POTASSCO SOLUTIONS®

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Mobility & Digital Products

Clasp: The AI That Solved the US Spectrum Challenge

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Success Story

Developed by Potassco, Clasp handled one of the most challenging optimization tasks we've seen - the U.S. radio spectrum reallocation. Utilized within the SAT-based Feasibility Checker (SATFC), Clasp solved 95% of instances in under a minute, helping save $5.1 billion in costs. This achievement was honored with the Prominent Paper Award from Artificial Intelligence in 2018.

Neil Newman, Alexandre Fréchette und Kevin Leyton-Brown (2017). Deep Optimization for Spectrum Repacking

The Challenge

The reallocation of the US radio spectrum in 2016-2017, known as the „Incentive Auction," was one of the most complex computational tasks ever attempted in market design. The objective was to free up 84 MHz of television spectrum for wireless internet and to repack thousands of TV stations in the US and Canada into a reduced set of channels without causing interference.

This problem was extremely computationally intensive. With over a million interference constraints in the FCC's problem formulation, the number of possible configurations exceeded the atoms in the universe. Time was critical - each of the tens of thousands of queries during the auction had to be solved „on the order of minutes."

Conventional commercial software proved inadequate. Gurobi and CPLEX, the industry-standard optimization tools, could only solve about 10-25% of the problems within the 100-second cutoff. Given the auction's complexity, this failure rate would have been catastrophic. Each 1% of feasibility checking failures threatened to add approximately $150 million to the cost of acquiring broadcast rights.
The enormous complexity necessitated a fundamentally new approach.

Our Solution

The solution was Clasp, an AI-driven, highly-parameterized Conflict-Driven Answer Set Solver from the University of Potsdam. Clasp doesn't explore all possibilities systematically like traditional software. Instead, it learns from conflicts - when it hits a dead end, it understands why and eliminates millions of related possibilities without checking them.

Researchers at the University of British Columbia recognized Clasp's potential and integrated it as the core of their SAT-based Feasibility Checker (SATFC) - where SAT stands for Boolean Satisfiability. The system was enhanced with:

- **Eight parallel algorithms** running simultaneously as a portfolio approach
- Domain-specific techniques **including constraint-graph decomposition**
- **Novel caching mechanisms** to remember solutions
- Training on **approximately 1.4 million problem** instances generated from auction simulations

This combination of Clasp's conflict-driven learning with specialized optimization techniques created a system that could navigate the exponentially complex solution space efficiently. The entire solution is available as open-source software.

Over 95% of problems solved within one minute (vs. 10-25% for commercial software within 100-second cutoff) 87.73% solved in just one second - near-instantaneous for most queries. Many problems that exceeded the capabilities of commercial solvers were solved in seconds.

The Benefits

The deployment of Clasp within SATFC delivered extraordinary results:

Outstanding Performance

- **Over 95% of problems solved** within one minute (vs. 10-25% for commercial software within 100-second cutoff)
- **87.73% solved in just one second** - near-instantaneous for most queries
- Many problems that exceeded the capabilities of commercial solvers were-solved in seconds

Massive Cost Savings

- **5.114 billion saved** compared to a simple, greedy checking method in national simulations
- **$2.030 billion in value preserved** by preventing unnecessary losses
- **Hundreds of millions to billions saved** when SATFC dominated other advanced feasibility checkers such as PicoSAT and Gurobi
- Substantially **outperformed all alternatives**

Successful Auction

- **$19.8 billion in gross revenues** generated for spectrum licenses
- **Over $7 billion net** for the US government after costs
- **Thousands of TV stations** successfully repacked without service disruption
- **On-schedule completion** despite unprecedented complexity

Recognition and Impact

The foundational work on Clasp received the Prominent Paper Award 2018 from the journal „Artificial Intelligence." The research, documented in „Deep Optimization for Spectrum Repacking" by Neil Newman, Alexandre Fréchette, and Kevin Leyton-Brown (2017), has become a landmark in computational problem-solving.

What This Means

The spectrum auction proved that problems once considered computationally impossible can be solved with the right approach. Clasp demonstrated that AI-driven solvers can solve 4 to 9 times more problems than traditional optimization software within comparable time limits. While the spectrum auction represents a specific application, similar complexity exists across many domains - from hospital scheduling to supply chain optimization, from manufacturing configuration to regulatory compliance. Wherever constraints multiply exponentially and traditional software fails, the approach pioneered by Clasp offers hope.
The entire Potassco suite, including Clasp, is available as open-source software at potassco.org. The technology that saved billions for the US government is freely accessible to researchers, businesses, and governments worldwide. The success of Clasp in the Incentive Auction isn't just a technical achievement—it's proof that academic research, open-source development, and real-world application can combine to solve society's most complex challenges.

Based on documented FCC Incentive Auction results (2016-2017).

Clasp is part of the Potassco suite developed at the University of Potsdam under the leadership of Prof. Dr. Torsten Schaub.

References

- Neil Newman, Alexandre Fréchette, and Kevin Leyton-Brown (2017). „Deep Optimization for Spectrum Repacking," Artificial Intelligence.