# Parallel Fringe Search

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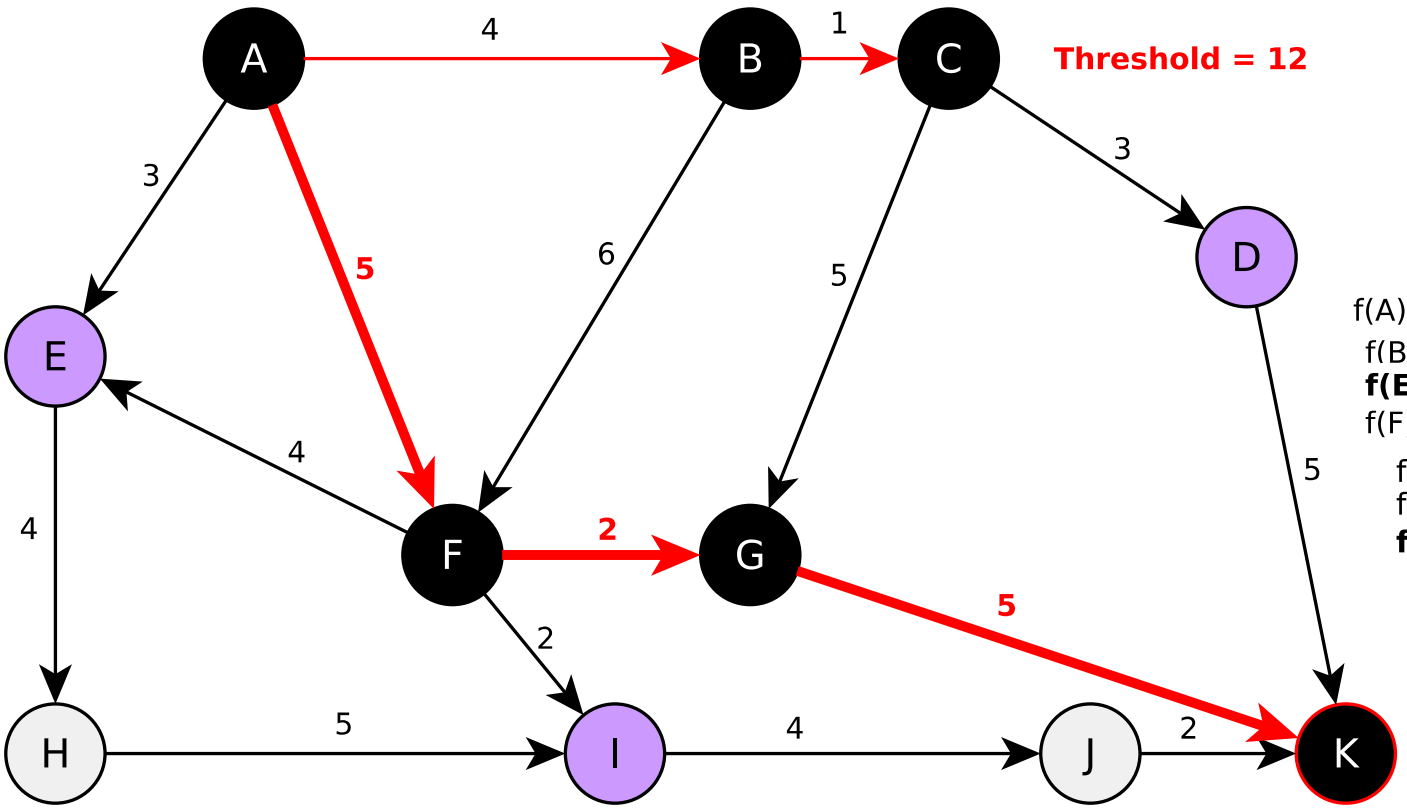
*Design of Parallel and High-Performance Computing*

December 15, 2013

# Overview


1. Fringe Search
2. What we have done
3. Locking concepts
4. Benchmarks
   - Locks
   - Strong scaling
   - Weak scaling
   - Path length
   - Threshold handling
5. Conclusions

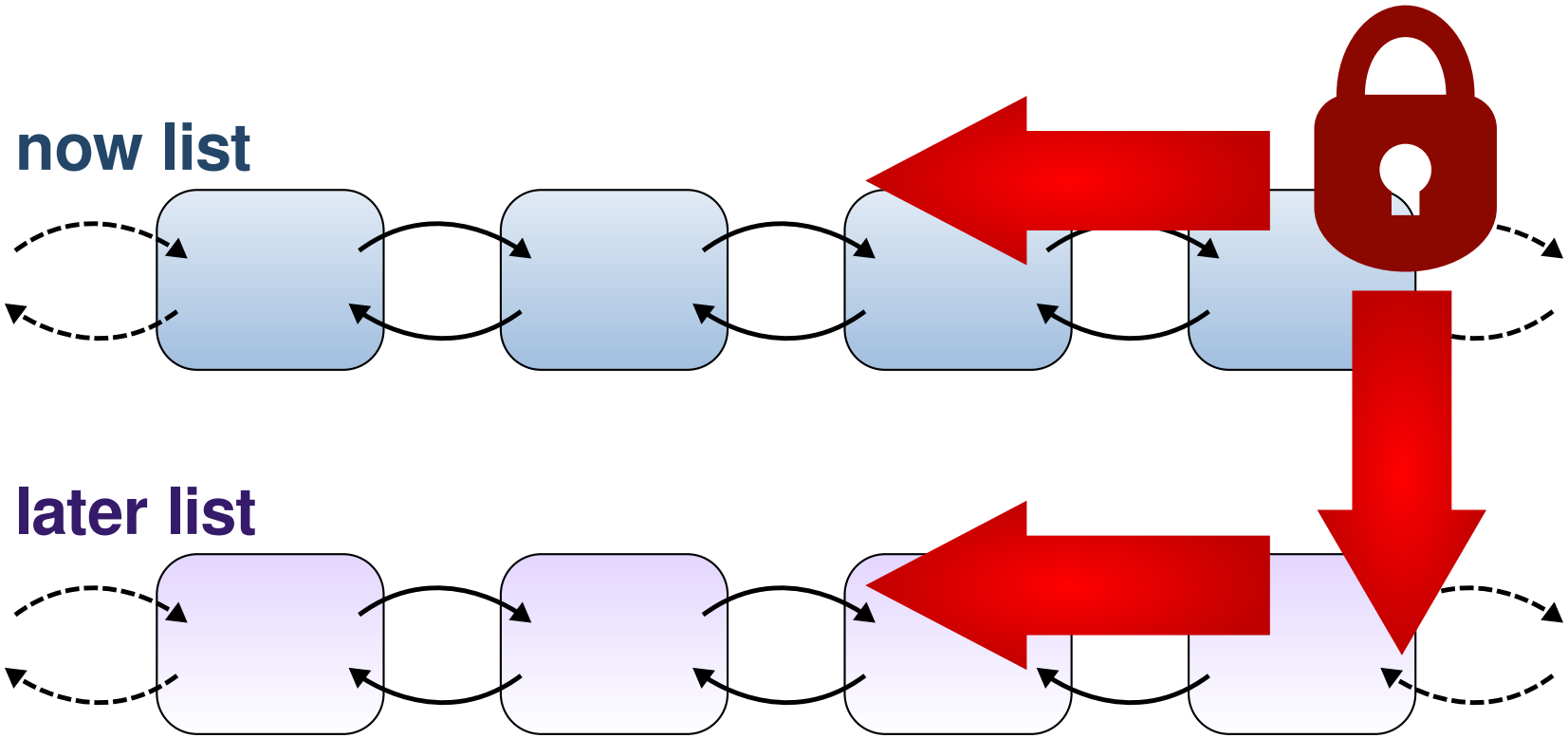
# Fringe Search



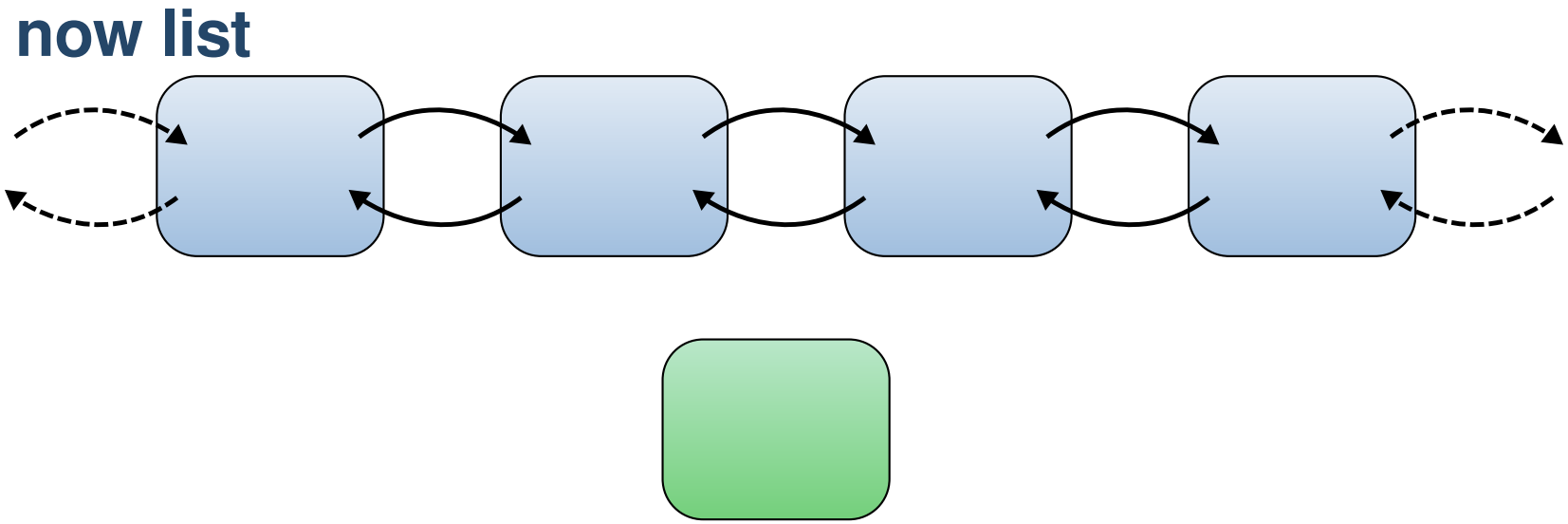
# What we have done

- Serial implementation of fringe search (much faster than Boost A*)
- Parallel implementation with Open MP
  - 2 different locking concepts
  - Locks implemented using inline assembly (faster than Open MP locks)
- Benchmarking
  - Strong scaling
  - Weak scaling
  - Path quality

# Locking concept: Deadlock prevention



# Locking concept: Insert node



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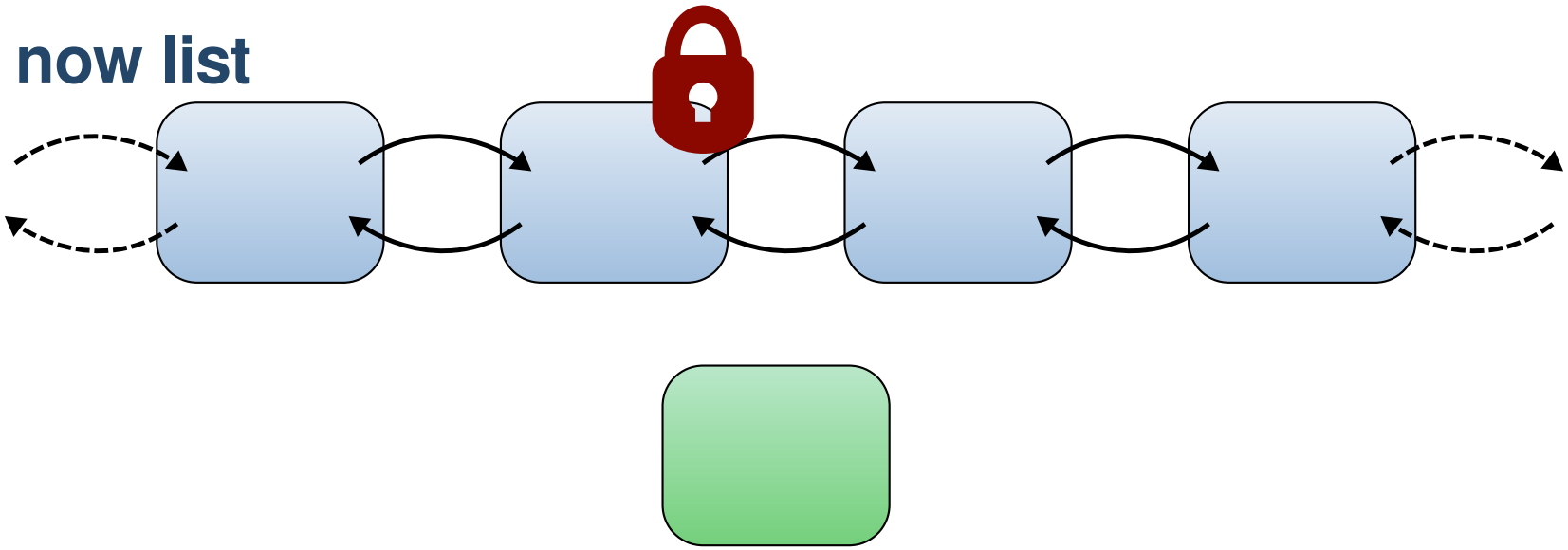

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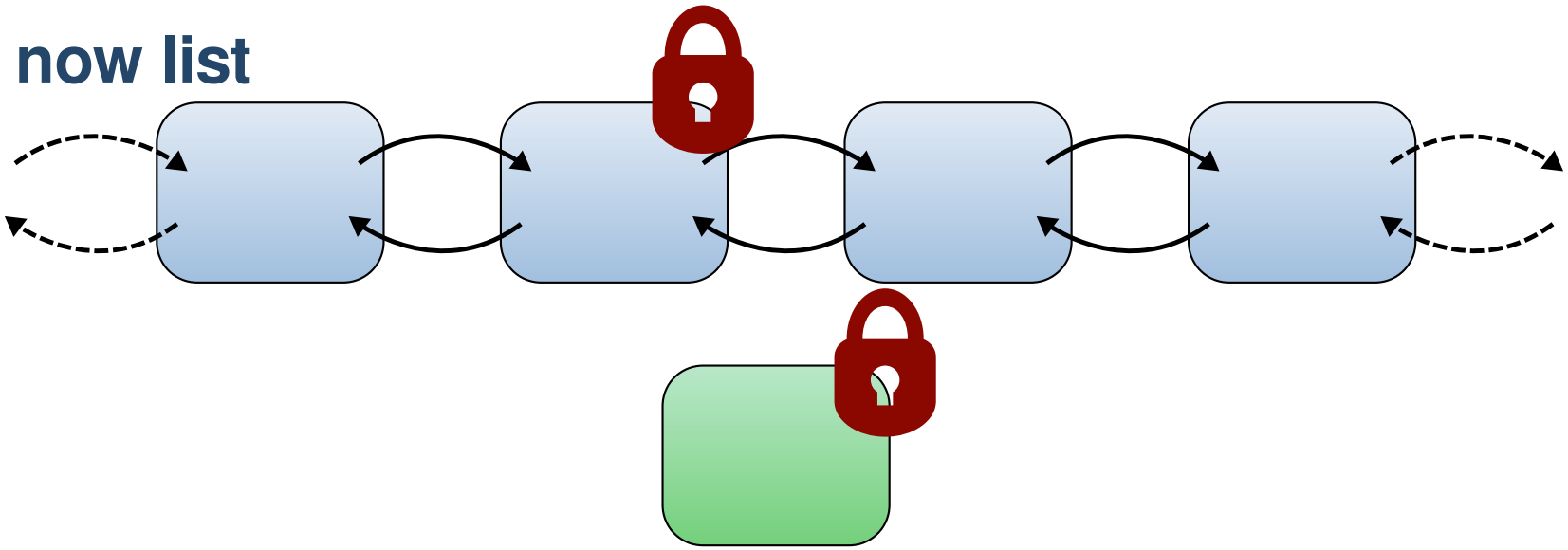

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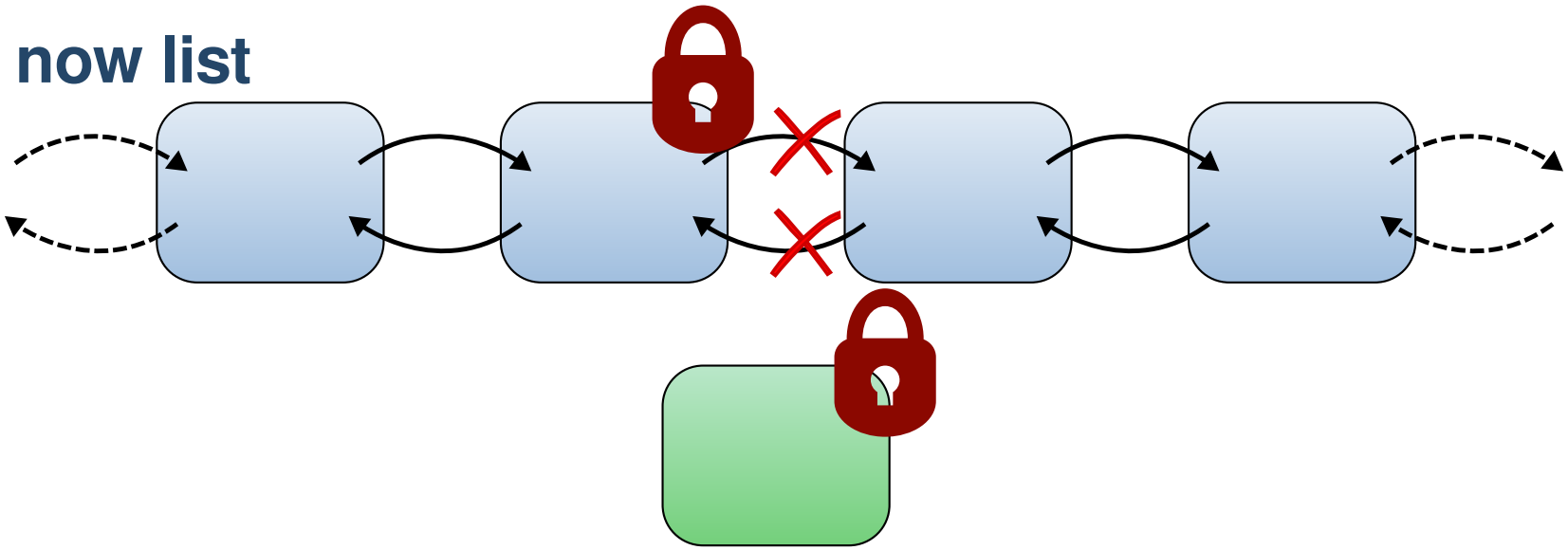

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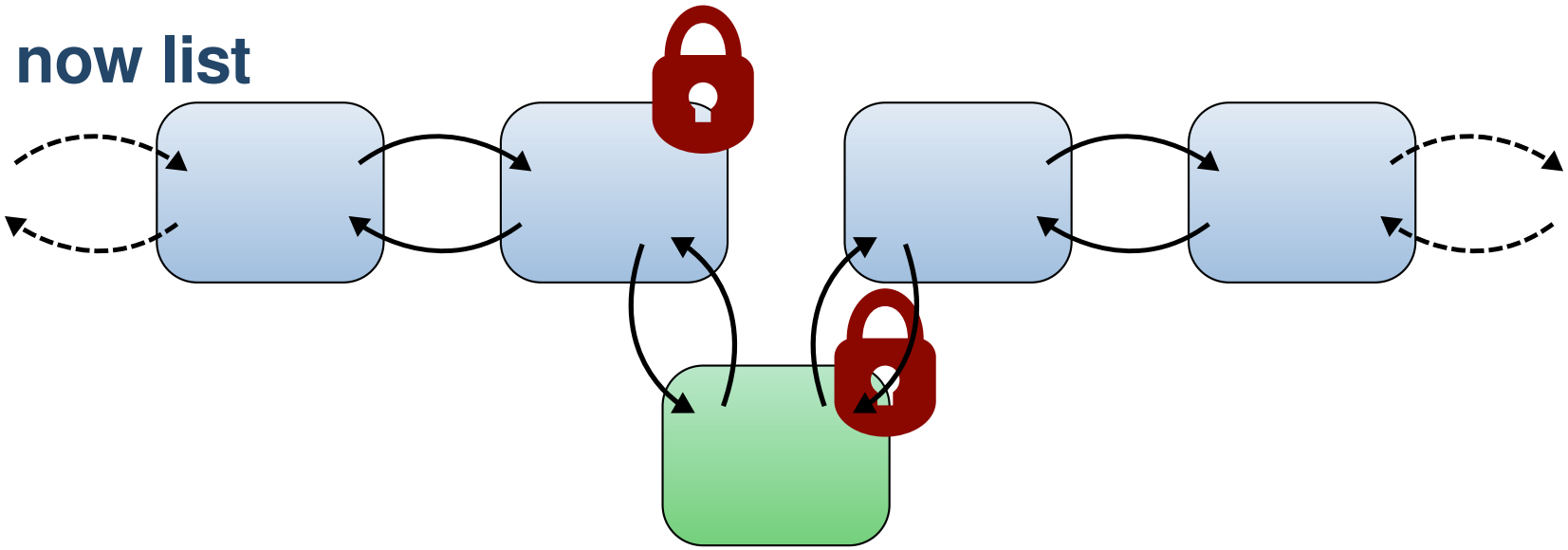

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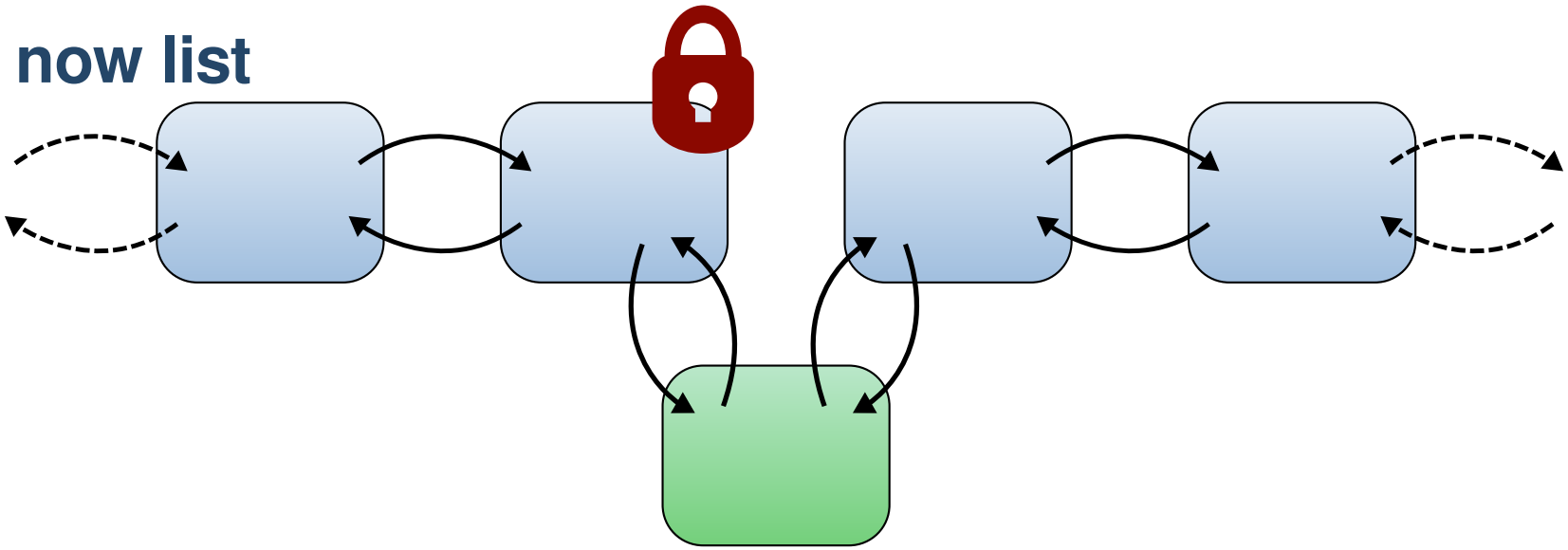

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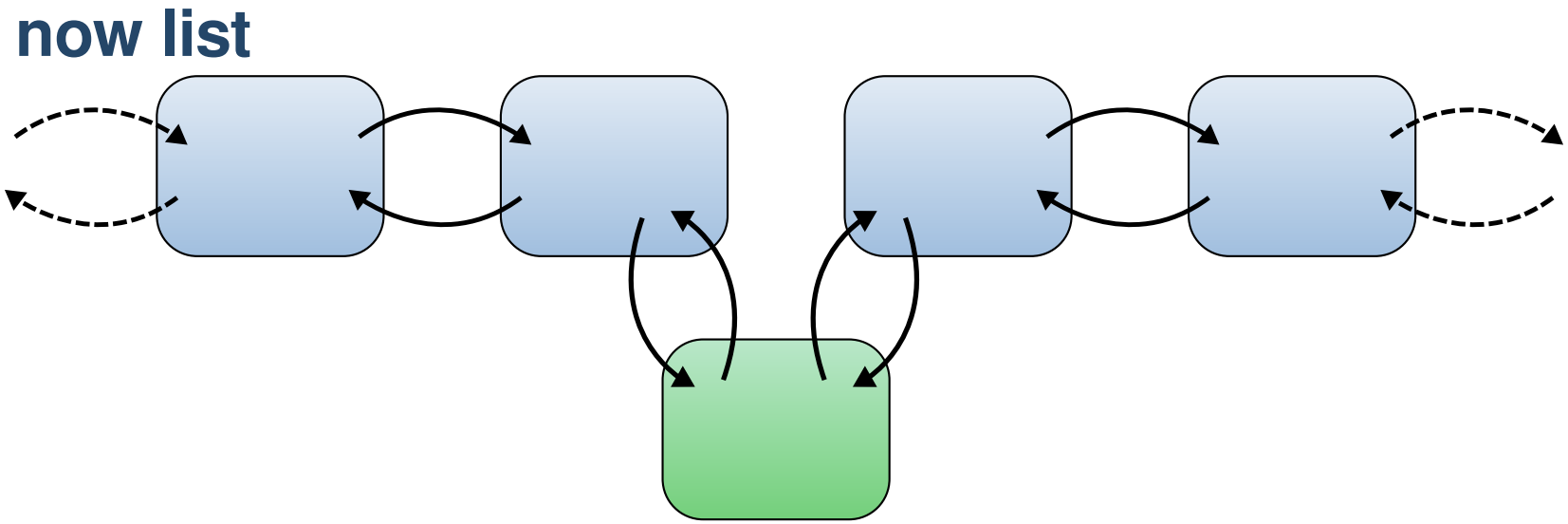
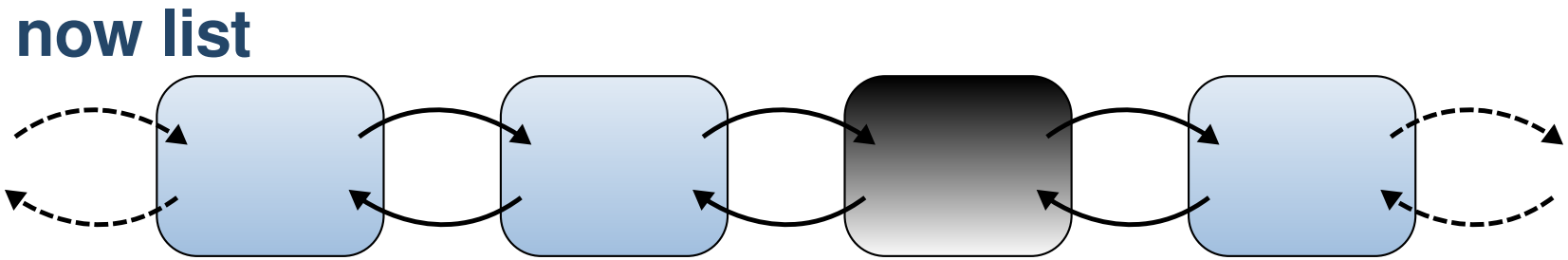


# Locking concept: Remove node



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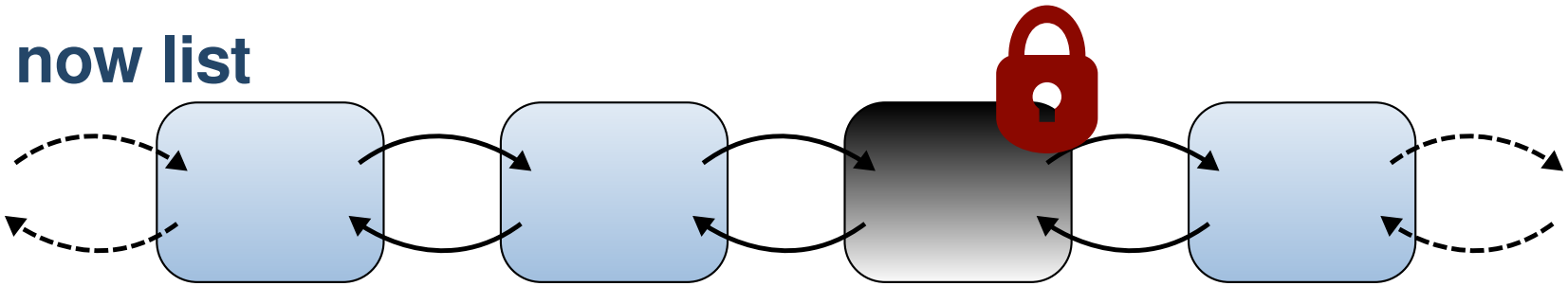

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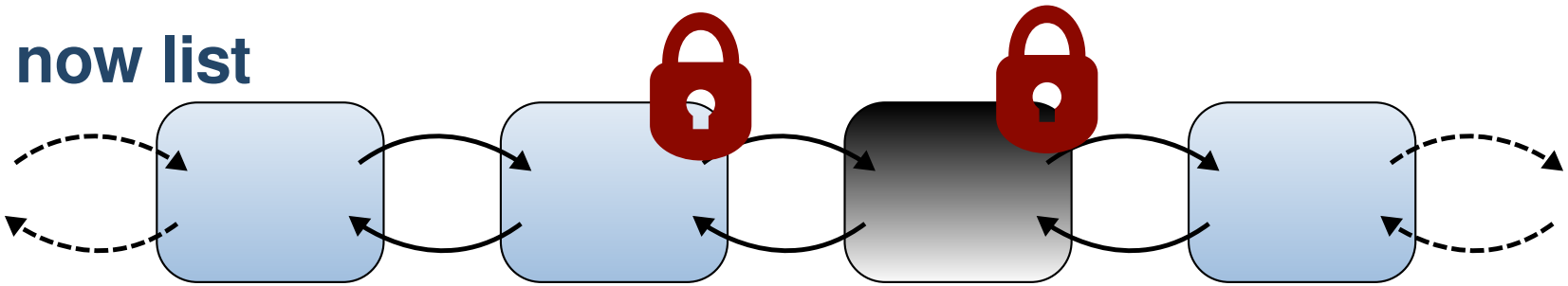


*make sure they're still connected!!!*

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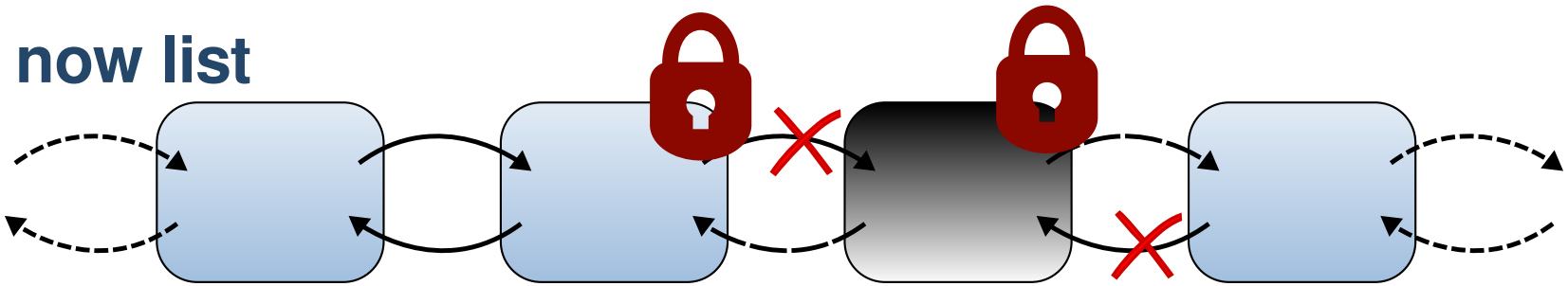

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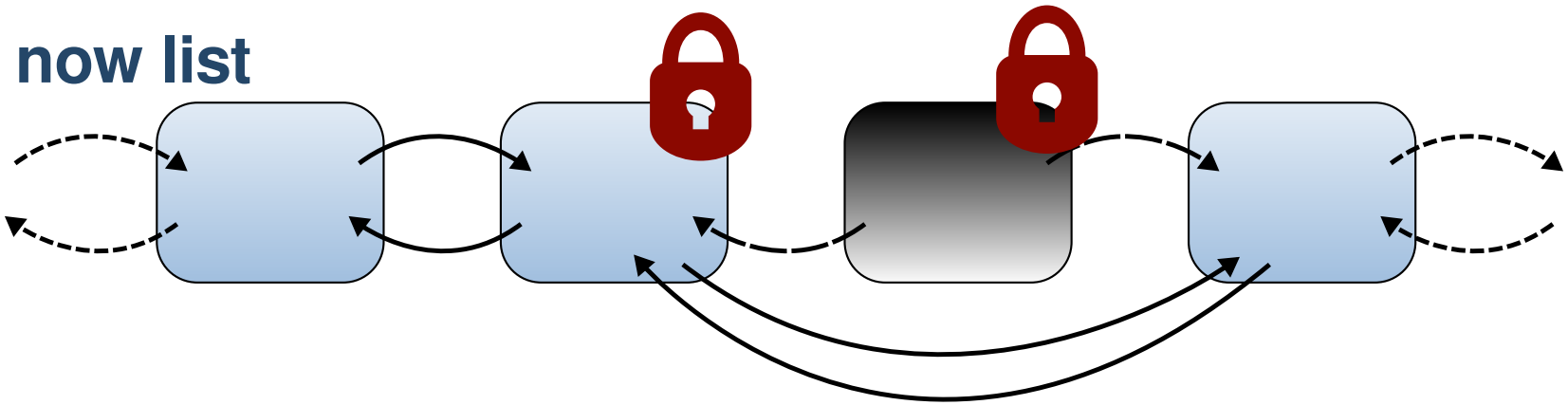

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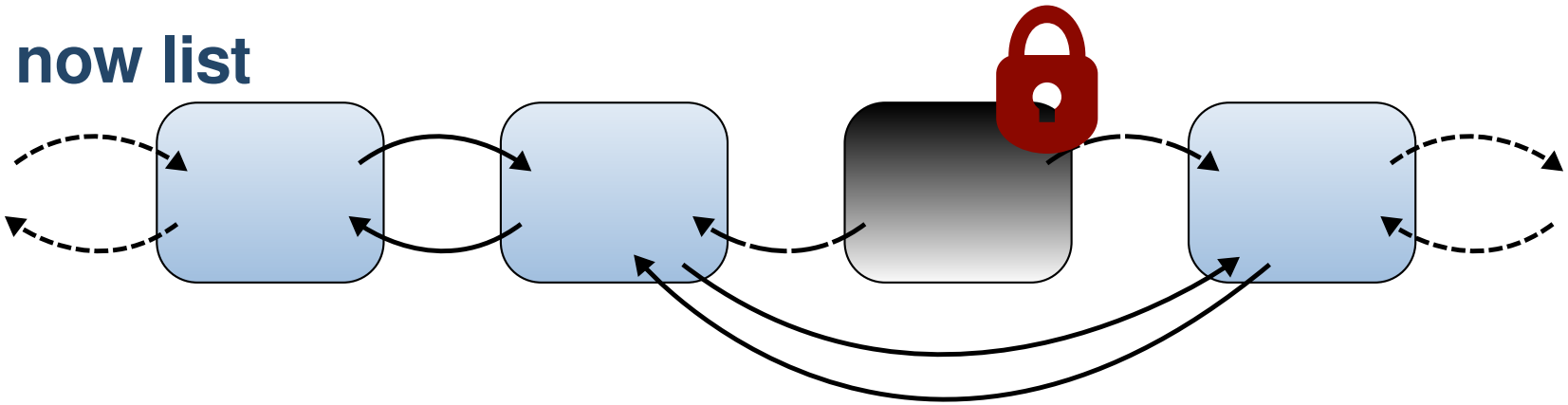

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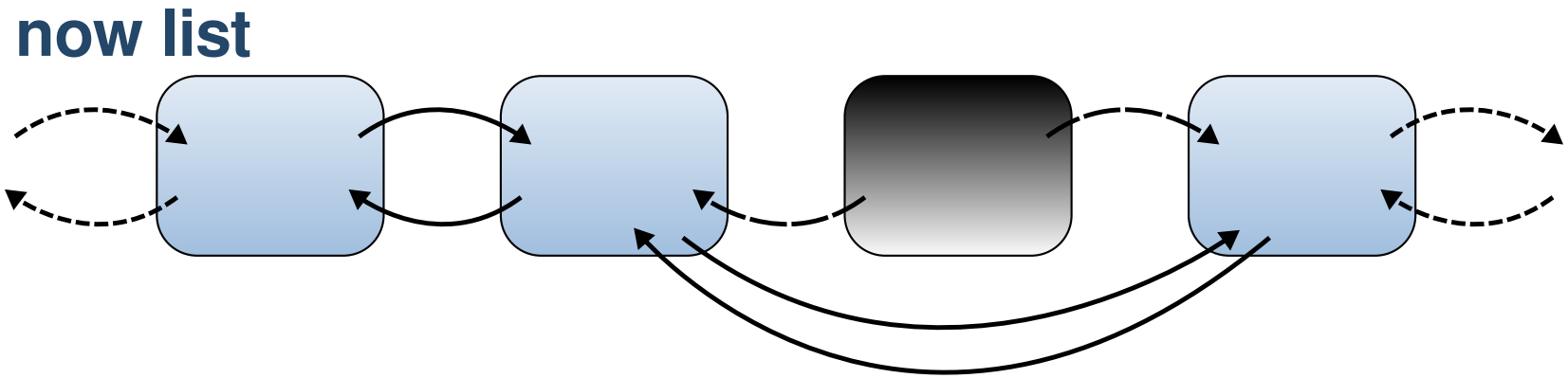


# Locking concept: 2 concepts for removing nodes

Both concepts use optimistic locking for acquiring the locks.

**Normal:**

- Lock node and predecessor as shown before and remove it right away

**Lazy locking:**

- Don't lock anything and just mark the node as removed
- Other threads will clean up and remove it later

# Benchmarking

**Setup:**

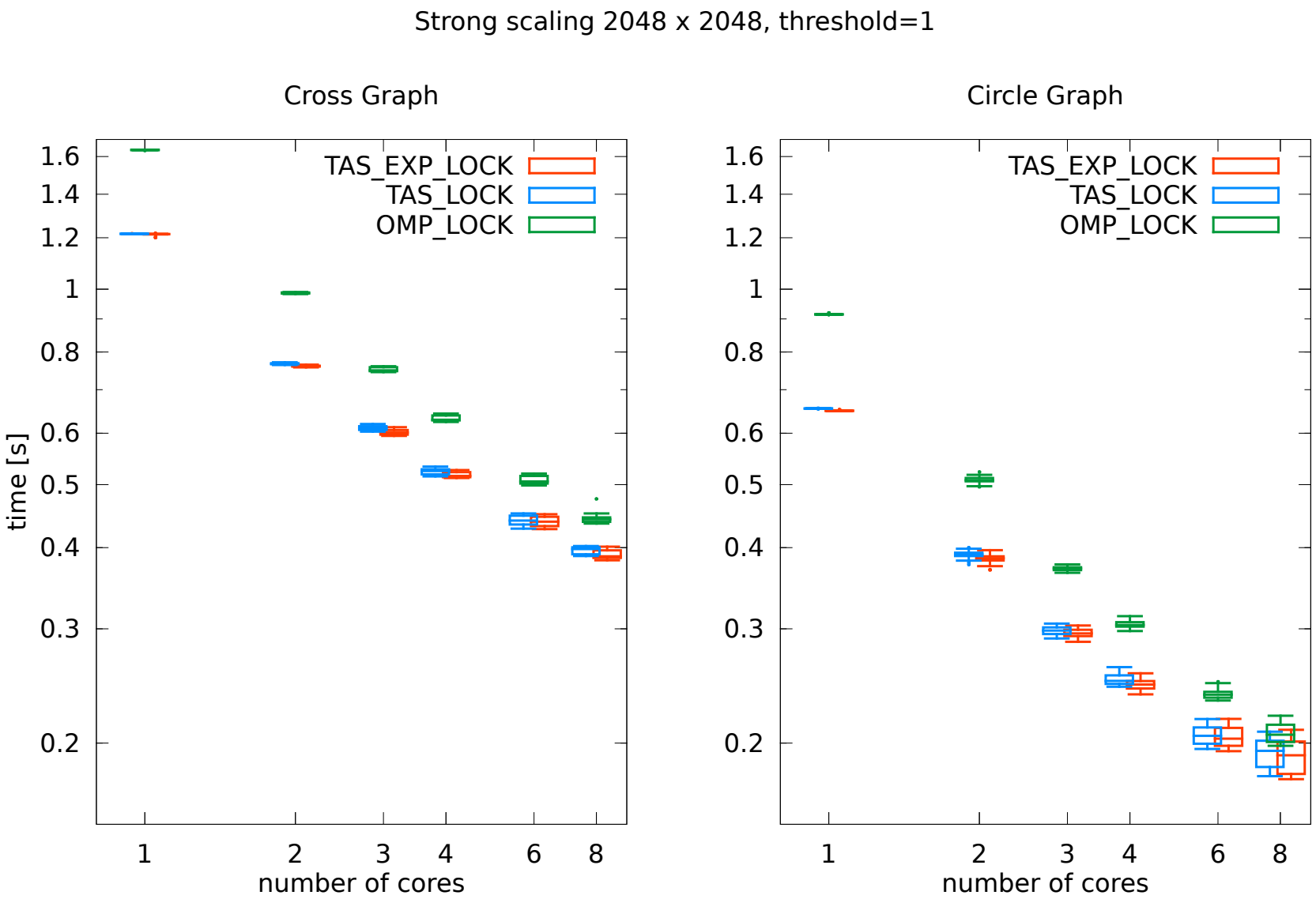
Each of the following boxplots was generated from data from **50 runs** on **1 node** of kanifushi.inf.ethz.ch.

Specifications of kanifushi.inf.ethz.ch:

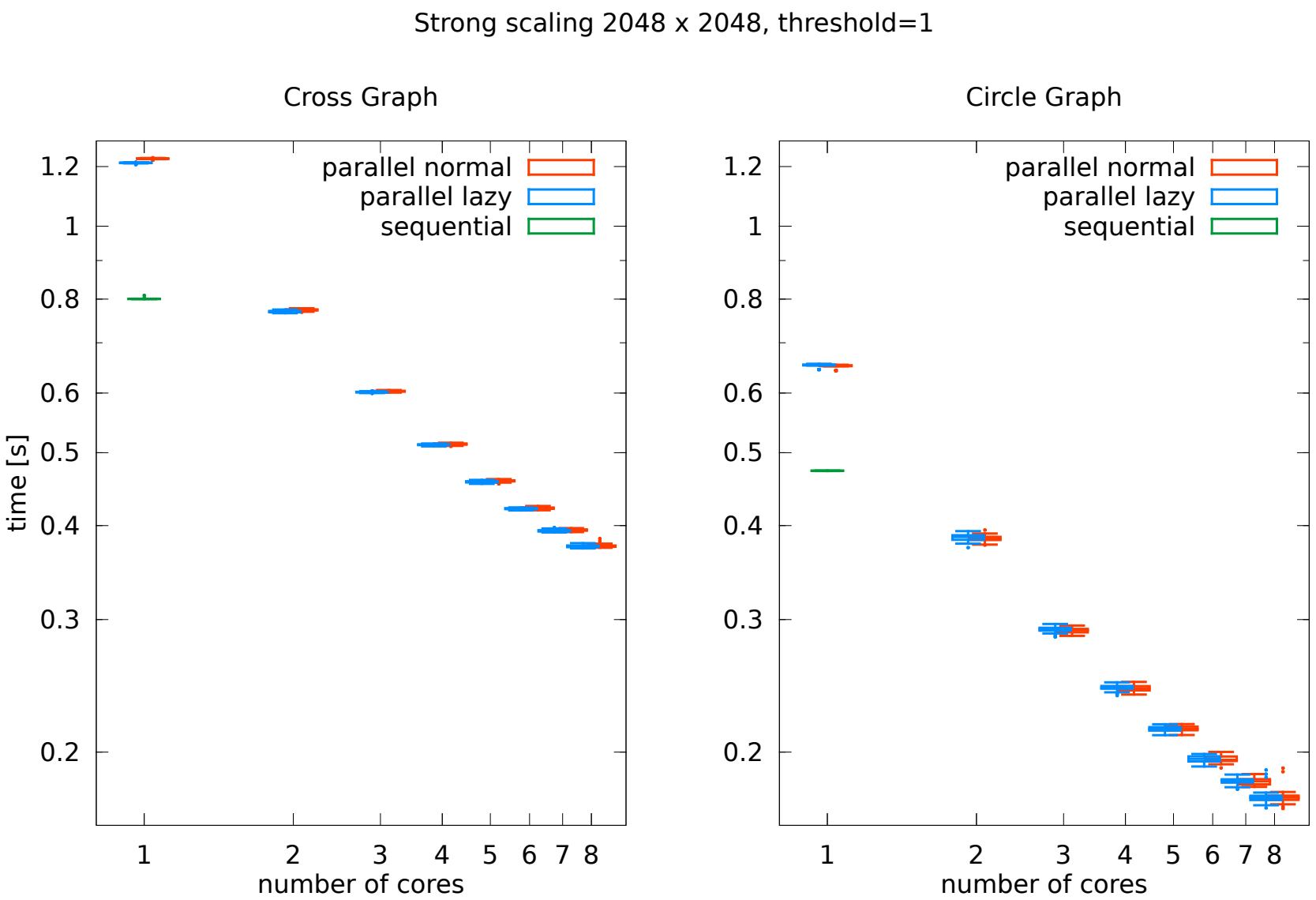
- NUMA model with 32 CPUs on 4 nodes
- 8 CPUs per node
- Intel(R) Xeon(R) CPU E7- 4830 @ 2.13GHz
- per CPU: 32KB L1 cache, 256KB L2 cache
- per node: 24MB L3 cache, 16GB memory

The code is written in C++ / Open MP and it has been compiled with g++ v. 4.6.1 using O1 optimization.

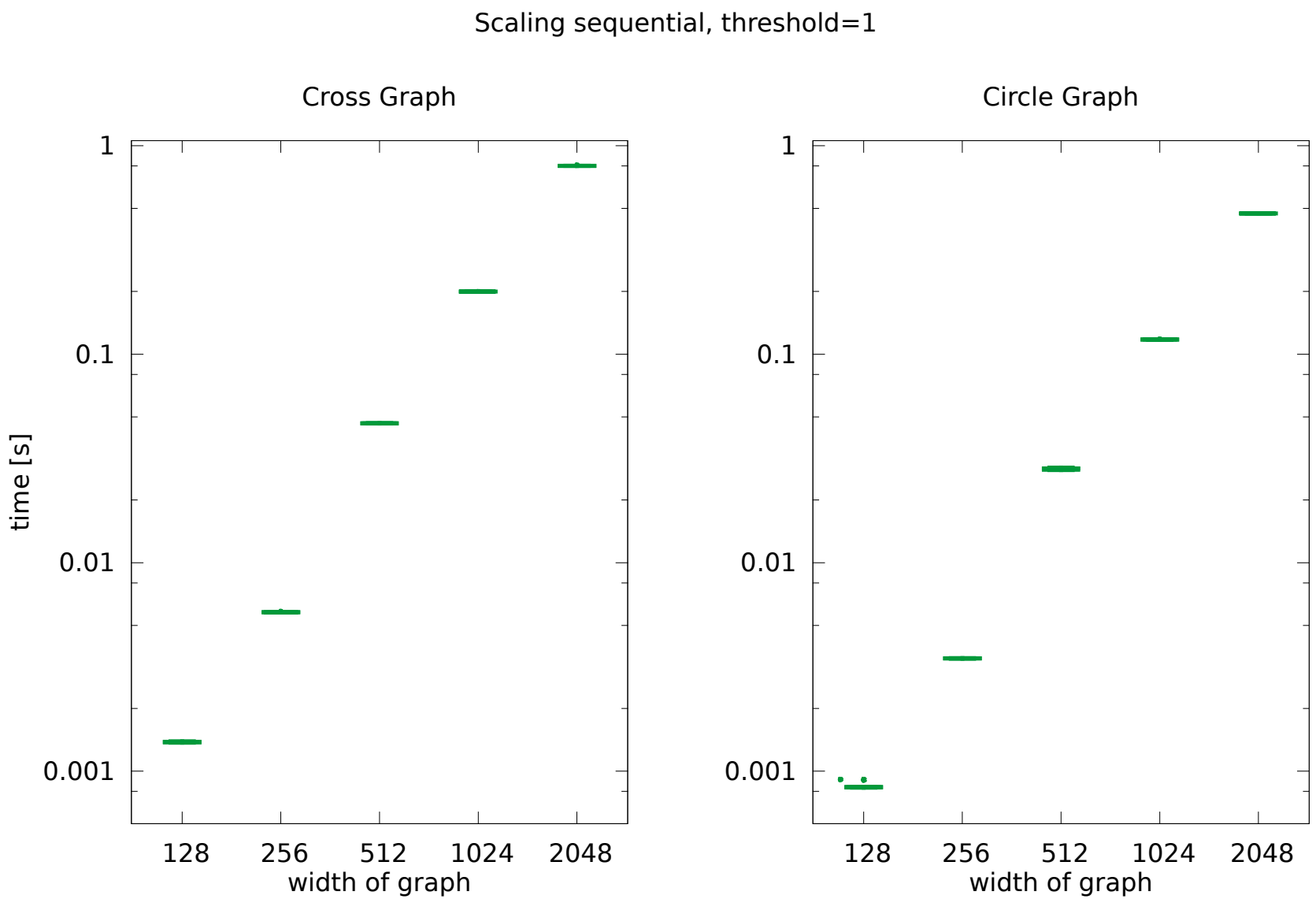
# Benchmarking: Locks



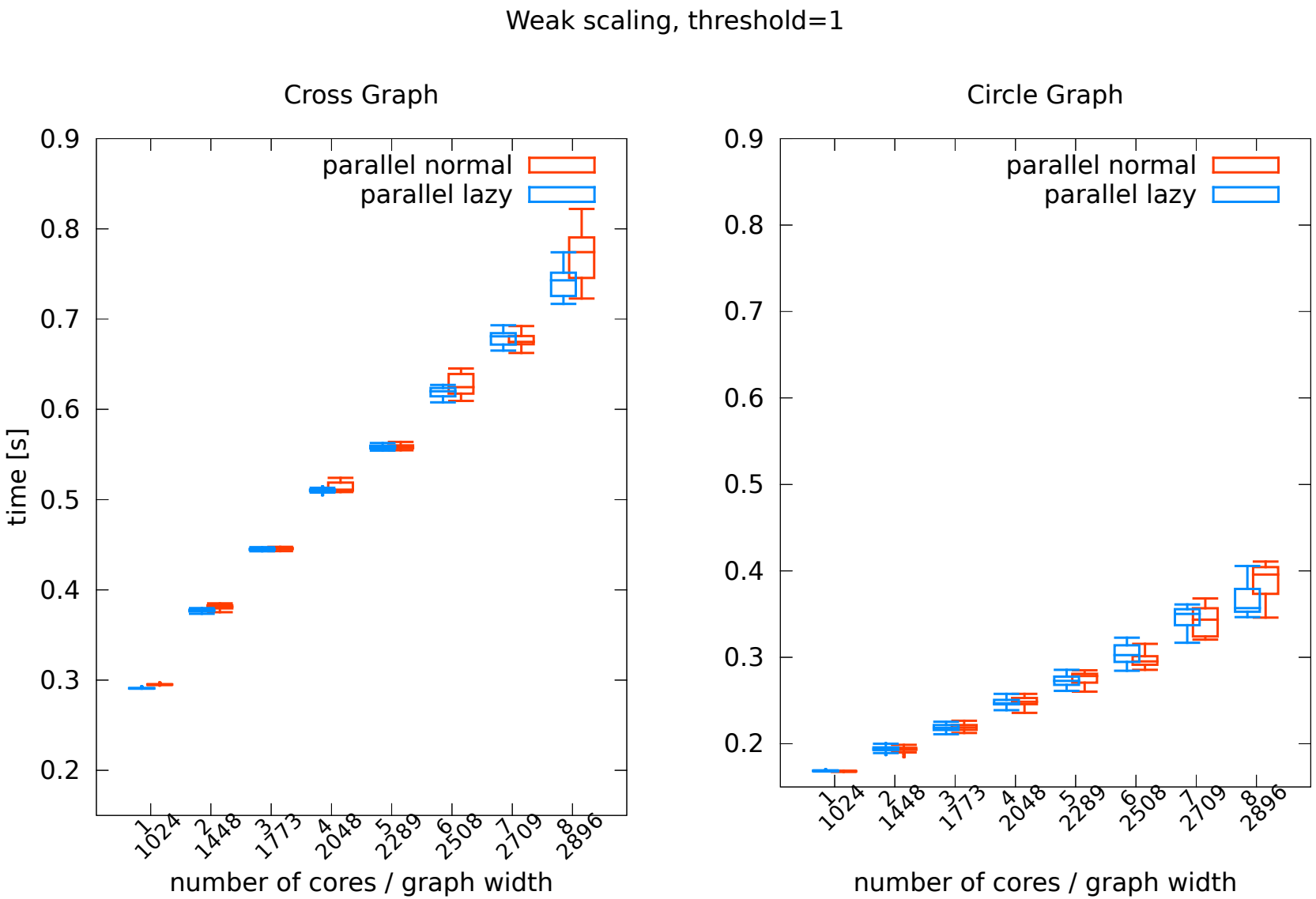
# Benchmarking: Strong scaling



# Benchmarking: Sequential scaling

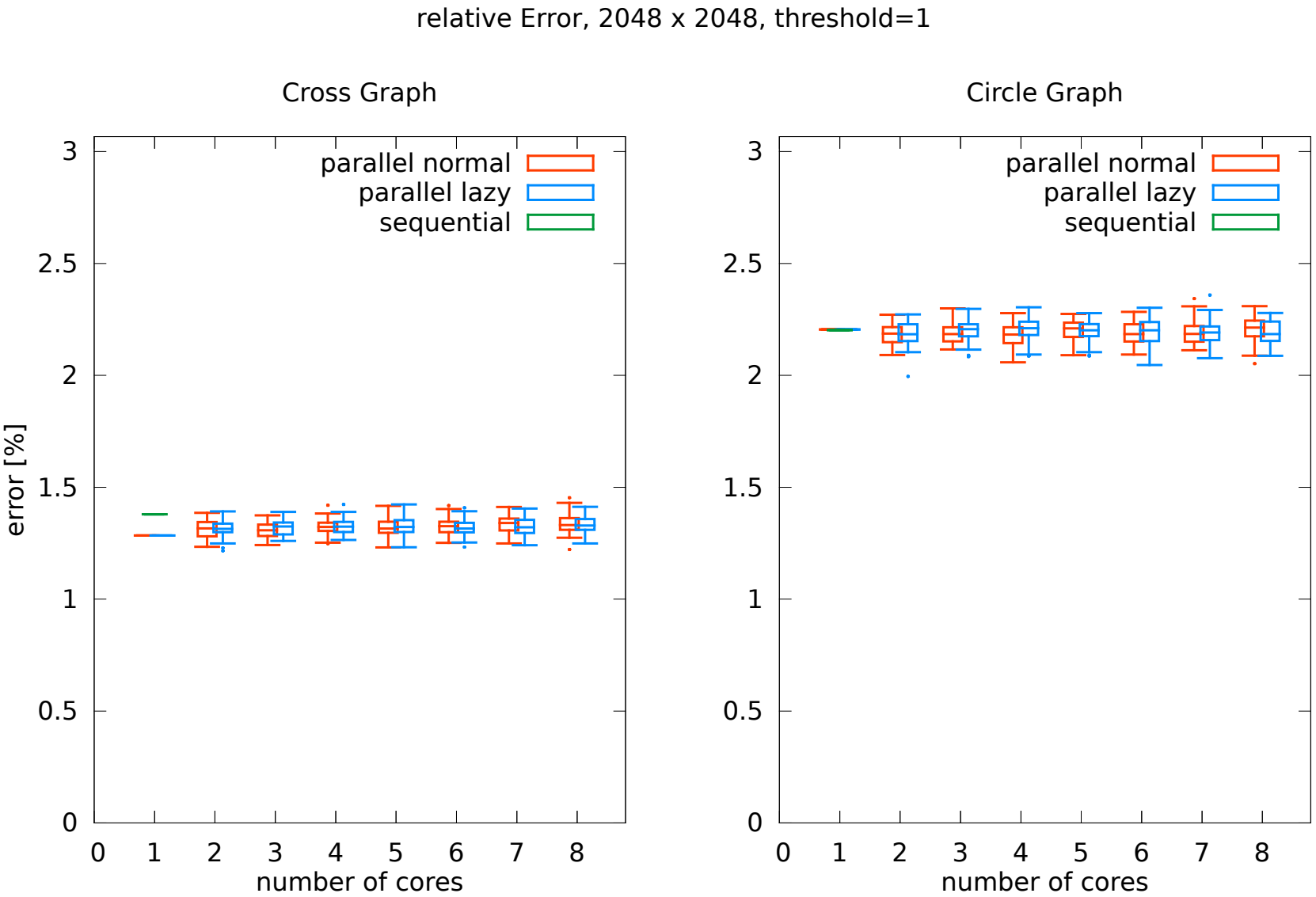


# Benchmarking: Week scaling



# Benchmarking: Path length $\leftrightarrow$ # cores

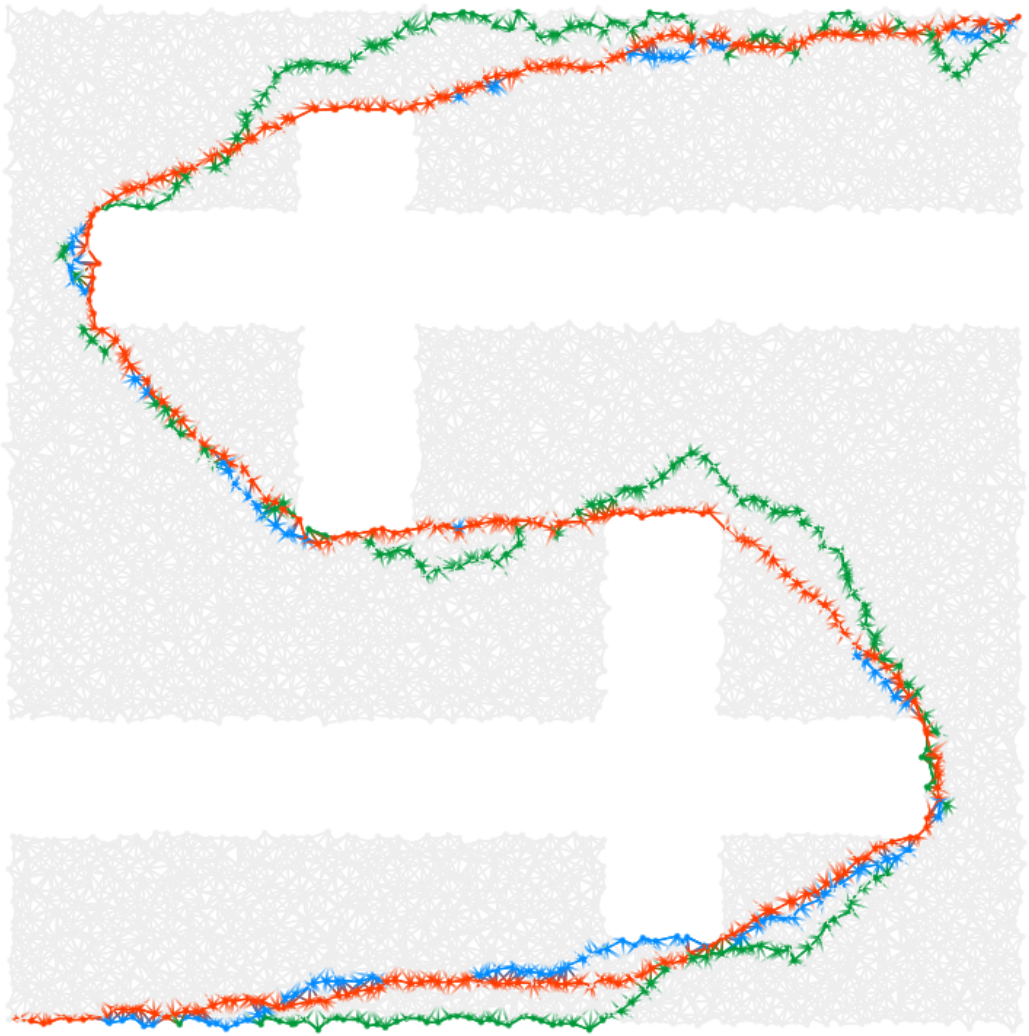
compared to A* from Boost Graph Library



# Benchmarking: Path length $\leftrightarrow$ Threshold update

**Threshold update**

- threshold += **0.1**
- threshold += **1**
- threshold += **10**



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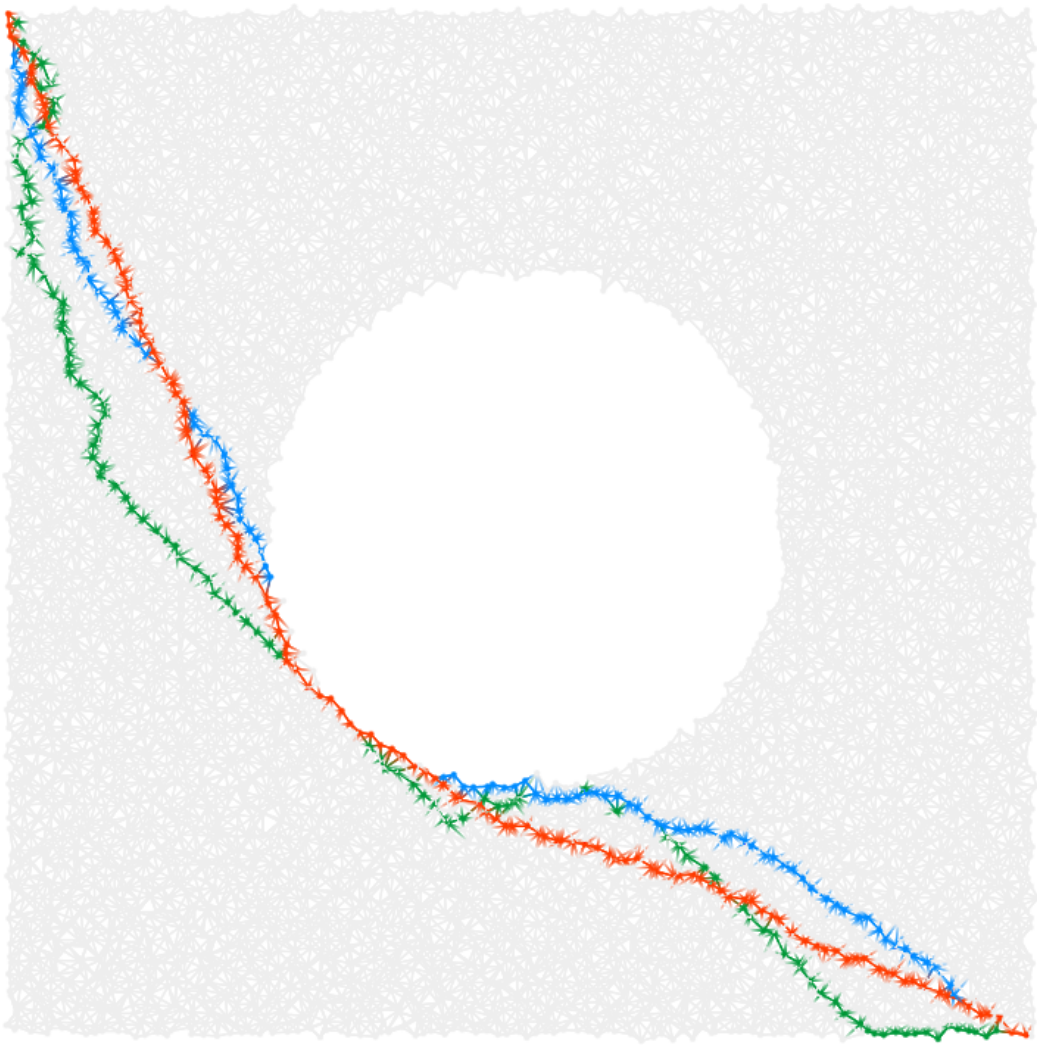

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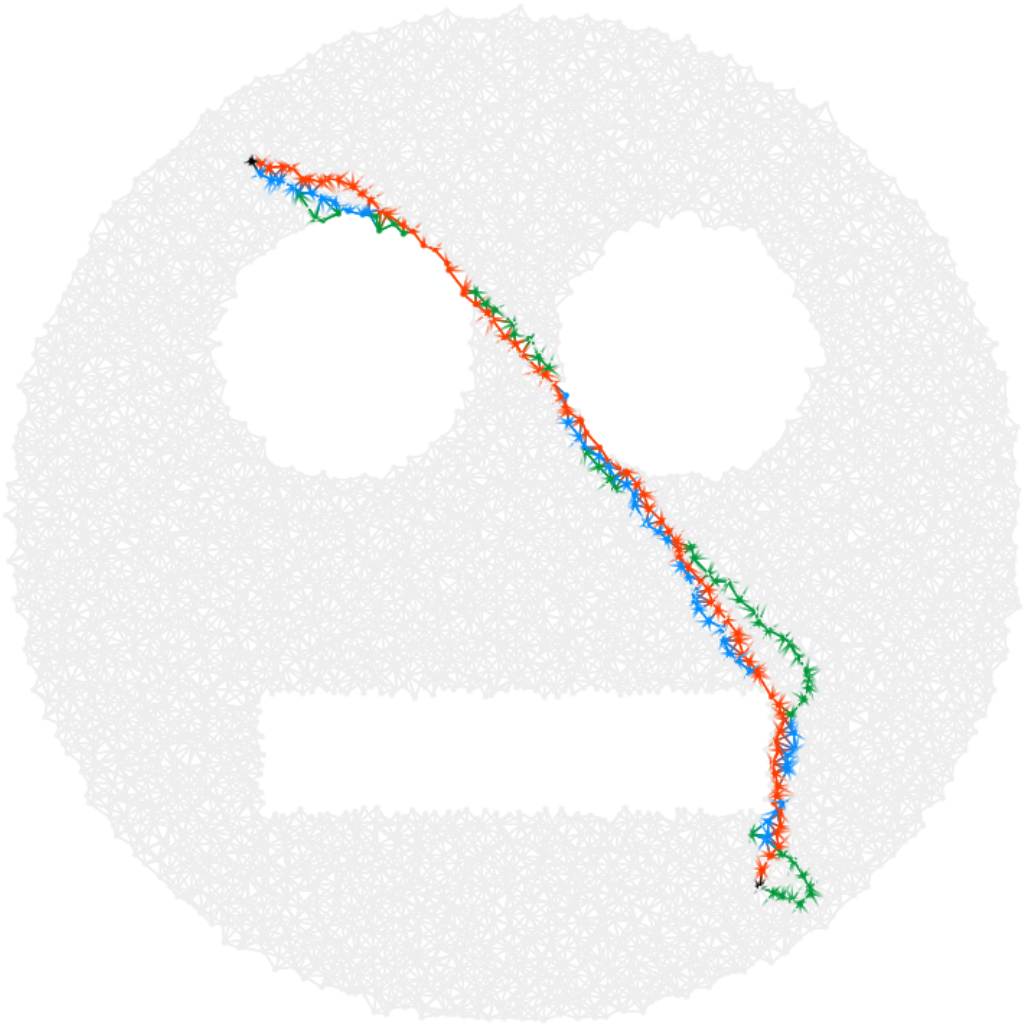

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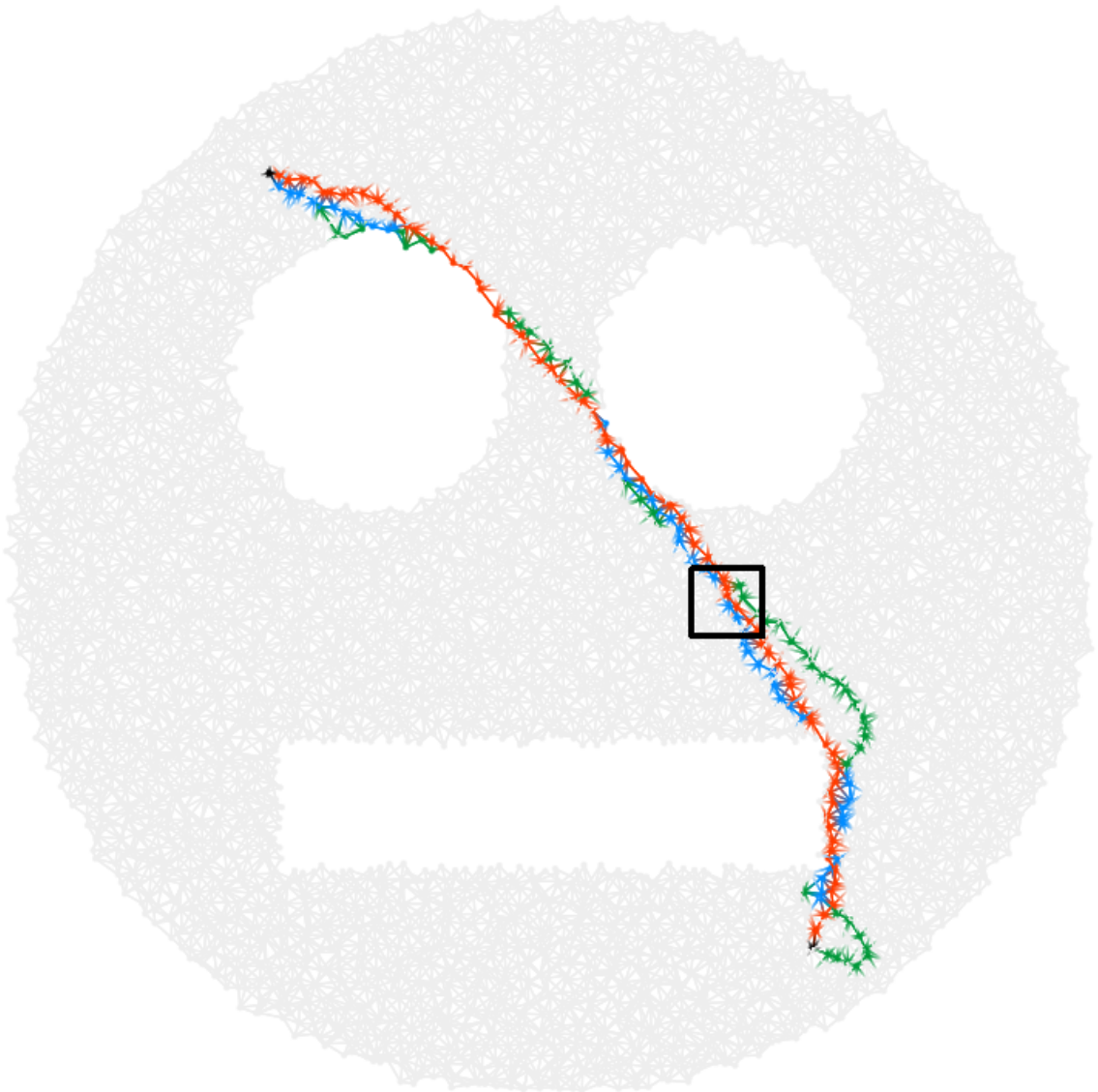

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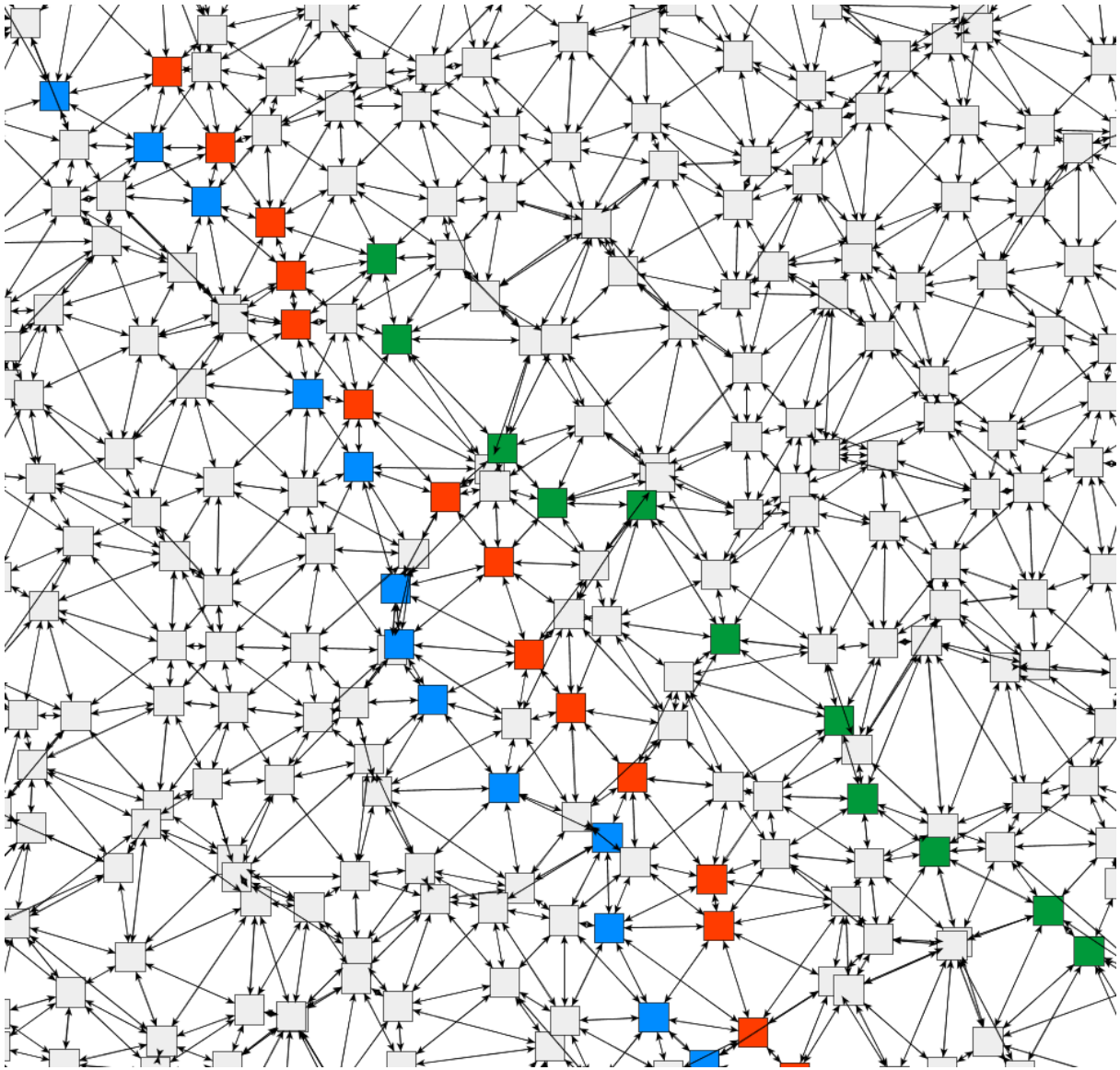

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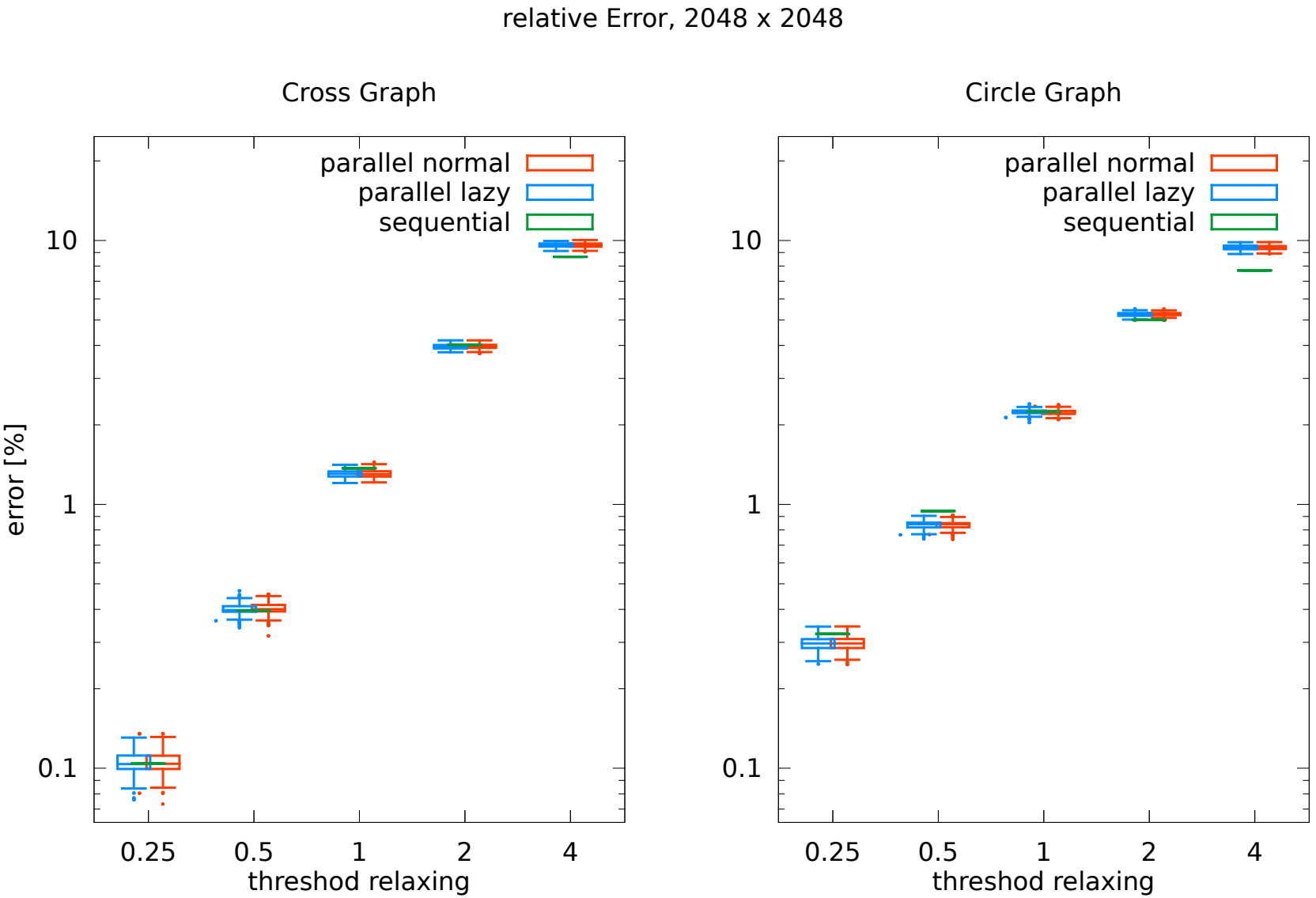
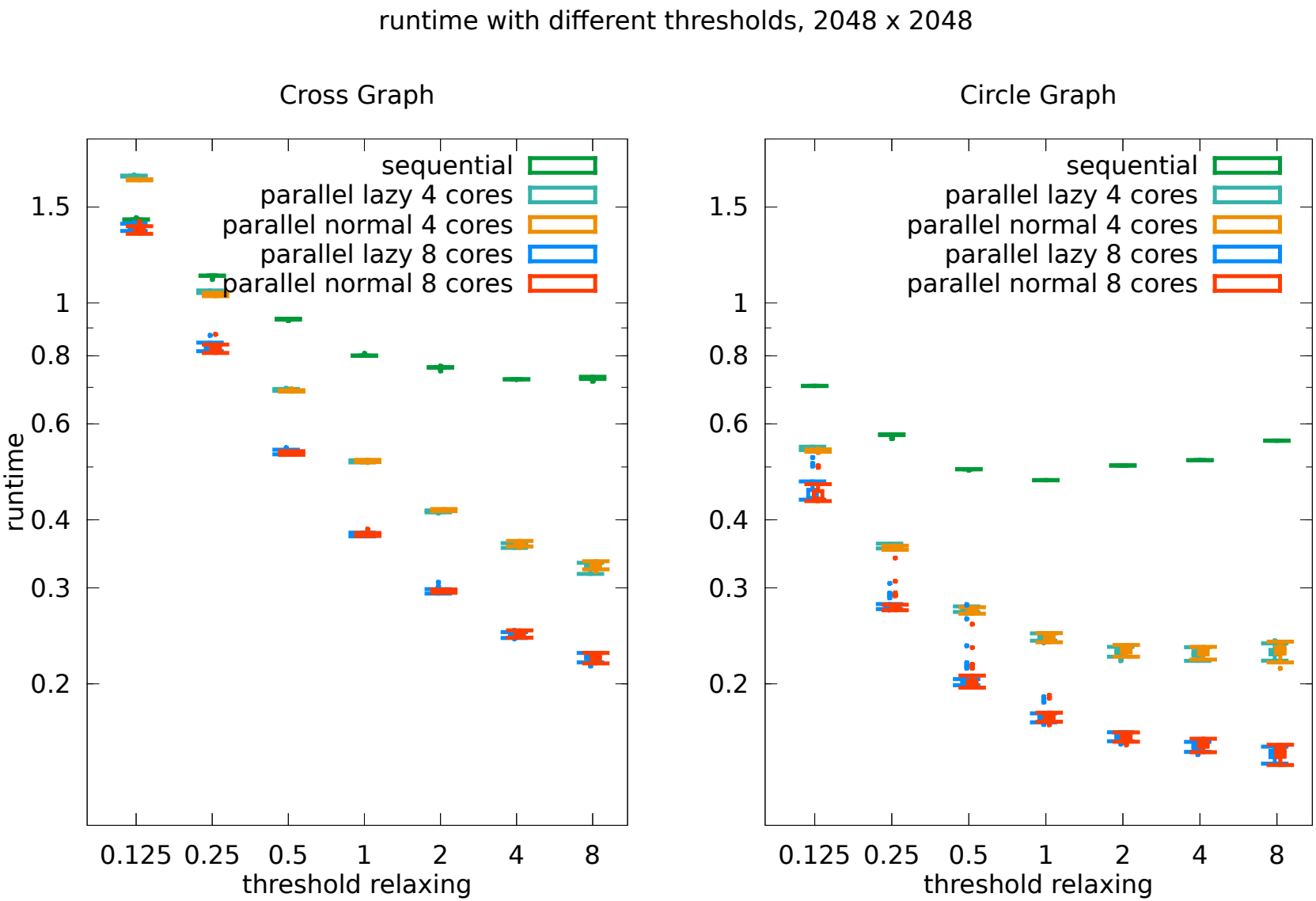


# Benchmarking: Run time $\leftrightarrow$ Threshold update



# Conclusions

In general Fringe Search is a good single source shortest path algorithm, that can be very well implemented in parallel.

- Path quality not dependent of # cores
- Good strong scaling
- Weak scaling is not perfect
- quality $\leftrightarrow$ runtime trade-off can be tuned for desired result

# The End