FROM SINGLE-OBJECTIVE TO MULTI-OBJECTIVE MAXSAT

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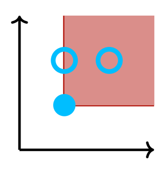
BI-OBJECTIVE OPTIMIZATION

- Many real-world problems have multiple conflicting objectives.
- Aim: **Pareto-optimal** solutions
- Linear comb. of objectives not sufficient



MAXIMUM SATISFIABILITY

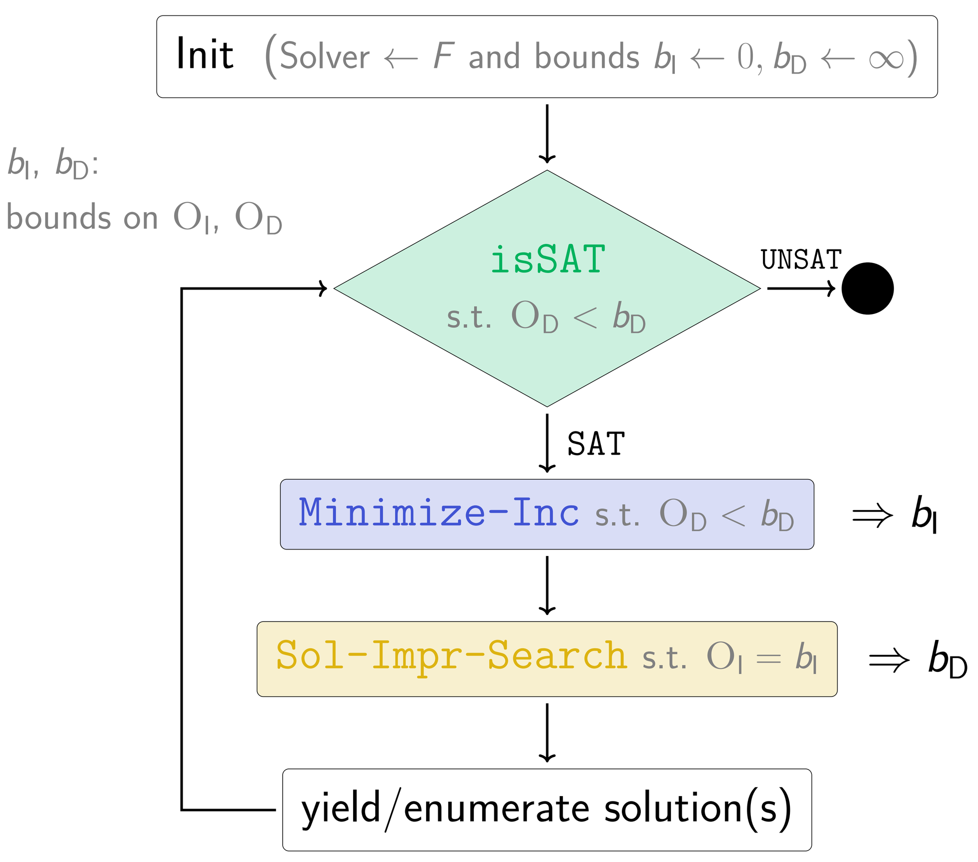
- Constraints: propositional formula, objective(s): linear function over variables
- Proven efficient for real-world optimization problems

CONTRIBUTIONS

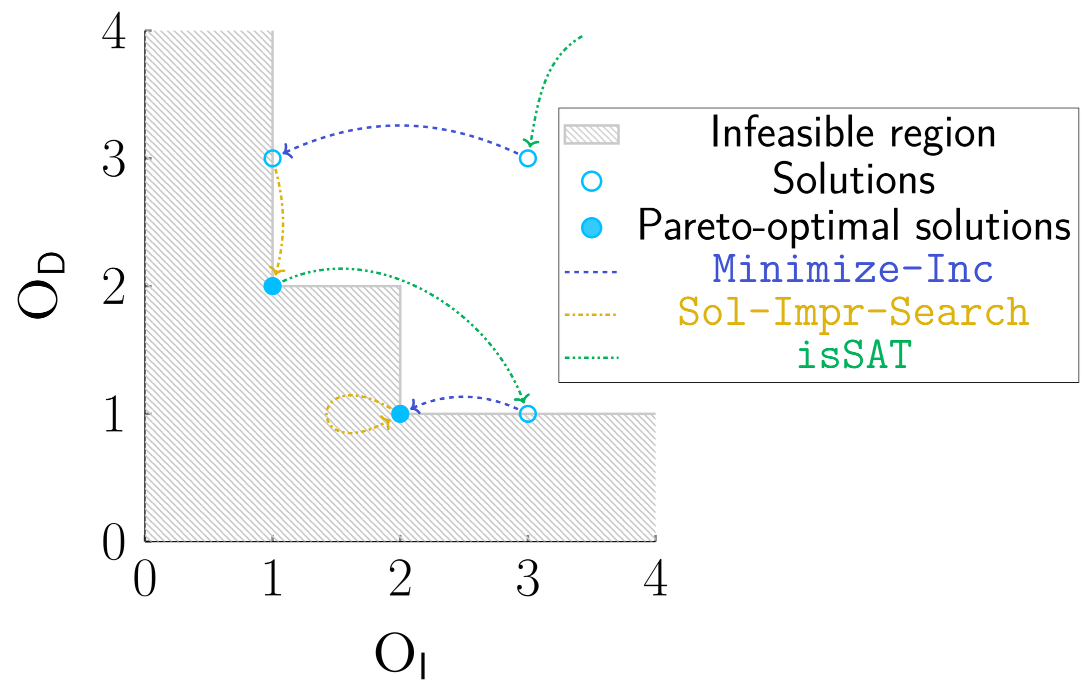
- BiOptSat framework
- 6 MaxSAT algorithm based instantiations
- Open-source implementation
- Empirical evaluation

THE BIOPTSAT ALGORITHM

THE FRAMEWORK



SEARCH TRACE



DETAILS

- Incremental use of a single SAT solver
- Incremental pseudo-Boolean constraint encodings
- Enumerate representatives or all solutions

INSTANTIATING MINIMIZE-INC

MAXSAT-BASED INSTANTIATIONS

Based on algorithms for single-objective MaxSAT

- Solution-improving: `SAT-UNSAT`
- Lower-bounding: `UNSAT-SAT`
- Core-guided: `MSU3`, `OLL`

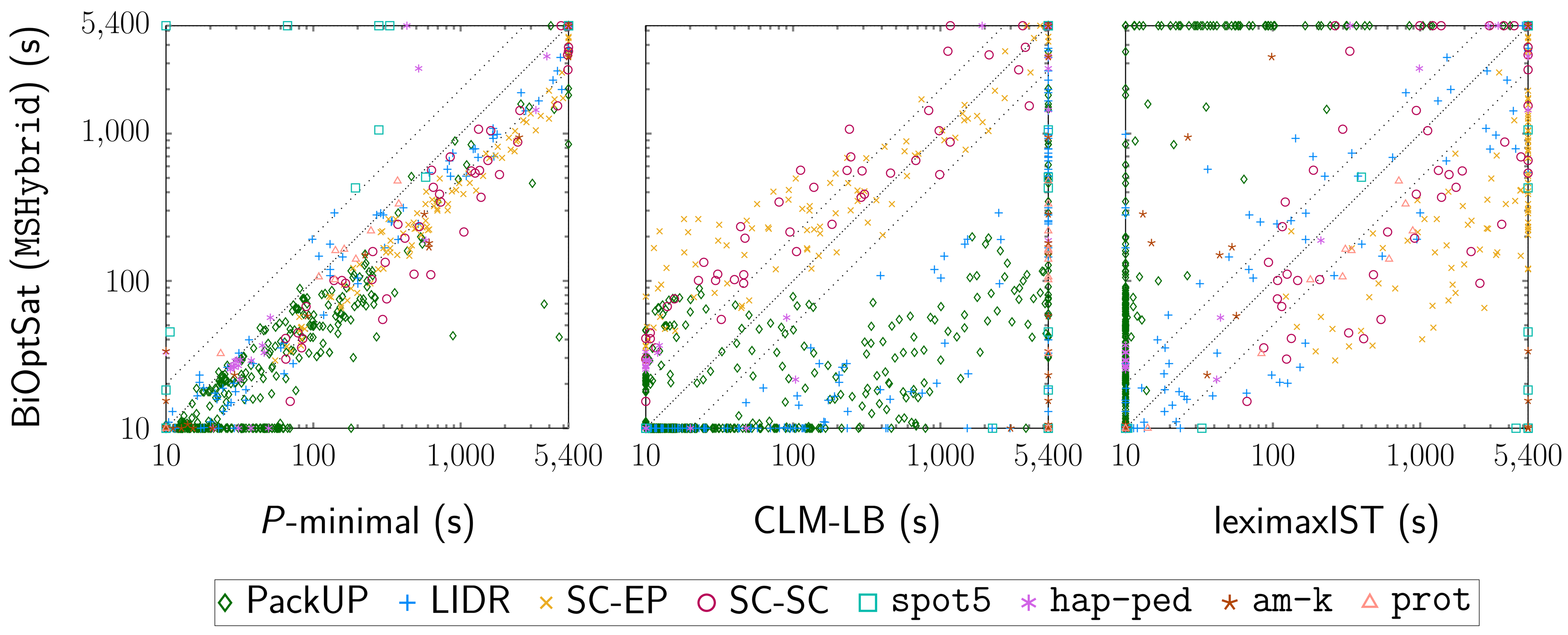
HYBRID INSTANTIATIONS

Start with core-guided search, then switch to solution-improving search: `MSHybrid`, `OSHybrid`.

EXPERIMENTAL EVALUATION

RESULTS

PER-INSTANCE RUNTIME



NUMBER OF SOLVED INSTANCES

Domain	LIDR	Set Covering			MaxSAT Lib			
		SC-EP	SC-SC	PackUP	spot5	hap-ped	am-k	prot
# Inst.	371	120	120	1057	32	100	36	11
`SAT-UNSAT`	**222**	**94**	42	846	20	21	**24**	**11**
`UNSAT-SAT`	**222**	89	38	846	20	21	23	**11**
`MSU3`	221	89	38	**848**	18	22	23	**11**
`OLL`	221	73	41	847	**24**	22	23	**11**
`MSHybrid`	**222**	**94**	42	**848**	16	22	**24**	**11**
`OSHybrid`	**222**	90	**47**	847	10	21	23	**11**
P-minimal	220	89	40	846	20	**23**	23	**11**
CLM-LB	185	93	43	819	5	19	1	0
CLM-IHS	86	86	39	626	4	7	0	0
Seesaw	135	60	39	204	6	18	0	2
Pareto-MCS	34	0	0	277	0	1	0	0
leximaxIST	220	52	42	962	8	23	18	11

COMPETING APPROACHES

- *P*-Minimal [Soh et al. CP'17]
- CLM Lower-bounding/IHS [Coretes et al. TACAS'23]
- Seesaw [Janota et al. CP'21]
- Pareto-MCS [Terra-Neves et al. IJCAI'18]
- leximaxIST [Cabral et al. SAT'22]

BENCHMARKS

- Learning Interpretable Decision Rules [Malioutov et al. CP'18]
- Set covering (2 variants)
- Package upgradeability [Janota et al. JSAT'12]
- Reverse engineered MaxSAT instances

REFERENCES

C. Jabs, J. Berg, A. Niskanen, and M. Järvisalo: "*MaxSAT-Based Bi-Objective Boolean Optimization*", SAT 2022.

C. Jabs, J. Berg, A. Niskanen, and M. Järvisalo: "*From Single-Objective to Bi-Objective Maximum Satisfiability Solving*", Journal of Artificial Intelligence Research (accepted).

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