



# JLiSA: The Java Frontend of the Library for Static Analysis (Competition Contribution)

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**Abstract.** JLiSA is the extension to the Java programming language of LiSA, an analysis engine that works on a generic and extensible control flow graph representation of the program to analyze. LiSA implements several standard abstract domains and analyses aimed at approximating numerical values, strings, and heap structures. At the end of the analysis, it produces an abstract state for each program point. Then, checkers produce warnings indicating whether a property of interest is respected. JLiSA provides a front-end to translate Java programs into the internal LiSA control flow graph representation, the semantics of various parts of the Java standard library, and checkers to verify assertions and detect whether exceptions might be thrown and not caught. This paper presents our first participation in SV-COMP in the Java category, where we achieved 3<sup>rd</sup> place.

## 1 Verification Approach

JLiSA relies on LiSA [9,13,11] (Library for Static Analysis), a Java library that provides a complete infrastructure for the development of static analyzers based on abstract interpretation [6,7]. In particular, LiSA implements several standard components of abstract interpretation-based analyzers, including an extensible control flow graph (CFG) representation, a standard analysis framework for developing new static analyses, and fixpoint algorithms on LiSA CFGs. LiSA has been extended and applied to a large variety of properties, programming languages and contexts: Go smart contracts and blockchain software [21,22,17,19,18,16,14], Python robotic software [25,24], microservices [26], Michelson [20,15] and EVM bytecode [3,2], as well as for teaching purposes [12]. JLiSA builds on top of LiSA to analyze Java programs. In particular, it consists

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of a front-end that translates Java programs into LiSA’s internal control flow graph representation. This representation is enriched with the semantics of a subset of the Java standard library, corresponding to the classes and methods exercised by the AutoStub category of the SV-COMP benchmarks<sup>3</sup>. Then, the parsed code is passed to LiSA, along with Java-specific semantic algorithms (e.g., class hierarchy traversal, call target matching, ...) and the analysis configuration. The latter includes, among others, the list of abstract domains to execute and the property checkers that will issue warnings. These can be either existing components provided by LiSA or custom ones defined in JLiSA. Regarding SV-COMP 2026 [4], JLiSA was configured with the following settings:

- *Analysis Settings.* We configured the interprocedural analysis, which computes a program-wide fixpoint, to start in the `main` methods and use a call-string-based approach for managing contexts at call sites [23], with a maximum depth of 150 nested calls. After evaluation, we found that this depth is well-suited for SV-COMP benchmarks, providing a good trade-off between precision and performance. For call chains longer than 150, the analysis resorts to an over-approximation (the top abstract state). Since call-string analysis alone does not resolve Java’s virtual method targets, 0-CFA [10] was used to construct the call graph.
- *State Settings.* The state of the analysis was structured according to Ferrara et al. [8], employing: (i) a field-sensitive program-point based heap abstraction [1] to track objects and their fields, (ii) a reduced product between a constant propagation analysis (tracking numerical, string, and Boolean values) and the interval domain [6,7], for abstracting values, and (iii) type inference for considering the runtime types of expressions. The state was further wrapped into a *reachability* analysis, that distinguishes definitely reachable instructions from possibly reachable or unreachable ones relying on the traversed conditions; for instance, the true branch of an if-then-else statement is definitely reachable only if (i) the condition is reachable, and (ii) the condition is always satisfied — if the latter is instead sometimes satisfied, the branch is considered possibly reachable.

After the analysis, two property checkers were executed, one for runtime exceptions and one for failing asserts.

## 1.1 Tool pipeline and Software Architecture

The BenchExec framework [5] orchestrates the execution of our tool within the SV-COMP benchmarking infrastructure. A dedicated CLI tool preprocesses the Java benchmarks by translating property specifications and configuration files into JLiSA inputs. This preprocessing step sets the *checks options*, such as runtime safety and assertion violation checks, and other *configuration options*, according to the properties to be verified and the Java source files under analysis.

<sup>3</sup> <https://gitlab.com/sosy-lab/benchmarking/sv-benchmarks/-/tree/svcomp26/java/autostub>

At the end of execution, JLiSA frontend may return an analysis result, containing warnings. The CLI tool then collects and post-processes the analysis results. Specifically, it uses the property file to determine which warnings to extract and process from JLiSA’s analysis output and the selected warnings are used to produce a final report in the format required by SV-COMP. In particular, there are two main generic families of warnings (possible or definite). In addition, warnings about assertions report whether an assertion holds or does not. JLiSA reports that a test case is verified if either no warning is produced, or only definite warnings about assertions that hold are produced. Instead, it reports that a test case is not verified if only definite warnings about thrown exceptions or assertions that do not hold are produced. In all other cases (e.g., assertions that may or may not hold), JLiSA returns unknown to avoid false positives and false negatives. LiSA and JLiSA are both developed in Java (version 11 and 17, respectively), and rely on several standard libraries (such as log4j, JUnit, and reflections). JLiSA parses Java code through the Eclipse Java Development Tools. Instead, the CLI tool is written in Python and relies on PyYAML to read YAML files, and Typer to build the CLI application.

## 1.2 JLiSA Architecture

Figure 1 draws the overall architecture and an in-depth overview of JLiSA frontend components.

As shown in Figure 1, JLiSA (i) transforms the Java source code into its internal representation (middle left), (ii) performs a fixpoint computation of the semantics over the domains specified in the configuration (center), and (iii) produces an abstract state for each program point. All the standard components of the analysis rely on the LiSA library (grey background), while other components have been extended and customized in JLiSA (white background).

$\top$  and  $\perp$  are special elements, representing *any value* and *no possible value*, respectively. Instead, CP, INT, R, DR denote *constant propagation* and *interval* abstract domains, *reachability*, and *definitely reachable*, respectively.

After the analysis, two semantic checks are executed to produce the final report (bottom right). The first verifies the validity of assert statements by reasoning about (i) their reachability and (ii) the satisfiability of their conditions. The second identifies statements that may throw runtime exceptions and determines whether such exceptions are properly caught. The two checks are always executed simultaneously, and JLiSA is unaware of which property is under investigation; therefore, both kinds of warnings may appear in its output. It is the CLI tool that uses the property file to determine which warnings to extract and process from JLiSA’s analysis output.

## 2 Strengths and Weaknesses

The main strength and weakness of JLiSA are in its foundation in abstract interpretation theory. We strongly believe in the need for (coarse) approximation

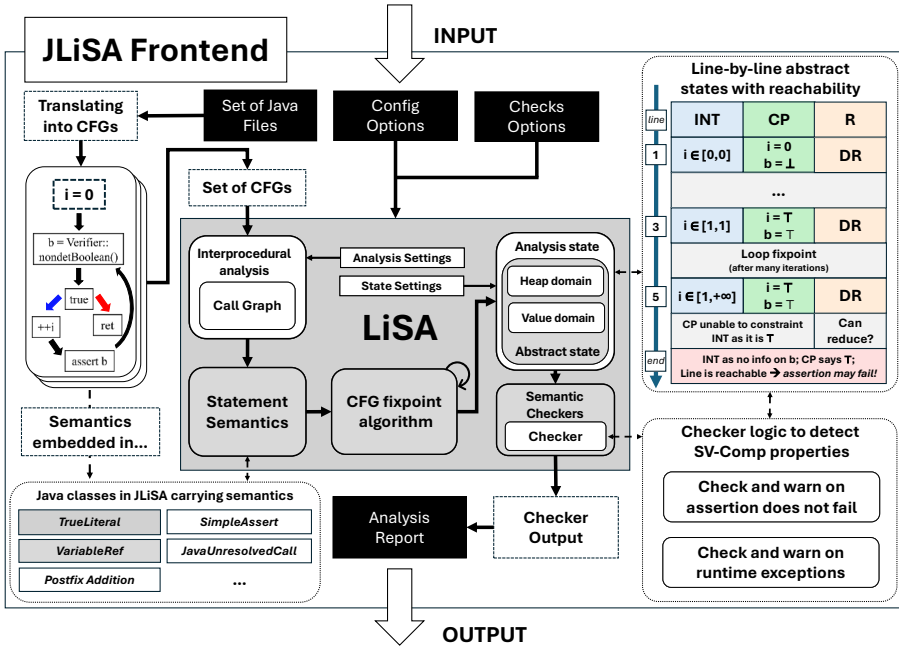


Fig. 1: JLiSA architecture

in order to make sound static analysis feasible. In practice, this means that (i) we can develop a wide variety of abstractions, modifying them based on our needs (strength), and (ii) we might produce false alarms (weakness). Point (i) gave us a strong advantage over other tools, since we could quickly adapt and modify the analyses we apply to the SV-COMP benchmark, especially when test cases were added (which was quite the case this year in the Java category). Point (ii) penalizes us since false alarms in SV-COMP are highly penalized. Generally speaking, a precision of 90% (that is, a pretty good precision for any generic abstract interpretation-based static analyzer) would be an excellent result, but this would end up in a negative score at SV-COMP (as a single false alarm incurs a  $-16$  penalty versus a  $+2$  benefit for a true alarm). To mitigate this weakness, we carefully post-processed the alarms generated by our analysis, as described in Section 1.2, and reported an alarms only when we were fully confident that it was a true positive.

The scores obtained by JLiSA at SVCOMP properly reflect our design choices. In particular, more than 95% of the points were awarded for correct true reports. Since the rules we applied to raise warnings were quite strict to avoid incorrect false reports, JLiSA did not produce any, thanks also to our conservative approach detailed in Section 1 for handling unproven cases. In addition, since JLiSA is sound, no incorrect true report was produced.

*Data Availability Statement.* The Unix binary of JLiSA that participated in SV-COMP 2026 is available at <https://doi.org/10.5281/zenodo.17609338>. The source codes are publicly available at <https://github.com/lisa-analyzer/jlisa> and <https://github.com/lisa-analyzer/lisa> for JLiSA and LiSA, respectively. JLiSA Gradle’s configuration defines its dependency on specific LiSA versions. Both projects are released with an MIT license. The competition artifact was generated from commit ID ce67adb (tag svcomp-2026 of the JLiSA repository).<sup>4</sup> The JLiSA executable can be obtained either by downloading the competition archive or by building it from source as described in the README<sup>5</sup>.

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<sup>4</sup> In the Zenodo artifact, we explicitly added the commit ID to the JLiSA version (v0.2-ce67adbda) to distinguish it from other versions. Locally built versions may appear without the commit ID.

<sup>5</sup> <https://github.com/lisa-analyzer/sv-comp#build-sv-comp-2026-executable>

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