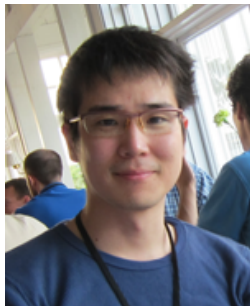


CSPSAT Projects and My Research Topics

Takehide Soh

March 18, 2014 at NII

Self Introduction



Takehide SOH

- ① 2008.04-2011.11
SOKENDAI, Ph.D., in Inoue Lab.
Studied applications of SAT technologies
(solving 2SPP and pathway analyses)
- ② 2011.11-2012.03
TRIC, Post-doc., in Inoue Lab.
Continuously studied pathway analyses
- ③ 2012.04-Current
Kobe Univ., Assist. Prof., in Tamura Lab.
Studying SAT-based CP System written
in Scala (Scarab) and its applications.

Table of Contents

- Overview of CSPSAT and CSPSAT2 Project
- My Research Topics on CSPSAT
- My Research Topics on CSPSAT2

CSPSAT and CSPSAT2 Projects

Overview

- CSPSAT project started on 2008 and is followed by running CSPSAT2 project started on 2012.
- The goal of projects is the research and development of enhanced SAT technologies as high-performance inference engines for hard problems.

Developed Software

SAT-based CSP Solvers Sugar, Azucar

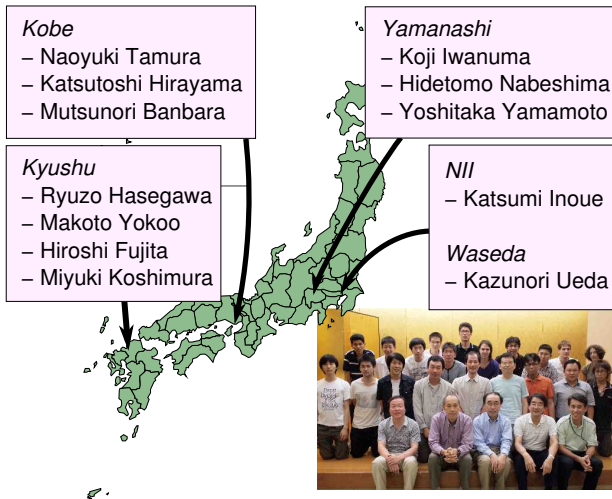
Max-SAT and PB Solvers QMaxSat, PBSugar

SAT Solvers GlueMiniSat, SCSat

Domain Specific Languages for CP Scarab, Copris and more...

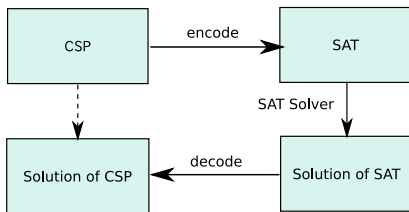
Introduce members and some researches in CSPSAT projects.

Members of CSPSAT



Sugar (Tamura et al.)

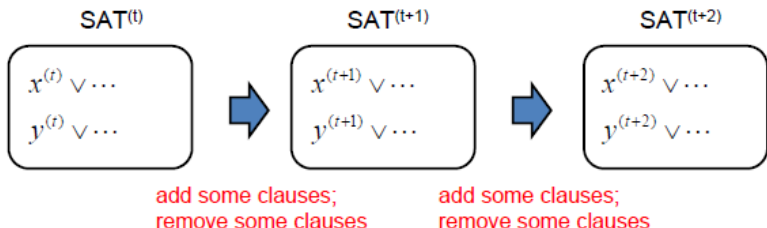
SAT-based CSP Solver



- Based on a new encoding named **Order Encoding** [Tamura et al., Constraints 2009]
- Winner of 2008 and 2009 CSP Solver Competitions in GLOBAL categories
- Closed three instances (j7-per0-0, j8-per0-1, j8-per10-2) of Open-Shop Scheduling Problem [Tamura et al., CP2006]
- There is also another version **Azucar** using **Compact Order Encoding** [Tanjo et al., SAT 2012].

Dynamic CSP/SAT (Hatano, Hirayama et al.)

Solving a Sequence of CSP/SAT Instances with Decision Change Costs



- Find a sequence of solutions that minimizes the sum of decision change costs for a given sequence of CSP/SAT instances.
- Lagrangian Decomposition works very well in terms of solution quality reached within a fixed amount of time [Hatano and Hirayama, IJCAI 2011].

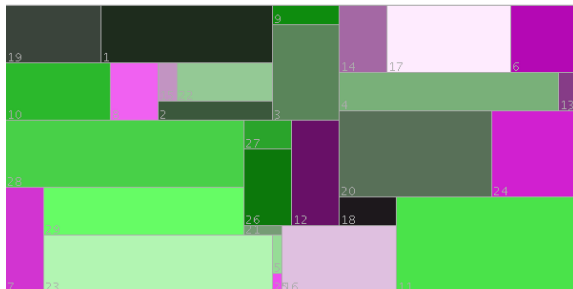
ASP as a Modeling Language for CB-CTT (Banbara et al.)

Proposed ASP-based method provides **175 best known bounds**.

Methods	Authors	# of Bests
ASP-based	M. Banbara	175
Tabu Search (110)	A. Schaerf	111
Hybrid Methods (1)		
Other	S. Abdullah & H. Turabieh	30
Tabu Search	Z. Lu & J. Hao	24
SAT-based	Barcelogic Team	19
Mathematical Programming	A. Phillips	18
Mathematical Programming	G. Lach	5
Local Search	T. Muller	5
Simulated Annealing	SaTT group	3
Very Large Neighborhood Search	A. Kiefer	2
Simulated Annealing	M. Muehlenthaler	1
Hybrid Methods	Khalid & Salwan	1

My Research Topics on CPSAT

Two-Dimensional Strip Packing (Soh and Inoue et al.)

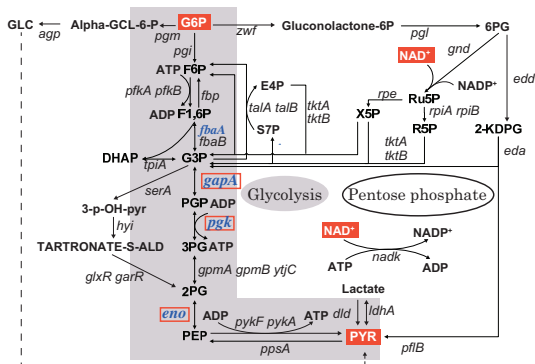


Optimum Packing of HT08

- Find a minimum height to pack all given rectangles in a fixed width strip.
- Closed 29 instances [Soh et al., FI, 2010]

My Research Topics on CSPSAT

Prediction of Gene Knockout Effects by Minimal Model Generation



Source metabolites (M_s): β -D-glucose-6-phosphate, NAD ⁺	G6P NAD ⁺
Target metabolite (M_t): pyruvate	PYR
Four essential genes confirmed by KEIO collection	<i>fbaA gapA pgk eno</i>
Genes predicted by our method	<input type="text"/>

Essential Genes of E. coli Predicted by a SAT-based Analysis Method
 [Soh and Inoue et al., Intl. J. Advances in Life Sciences, 2012]

My Research Topics on CPSAT2: Motivation

Researches I studied until 2012

- Solving Two-Dimensional Strip Packing Problem
 - Proposing a new solving method for an existing problem
- Analyses for Metabolic Pathways
 - Focusing on a Biological problem (Gene knockout effects)
 - Represent it as a new problem on bipartite digraphs
 - Proposing a solving method
- Both researches use SAT technologies and need trial and error on propositional modeling.

There are general demands of an useful workbench on SAT.

This is the motivation for the development of **Scarab**.

My Research Topics on CSPSAT2: Scarab

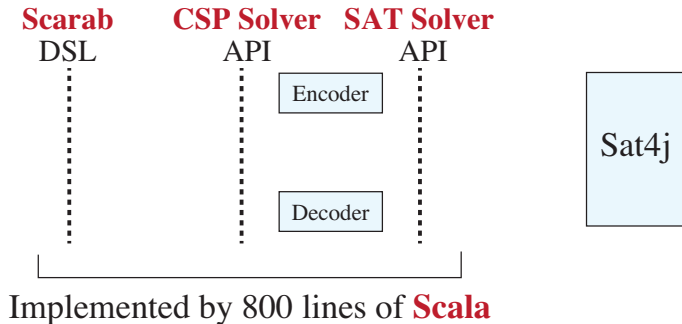
Tight Integrated System with SAT Solvers

- **Scarab** is a prototyping tool for developing SAT-based Constraint Programming (CP) systems.

My Research Topics on CPSAT2: Scarab

Tight Integrated System with SAT Solvers

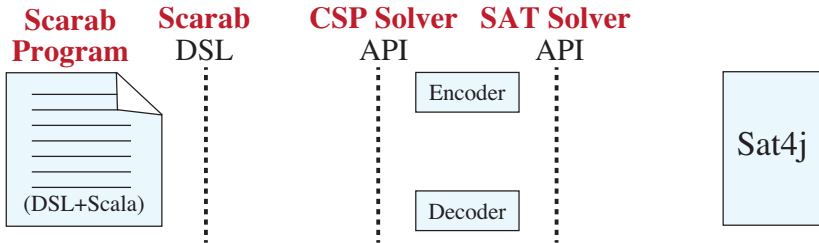
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- It consists of 1) CP Domain-Specific Language, 2) API of CSP solver, 3) SAT encoding module, and 4) API of SAT solvers.
- It uses **Order Encoding** and **Sat4j** in default.



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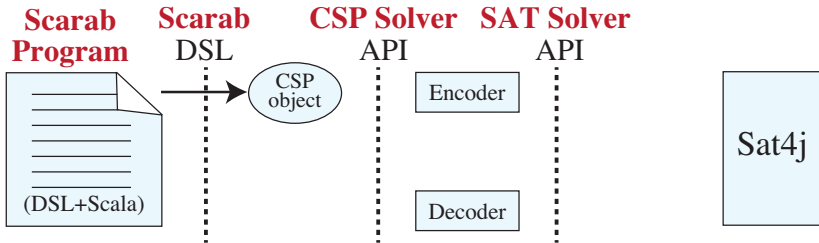
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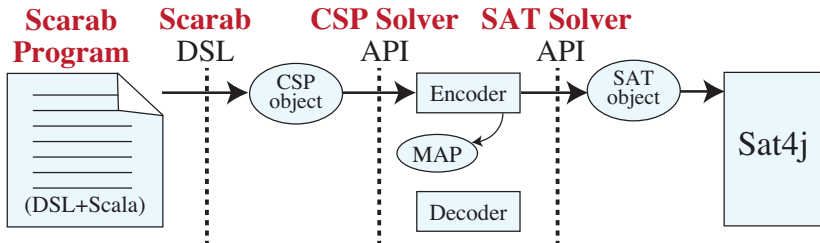
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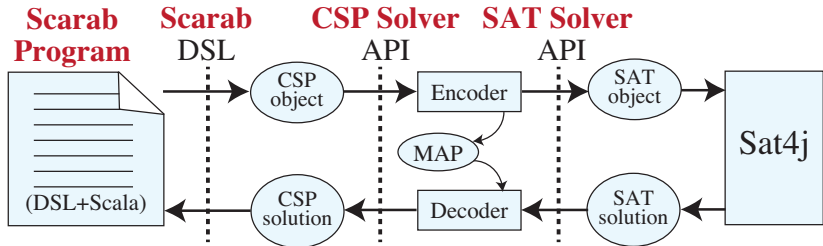
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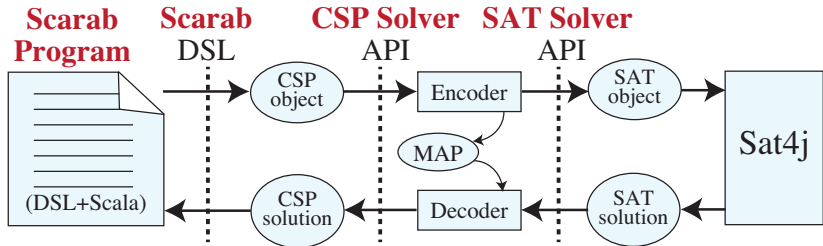
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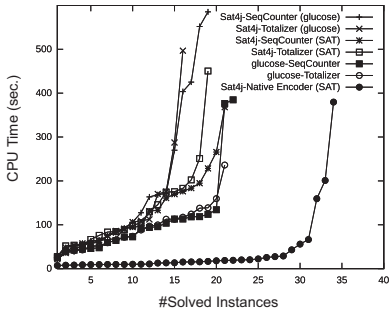


- It is developed to be an expressive, efficient, customizable, and portable workbench.

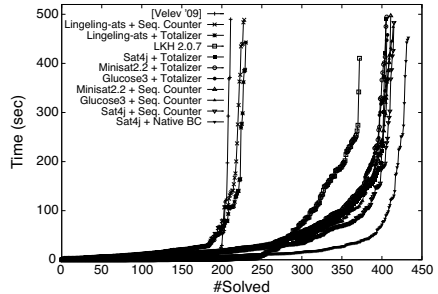
My Research Topics on CSPSAT2: Scarab

Applications using Scarab

We are now developing several applications using Scarab and they show good performances compared to other systems.



For Post-Enrollment Course Timetabling



For Hamiltonian Cycle Problem

Web Page for Scarab

`http://kix.istc.kobe-u.ac.jp/~soh/scarab/`

Scarab: a Tool for SAT-based CP Systems

kix.istc.kobe-u.ac.jp/~soh/scarab/index.html

Scarab: a Tool for SAT-based CP Systems

Home Documents Examples Advanced Usage Tutorial

What's New

To run Scarab, **Scala 2.10.1 or higher** is required.

- [2014.01.31] [Scarab - Version 1.0.8](#) is released
 - some bug fix.
- [2013.12.25] [Scarab - Version 1.0.6](#) is released
 - It supports `boolInt` type.
 - It supports external SAT solvers like `minisat`, `glucose`, and `lingeling`.
- [2013.11.25] [Scarab - Version 1.0.4](#) is released
 - Native Encoder is updated.
 - `Sat4j` included in Scarab JAR is updated.
 - This version is written in about 800 lines of Scala without comments.
- [2013.10.04] [Scarab - Version 1.0.3](#) is released
 - Internally, Constraints are now represented by using `LeZero`, `GeZero`, `EqZero`, `NeZero`, `Bool`, and `Not` (Until 1.0.2, all of constraints are represented by using only `LeZero`, `Bool` and `Not`).
 - Addition to `OrderEncoder`, `NativeEncoder` is now available, which directly passes Boolean cardinality constraints to `Sat4j` without SAT encoding.
 - This version introduces many `Sat4j` configurations: "`MiniLearningHeap`", "`MiniLearningHeapEzSimp`", "`Glucose21`", "`BestWL`", "`BestHT`", "`SAT`", "`UNSAT`", "`greedy`" etc
 - You can use it by defining SAT solvers like: `new Sat4j("MiniLearningHeap")`
- [2013.09.14] [Scarab - Version 1.0.2](#) is released
 - `Sat4j` version 2.3.5 is now included
 - some bug fix is done
 - "`findNext`" of solver is introduced for enumerating solutions (enumeration feature of "`find`" is discontinued).
- [2013.07.08-12] Scarab is presented at [PoS-13](#) and [SAT](#) (paper for the PoS workshop is available [here](#)).
- [2013.05.27] We have move examples (see [Examples](#))
- [2013.04.20] [Scarab - Version 1.0.1](#) is released
 - `Sat4j` version 2.3.3 is now included
 - `ModelIterator` of `Sat4j` is [available](#) to use

Web Page for CSPSAT2

http://www.edu.kobe-u.ac.jp/istc-tamlab/cspSAT/en/

The screenshot shows a web browser window with the URL `www.edu.kobe-u.ac.jp/istc-tamlab/cspSAT/en/index.html`. The page title is "CSPSAT2". The main content area is titled "News" and contains a list of news items with dates and descriptions. The browser's address bar and navigation buttons are visible at the top.

CSPSAT2

Last modified by Soh at 03/14/2014 06:29:52

English | [Japanese](#) CSPSAT (until FY2011)

News About Project Seminars & Meetings Publications & Softwares

News

- 2014.3.7 [An organized session "Theory, Practice, and Application of SAT" will be held at JSAI 2014 - The 28th Annual Conference of Japanese Society for Artificial Intelligence](#)
- 2014.2.26 [The 7th CSPSAT Seminar](#) will be held on 22, 23 of April 2014.
- 2014.2.13 [The 4th CSPSAT2 Meeting \(joint with The NII Grand Challenge "Inference and Learning on Dynamic Constraint Networks" and NII Collaborative Research\)](#) will be held on 13-16th of March 2014.
- 2013.7.12 [GlueMiniSat](#) (by Prof. Nabeshima) won the 2nd prize on [SAT Competition 2013](#) (Application, Certified UNSAT).
- 2013.7.12 [QMaxSAT](#) won the 2nd prize on [MaxSAT Evaluation 2013](#) (Partial MaxSAT industrial). [QMaxSAT](#) is developed by Prof. Koshimura (I-segawa Laboratory, Kyushu University), who was a core member of CSPSAT project.
- 2013.7.24-26 [Joint Seminar on Theory, Implementation, and Applications of Logic and Inference and The 3rd CSPSAT2 Meeting](#) was held in Hokkaido University.