Ranking source code static analysis warnings for continuous monitoring of FLOSS repositories

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Who am I?

- Former guest researcher at the US National Institute of Standards and Technology
- Masters degree student at University of São Paulo
- Fedora Project contributor

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What is Static Analysis?

- Extract facts from the **source code** to
- find **flaws**
- by reporting **warnings**.
- Warnings are aggregated in **reports**
- Reports are generated by **static analyzers**

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Why use Static Analysis?

- Find (and act on) **flaws**
- by exploring abstractions of **many** program behaviors
  - **Hard** to do with automated testing
- to increase software **quality**

Motivation

Undecidability

- Fundamental static analysis problems are **undecidable**
- Heuristics $\rightarrow$ **false positives** and **false negatives**

- **Reports** contain too much (misleading) information
- More misleading information $\rightarrow$ Less valuable tool
- Too much misleading information $\rightarrow$ **Worthless** tool

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Possible solution...

- Use **multiple** static analyzers
  - Increase coverage $\rightarrow$ reduce false negatives
- Apply a classification approach on the output (warnings)
  - Discard (**possible**) false positives

kiskadee: a continuous static analysis tool

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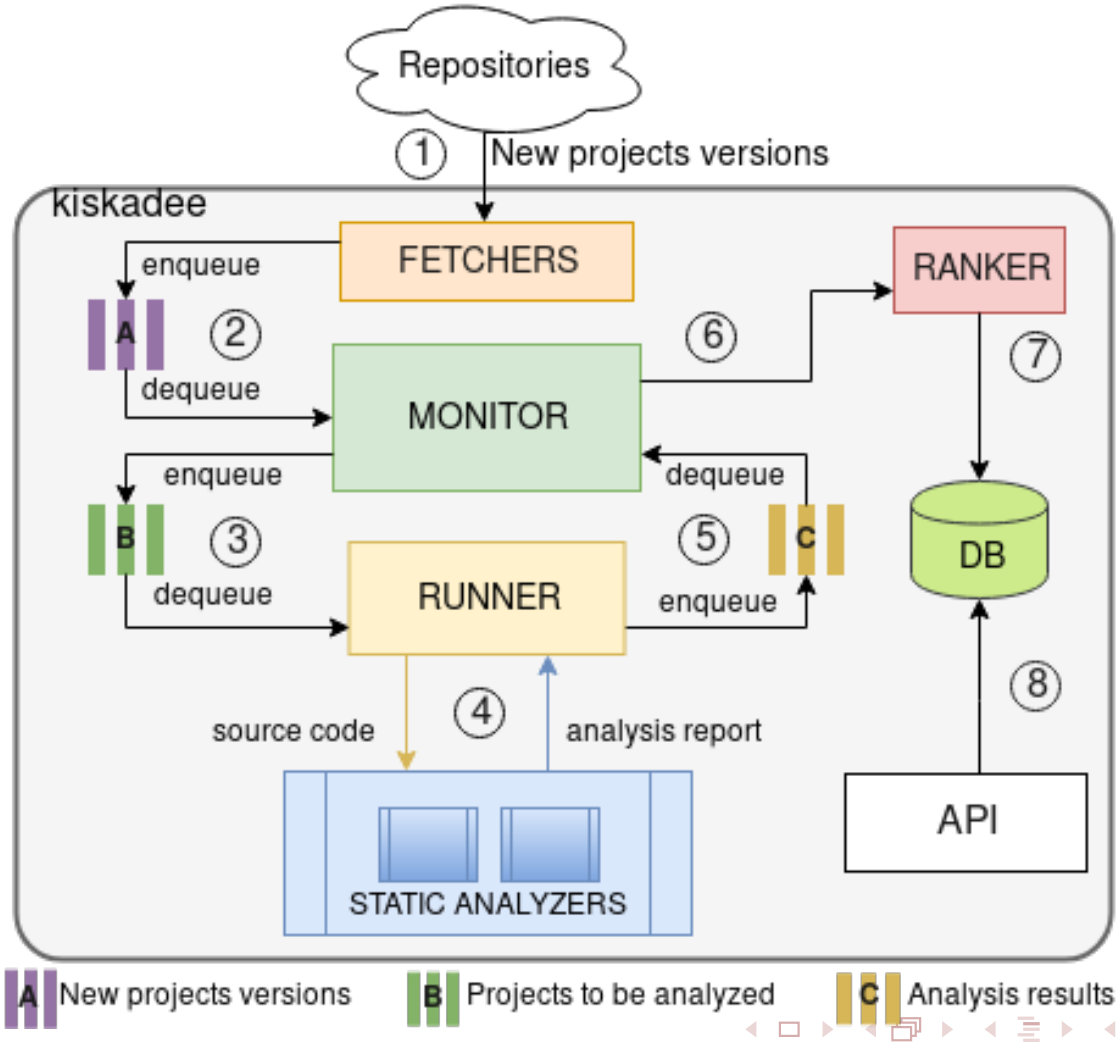
kiskadee design overview



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We start with a classification problem...

- True Positive / False Positive
- No information on the analyzed project
- Weak classifiers
  - AdaBoost
    - Boost decision trees
    - Can use both categorical and non-categorical features
    - DT are easy to train
- Supervised learning
  - We need a set of known flaws to train our model

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Juliet: Static analysis test suite

- NIST/SAMATE $\rightarrow$ **Juliet**
- Test suite with **61,387 test cases**
- **118** different **CWEs**
- C programming language
- Specific flaws in **known locations**

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Preparing a dataset from Juliet

	Before Pruning	After Pruning
C	36,078	22,459
C++	25,309	16,641
Total	61,387	**39,100**

Table: Number of Juliet test cases

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Running static analyzers on our Juliet subset

Tool	Warnings
Clang Static Analyzer	37,229
Cppcheck	124,025
Frama-C	120,573
Total	**281,827**

Table: Total number of warnings generated per tool

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Labeling warnings

Tool	Warnings	TP	FP	FP Rate	Precision
Clang Analyzer	6207	984	5223	0.84	0.16
Cppcheck	4035	314	3721	0.92	0.08
Frama-C	15717	8892	6825	0.43	0.57
Aggregated tools	25959	10190	15769	**0.61**	**0.39**

Table: Labeled warnings per tool

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Features and final dataset

- Dataset with features to train AdaBoost classifier extracted from labeled warnings
- Features
  - Tool name
  - Programming language
  - Severity
  - Redundancy (with tool names)
  - Number of neighbors
  - Category
  - Number of warnings in the same file
  - **True**/**False** positive

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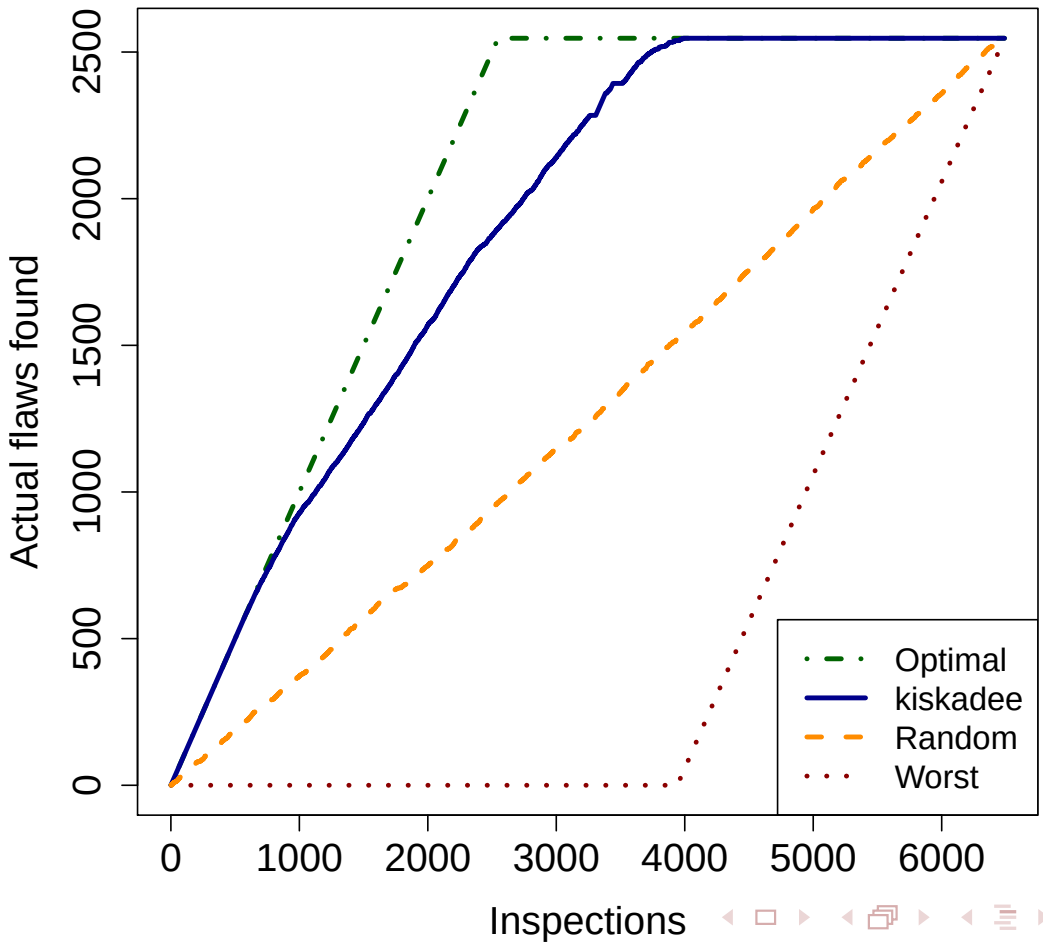
Ranking warnings

- Use AdaBoost classifier probabilities
- Warnings with higher probabilities of being True Positives to the top
- Warnings with lower probabilities of being True Positives to the bottom

Inspections vs flaws found



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Conclusions

- FLOSS static analyzers show poor FP rates
- Ranking model does not use features based on the analyzed project
- We trade accuracy for generalization

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- Fedora Project

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Questions?

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