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

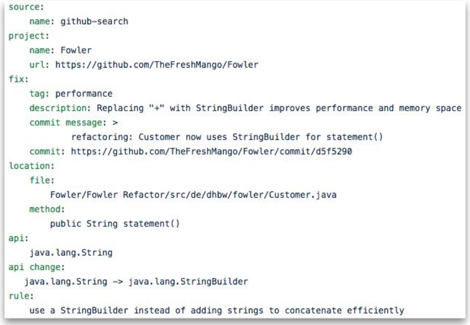
[3] RK. Saha, Y. Lyu, W. Lam, H. Yoshida, and MR. Prasad. Bugs.jar: a large-scale, diverse dataset of real-world Java bugs. MSR '18, pages 10-13. ACM, 2018.

[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

GitHub



```yaml
source:
    name: github-search
project:
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fix:
    tag: performance
    description: Replacing "+" with StringBuilder improves performance and memory space
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    use a StringBuilder instead of adding strings to concatenate efficiently
```

Identify Candidate Repositories

Extract commits using PyDriller

Manual Review

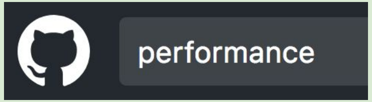
Documentation

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


performance

- ❖ 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

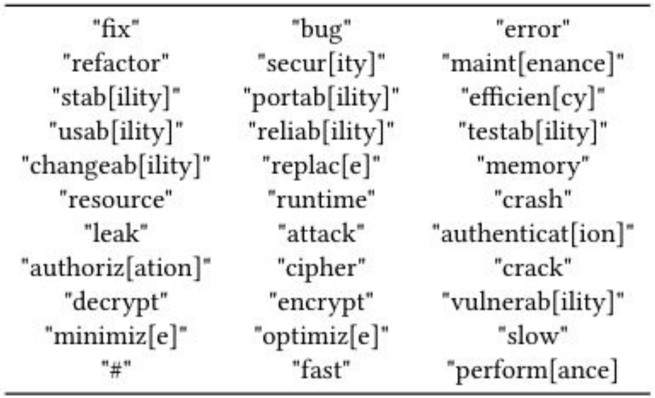
reaper

- ❖ 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.

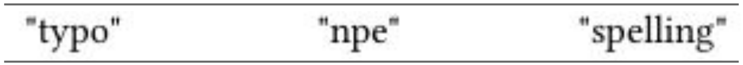
Extracting Commits Using PyDriller

- ❖ 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"	"spelling"

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].

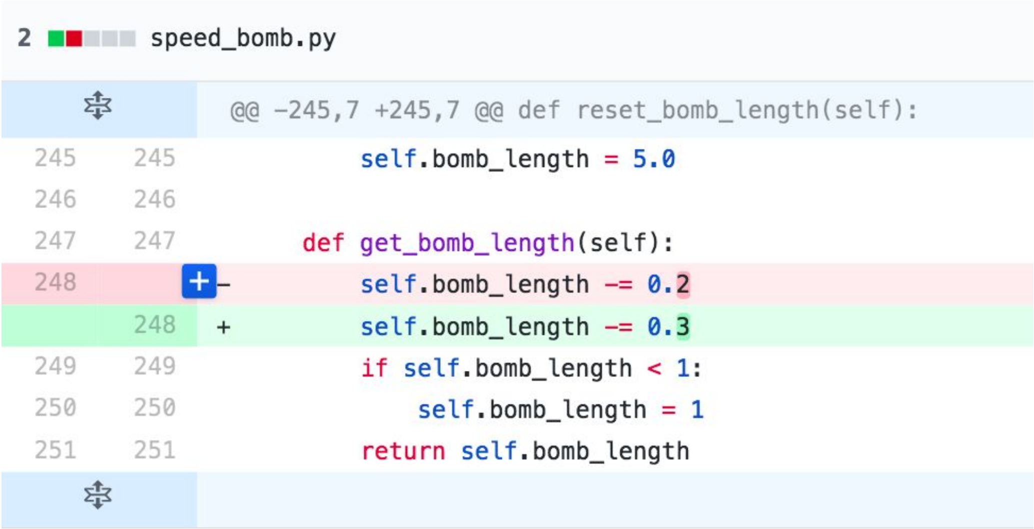
[1] D. Spadini, M. Aniche, and A. Bacchelli. PyDriller: Python Framework for Mining Software Repositories. ESEC/FSE. 2018. https://github.com/ishepard/pydriller

[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:

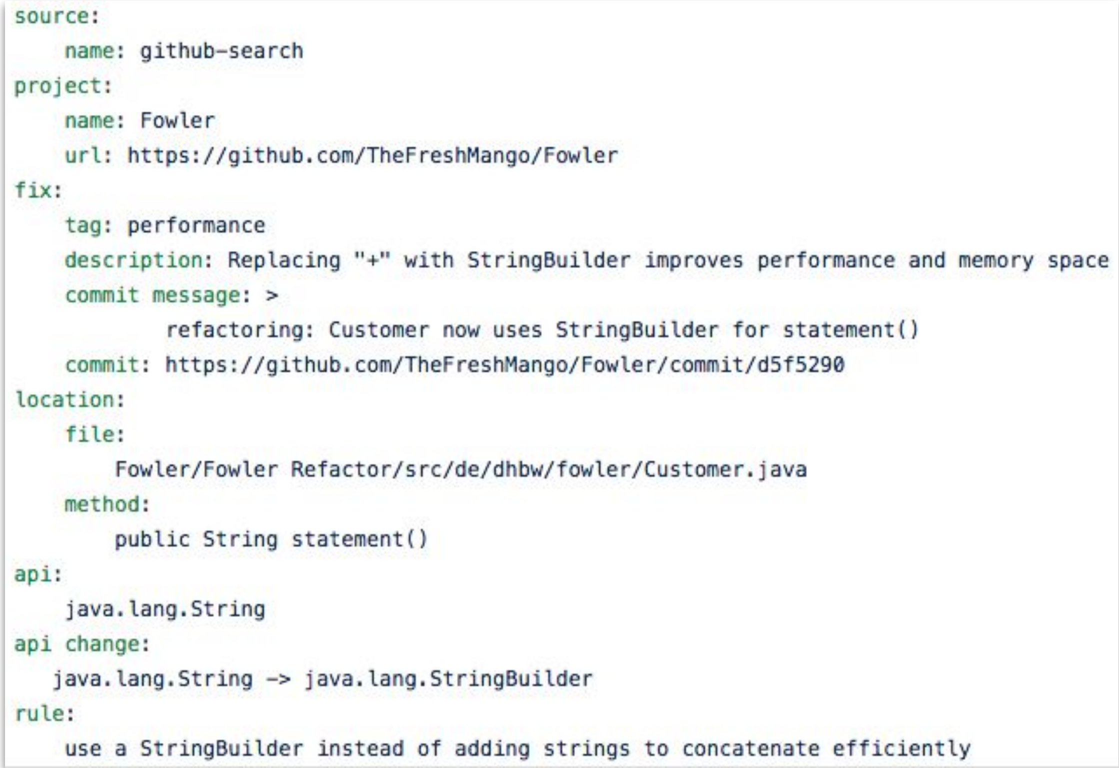


```
2 🟩🟥⬜⬜⬜ speed_bomb.py

@@ -245,7 +245,7 @@ def reset_bomb_length(self):
        self.bomb_length = 5.0

    def get_bomb_length(self):
-       self.bomb_length -= 0.2
+       self.bomb_length -= 0.3
        if self.bomb_length < 1:
            self.bomb_length = 1
        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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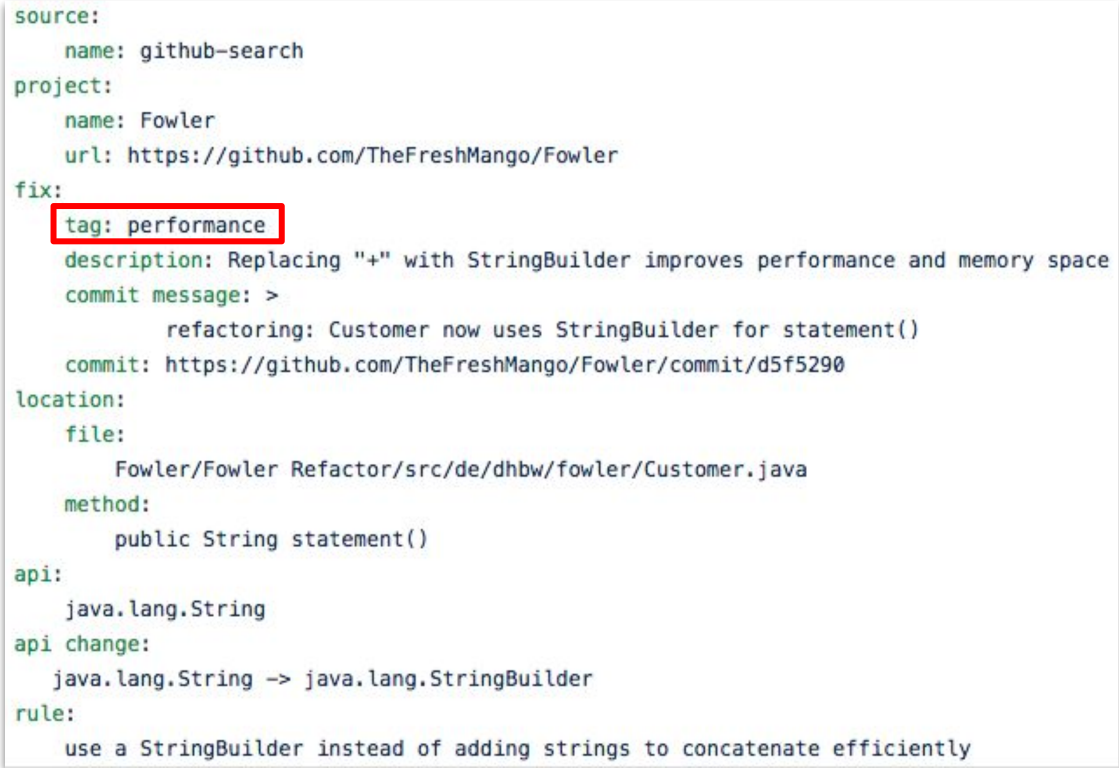

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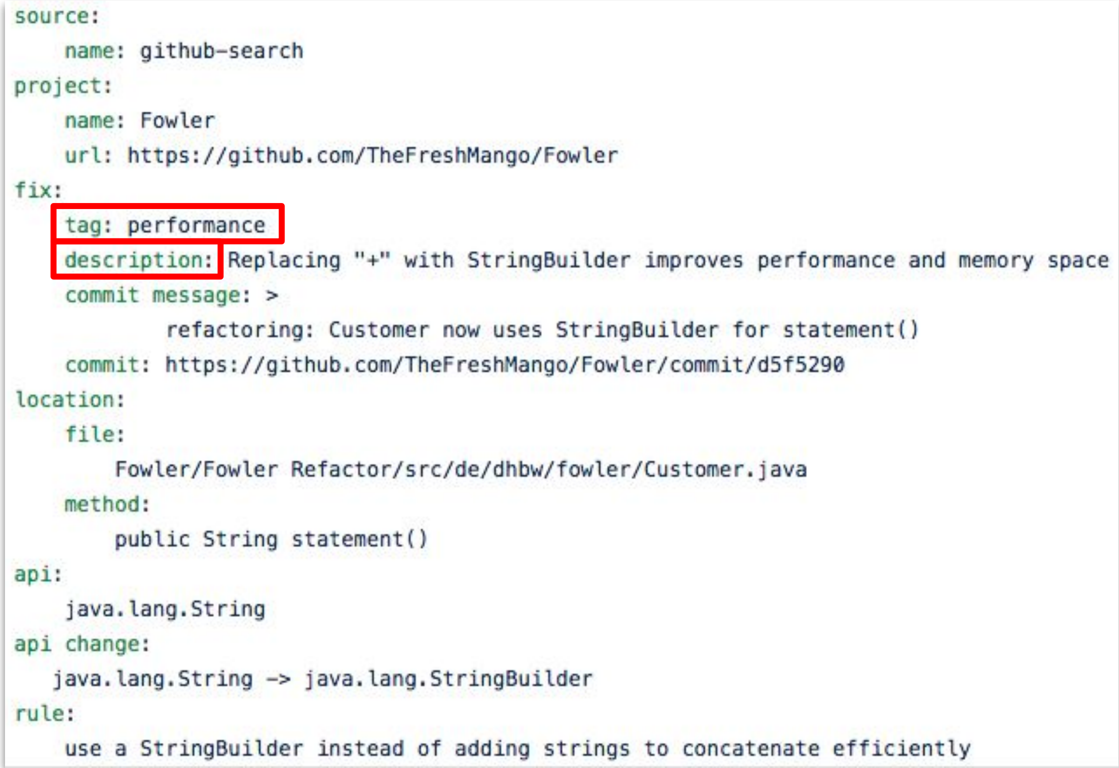
bug category

Documenting Bugs



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our interpretation
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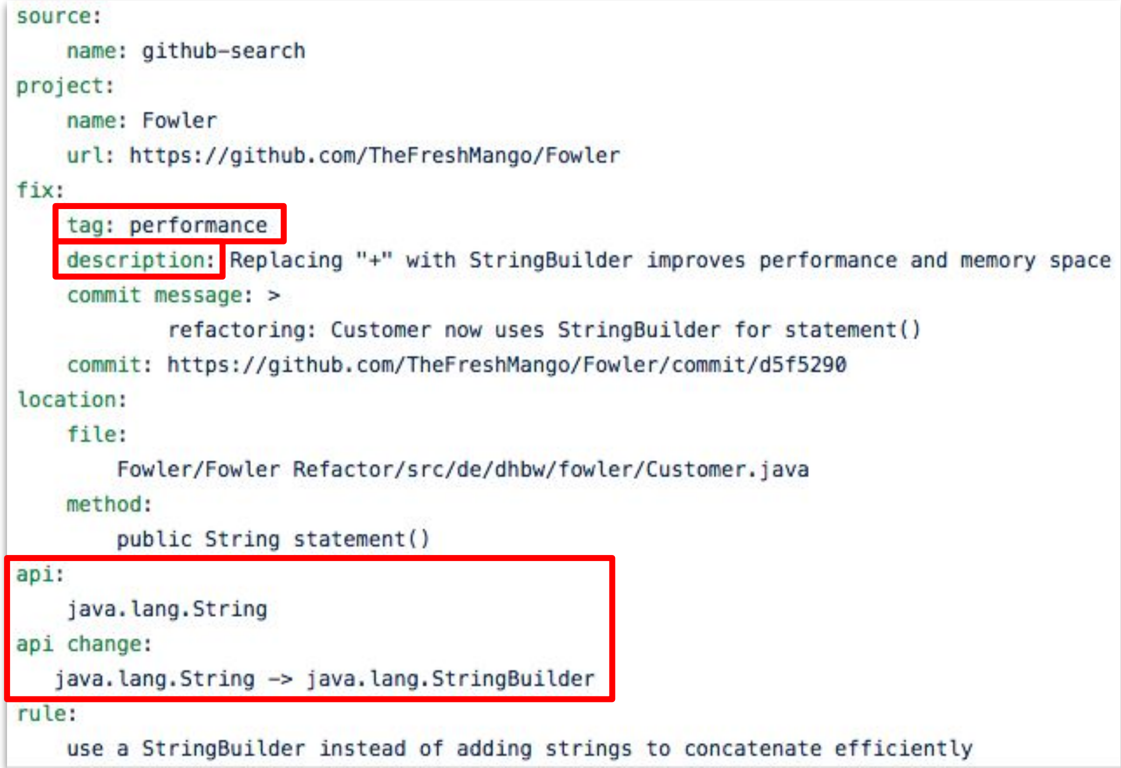

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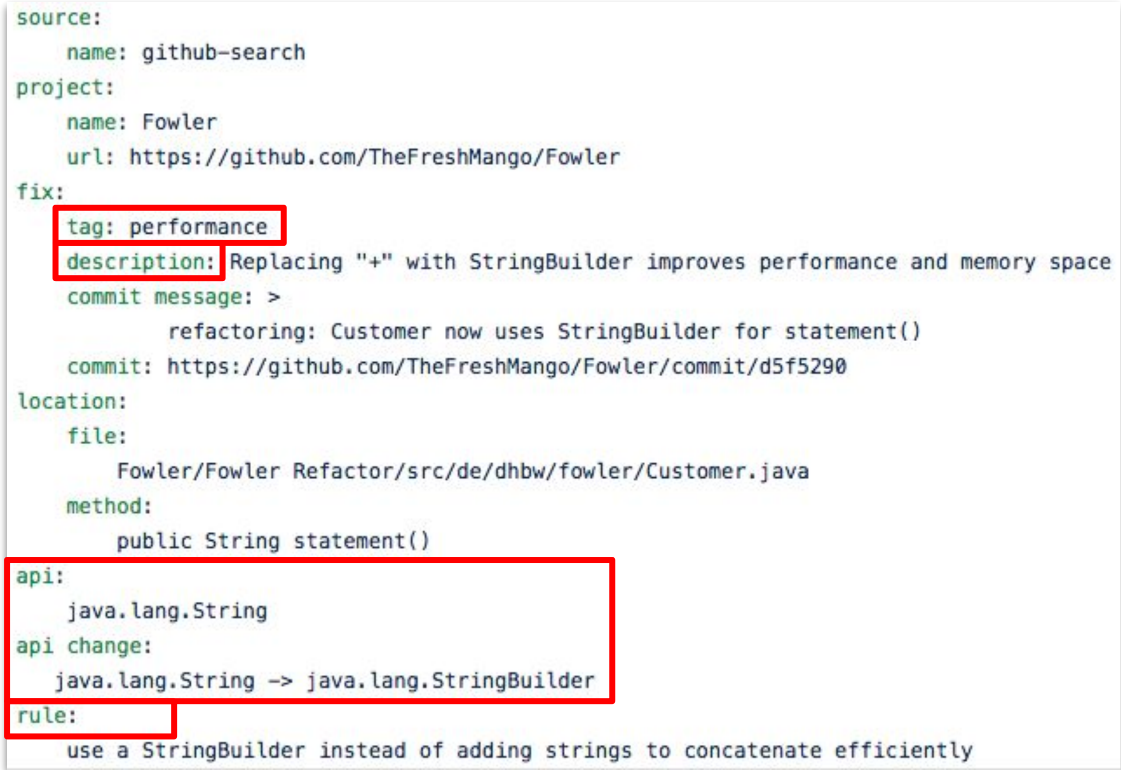

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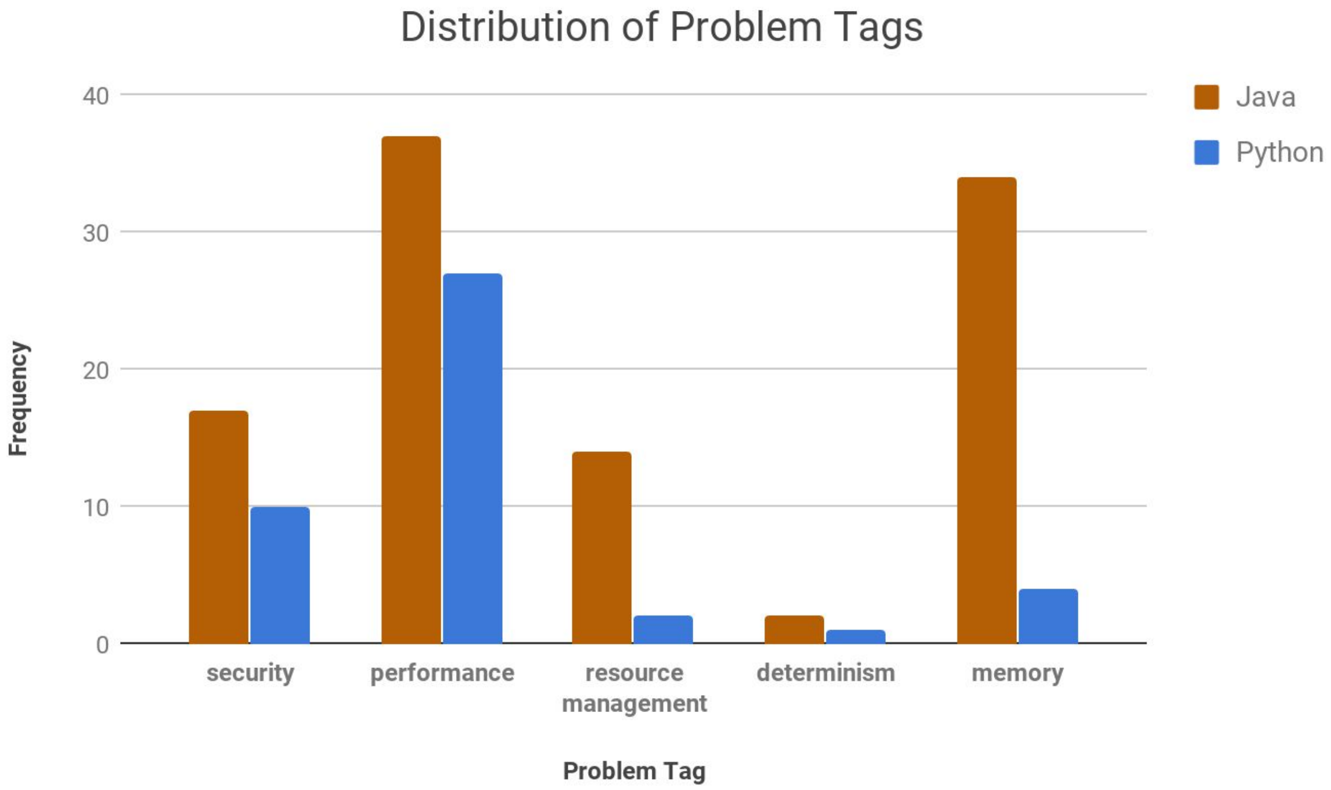
conclusion

Data Distribution



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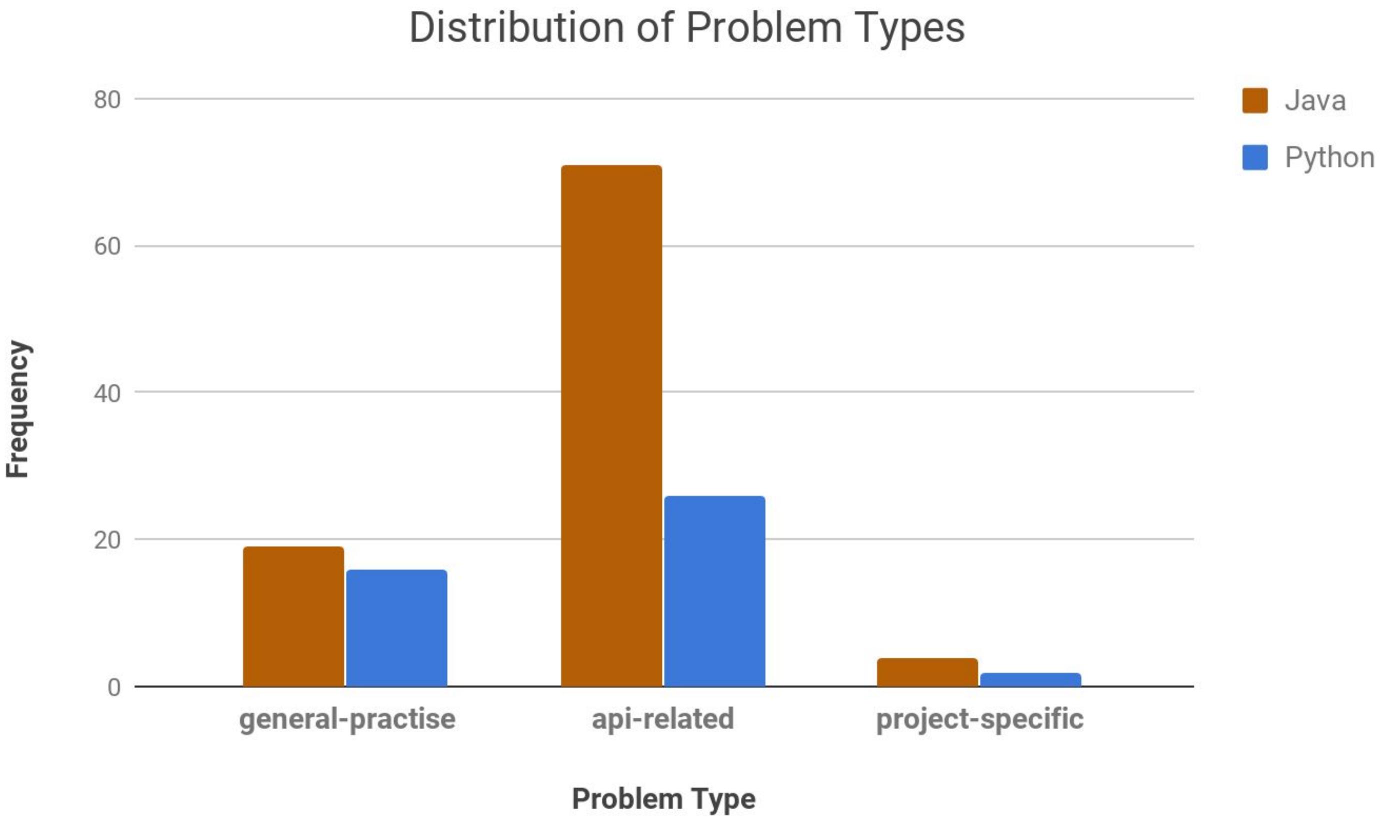

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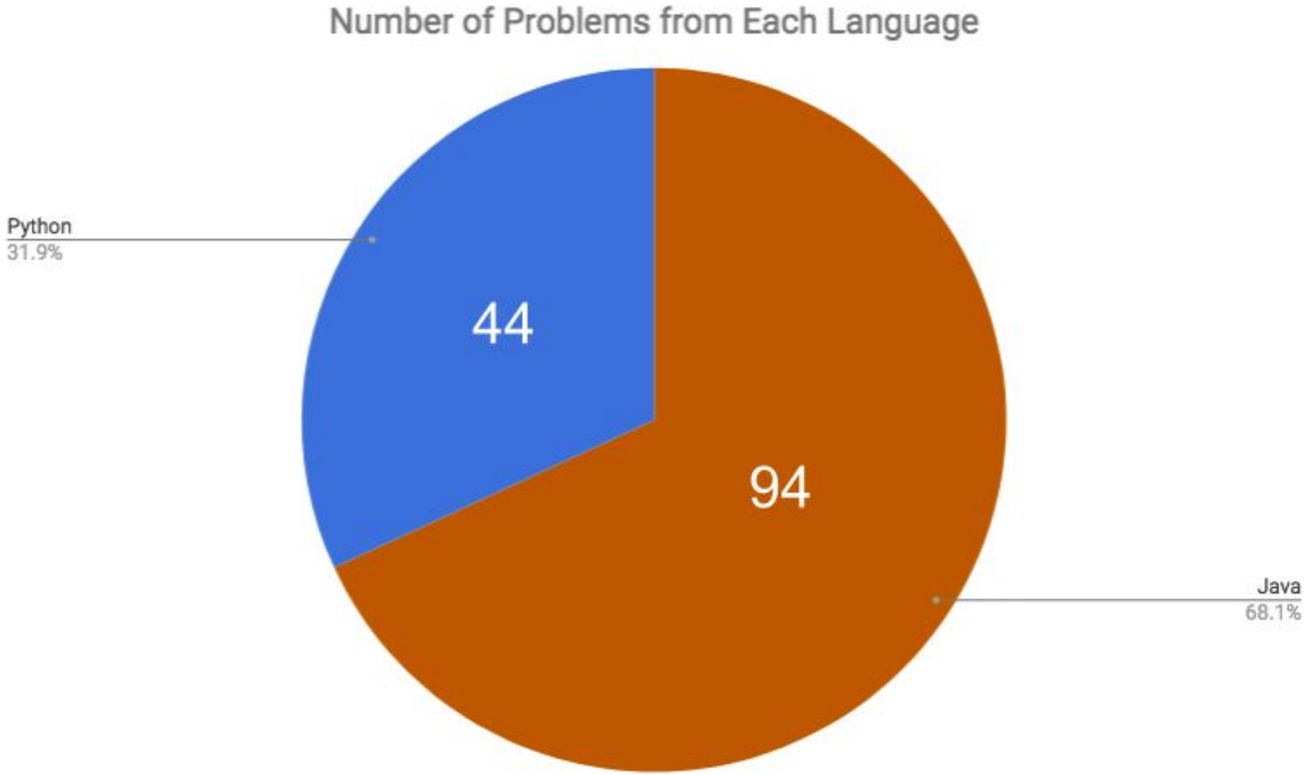
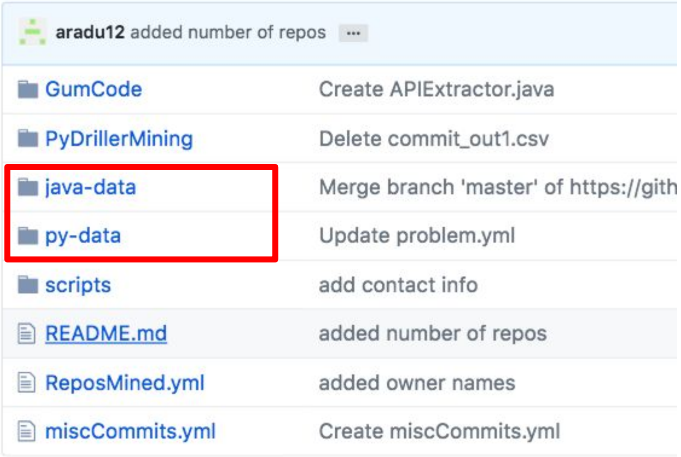


Repo Organization



aradu12 added number of repos ···

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- ❖ Separate folders for data in each language

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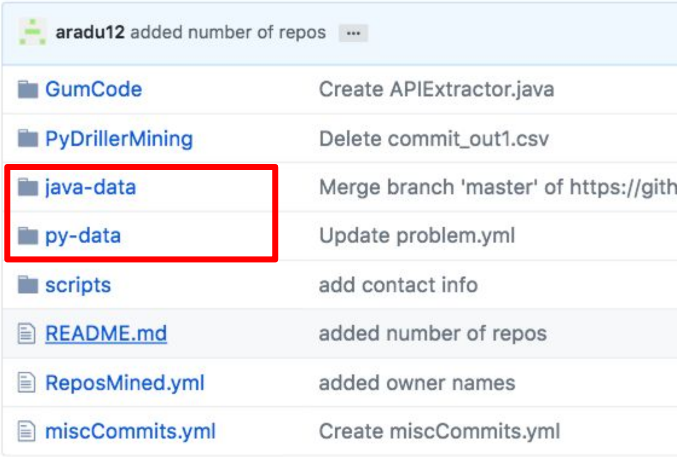

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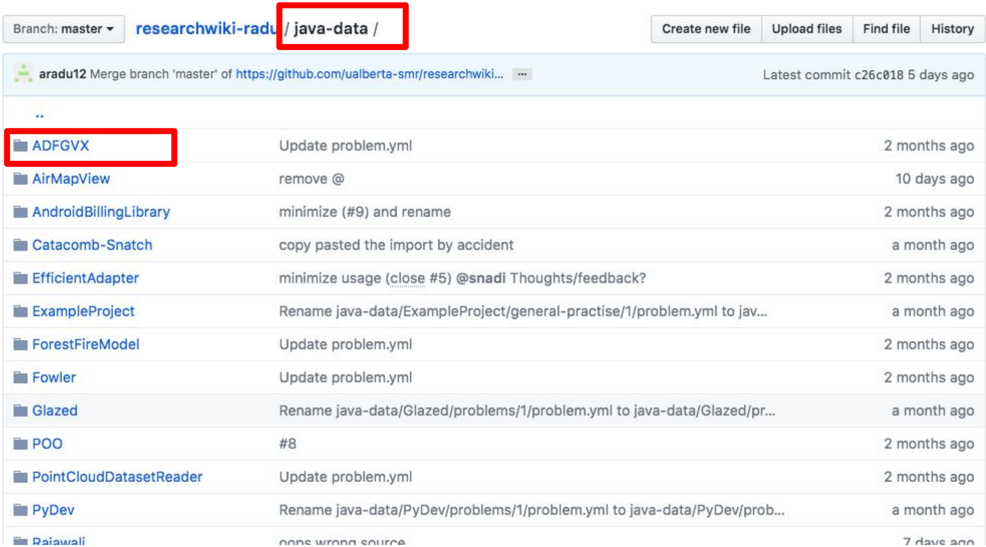


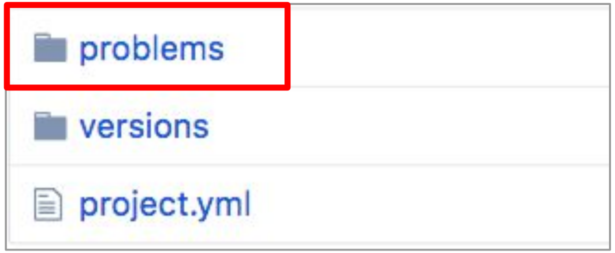
researchwiki-radu / java-data /

aradu12 Merge branch 'master' of https://github.com/ualberta-smr/researchwiki... ··· Latest commit c26c018 5 days ago

..		
ADFGVX	Update problem.yml	2 months ago
AirMapView	remove @	10 days ago
AndroidBillingLibrary	minimize (#9) and rename	2 months ago
Catacomb-Snatch	copy pasted the import by accident	a month ago
EfficientAdapter	minimize usage (close #5) @snadi Thoughts/feedback?	2 months ago
ExampleProject	Rename java-data/ExampleProject/general-practise/1/problem.yml to jav...	a month ago
ForestFireModel	Update problem.yml	2 months ago
Fowler	Update problem.yml	2 months ago
Glazed	Rename java-data/Glazed/problems/1/problem.yml to java-data/Glazed/pr...	a month ago
POO	#8	2 months ago
PointCloudDatasetReader	Update problem.yml	2 months ago
PyDev	Rename java-data/PyDev/problems/1/problem.yml to java-data/PyDev/prob...	a month ago
Rajawali	oops wrong source	7 days ago

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

Repo Organization



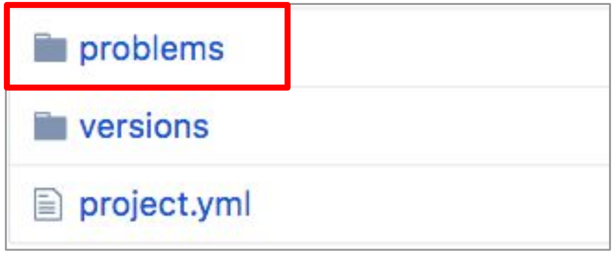
problems

versions

project.yml

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

Repo Organization



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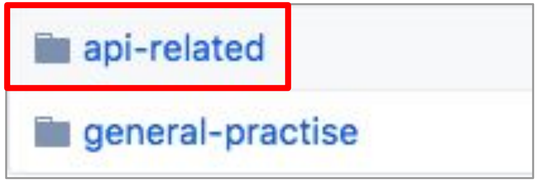
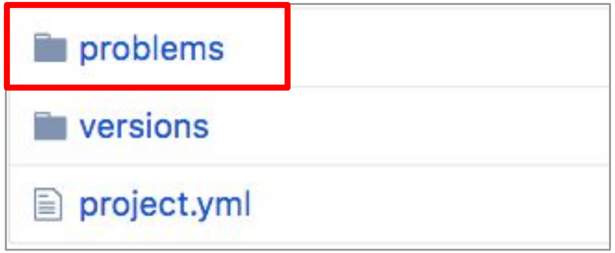


api-related

general-practise

problems are grouped by type

Repo Organization



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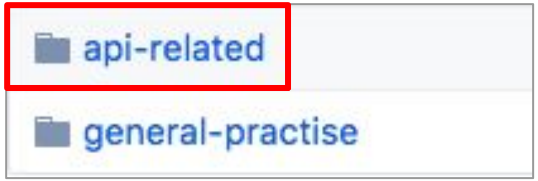

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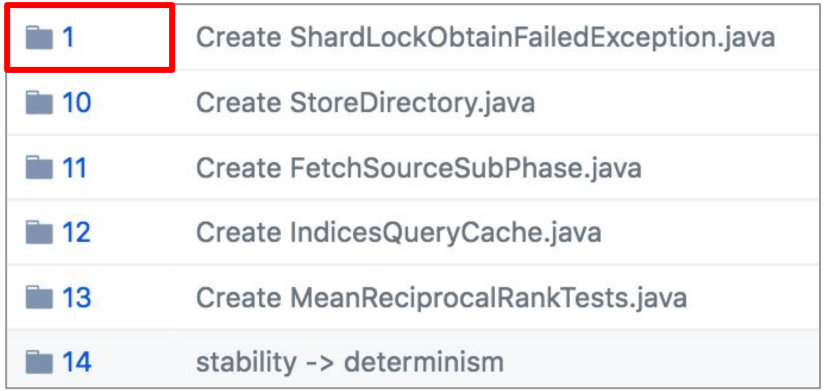

1	Create ShardLockObtainFailedException.java
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14	stability -> determinism

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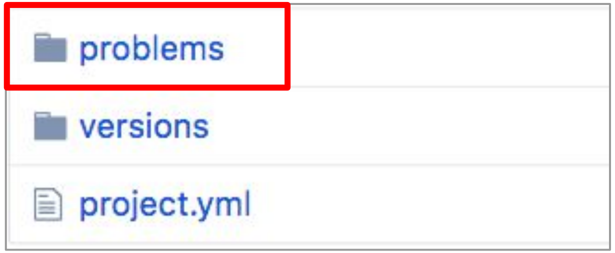

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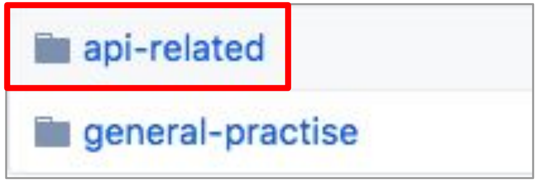

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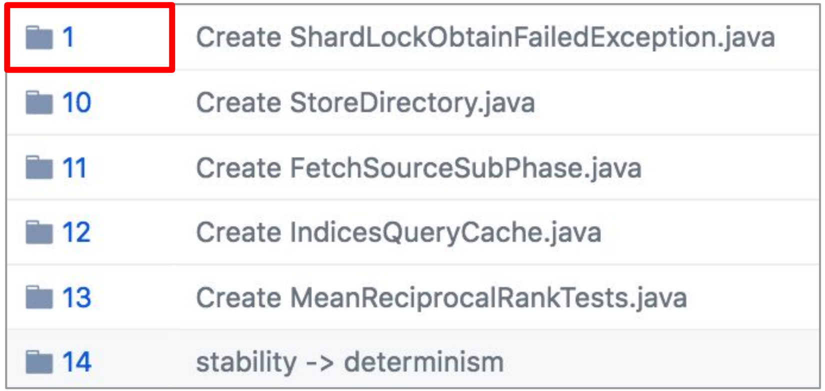

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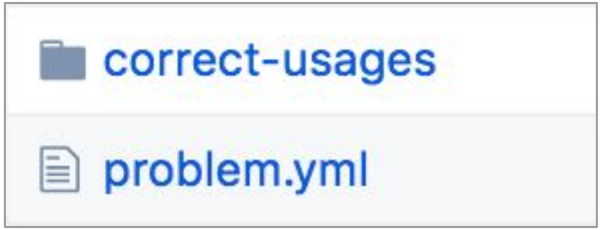
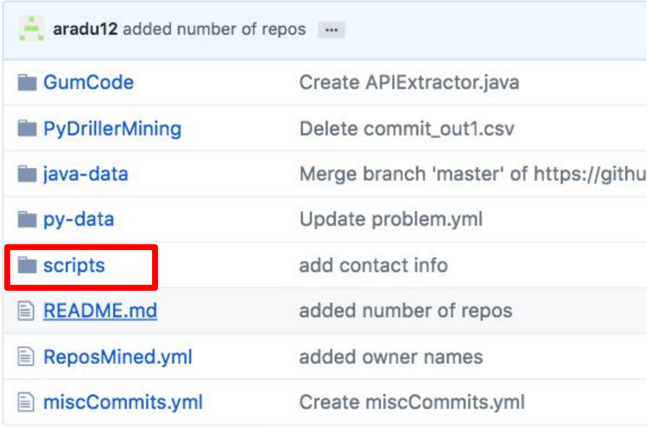


correct-usages

problem.yml

the problem details

Processing the Data



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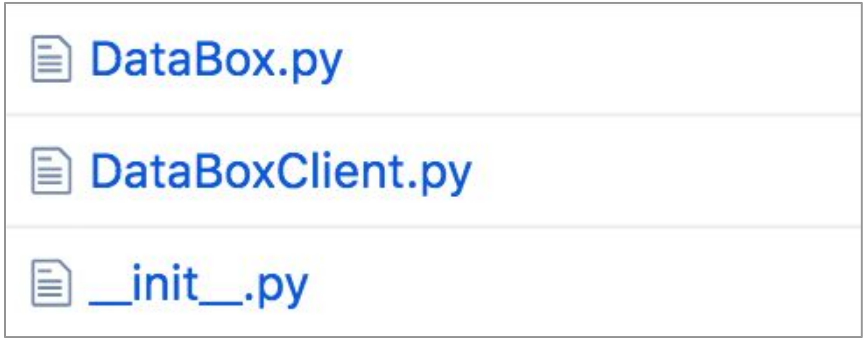


DataBox.py

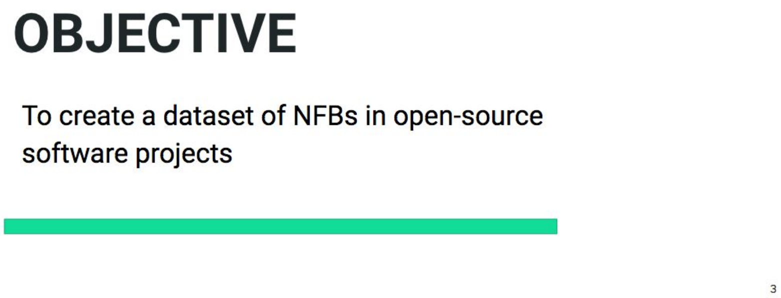
DataBoxClient.py

__init__.py

- ❖ 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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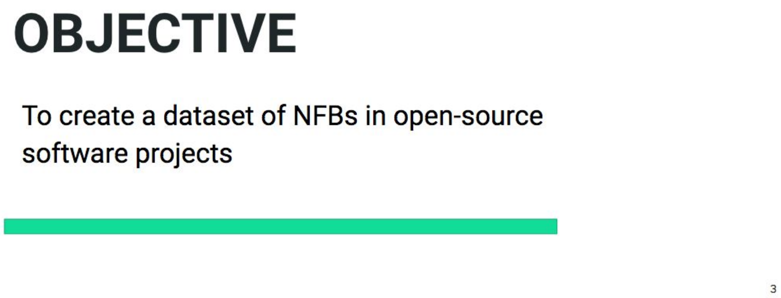

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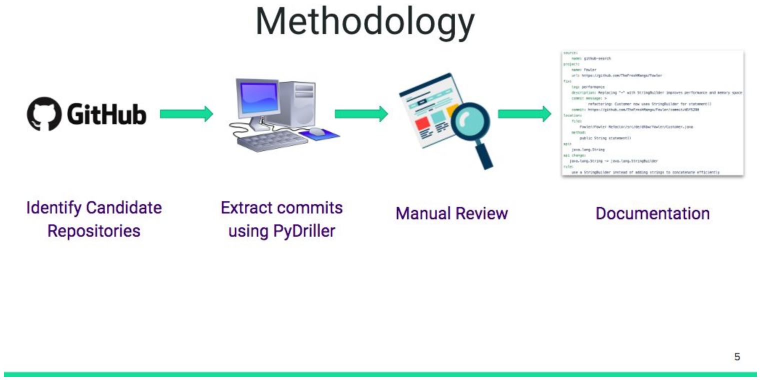

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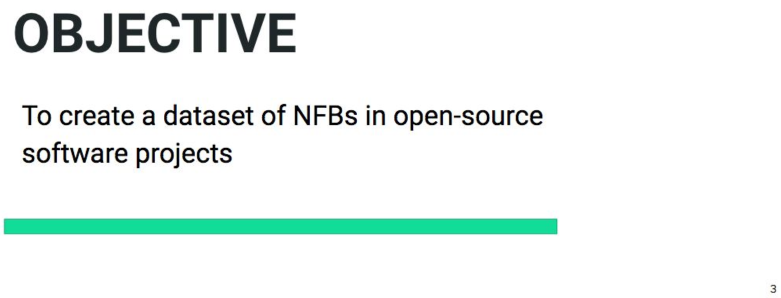
Identify Candidate Repositories → Extract commits using PyDriller → Manual Review → Documentation

5



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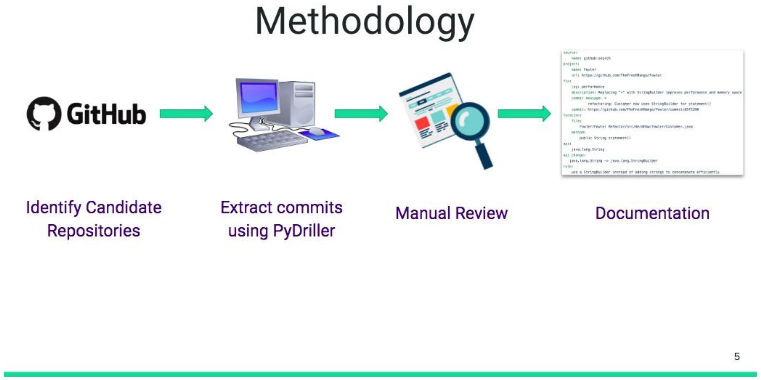

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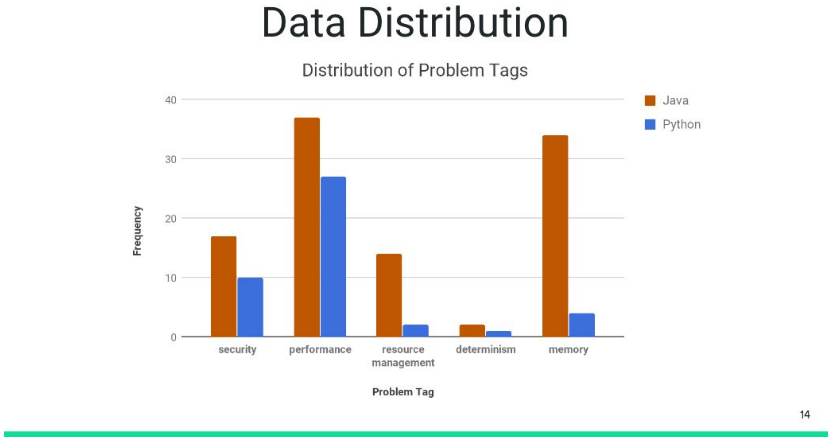
5



Data Distribution

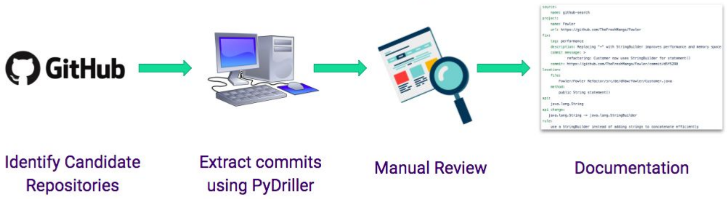
Distribution of Problem Tags

14

OBJECTIVE

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

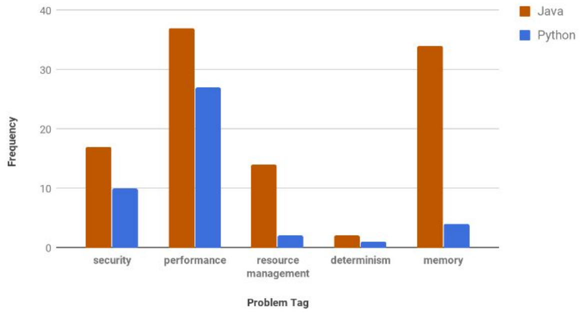
Methodology


GitHub
Identify Candidate Repositories
Extract commits using PyDriller
Manual Review
Documentation

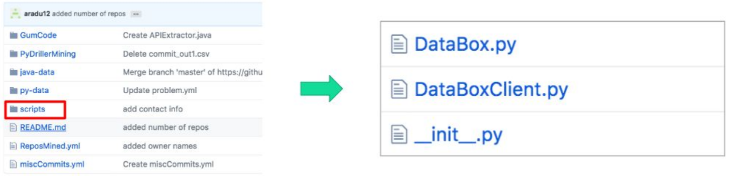
```
source:
    name: github-search
project:
    name: Fowler
    url: https://github.com/TheFreshMango/Fowler
fix:
    tag: performance
    description: Replacing "+" with StringBuilder improves performance and memory space
    commit message: >
            refactoring: Customer now uses StringBuilder for statement()
    commit: https://github.com/TheFreshMango/Fowler/commit/d5f5280
location:
    file:
       Fowler/Fowler Refactor/src/de/dhbw/fowler/Customer.java
    method:
       public String statement()
api:
    java.lang.String
api change:
   java.lang.String -> java.lang.StringBuilder
rule:
    use a StringBuilder instead of adding strings to concatenate efficiently
```

Data Distribution

Distribution of Problem Tags



Processing the Data



aradu12 added number of repos

GumCode	Create APIExtractor.java
PyDrillerMining	Delete commit_out1.csv
java-data	Merge branch 'master' of https://githu
py-data	Update problem.yml
scripts	add contact info
README.md	added number of repos
ReposMined.yml	added owner names
miscCommits.yml	Create miscCommits.yml

DataBox.py

DataBoxClient.py

__init__.py

- 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

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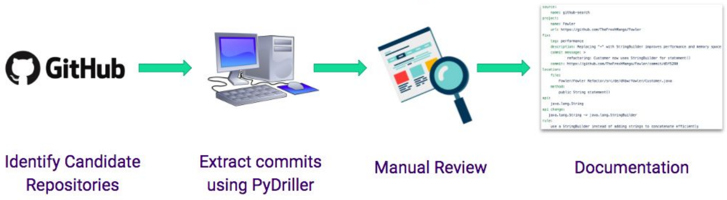

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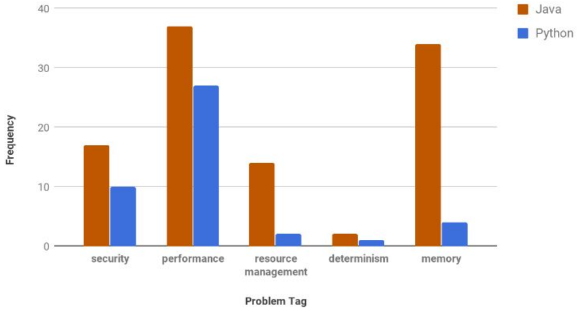

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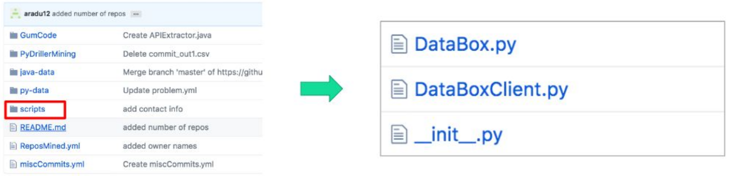

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Questions? aradu@ualberta.ca