UNIVERSITY OF ALBERTA

Identifying Bugs Related to Non-Functional Requirements in Java and Python

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Background: Non-Functional Bugs

- Non-Functional Bug (NFB) = a bug that does not affect what the program does, but **how** it does it

- Fixes include making programs more time efficient, memory efficient, secure, etc.

OBJECTIVE

To create a dataset of NFBs in open-source software projects

Related Work

1. **MuBench**: dataset of 89 API misuses from 33 open source projects and survey

2. **Defects4J**: 357 real Java bugs from 5 open source projects

3. **Bugs.jar**: 1,158 Java bugs from 8 open source Apache projects

4. **Ohira et al**: dataset of 4000 functional and non-functional bugs from 4 open source Apache projects

5. **iBugs**: dataset of 369 realistic Java bugs from AspectJ

Our Dataset:

- 138 bugs from 67 open-source projects
- exclusive to non-functional bugs
- Projects written in Java or Python

[1]S. Amann, S. Nadi, HA. Nguyen, TN. Nguyen, and M. Mezini. MUBench: a benchmark for API-misuse detectors. MSR '16, pages 464-467. ACM, 2016.

[2]R. Just, D. Jalali, and M. D. Ernst. Defects4J: A Database of Existing Faults to Enable Controlled Testing Studies for Java Programs. ISSTA'14, pages 437–440. ACM, 2014

[3]RK. Saha, Y. Lyu, W. Lam, H. Yoshida, and MR. Prasad. Bugs.jar: a large-scale, diverse dataset of real-world Java bugs. MSR '18, pages 10-13. ACM, 2018.

[4]M. Ohira, Y. Kashiwa, Y. Yamatani, H. Yoshiyuki, Y. Maeda, N. Limsettho, K. Fujino, H. Hata, A. Ihara, and K. Matsumoto. A dataset of high impact bugs: manually-classified issue reports. MSR '15, pages 518-521. IEEE Press, 2015.

[5]V. Dallmeier and T. Zimmermann. Extraction of Bug Localization Benchmarks from History. ASE'07, pages 433–436. ACM, 2007.

Methodology

```yaml
source:
    name: github-search
project:
    name: Fowler
    url: https://github.com/TheFreshMango/Fowler
fix:
    tag: performance
    description: Replacing "+" with StringBuilder improves performance and memory space
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            refactoring: Customer now uses StringBuilder for statement()
    commit: https://github.com/TheFreshMango/Fowler/commit/d5f5290
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    file:
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api change:
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rule:
    use a StringBuilder instead of adding strings to concatenate efficiently
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Identify Candidate Repositories

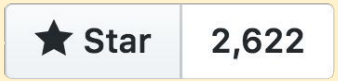
Extract commits using PyDriller

Manual Review

Documentation

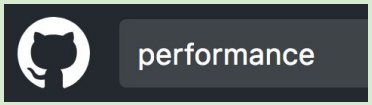
Identifying Candidate Repositories

Method One: Star Rating



- Github users “star” repositories they are interested in
- We chose the repositories with the highest number of stars
- 91 Java and 15 Python projects reviewed

Method Two: Github Search



- Github allows users to search for keywords in different domains (projects, commits, issues, etc.)
- 23 Java and 11 Python projects reviewed

Method Three: RepoReapers dataset

reaper

- Munaiah et al: set of “well-engineered” Github projects[1]
- we selected those with the most stars
- 17 Java and 10 Python projects reviewed

[1]Munaiah N, Kroh S, Cabrey C, and Nagappan M. Curating GitHub for engineered software projects. Empirical Software Engineering. 22(6): pages 3219-3253. Springer US. 2017.

Extracting Commits Using PyDriller

- PyDriller[1] is an open-source software-mining tool for Git
- Filtered the commit history of projects to messages containing **keywords** related to NFBs
- Restricted search to commits that changed .java or .py files

"fix"	"bug"	"error"
"refactor"	"secur[ity]"	"maint[enance]"
"stab[ility]"	"portab[ility]"	"efficien[cy]"
"usab[ility]"	"reliab[ility]"	"testab[ility]"
"changeab[ility]"	"replac[e]"	"memory"
"resource"	"runtime"	"crash"
"leak"	"attack"	"authenticat[ion]"
"authoriz[ation]"	"cipher"	"crack"
"decrypt"	"encrypt"	"vulnerab[ility]"
"minimiz[e]"	"optimiz[e]"	"slow"
"#"	"fast"	"perform[ance]

terms filtered out		
"typo"	"npe"	"spell"

These keywords include original words relevant to the study, as well as subsets from Hindle et al.[2] and de la Mora and Nadi[3].

[1]D. Spadini, M. Aniche, and A. Bacchelli. PyDriller: Python Framework for Mining Software Repositories. ESEC/FSE. 2018. https://github.com/ishepard/pydriller
[2]A. Hindle, NA. Ernst, MW. Godfrey, and J.Mylopoulos. Automated topic naming to support cross-project analysis of software maintenance activities. MSR '11, pages 163-172. ACM, 2011
[3]FL. de la Mora and S. Nadi. Which library should I use? A metric-based comparison of software libraries. ICSE NIER '18, pages 37-40. ACM, 2018

Manual Review

- Weeding out false positives
- Example:

2 speed_bomb.py

```
@@ -245,7 +245,7 @@ def reset_bomb_length(self):
245 245            self.bomb_length = 5.0
246 246
247 247        def get_bomb_length(self):
248     -          self.bomb_length -= 0.2
    248 +          self.bomb_length -= 0.3
249 249            if self.bomb_length < 1:
250 250                self.bomb_length = 1
251 251            return self.bomb_length
```

Commit Message: “`Update speed_bomb.py made speed change faster`”

https://github.com/adangert/JoustMania/commit/a9711c2

Documenting Bugs

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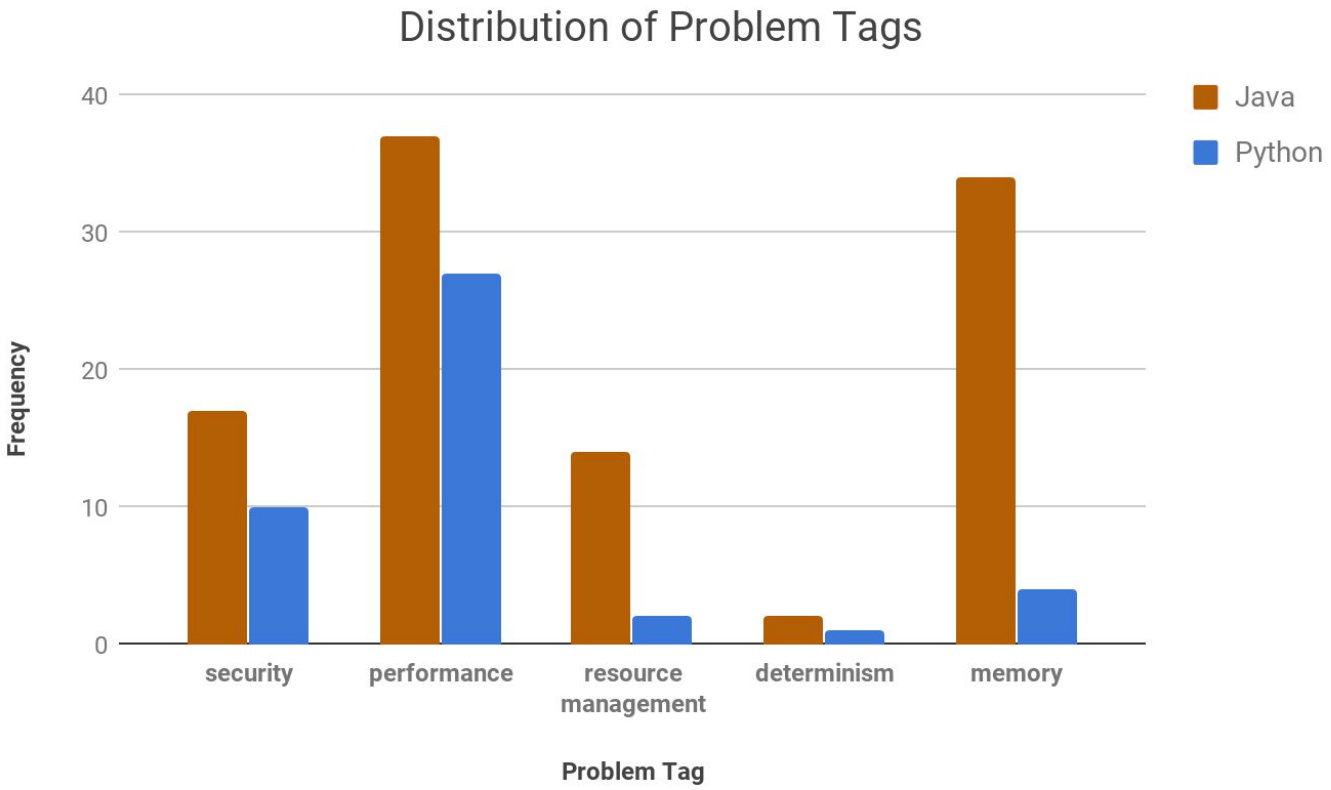
conclusion

Data Distribution



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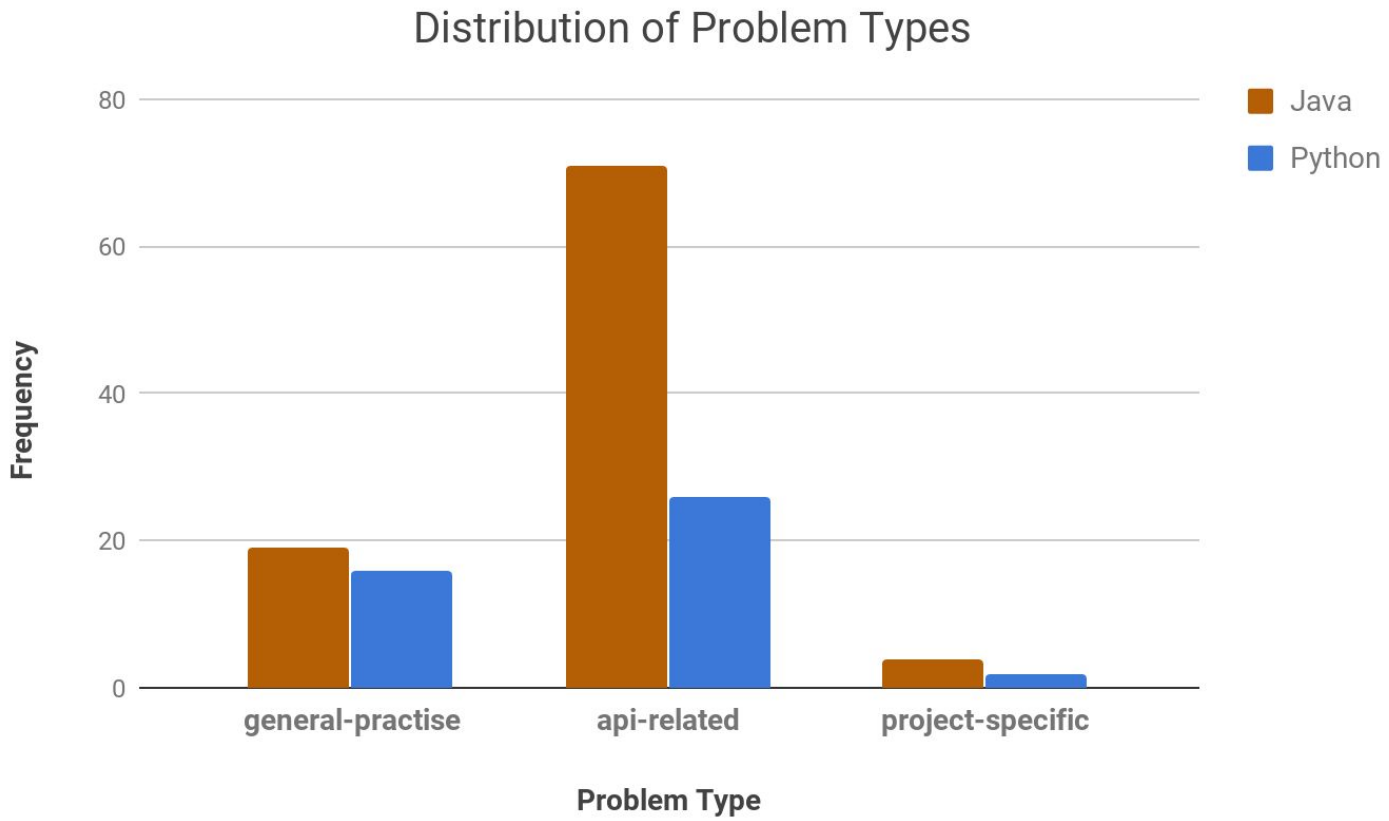

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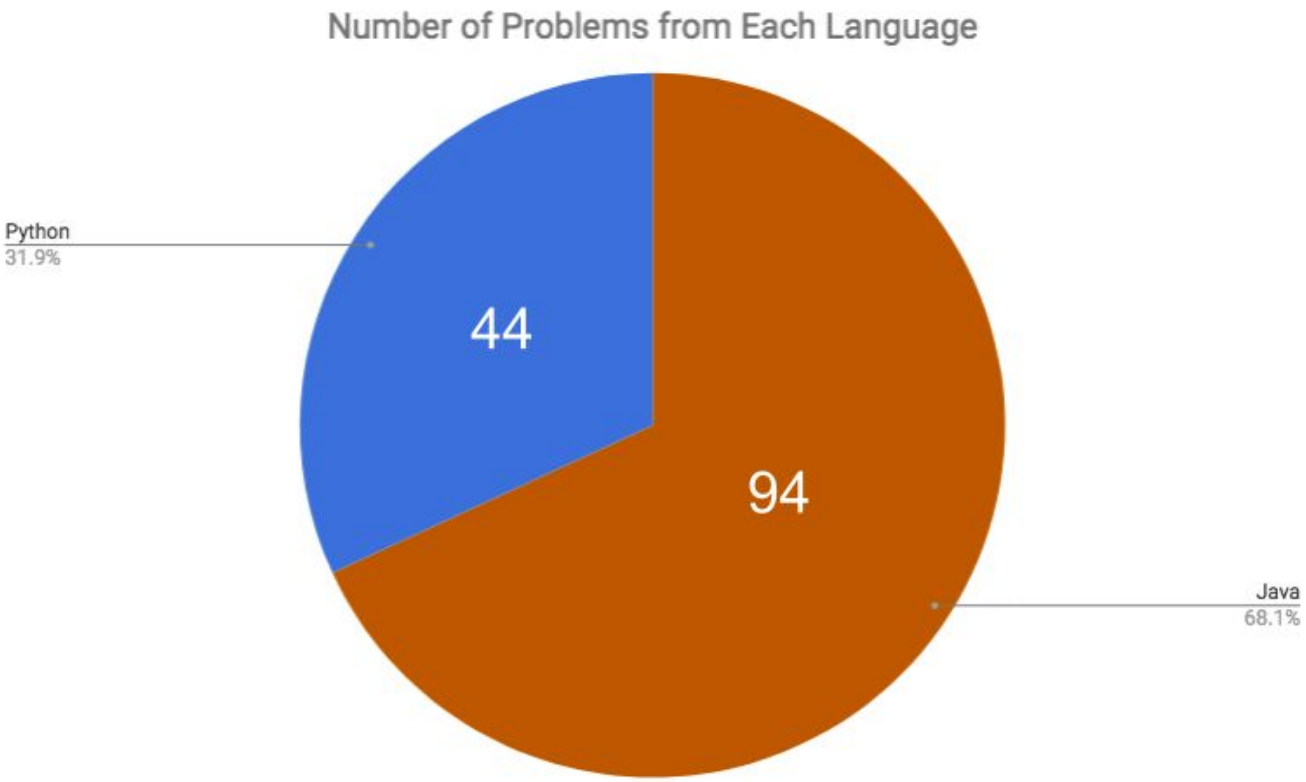
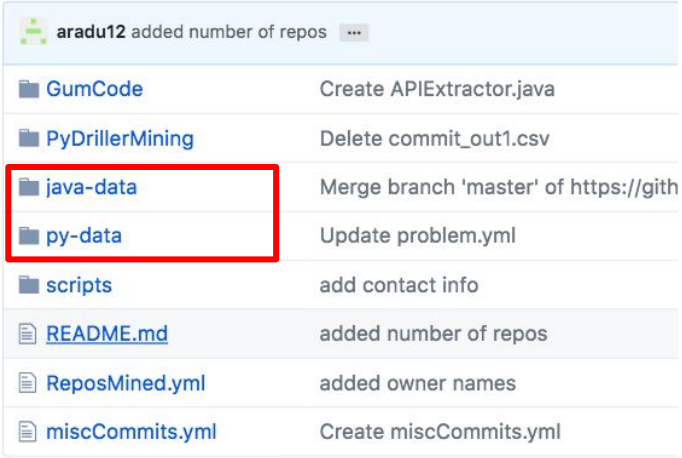


Repo Organization



- Separate folders for data in each language

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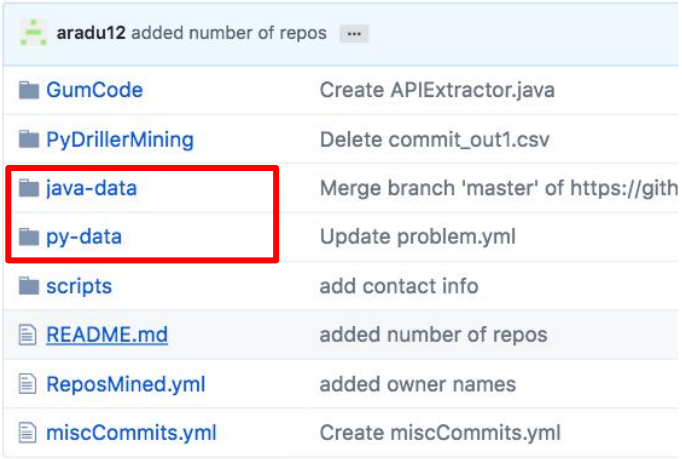

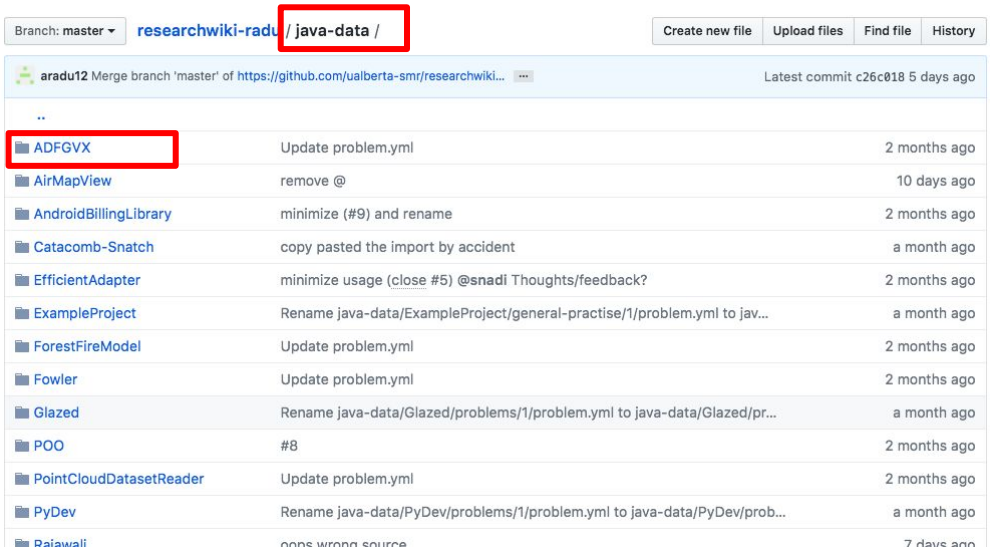

- Separate folders for data in each language
- Each project has its own folder

Repo Organization

these folders contain problems, problem version IDs, and project metadata

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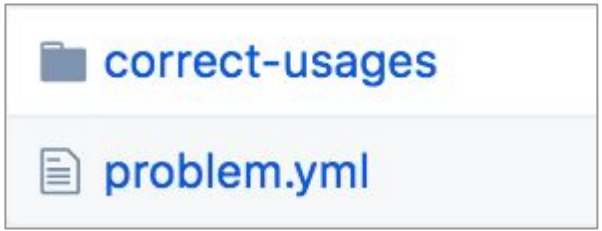
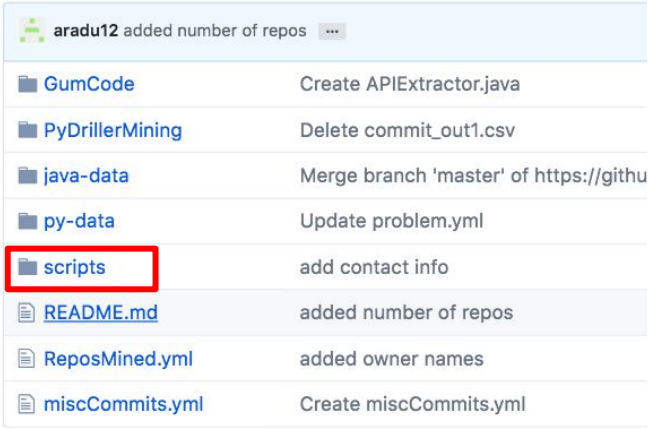


the problem details

Processing the Data



- We provide scripts to manage the data
- DataBox class allows users to filter problems by star rating, tag, problem type, etc.
- Users can write their own client script or use our example: DataBoxClient.py

Applications of the Dataset

- Code Recommenders
- Training set for bug detection tools
- Analysis of coding practices between veterans and beginners

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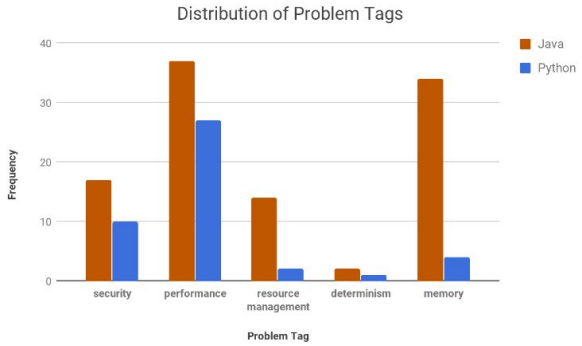

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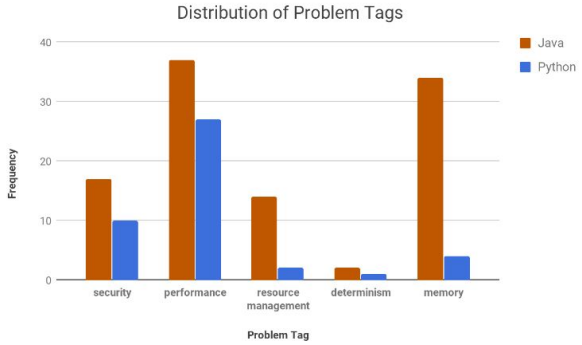
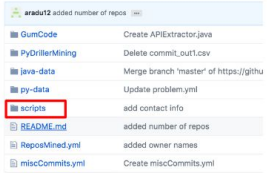


14

Processing the Data



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Access the Dataset: https://github.com/ualberta-smr/NFBugs

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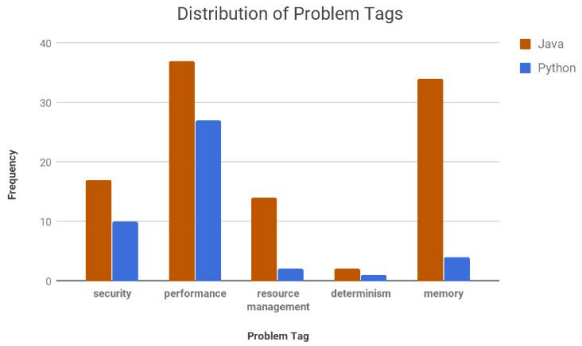

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Questions? aradu@ualberta.ca