

Cooperation control in Parallel SAT Solving

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Parallel SAT Solving

Decentralized resolution

- Each core: conflict-directed clause learning
- Cooperation: each core sends the learned clauses to other cores
- Why? additional clauses help pruning the search space.

Previous work

Hamadi et al. 09

- Controlling the length of the shared clauses (TCP/IP congestion avoidance)

Limitations

Does not scale up when the number of cores increases.

Position of the problem

- Dynamically control the topology of the network
- This work: density ρ is fixed

Designing the reward of an emitter core

Reward(emitter): sum of reward(shared clauses)

I. Global clause rewards

- Size-based: clause of length s removes 2^{N-s} instances:

$$r(c) = -\log(1 - 2^{-s})$$

- Literal-block distance (LBD): each literal (decision level) produces unit propagations - LBD: difference between highest and lowest decision levels in the clause literals
- Mixtures of the above: **FAIL**

II. Receiver-specific clause rewards

- Literals ℓ are associated their activity $a(\ell)$
(their assignment \rightarrow failure)

$$r(c) = \frac{1}{c} \sum_{\ell \in c} \text{sigmoid}\left(\frac{a(\ell)}{a_{max}}\right)$$

BESS: Bandit Ensemble for parallel SAT Solving

Core tasks

- Design the reward
- Adjust the decision schedule wrt internal SAT schedule

BESS structure

- Each receiver core
- Selects n emitter cores

$$n = (1/2 \text{ #cores})$$

BESS Algorithm

In each core, independently

- Maintain a reward threshold
- Update the reward of alive emitters (relaxation)
- Pr (removing emitter) = Pr (emitter reward < threshold)
- Turns (oldest) sleeping emitters into alive ones to achieve n alive emitters at all time.

Experimental validation

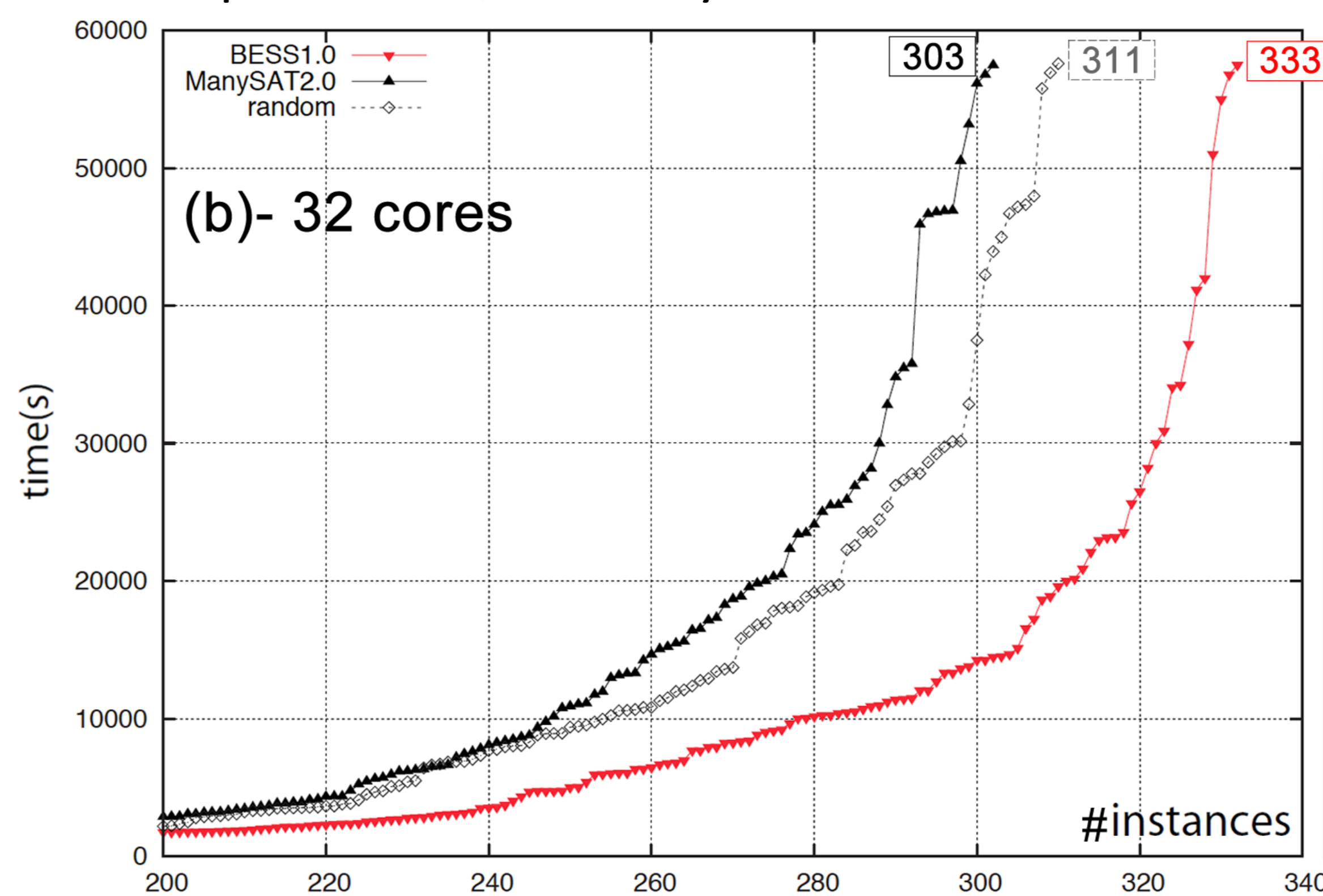
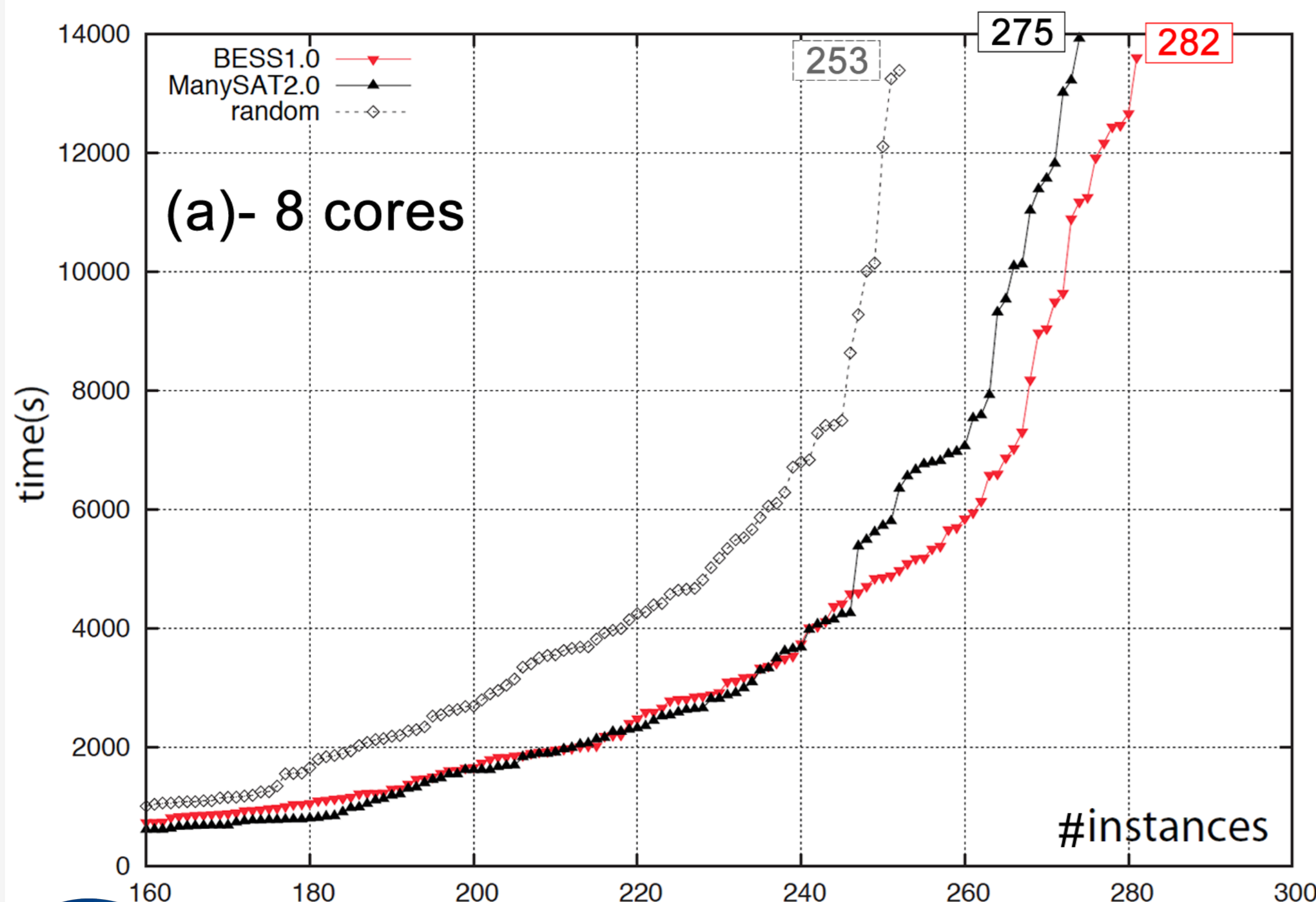
Parameters

- 588 SAT+UNSAT instances.
- CPU time limit = 30mn CPU per core
- Shared clause limit size: 8

8-cores: BESS slightly improves on ManySAT2.0 for difficult problems

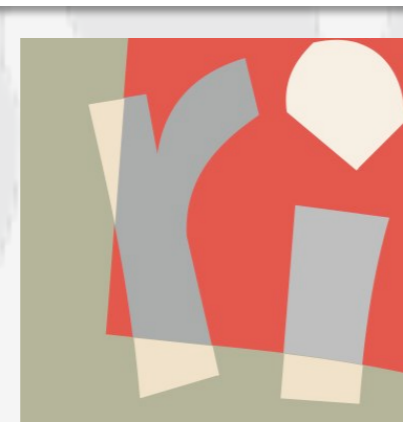
32-cores:

- ManySAT2.0 lacks scalability
- BESS: 10% improvement on ManySAT2.0



Perspectives

1. Adjust the number of emitters for each core
2. Adjust the clause length limit
3. Share information among cores to speed-up cooperation, enforce diversification.



JOINT CENTRE