STATIC ANALYSIS WITH SOOT AND PHASAR

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SOAP 2020 | 15.06.2020

Fraunhofer IEM

HEINZ NIXDORF INSTITUT
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AGENDA

1. A few words about us
2. Soot and Phasar
   a) General functionality
   b) Some internals
   c) How to use the frameworks
   d) Future development
3. Contributing

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Soot and Phasar

A brief history

- Established around 1999,
  by Sable Research group @ McGill
- Tutorial at PLDI 2003
- Support for Java, Android (since 2011)
- Large user base, >1.300 citations
  118 👀, 1.400 ☆ on Github
- Several commercial deployments
- LGPL-2.1 licence

https://www.sodafactory.com.au/events/jukebox-thursday-aug1/

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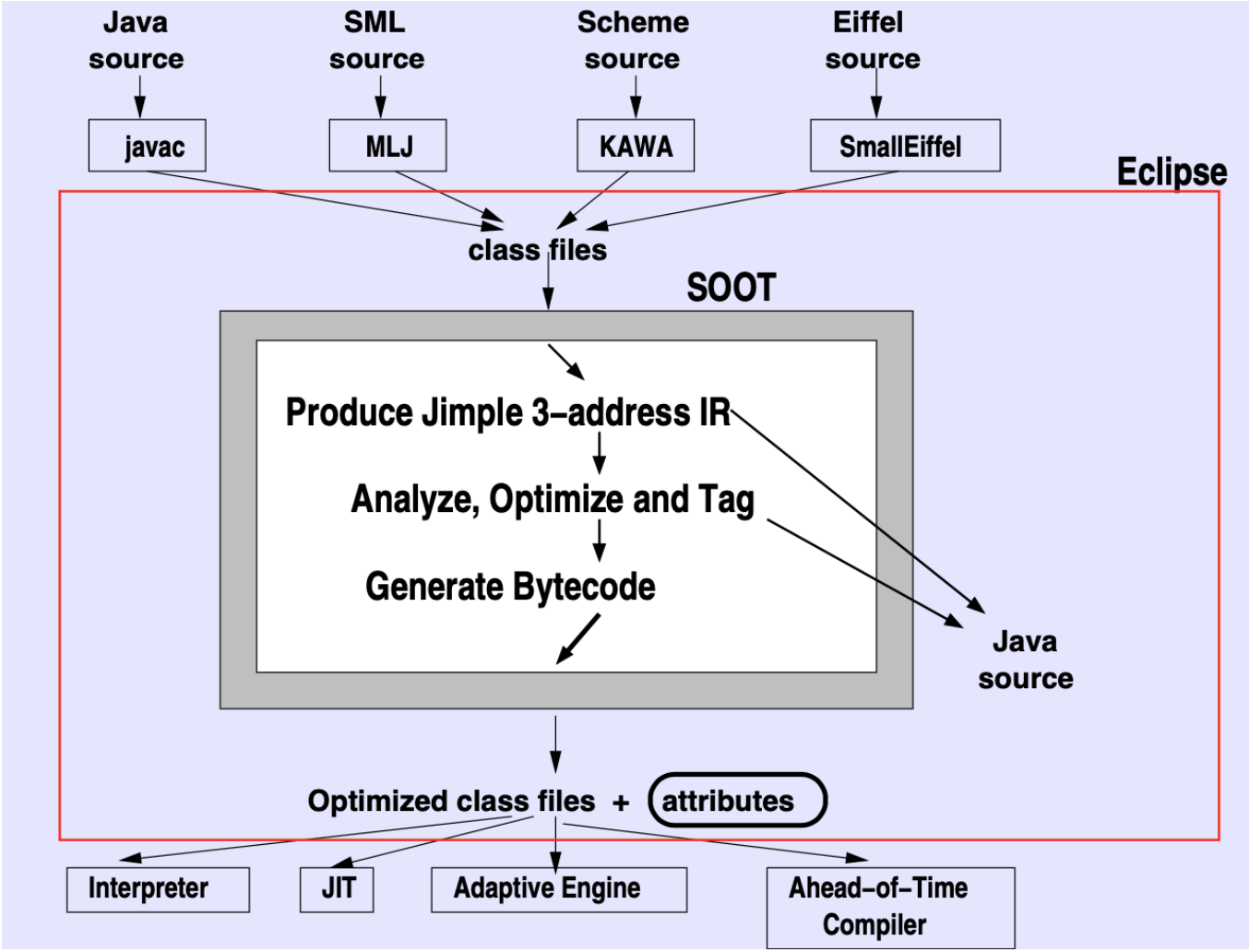

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- Established around 2016, by us
- Tutorial at PLDI 2018
- Support for LLVM IR (particularly C/C++)
- Growing user base
  26 👀, 391 ☆ on Github
- Some commercial engagement
- MIT license

Soot and Phasar

How to access

- https://www.soot-oss.org/ (GitHub)
- Usage documentation in wiki
- Easily obtained or built via Maven
- Supports Java bytecode up to version 14, some support for source code
- Code analysis and transformation

- https://phasar.org
- https://github.com/secure-software-engineering/phasar
- Usage documentation in wiki
- Built via CMake
- Supports C-like languages including C/C++
- Code analysis and transformation

Soot and Phasar

Introductory papers

Vallée-Rai et al.: **Soot - a Java bytecode optimization framework.** CASCON'99

Patrick Lam et al. **The Soot framework for Java program analysis: a retrospective.** CETUS 2011

Vallée-Rai and Laurie Hendren: **Jimple: Simplifying Java Bytecode for Analyses and Transformations.** Sable TR 1998-4

Schubert et al.: **Static Analysis for C++ with Phasar.** PLDI'18 tutorial

Schubert et al.: **PhASAR: An Inter-procedural Static Analysis Framework for C/C++.** TACAS'19

Schubert et al.: **Know Your Analysis: How Instrumentation Aids Understanding Static Analysis.** SOAP'19

Soot and Phasar

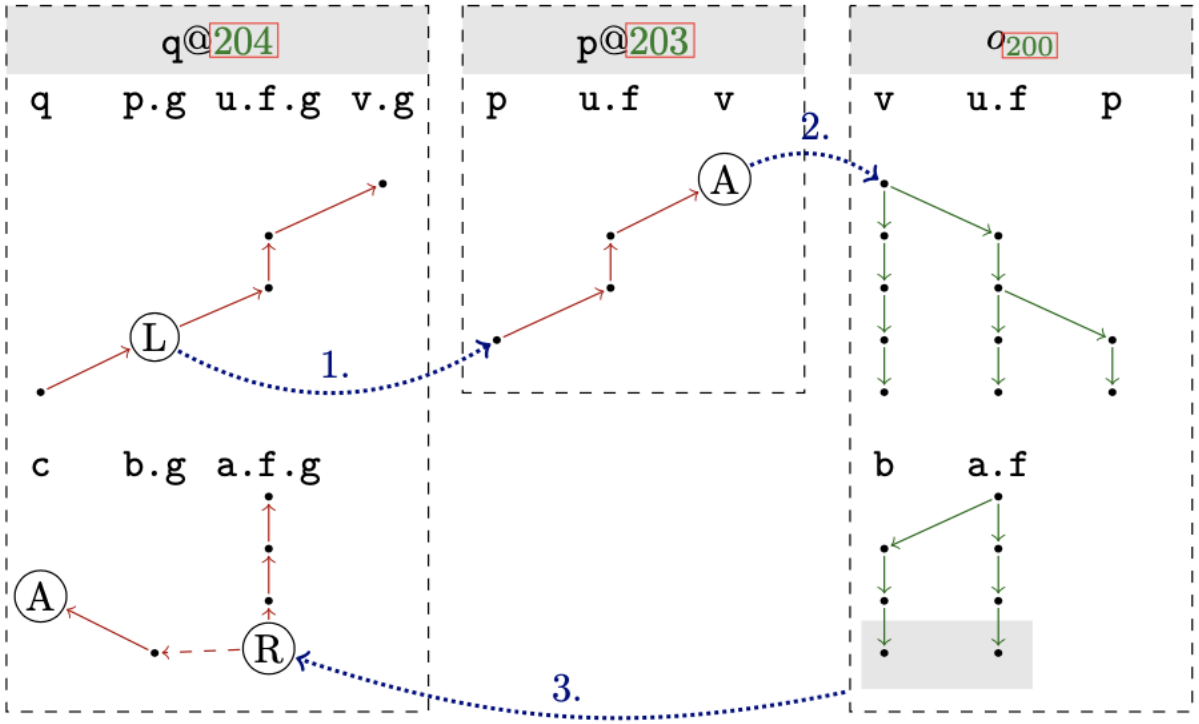
Core functionalities

Intermediate 3-address-code representation	
Jimple, high level	LLVM IR, low level, SSA; other IRs possible
Call-graph analysis	
Spark: CHA, RTA, VTA, Andersen, ..., FlowDroid	CHA, RTA, DTA, Andersen, Steensgaard
Points-to analysis	
Andersen-style, Refinement-based (PLDI‘06) Boomerang (ECOOP‘16)	LLVM points-to infrastructure (including Andersen and Steensgaard-style analyses)
Inter-procedural data-flow solvers	
IFDS/IDE (through Heros), FlowDroid, IDE*al*, Synchr. Pushdown Systems (SPDS)	IFDS/IDE, Call-strings, WPDS (via WALi-OpenNWA)

Latest Solver: Synchronized Pushdown System (SPDS)

Demand-driven flow-, field- and context-sensitive

```
198 foo(){
199   u = new;
200   v = new;
201   u.f = v;
202   setG(u);
203   p = u.f;
204   q = p.g;
205 }
206 setG(a){
207   b = a.f;
208   c = new;
209   b.g = c;
210 }
```



no k-limiting!

∞-context-sensitive

∞-field-sensitive

... both for pointer and client analysis!

Johannes Späth: **Synchronized Pushdown Systems for Pointer and Data-Flow Analysis**, PhD thesis, Universität Paderborn, 2019.

Johannes Späth, Karim Ali, Eric Bodden: **Context-, Flow-, and Field-sensitive Data-flow Analysis Using Synchronized Pushdown Systems**, In Proceedings of the ACM SIGPLAN Symposium on Principles of Programming Languages, pages 48:1–48:29, 3(POPL), 2019.

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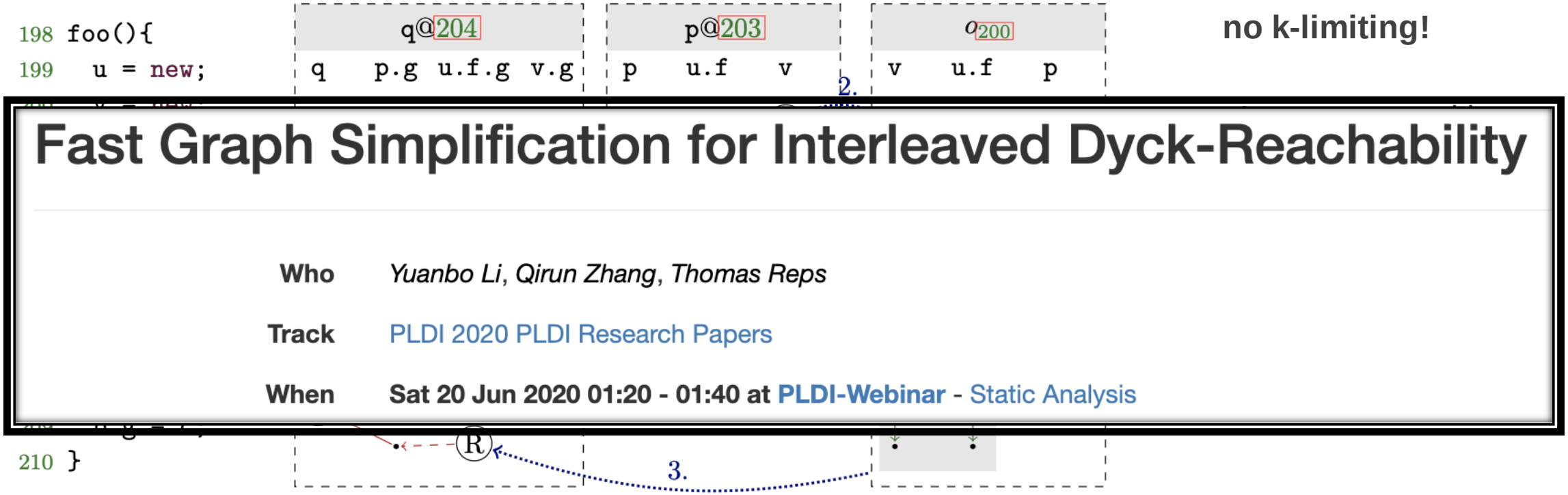

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Soot and Phasar

Interaction and usages

- Provides core functionalities
- Generic data-flow solvers as extensions
- Java dependency
  - Can be included using *Maven*, Gradle, SBT, etc.
- Command-line tool
- Get help through mailing list and issue tracker

- Monorepo organized using CMake
- Usages
  - (Sub)libraries
  - Plugins
  - *phasar-llvm* command-line tool
- Find help on Slack phasar.slack.com

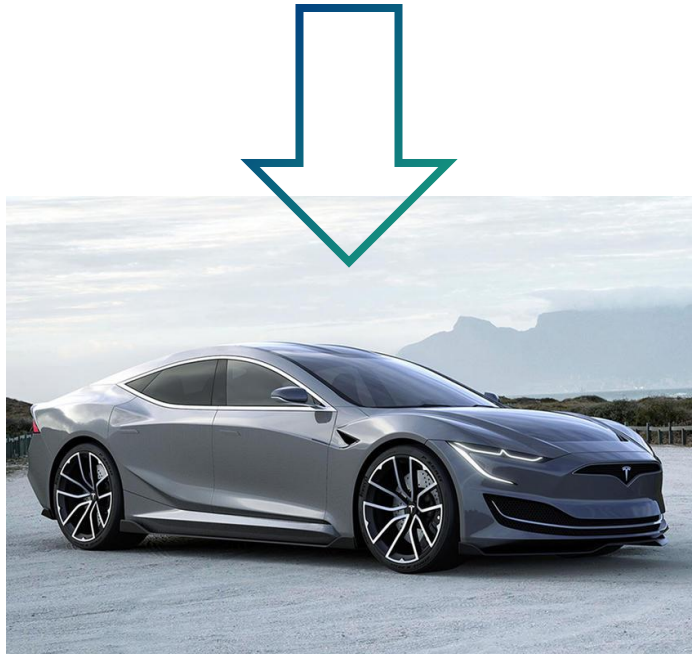
Soot and Phasar

Future development

Funded by
DFG Deutsche Forschungsgemeinschaft
German Research Foundation

FutureSoot DFG project

- Completely new architecture (no singletons)
- Support for multiple “scenes”, comparative and incremental code analysis
- More modularity, less legacy, better testability
- IR akin to Jimple but optimized for fast access
- First release hopefully still this year
- Upcoming: workshop with interested stakeholders



Soot and Phasar

Future development

https://images.app.goo.gl/ShtuzjJSDG6aeeJr9

Technical improvements

- Completely revised analysis model
- Improved usability
- Performance improvements

Old dogs new tricks: improve on SPDS

- Add support for strong updates
- Fine tune algorithmic and technical details
- Overcome C/C++ specific difficulties
- Evaluation on large production software

Using Soot and PhASAR

Contributions and Collaborations

- Static Analysis is hard
- Maintaining tools is fun but a lot of work
- We welcome any contribution
  - Report bugs
  - Fix bugs `good first issue`
  - Contribute features
- Become a committer!

Questions?