

Relaxed Scheduling for Scalable Belief Propagation

Janne H. Korhonen

IST Austria

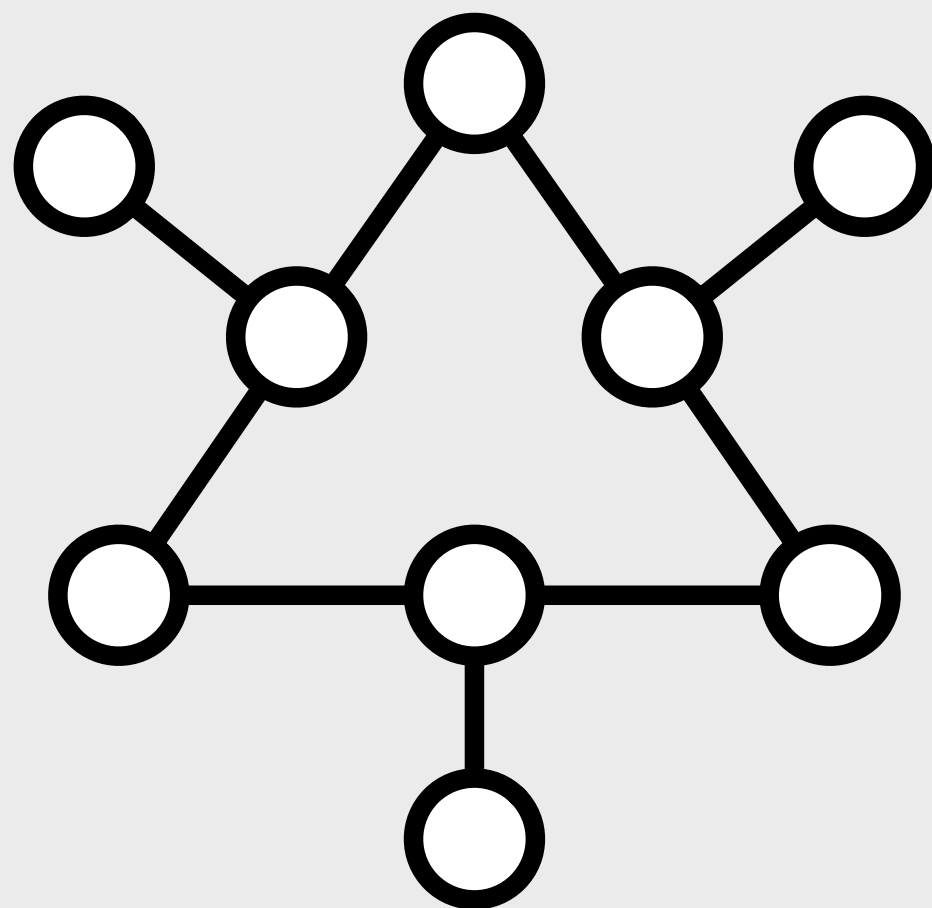
Joint work with

Dan Alistarh^{*} and Vitaly Aksenov[†]

^{*}IST Austria, [†]ITMO University

Inference on probabilistic graphical models

graphical model



$$\Pr[X = x] \propto \prod_i \psi_i(x_i) \prod_{ij} \psi_{ij}(x_i, x_j)$$

**inference
algorithm**



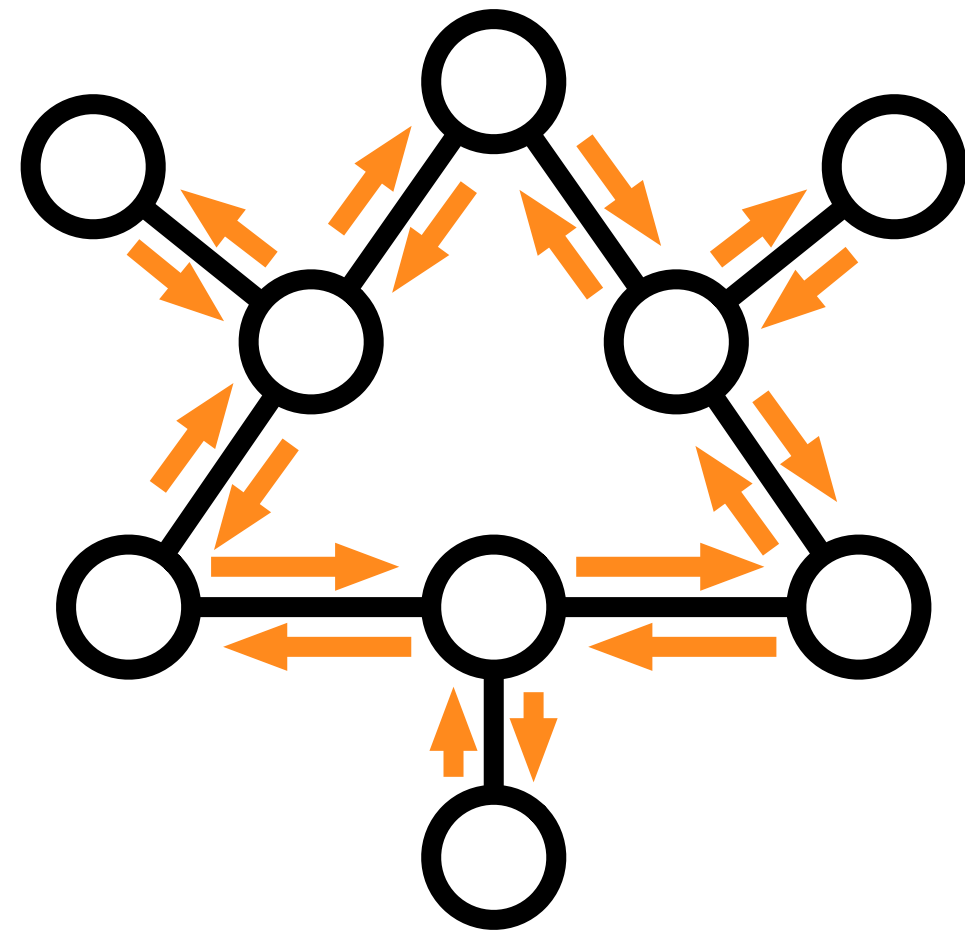
**marginal
probabilities**

$$\Pr[X_i = x_i]$$

Parallelising belief propagation

(in shared memory parallel setting)

Belief propagation



messages associated with edges of the graph

$$(\mu_{i \rightarrow j} \in \mathbb{R}^d)$$

apply **local update rule** to messages

$$\mu_{i \rightarrow j}(x_j) \propto \sum_{x_i \in D_i} \psi_i(x_i) \psi_{ij}(x_i, x_j) \prod_{k \in N(i) \setminus \{j\}} \mu_{k \rightarrow i}(x_i)$$

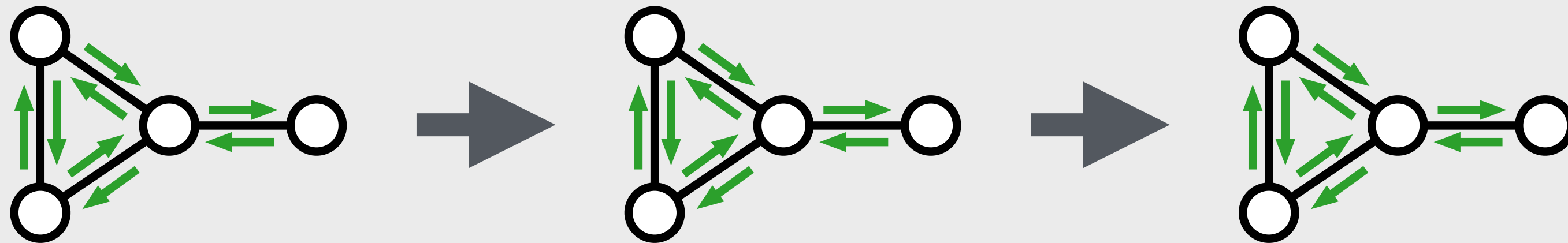
convergence to a fixed point

estimate marginals from messages

$$\Pr[X_i = x_i] \propto \psi_i(x_i) \prod_{j \in N(i)} \mu_{j \rightarrow i}(x_i)$$

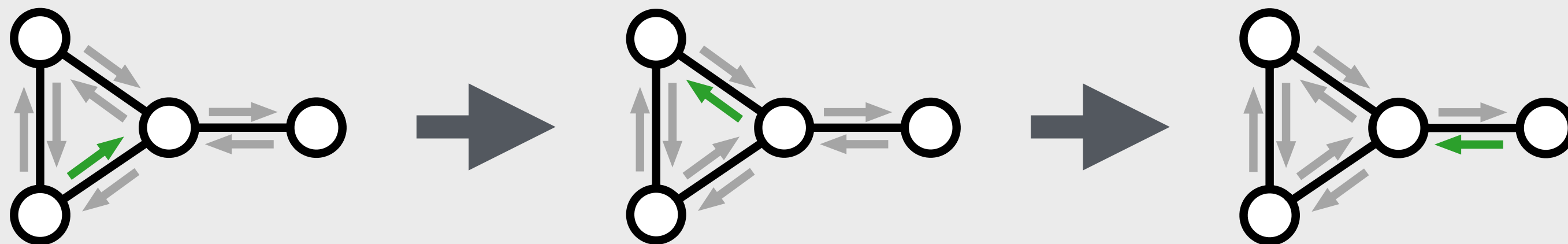
Belief propagation message updates can be **scheduled** in any order

synchronous



lots of updates
easy to parallelise

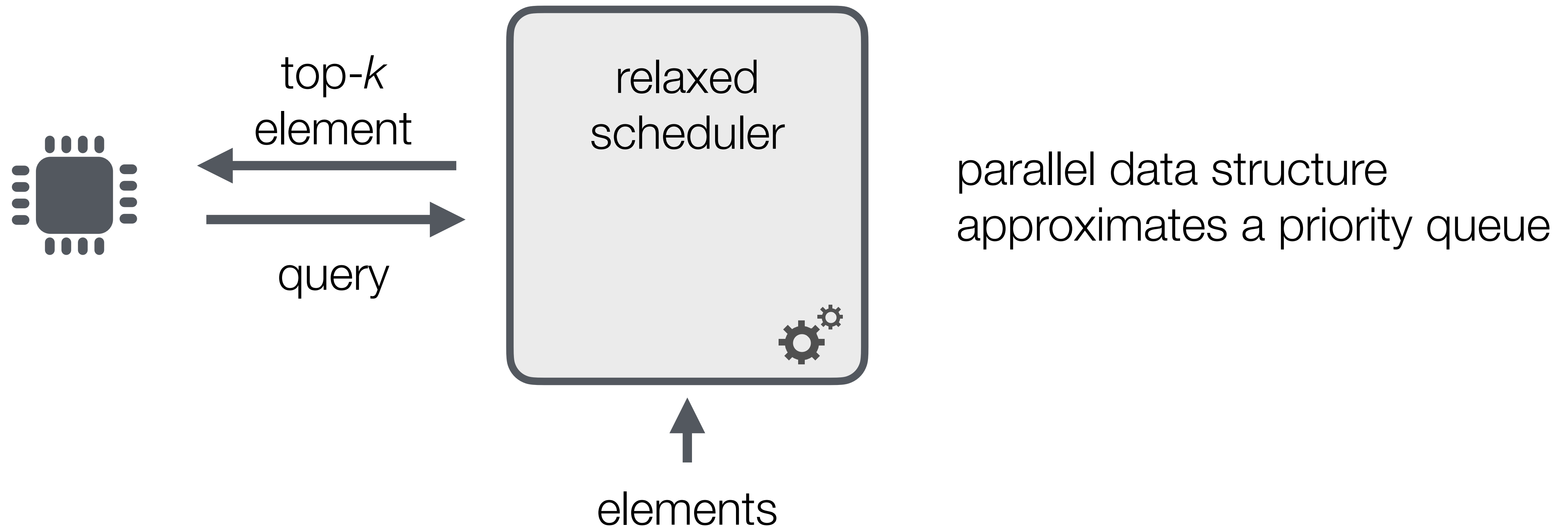
priority-based



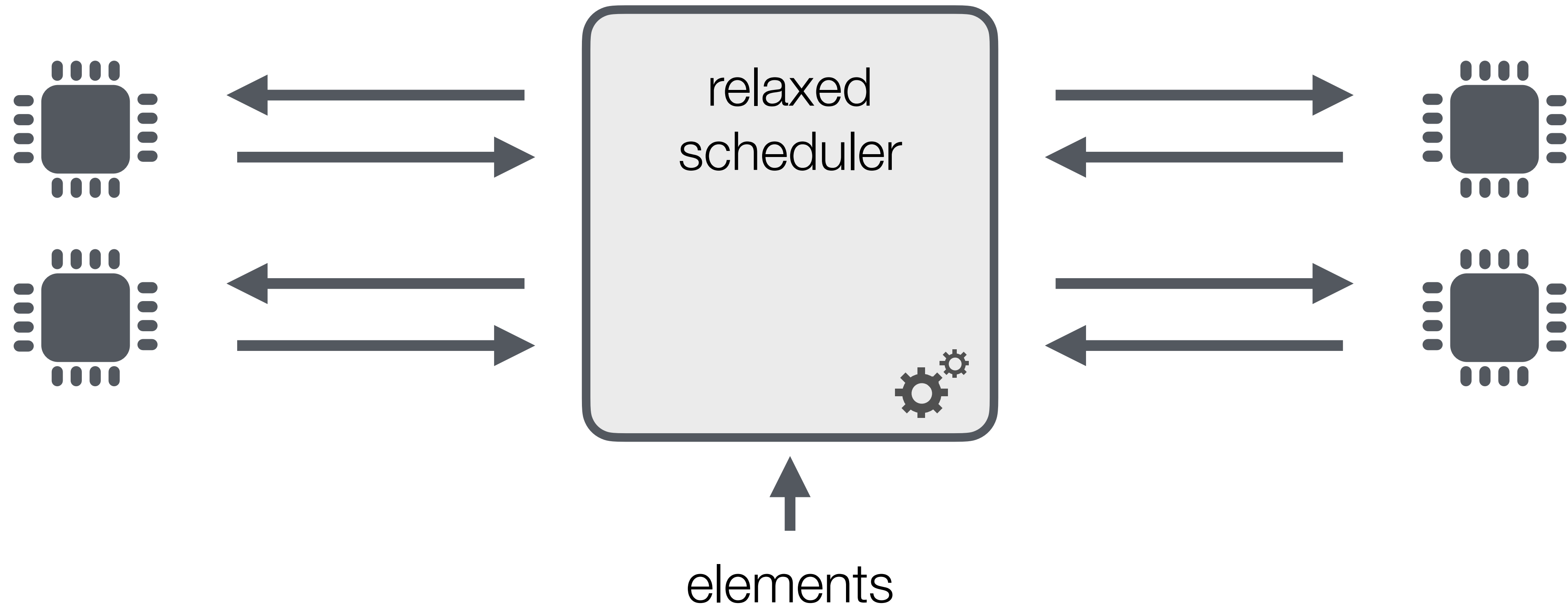
faster convergence
fewer updates
sequential, **hard** to parallelise

[Elidan et al., UAI 2006]

Priority-based belief propagation can be parallelised efficiently using **relaxed schedulers**

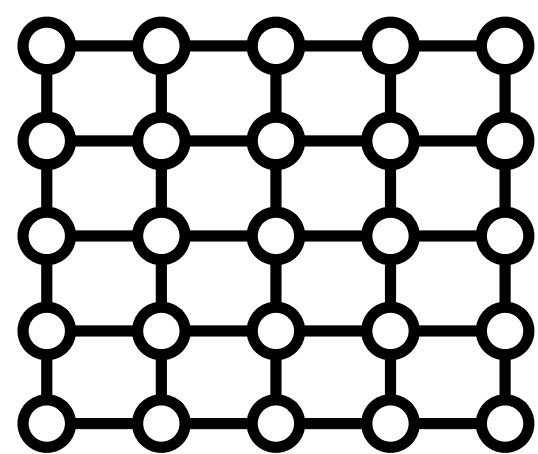


Priority-based belief propagation can be parallelised
efficiently using **relaxed schedulers**



Priority-based belief propagation can be parallelised efficiently using **relaxed schedulers**

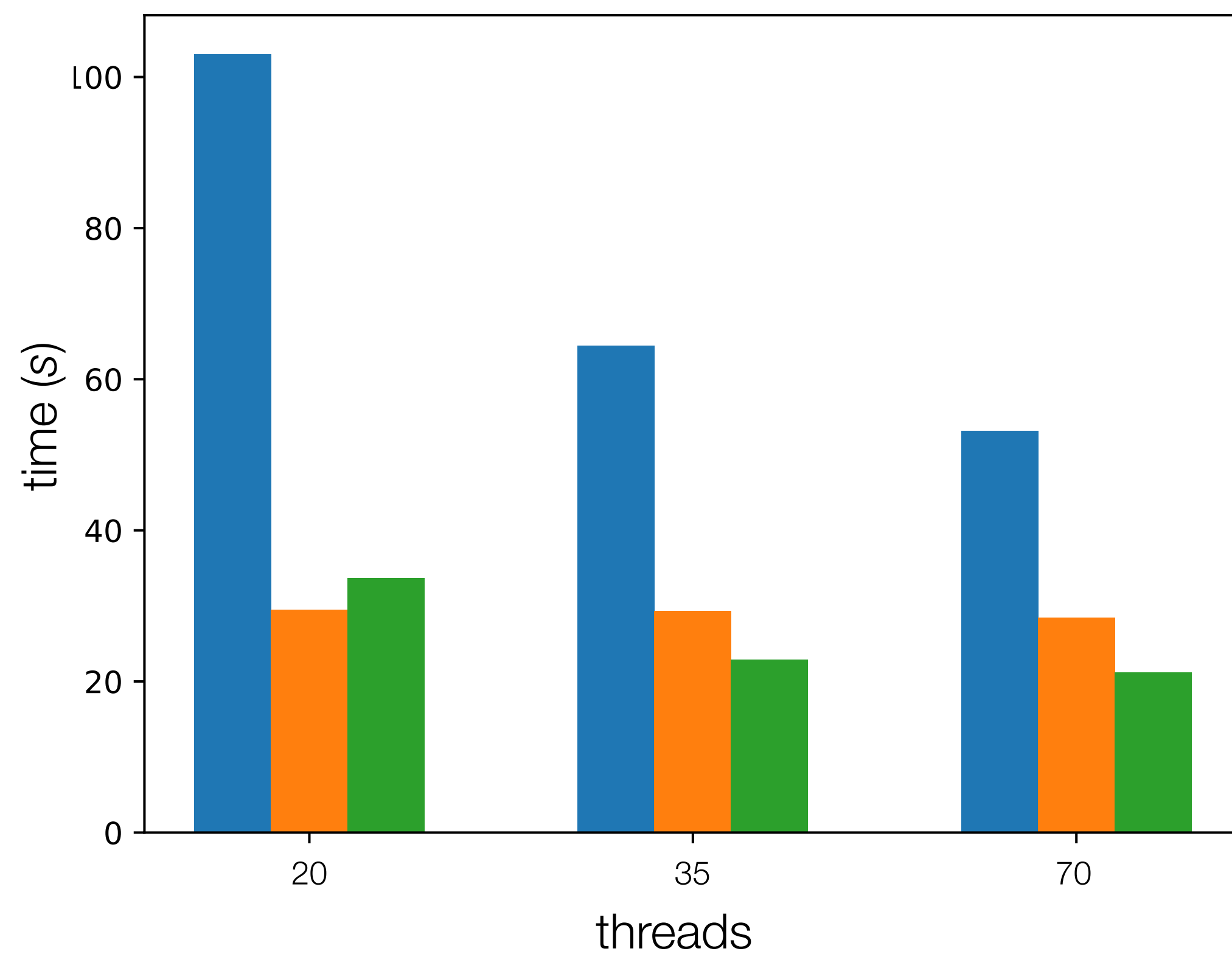




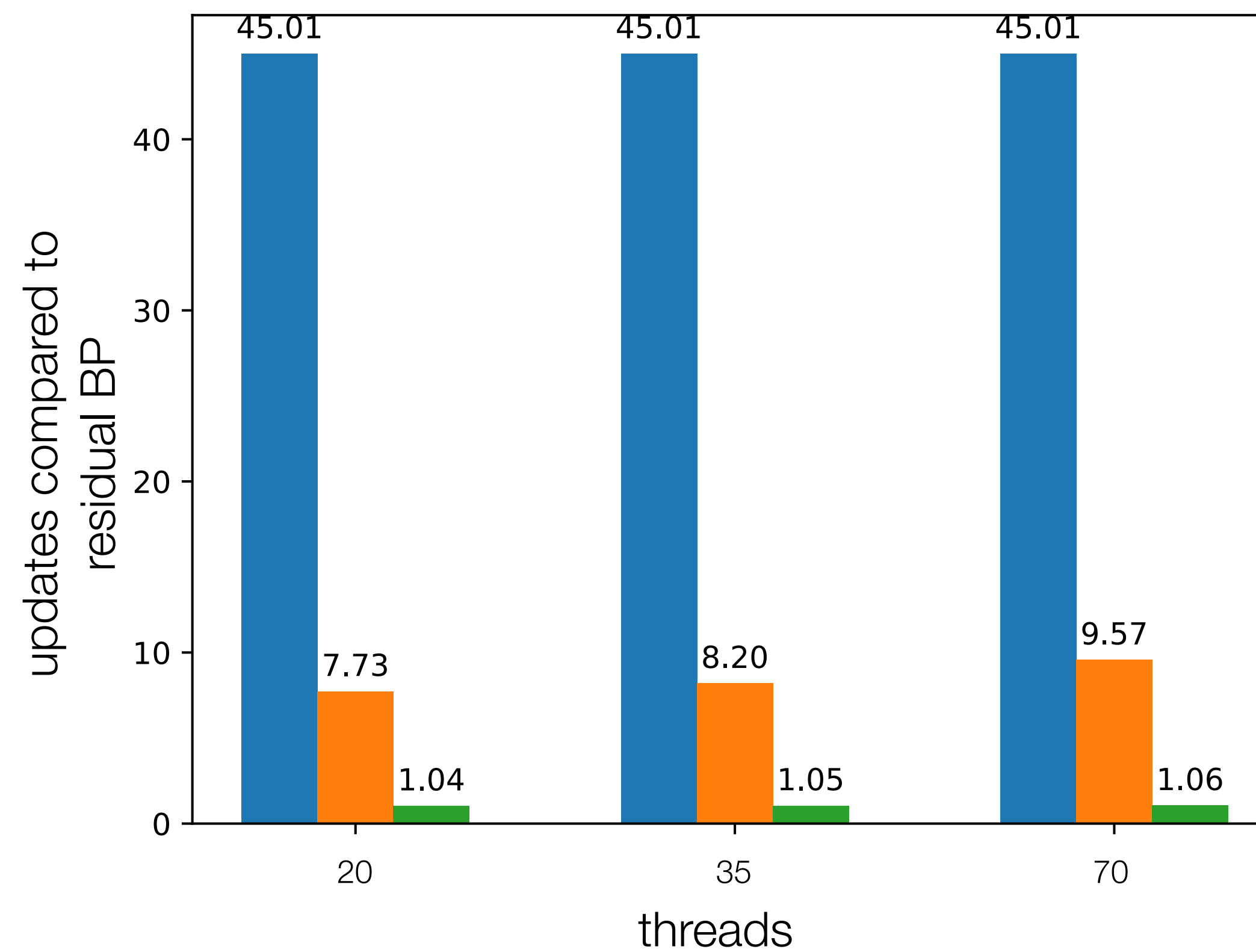
Ising model
1000×1000 grid

- synchronous
- residual splash [Gonzales et al, UAI 2009]
- relaxed residual (**this work**)

Time



Number of updates



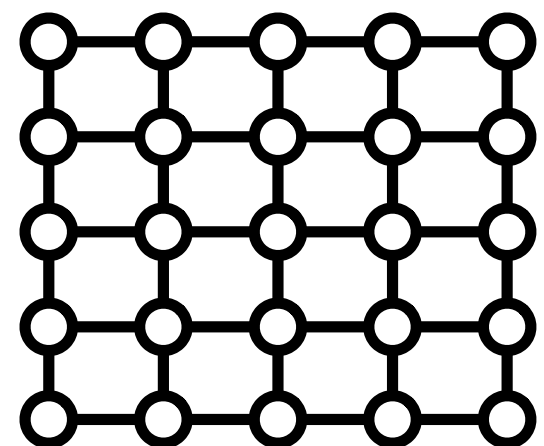
1

Simple **parallel belief propagation**
implementation with state-of-the-art scaling

2

Relaxed schedulers are a powerful tool for
parallelising iterative machine learning algorithms

arXiv:2002.11505



Ising model
1000×1000 grid

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