

SATzilla: Portfolio-based Algorithm Selection for SAT

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Background: It has been widely observed that there is no single “dominant” SAT solver; instead, different solvers perform best on different instances.

Objectives: Rather than following the traditional approach of choosing the best solver for a given class of SAT instances, we aim to make this decision fully automatically, online and on a per-instance basis, with the goal of solving a broad range of SAT instances more efficiently in terms of running time.

Methods: We describe SATzilla, an automated approach for constructing per-instance algorithm portfolios for SAT that use so-called empirical hardness models to choose among their constituent solvers. This approach takes as input a distribution of problem instances and a set of component solvers, and constructs a portfolio optimizing a given objective function (such as mean running time, percent of instances solved, or score in a competition). In this article, we go well beyond earlier versions of SATzilla, by making the portfolio construction scalable and completely automated, and improving it by integrating local search solvers as candidate solvers, by predicting performance score instead of running time, and by using hierarchical hardness models that take into account different types of SAT instances.

Results: The excellent performance of SATzilla was independently verified in the 2007 SAT Competition, where our SATzilla07 solvers won three gold, one silver and one bronze medal. We demonstrate the effectiveness of the new techniques introduced here in extensive experimental results on data sets including instances from the most recent SAT competition.

Conclusions: The effectiveness of the SATzilla approach demonstrated in this article suggests that per-instance automated algorithm selection may also be possible for NP-hard problems other than SAT. We expect this to pave the way for achieving substantial improvements in the state of the art in solving other important problems in AI and beyond.

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1 Introduction

This document describes the revised \LaTeX template used by JAIR starting with volume 83 (2025). The template is based on ACM’s consolidated article template, introduced in 2017, which provides a consistent \LaTeX style for use across ACM publications, and incorporates accessibility and metadata-extraction functionality necessary for future Digital Library endeavors. JAIR adopted this template because 1) our old template was sadly out of date and we wanted a reliable, maintained template and 2) the journal is now distributed as part of the ACM library

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Ψ ₁ ²	1 in 40,000	Unexplained usage

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10.2 Display Equations

A numbered display equation—one set off by vertical space from the text and centered horizontally—is produced by the `equation` environment. An unnumbered display equation is produced by the `displaymath` environment. Again, in either environment, you can use any of the symbols and structures available in \LaTeX ; this section will just give a couple of examples of display equations in context. First, consider the equation, shown as an inline equation above:

$$\lim_{n \rightarrow \infty} x = 0 \tag{1}$$

Notice how it is formatted somewhat differently in the `displaymath` environment. Now, we’ll enter an unnumbered equation:

$$\sum_{i=0}^{\infty} x + 1$$

and follow it with another numbered equation:

$$\sum_{i=0}^{\infty} x_i = \int_0^{\pi+2} f \tag{2}$$

just to demonstrate \LaTeX ’s able handling of numbering.

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2007; Poker-Edge.Com 2006; Thornburg 2001), a video game (Case 1) (Obama 2008) and (Case 2) (Novak 2003) and (Lee 2005) and (Case 3) a patent (Scientist 2009), work accepted for publication (Rous 2008). Other cites might contain 'duplicate' DOI and URLs (some SIAM articles) (Kirschmer and Voight 2010). Boris / Barbara Beeton: multi-volume works as books (Hörmander 1985b) and (Hörmander 1985a). A couple of citations with DOIs: ("IEEE TCSC Executive Committee" 2004; Kirschmer and Voight 2010). Online citations: (Thornburg 2001; *Institutional members of the T_EX Users Group* 2017; Veytsman 2017). Artifacts: (R Core Team 2019) and (Anzaroot and McCallum 2013).

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```
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```

```
...
```

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```

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```
\appendix
```

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Acknowledgments

To Robert, for the bagels and explaining CMYK and color spaces.

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A Research Methods

A.1 Part One

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Morbi malesuada, quam in pulvinar varius, metus nunc fermentum urna, id sollicitudin purus odio sit amet enim. Aliquam ullamcorper eu ipsum vel mollis. Curabitur quis dictum nisl. Phasellus vel semper risus, et lacinia dolor. Integer ultricies commodo sem nec semper.

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- (8) The execution environment for experiments, the computing infrastructure (hardware and software) used for running them, is described, including GPU/CPU makes and models; amount of memory (cache and RAM); make and version of operating system; names and versions of relevant software libraries and frameworks. [yes/partially/no]
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- (11) Reported results have not been “cherry-picked” by silently ignoring unsuccessful or unsatisfactory experiments. [yes/partially/no]
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- (7) All methods used for preprocessing, augmenting, batching or splitting data sets (e.g., in the context of hold-out or cross-validation) are described in detail. [yes/partially/no/NA]

Explanations on any of the answers above (optional):

[Text here; please keep this brief.]

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