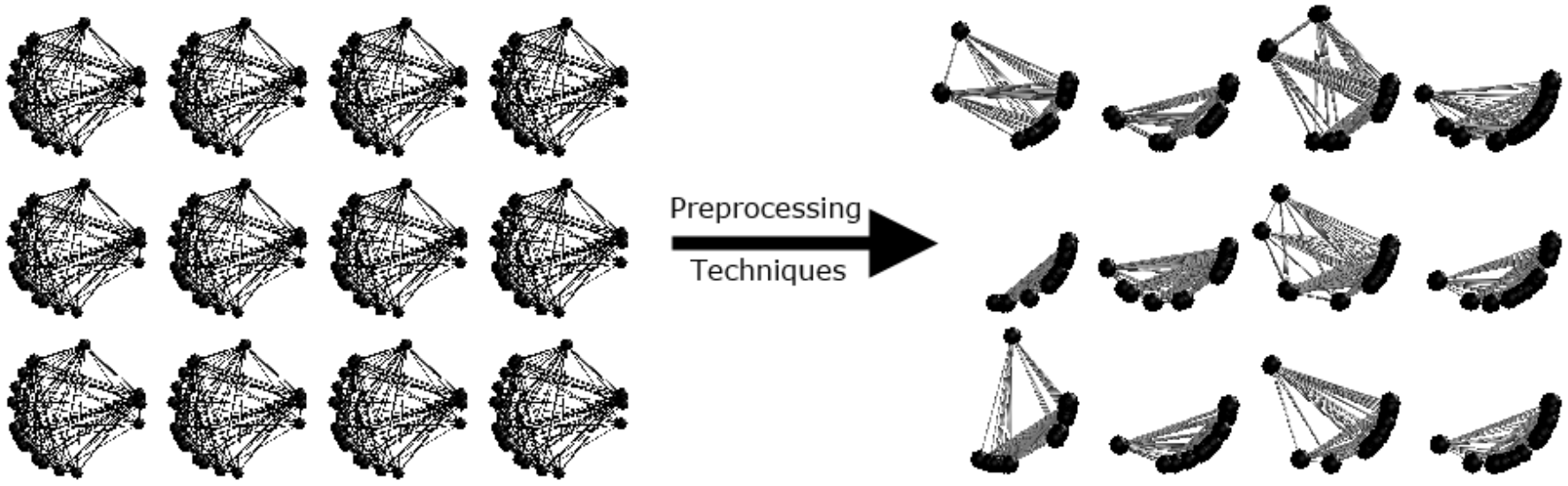

An Extended Analysis of the Utility of Preprocessing Techniques for SAT Solvers

Adrian Balint, Nobert Manthey

08.03.2013

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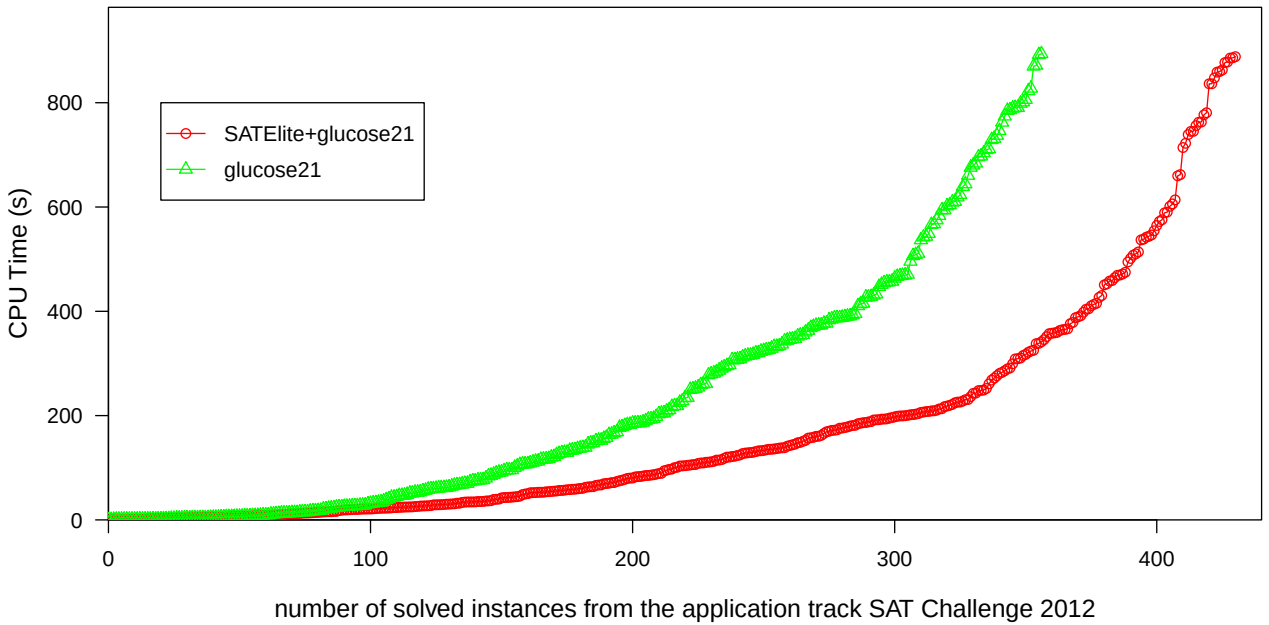

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- SLS solvers seldom applied to structured problems

Goals of our Work

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Validate best found PPTs with other solvers

Preprocessing Techniques implemented in CP3

1. Unit Propagation (**UP**)
2. Subsumption (**SUB**)
3. Strengthening (**STR**)
4. (Bounded) Variable Elimination (**BVE**)
5. (Bounded) Variable Addition (**BVA**)
6. Probing (**Probe**)
7. Covered Clause Elimination (**CCE**)
8. Hidden Tautology Elimination (**HTE**)
9. Equivalent Literal Elimination (**EE**)
10. Unhiding (**Unhide**)
11. Ternary Resolution (**3RES**)
12. Add Binary Resolvents (**ADD2**)
13. **Dense**

Preprocessing Techniques implemented in CP3 - Details

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Resolve ternay clauses with ternary or binary clauses and keep resolvent if the resulting clause is ternary or smaller.

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ADD2 - Add Binary Resolvents - specially for SLS

Introduces additionally binary clauses to "‘short-cut"’ implication chains.

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- Each PPT evaluated individually with standard parametrization

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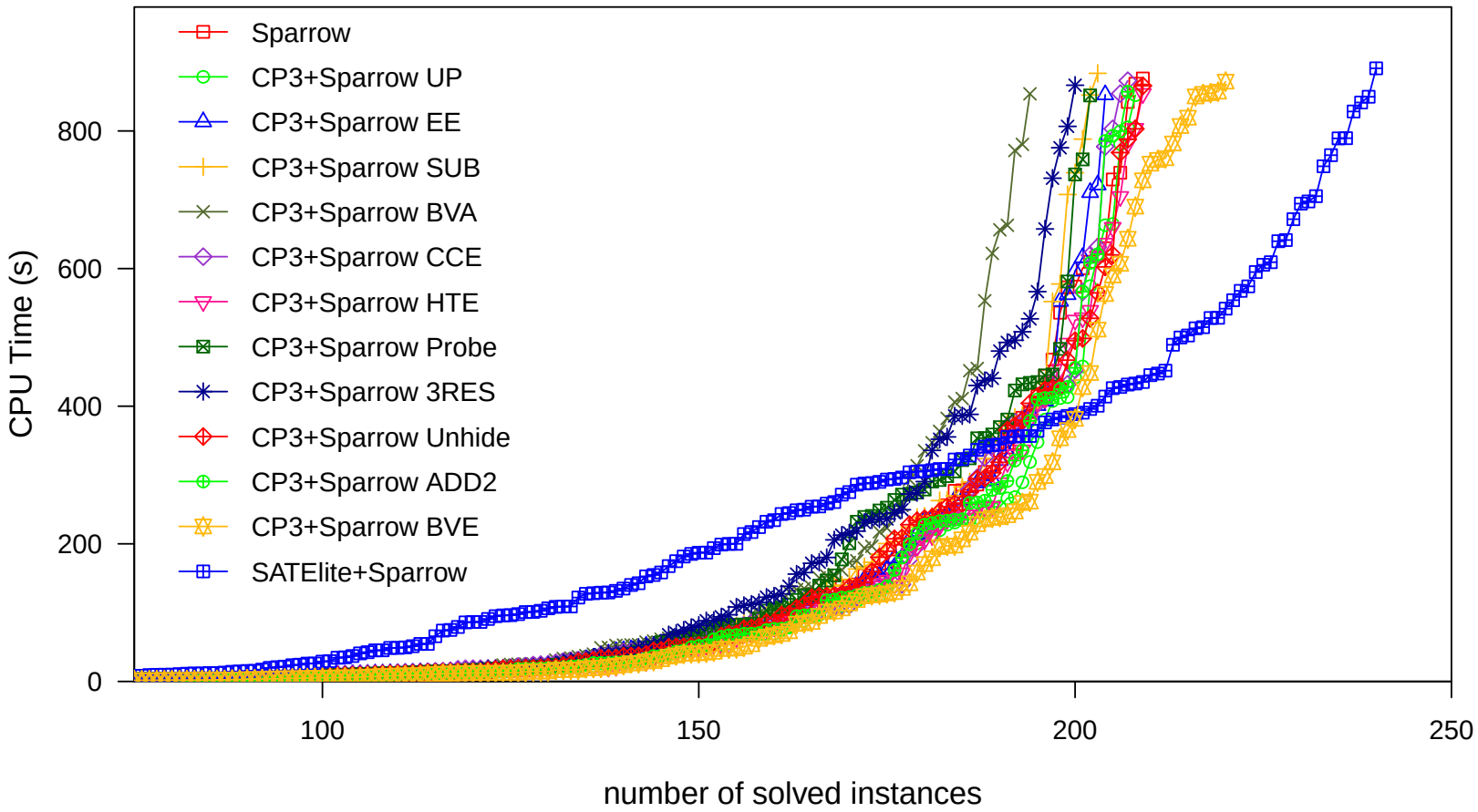

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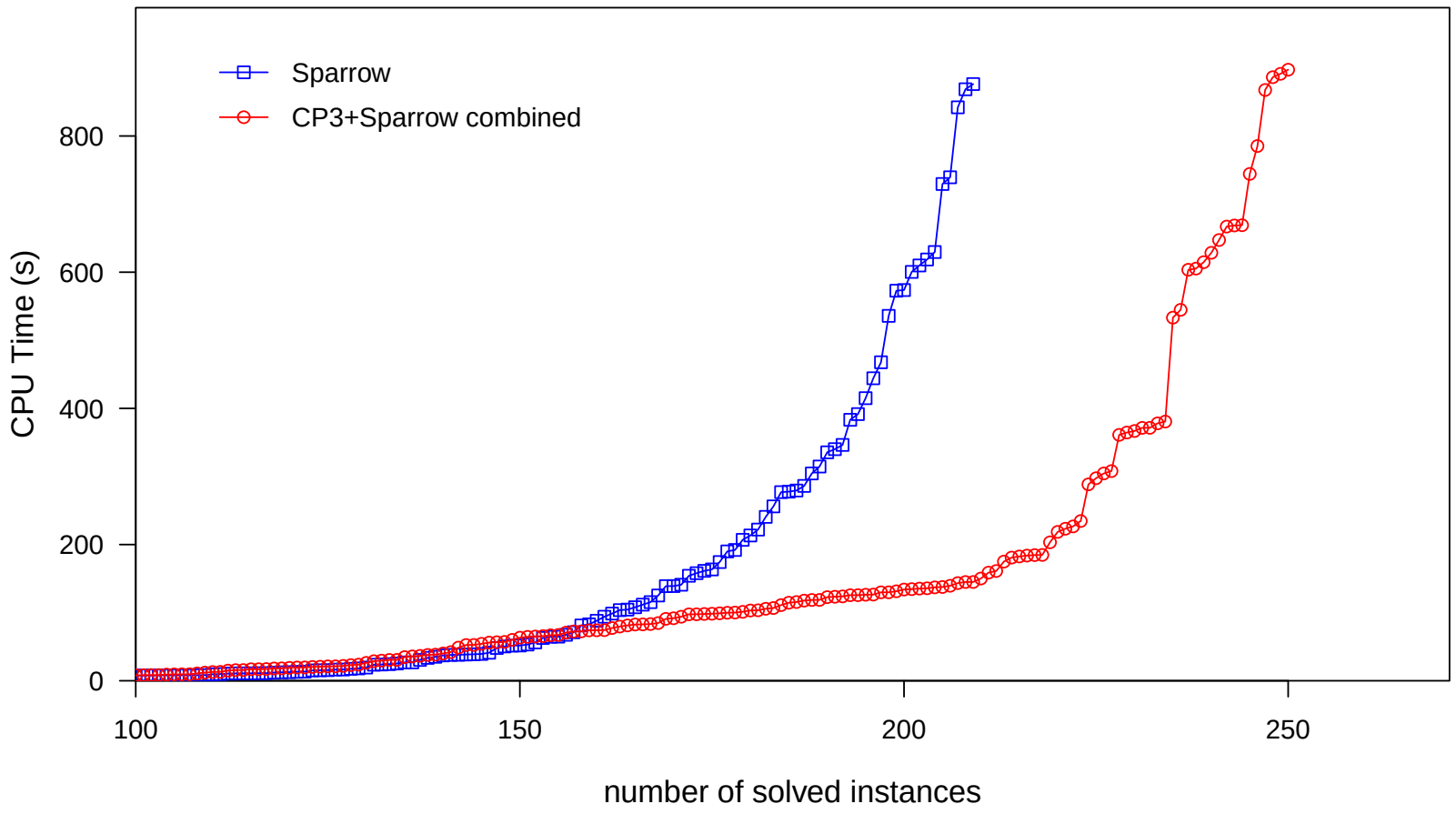

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Results of the optimization of BVE for SLS

- Choose variable with maximum occurrence first (totally contrary to BVE for CDCL: choose variable with minimum occurrence first)
- Allow the formula to increase up to 10 clauses per step and totally not more than 1000 clauses

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- Results compared to SatElite+Sparrow which is also mainly using BVE (but in a CDCL friendly way)

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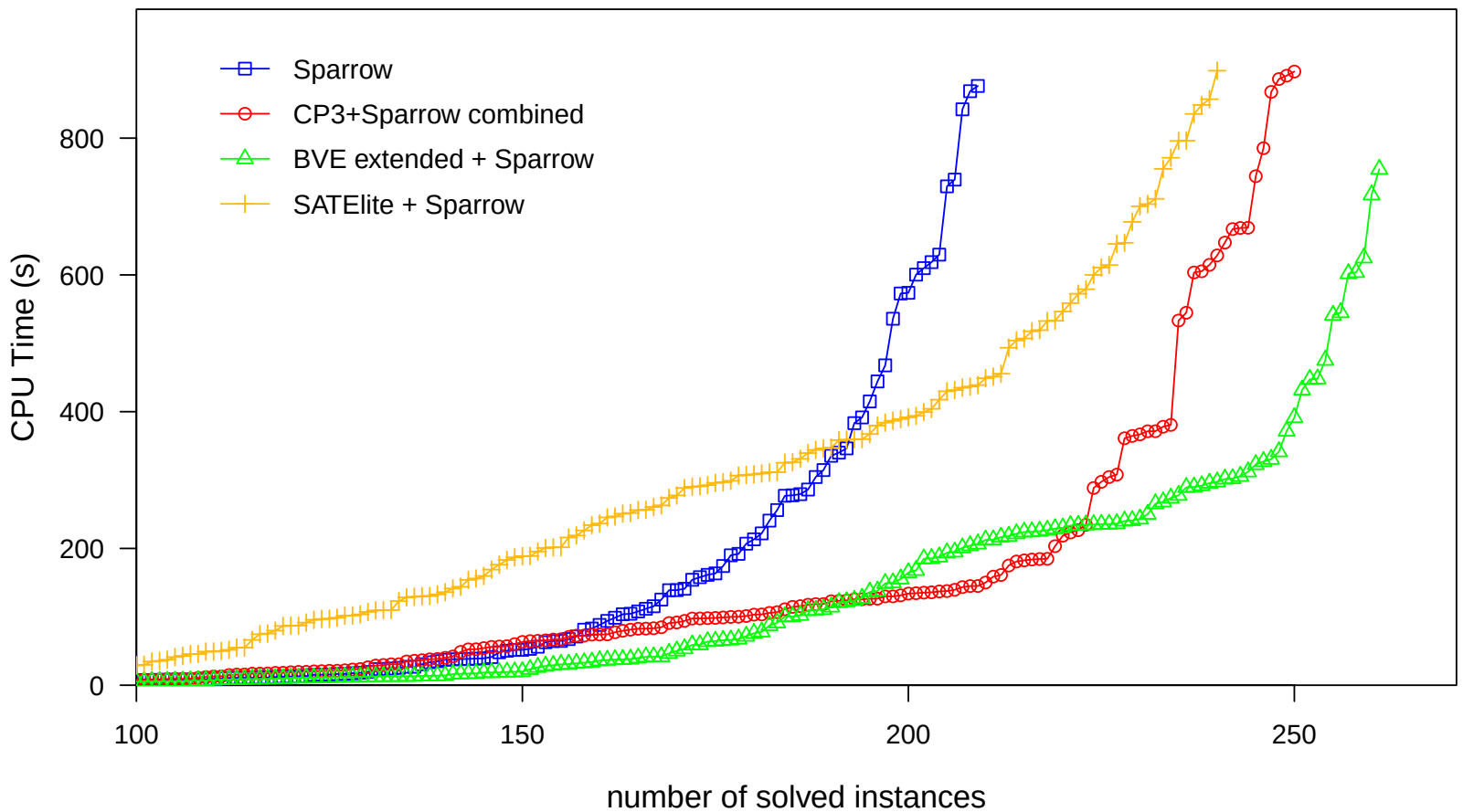

PPT for SLS - Applicability to other Solvers

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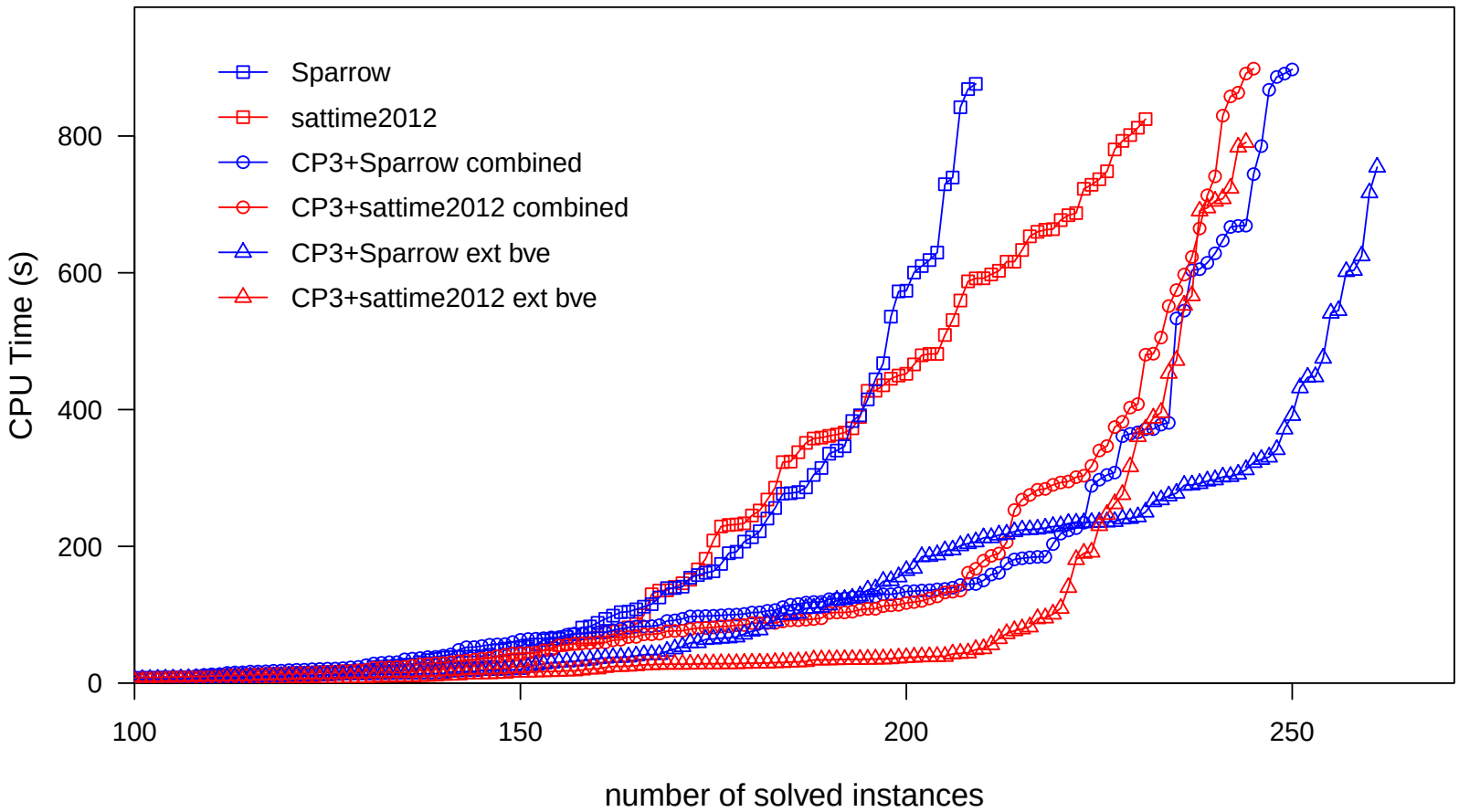

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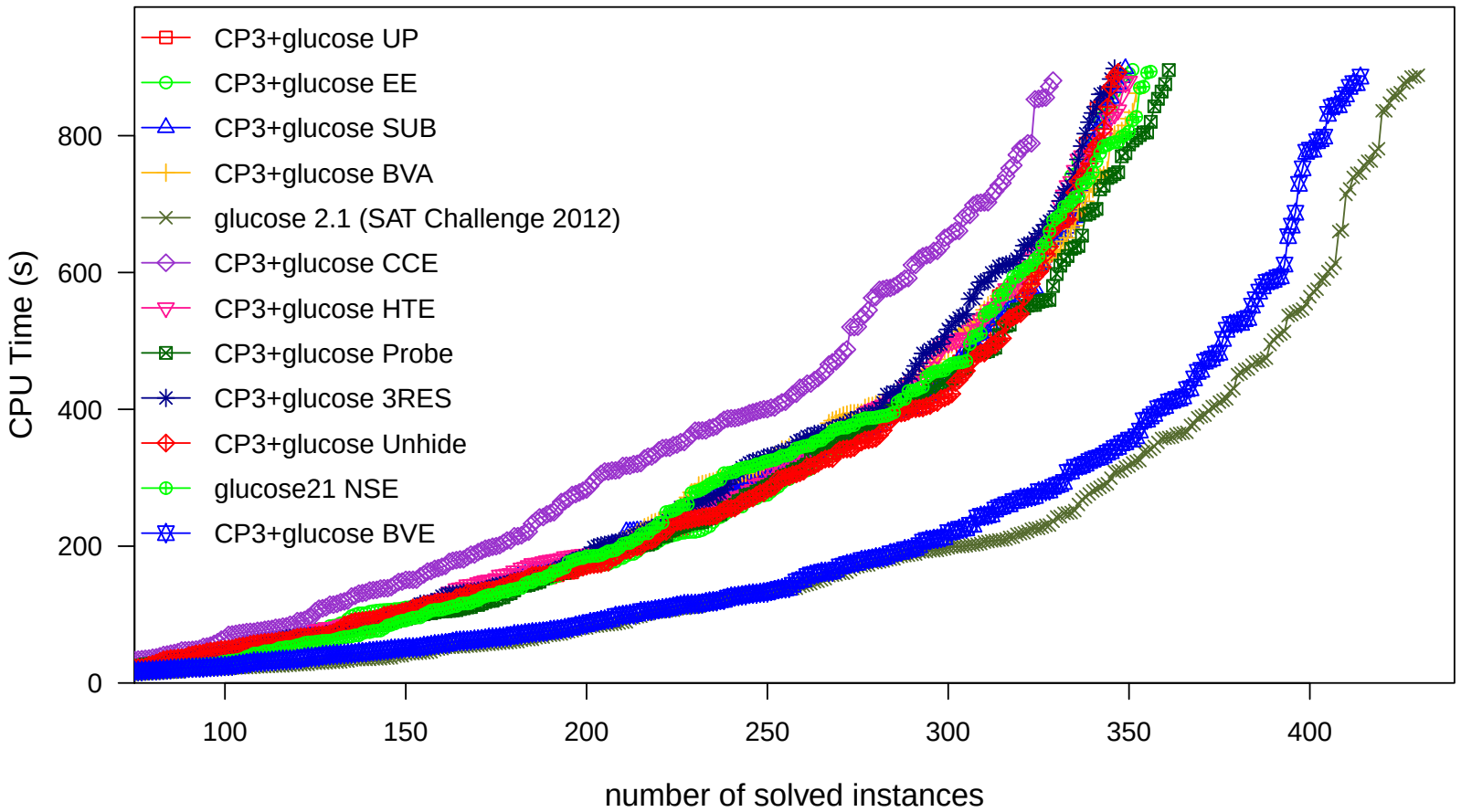

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Similar to "'unique solver contribution"': the number of instances that can be solved only when using a certain PPT.

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Similar to "'unique solver contribution"': the number of instances that can be solved only when using a certain PPT.

	None	UP	3RES	SUB+STR	EE	Unhide	HTE	Probe	BVE	BVA	CCE
UPT	2	–	–	1	6	–	1	5	52	2	2
solved	356	347	346	349	351	347	350	361	414	352	329

Single UPT contribution of each PPT.

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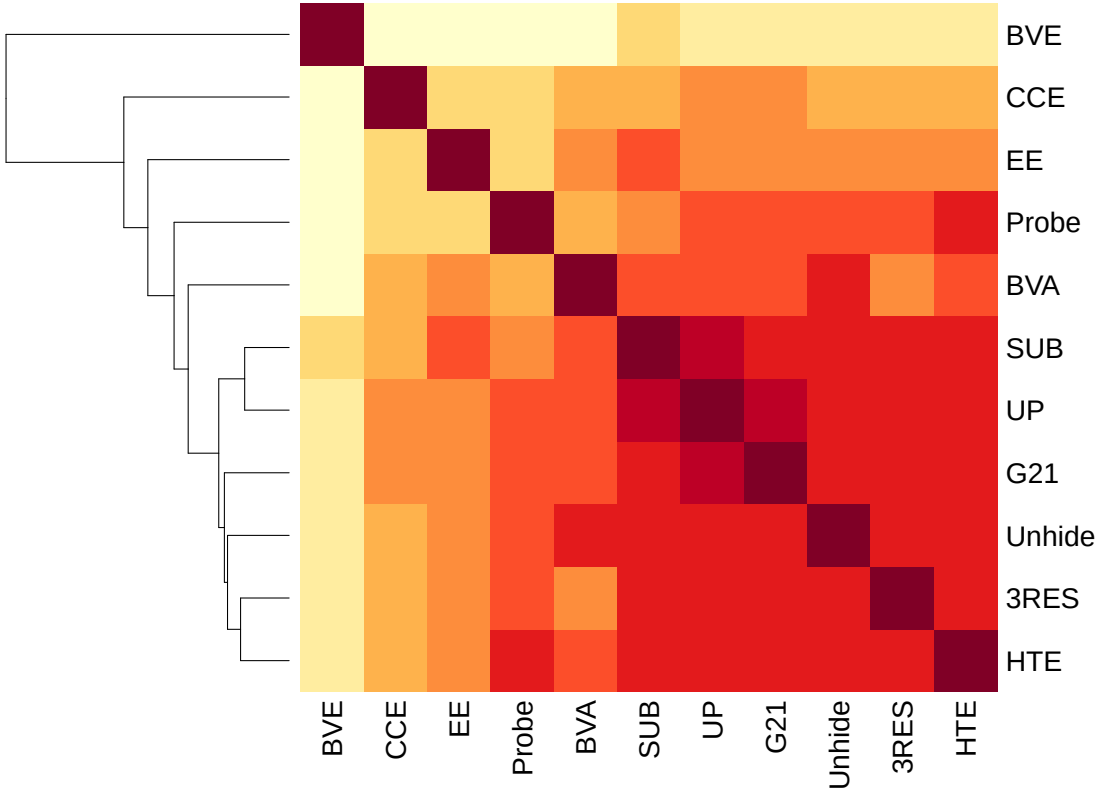

Heatmap visualization of the Spearman correlation matrix

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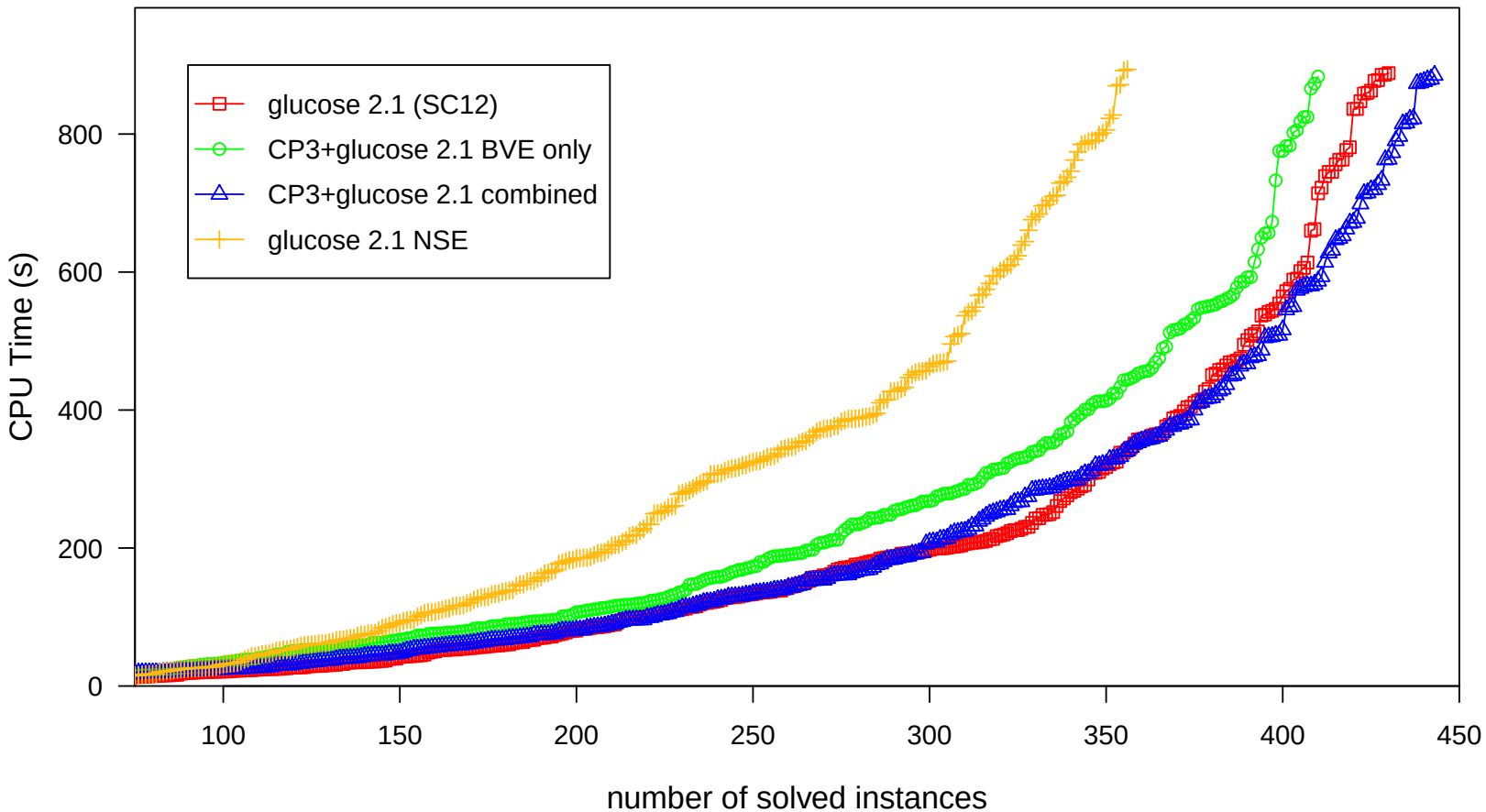

Best configuration uses Unhide+BVE+BVA.

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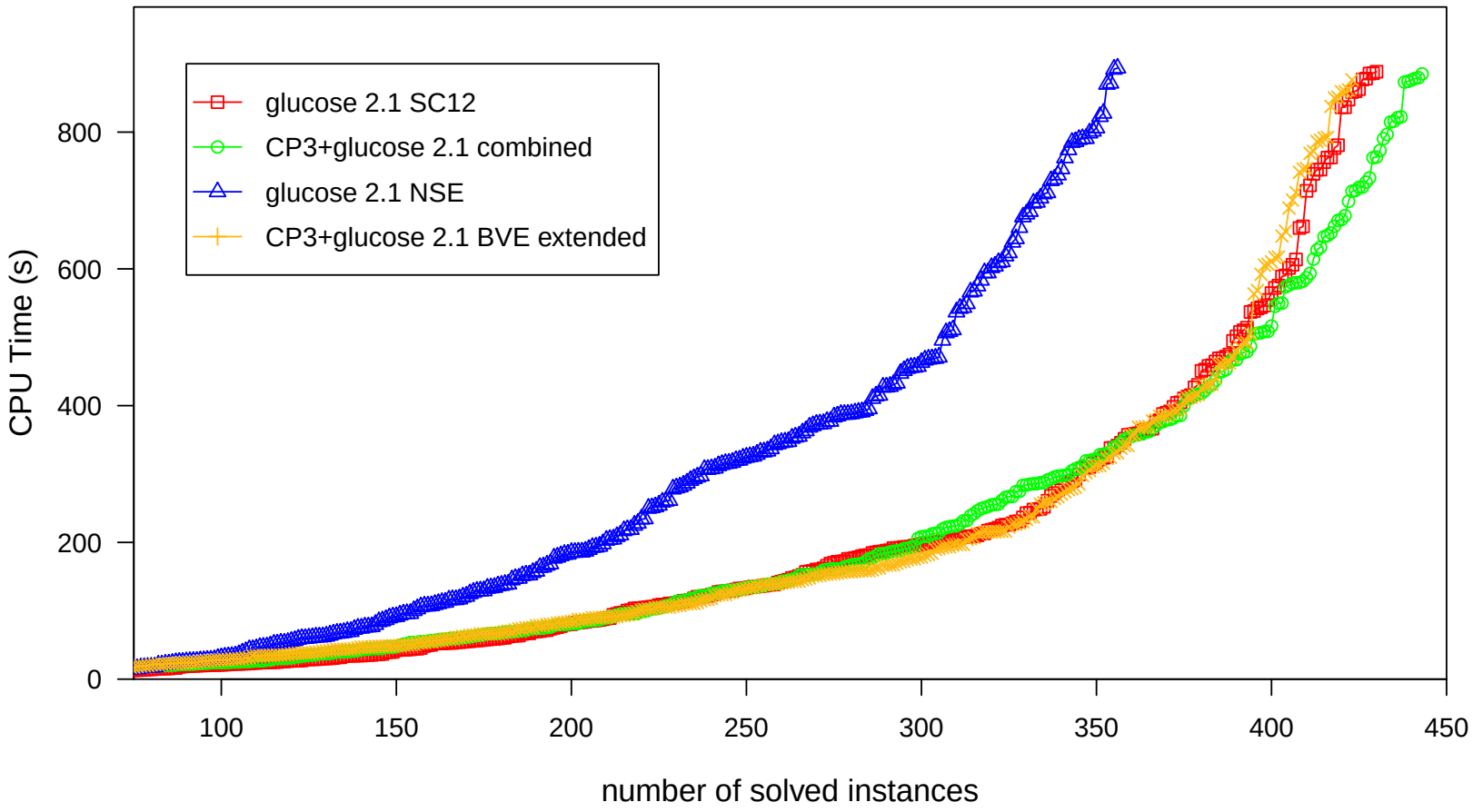

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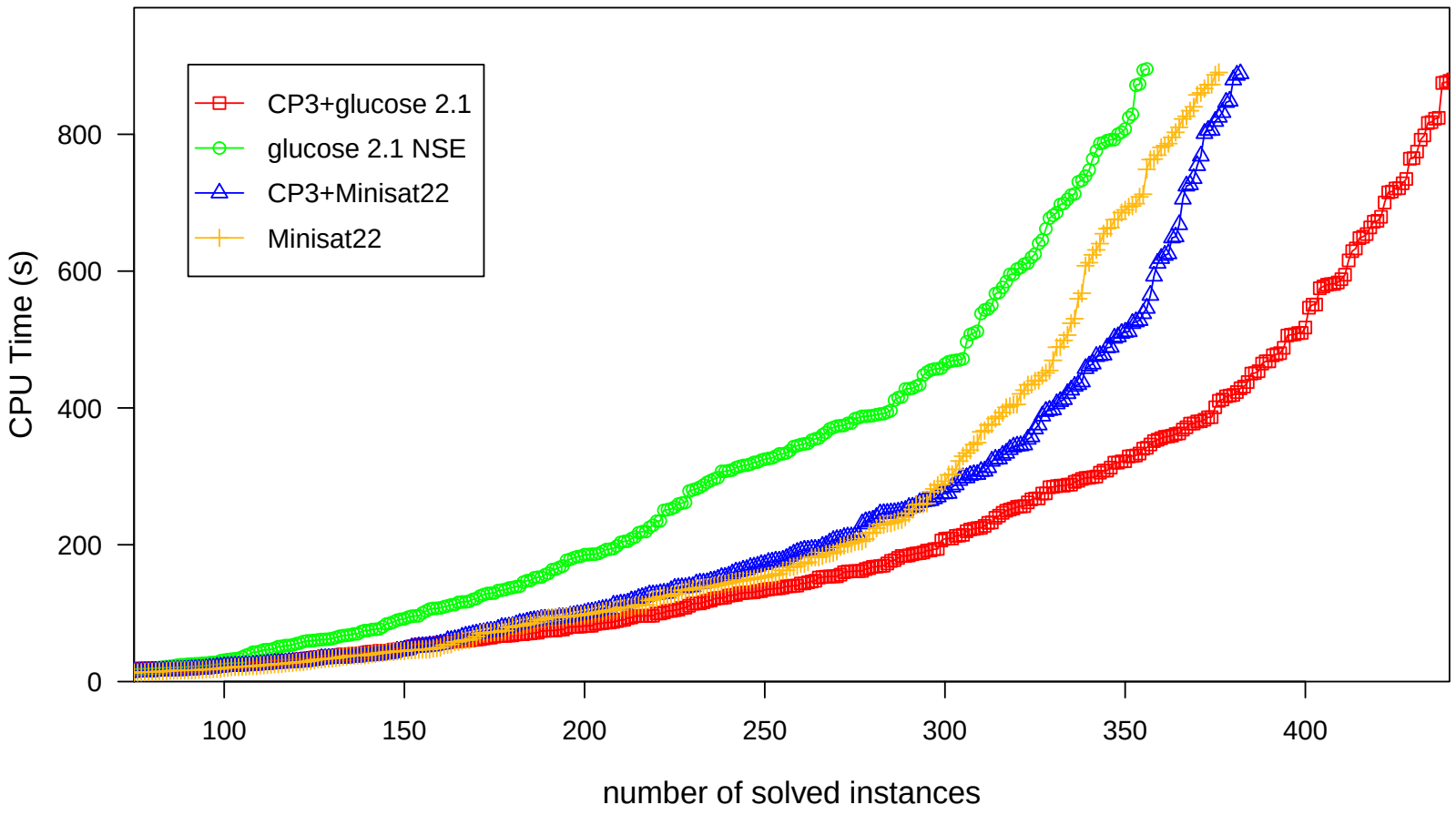

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- PPTs integrated also as inprocessing (IP) have high potential
- The application order and the number of application of each PPT has not been optimized yet (search space explosion)
- Optimizing the parameters of the solver and PP might yield even better improvements

This work at SAT Competition 2013

CP3+Sparrow in HC SAT

1. Runs CP3 with the HC-SLS configuration
2. Executes an improved version of Sparrow

SparrowToRiss in HC SAT+UNSAT

1. Runs CP3 with the HC-SLS configuration
2. Executes an improved version of Sparrow for $5 \cdot 10^8$ flips
3. Runs CP3 with the HC-CDCL configuration
4. Runs CDCL solver RISS (based on glucose 2.2 which incorporates CP3) initializing the phase savings with the last assignment found by Sparrow in chronological order (i.e. last flipped variable first)