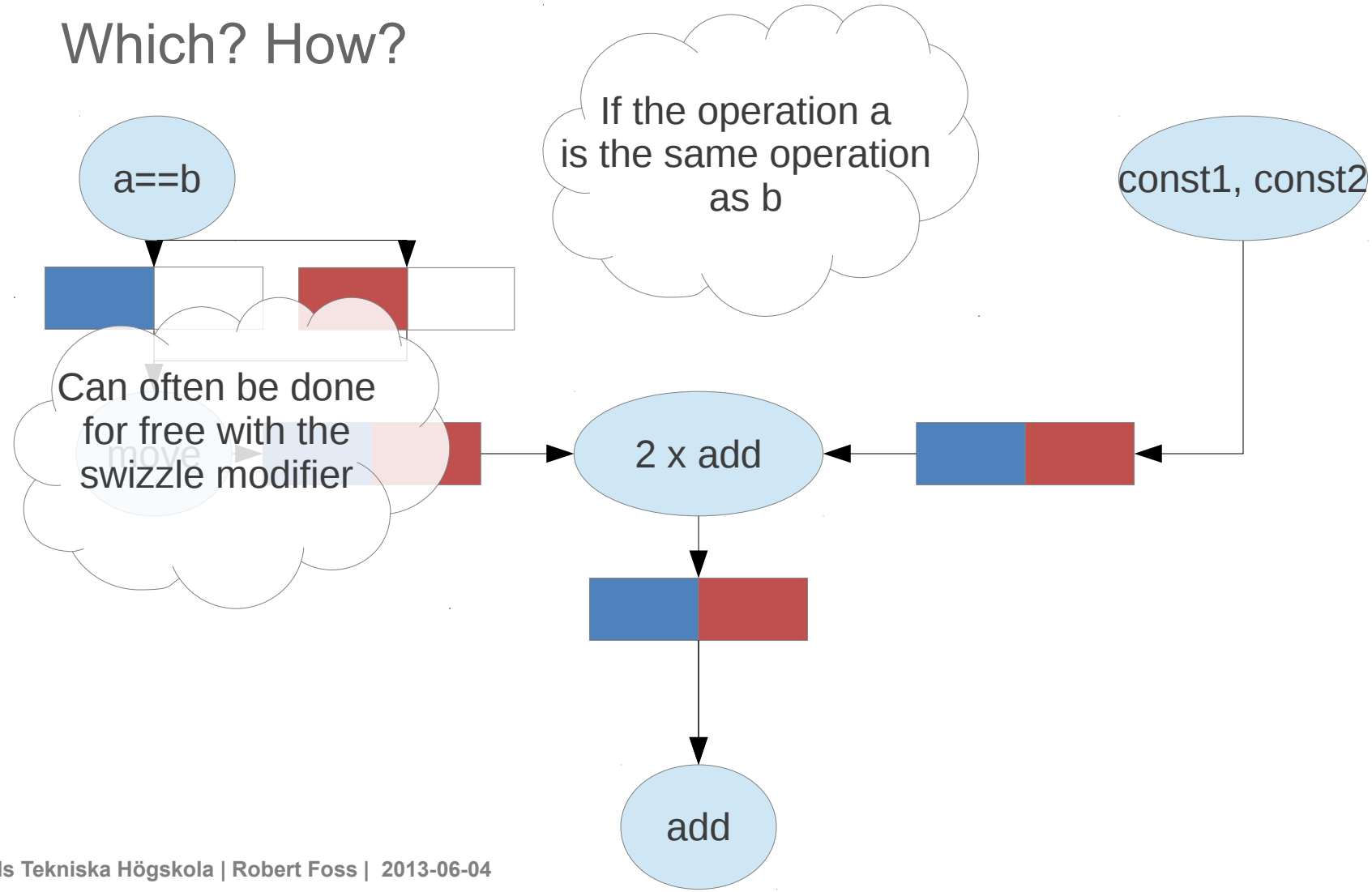


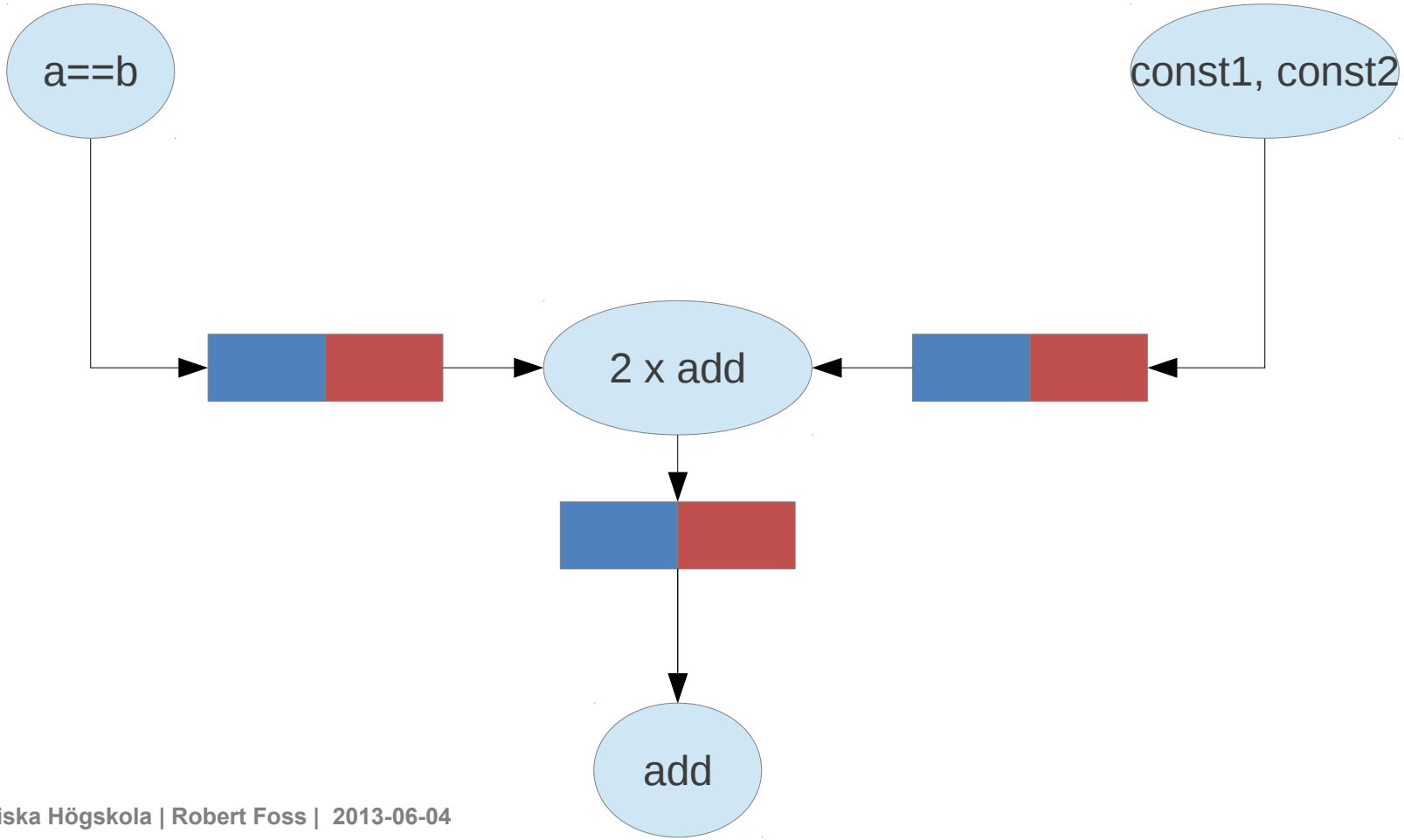
Heuristics

Which? How?



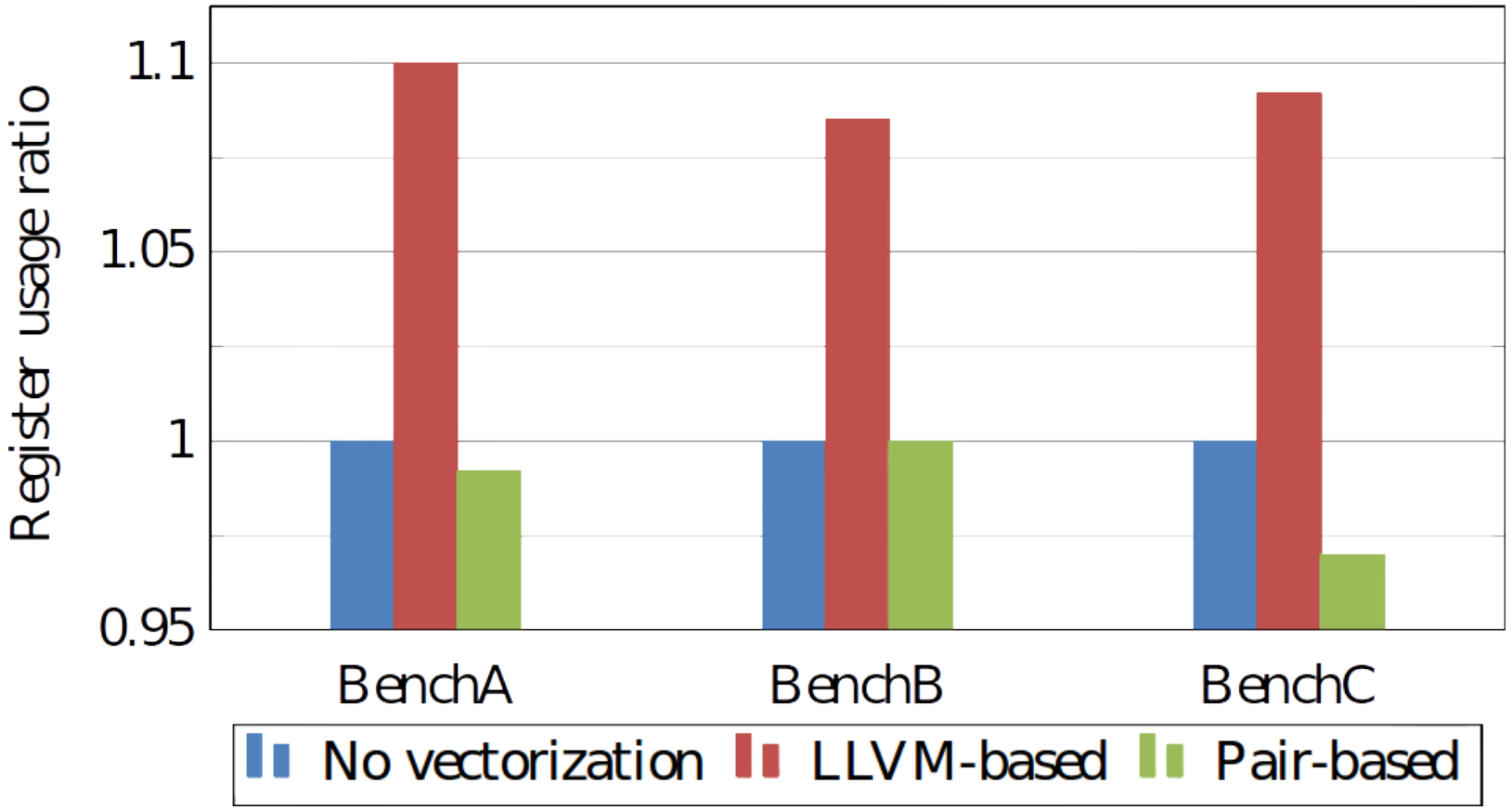
Heuristics

Which? How?



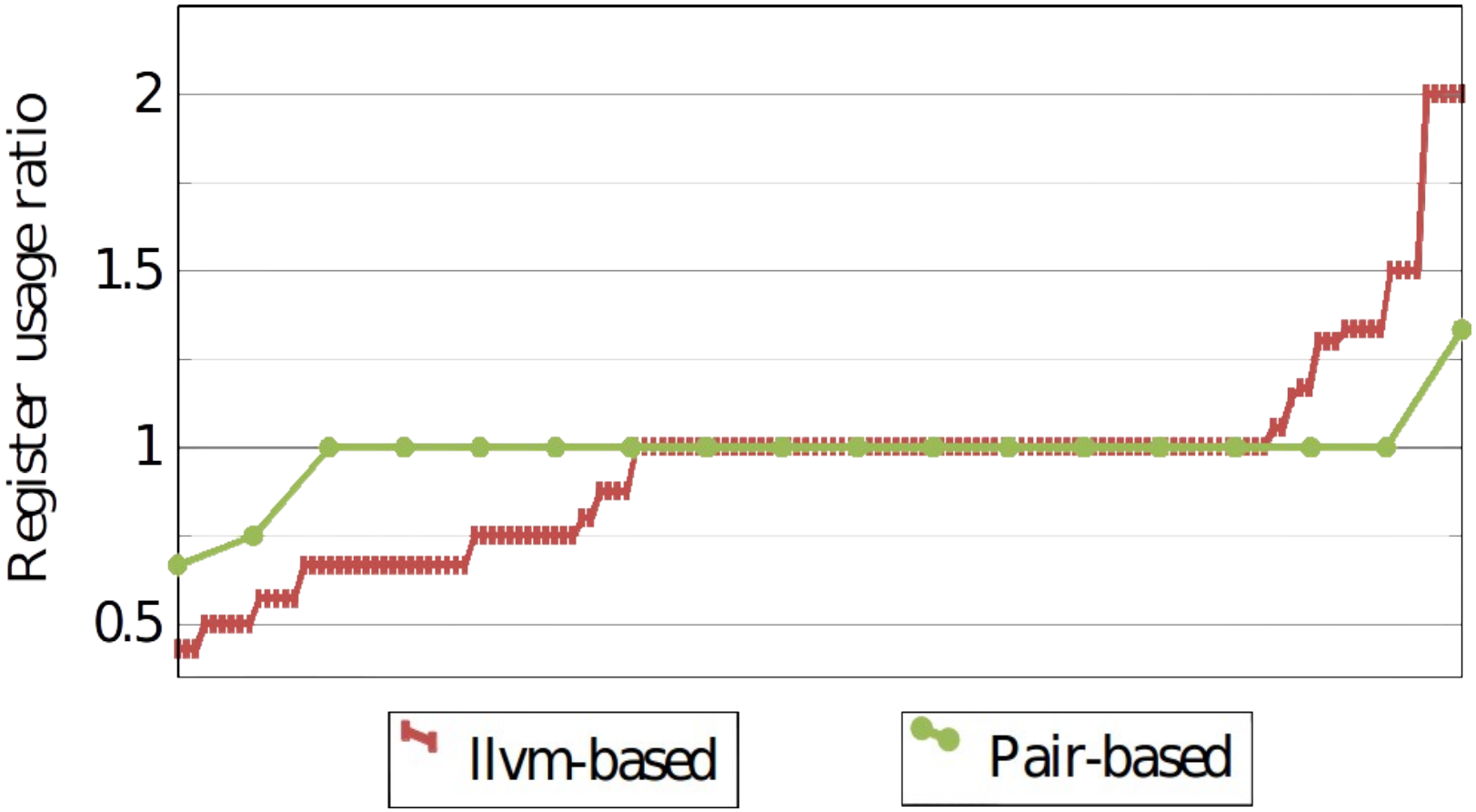
Results

Work Register Usage



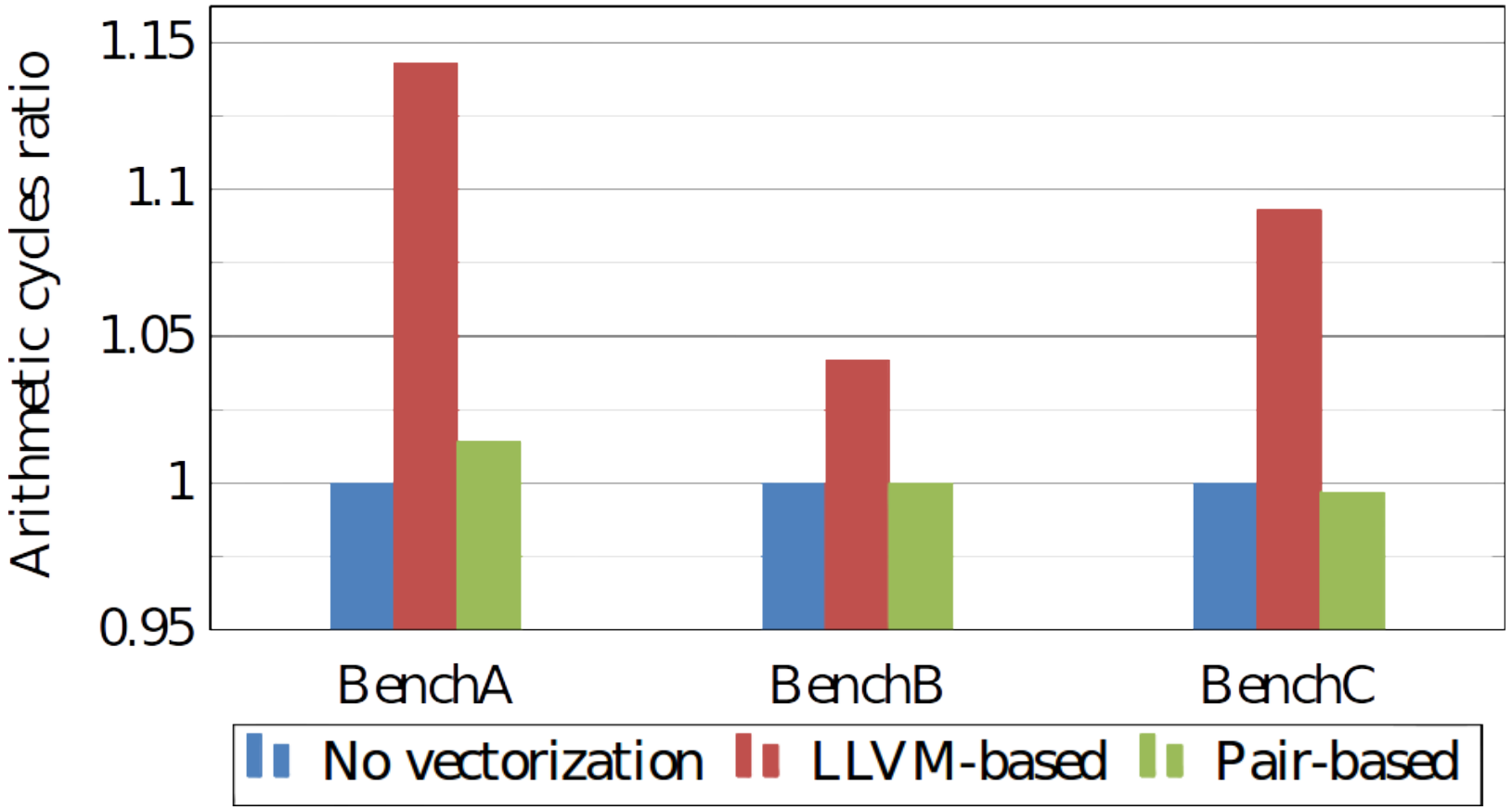
Results

Work Register Usage



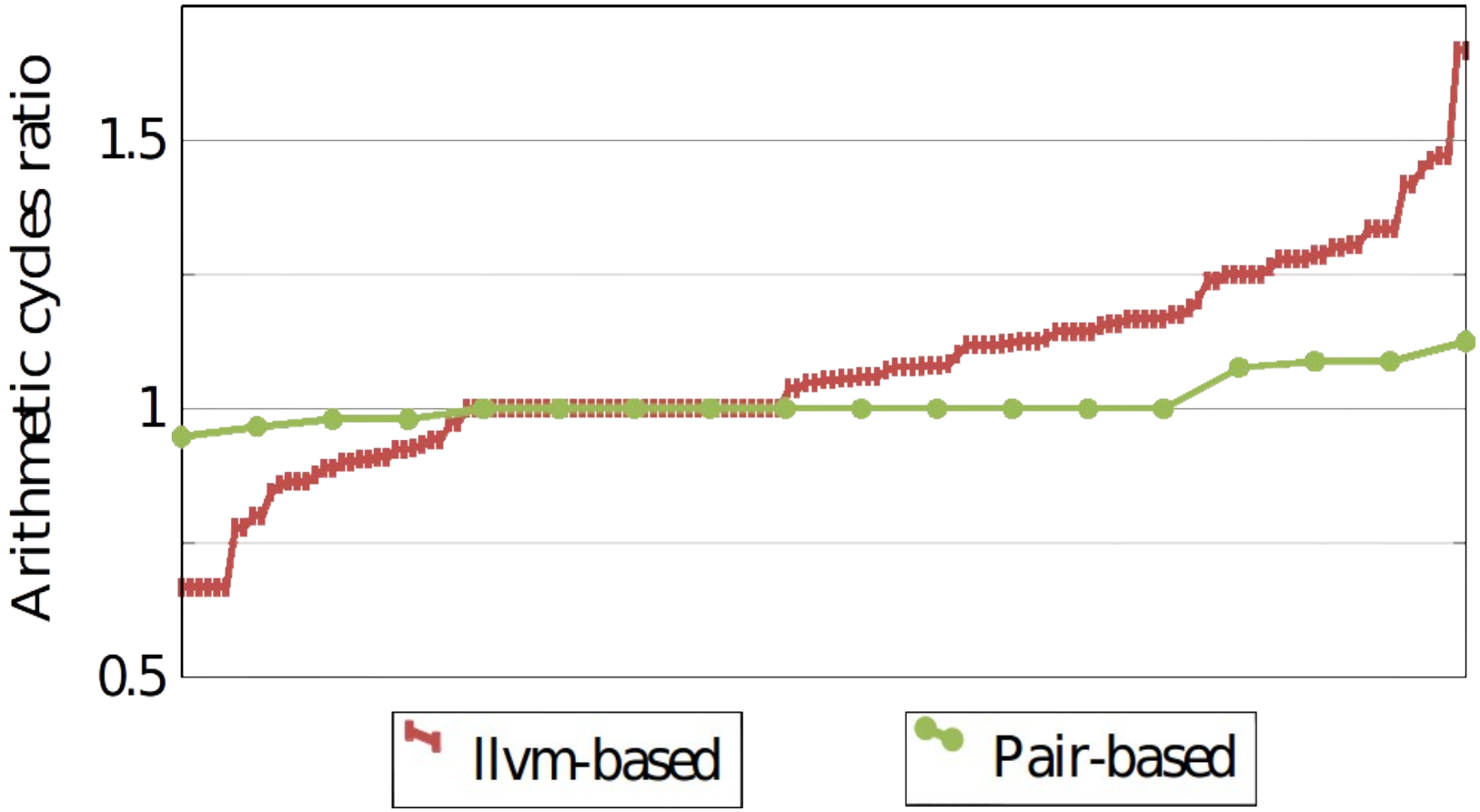
Results

Arithmetic Cycles



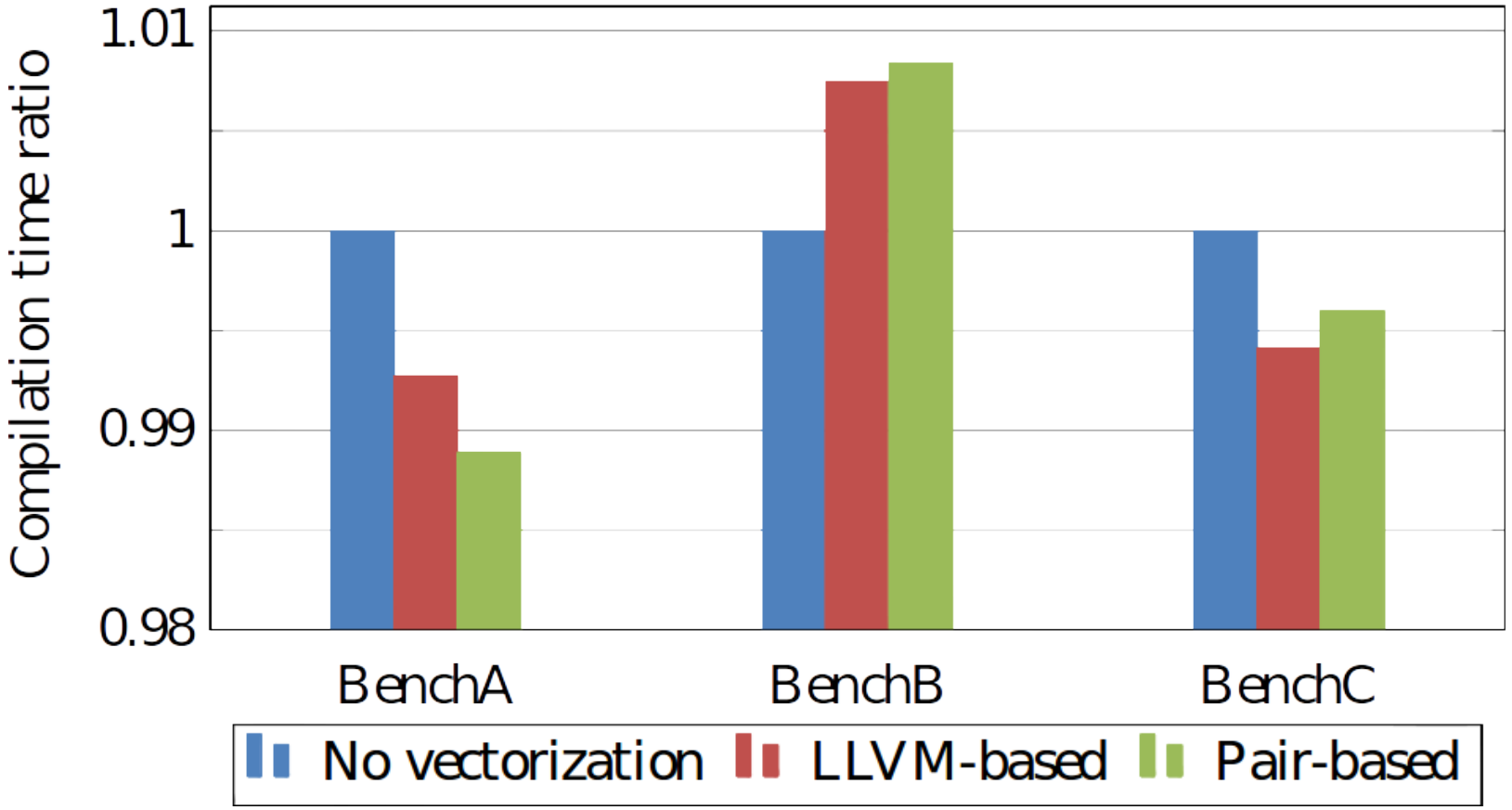
Results

Arithmetic Cycles



Results

Compilation Time



Results

Why?

Results

Why?

- Increased register pressure

Results

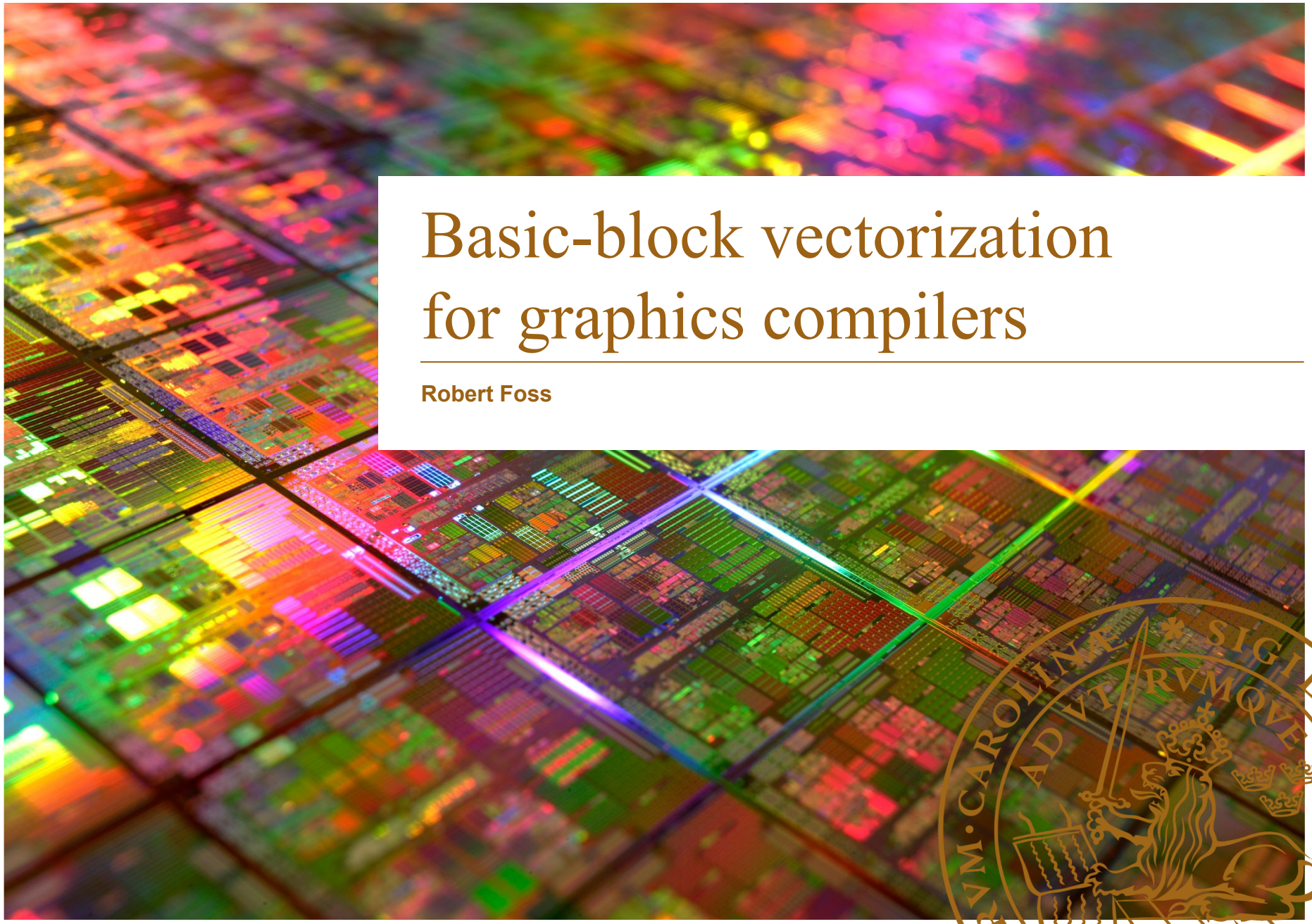
Why?

- 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