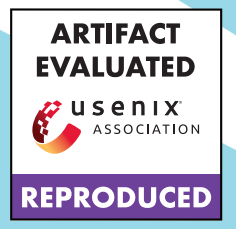
CISPA
HELMHOLTZ CENTER FOR INFORMATION SECURITY



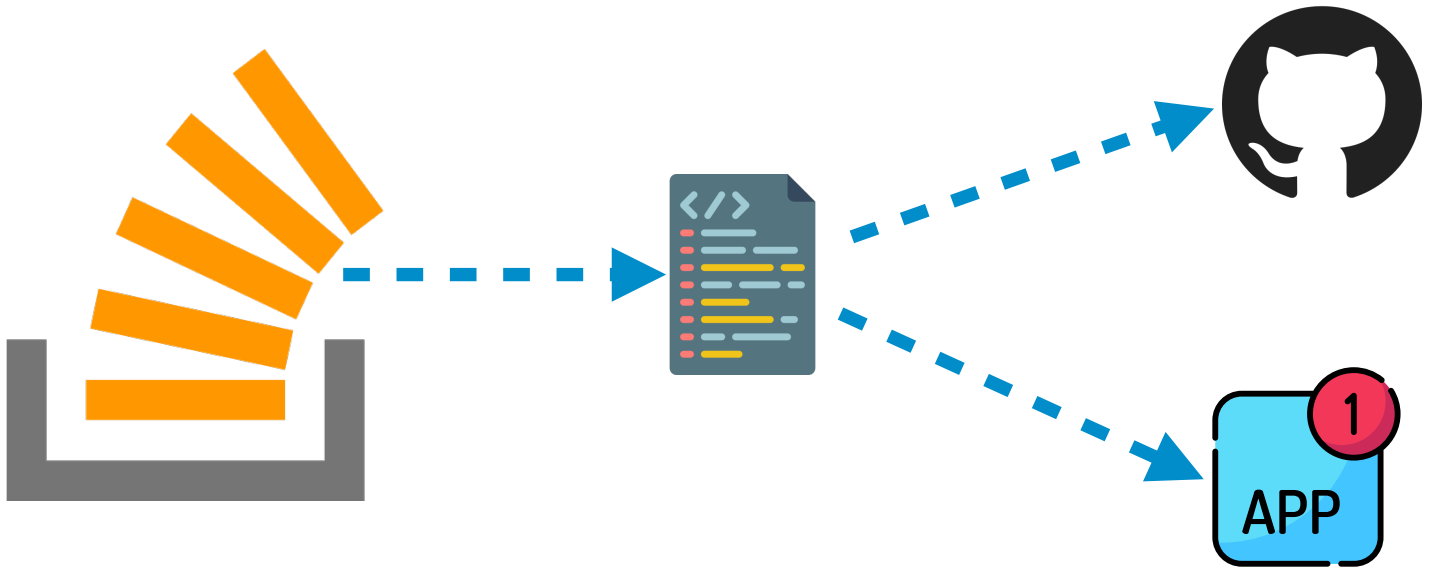
Stack Overflow Meets Replication: Security Research Amid Evolving Code Snippets

Alfusainey Jallow, *Sven Bugiel*

34th USENIX Security Symposium | August 2025

Stack Overflow

A widely-used resource from where developers reuse functional code snippets to accelerate development.



Data-driven Security Studies Focused on Stack Overflow

Stack Overflow Considered Harmful?
The Impact of Copy&Paste on Android Application Security

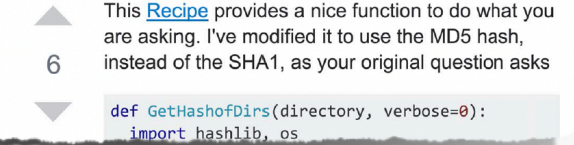
Felix Fischer, Konstantin Böttinger, Huang Xiao, Christian Stransky*, Yasemin Acar*, Michael Backes*, Sascha Fahl*
Fraunhofer Institute for Applied and Integrated Security; *CISPA, Saarland University

Abstract—Online programming discussion
tack Overflow serve as a rich source of infor
evelopers. Available information include

Snakes in Paradise?: Insecure Python-related Coding Practices in Stack Overflow

Akond Rahman, Effat Farhana, and Nasif Imtiaz
North Carolina State University, Raleigh, North Carolina
Email: aarahman@ncsu.edu, efarhan@ncsu.edu, simtiaz@ncsu.edu

e most popular question and an-
velopers, answers posted on Stack
to contain Python-related insecure
c analysis on how frequently inse-
in SO answers can help the SO
ence of insecure Python code blocks



A Study of C/C++ Code Weaknesses on Stack Overflow

Haoxiang Zhang, Shaowei Wang, Heng Li, Tse-Hsun Chen, and Ahmed E. Hassan, *Fel*

Measuring the Effects of Stack Overflow Code Snippet Evolution on Open-Source Software Security

Alfusainey Jallow, Michael Schilling, Michael Backes, Sven Bugiel
CISPA Helmholtz Center for Inform

You Get Where You're Looking For
The Impact of Information Sources on Code Security

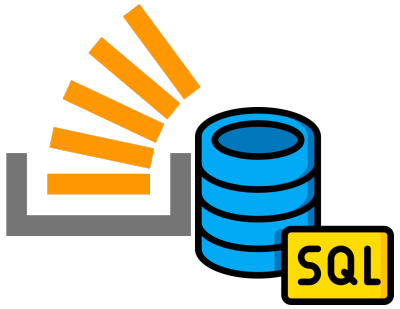
Yasemin Acar, Michael Backes, Sascha Fahl, Doowon Kim†, Michelle L. Mazurek†, Christian Str
University of Maryland, College Park

Dicos: Discovering Insecure Code Snippets from Stack Overflow Posts by Leveraging User Discussions

Hyunji Hong Seunghoon Woo Heejo Lee*

Typical Workflow in Stack Overflow Research

Typical Workflow in Stack Overflow Research



Archived Snapshot
(via archive.org)

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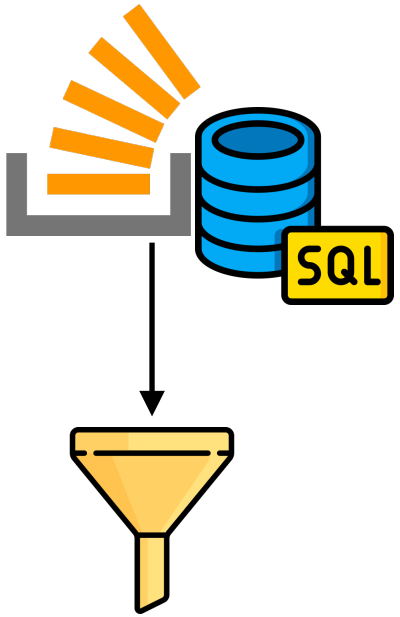

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Code Filtering
(e.g., by language)

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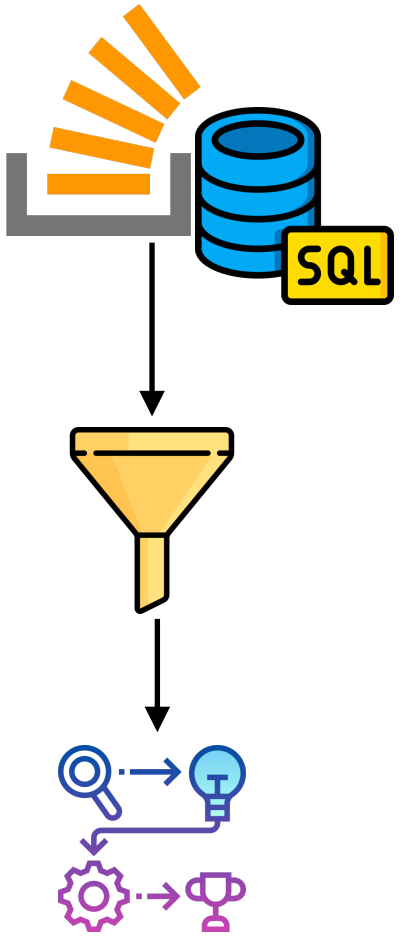

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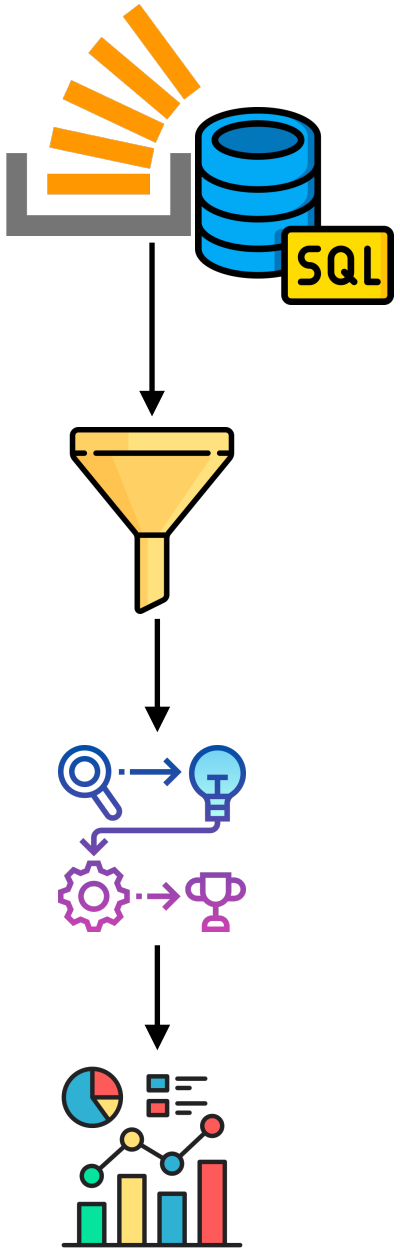

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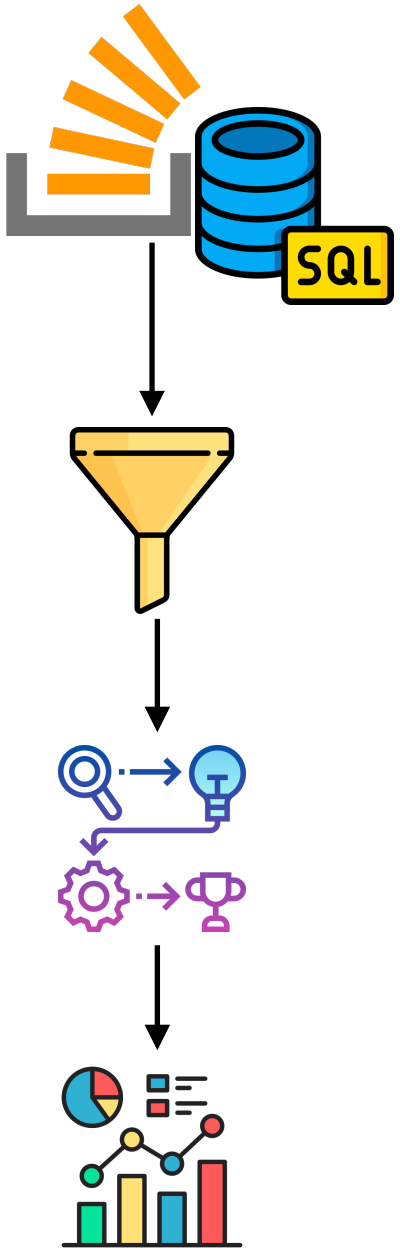
Study Results & Insights

Typical Workflow in Stack Overflow Research

Researchers typically analyze **static Stack Overflow snapshots**, applying code filtering and experimental methods to draw conclusions.



Archived Snapshot
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Code Filtering
(e.g., by language)

Experiment Pipeline
(e.g., ML, NLP)

Study Results & Insights

The results of such studies are valid at the time they were conducted

Code Snippets Evolve Over Time

2

refine the code to avoid resource leakage

Source Link

edit approved Jul 4, 2020 at 18:20

[redacted]

143 ● 1 ● 1 ● 9

Inline **Side-by-side** Side-by-side Markdown

```
char *result = (char *) malloc(size);
if(!result) {
    fputs("Memory error.\n", stderr);
    return NULL;
}

if(fread(result, 1, size, file) != size) {
    fputs("Read error.\n", stderr);
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fclose(file);
```

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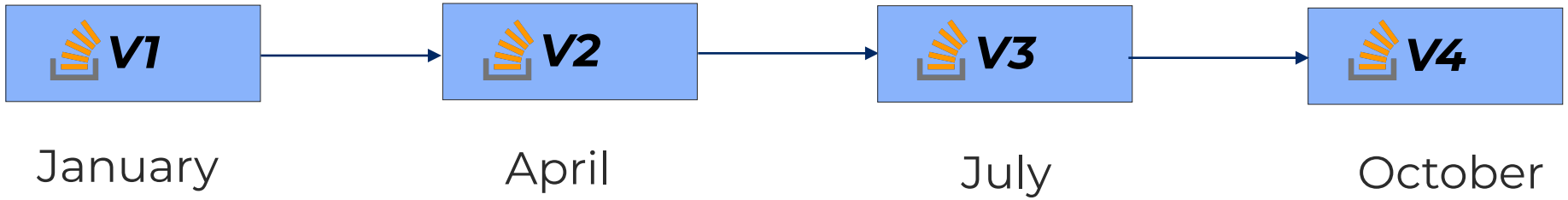
Stack Overflow Dataset Release Model



Quarterly release model (every release is a *snapshot*)

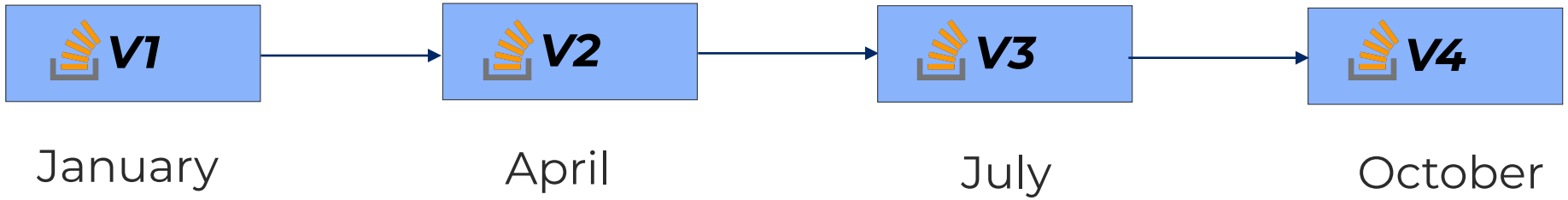
Released on archive.org (“only latest version is preserved”)

Researchers study a specific snapshot → Cross-sectional studies

Cross-sectional studies analyze only a snapshot in time

→ Not ideal for analyzing evolving phenomena (c.f., stock prices, or climate)

Stack Overflow Dataset Release Model



- Quarterly release model (every release is a *snapshot*)
- Released on archive.org (“only latest version is preserved”)
- **Researchers study a specific snapshot → Cross-sectional studies**
- Cross-sectional studies analyze only a snapshot in time

  → Not ideal for analyzing evolving phenomena (c.f., stock prices, or climate)
- Longitudinal studies can reveal trends and recurring patterns across versions

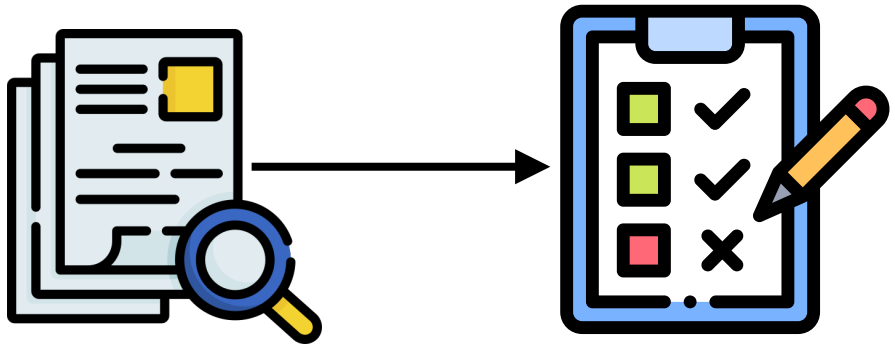
Research Questions

MQ1: Which aspects of Stack Overflow affect the results of prior research?

MQ2: How much do Stack Overflow code snippets and surrounding context evolve?

MQ3: How would the results of prior research differ if replicated on a newer dataset version?

Study Methodology

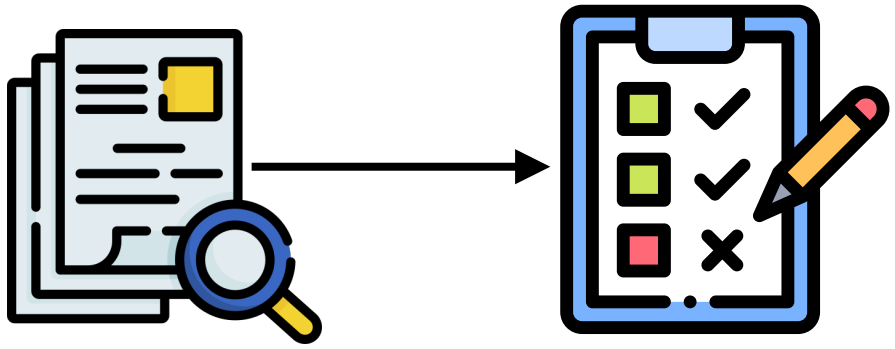


Systematic LR*

Comparison Criteria (MQ1)

* Kitchenham et al. Guidelines for performing systematic literature reviews in software engineering, ESEM 2007

Study Methodology



Systematic LR*

Comparison Criteria (MQ1)

		Dataset Snapshot	D1. Prog. Languages	D2. Code Scanners	D3. Code Evolution	D4. Surrounding Context	D5. Sample Size Filter	R1. Artifact Availability	R2. Language Detection	R3. Code Reuse Detect.	R4. Human-Centered
Zhang et al.	[84]	12/2018	C	✔	✔	✘	✔	✘	✪, M	✘	✘
Hong et al.	[37]	12/2020	C	✪, N	✔	✔	✔	○	✔	✪, S	✘
Fischer et al.	[27]	03/2018	J	✪, M	✘	✘	✔	◐	N/A	✘	✘
Fischer et al.	[25]	03/2016	J	✪, M	✘	✘	✔	◐	N/A	✪, P	✘
Rahman et al.	[62]	12/2018	P	✪, SM	✘	✘	✔	◑	✔	✘	✘
Campos et al.	[22]	12/2018	JS	✔	✘	✘	✔	✪	✔	✔	✘
Verdi et al.	[78]	09/2018	C	✘	✘	✘	✔	◐	✔	✔	✘
Selvaraj et al.	[68]	01/2022	C	✔	✔	✘	✔	◐	✪, M	✘	✘
Acar et al.	[6]	10/2015	J	✘	✘	✘	✘	✘	N/A	✘	✔
Chen et al.	[19]	?/2018	J	✘	✘	✘	✔	✘	N/A	✘	✘
Meng et al.	[57]	08/2017	J	✘	✘	✔	✔	◐	✔	✘	✘
Ragkhitwets	[61]	01/2016	J	✘	✔	✘	✔	◐	✔	✪,SI,CC	✔
Bai et al.	[11]	N/A	J	✘	✘	✘	✔	✘	N/A	✪,M	✔
Bagherzadeh et al.	[10]	N/A	J,S	✘	✘	✔	✔	◐	✔	✘	✘
Chen et al.	[18]	?/2018	J	✪,M	✘	✘	✔	✘	N/A	✘	✘
Zhang et al.	[85]	10/2016	J	✪,P	✘	✘	✔	✘	✔	✔,CC	✘
Rahman et al.	[63]	08/2021	J	✘	✘	✘	✔	✘	✔	✔,CC	✔
Reinhardt et al.	[64]	N/A	J	✔	✘	✘	✔	✘	✔	✔,CC	✘
Licorish et al.	[49]	?/2016	J	✔	✘	✔	✘	✘	✔	✘	✘
Schmidt et al.	[66]	03/2022	JS,P	✘	✘	✔	✘	◑	✔	✘	✘
Yi Liu et al.	[51]	N/A	J	✪,M	✘	✔	✘	✘	✔	✘	✘
Ren et al.	[65]	03/2019	J	✪,M	✘	✔	✔	✘	✔	✘	✔
Licorish et al.	[50]	?/2016	J	✔	✘	✘	✔	✘	✔	✘	✘
Rangeet Pan	[60]	N/A	P	✘	✘	✔	✔	✘	✔	✘	✘

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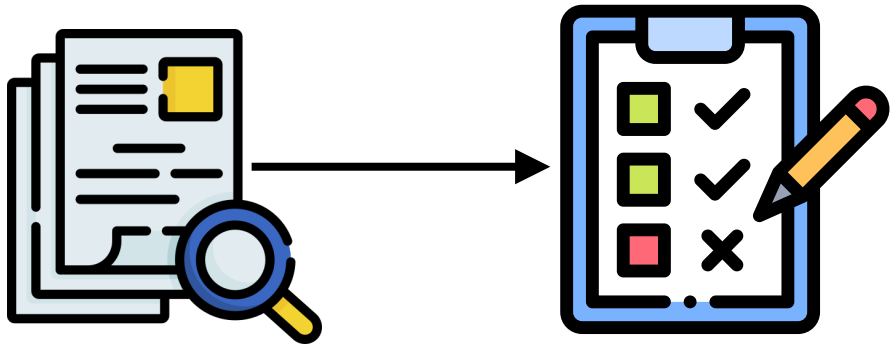
Study Methodology



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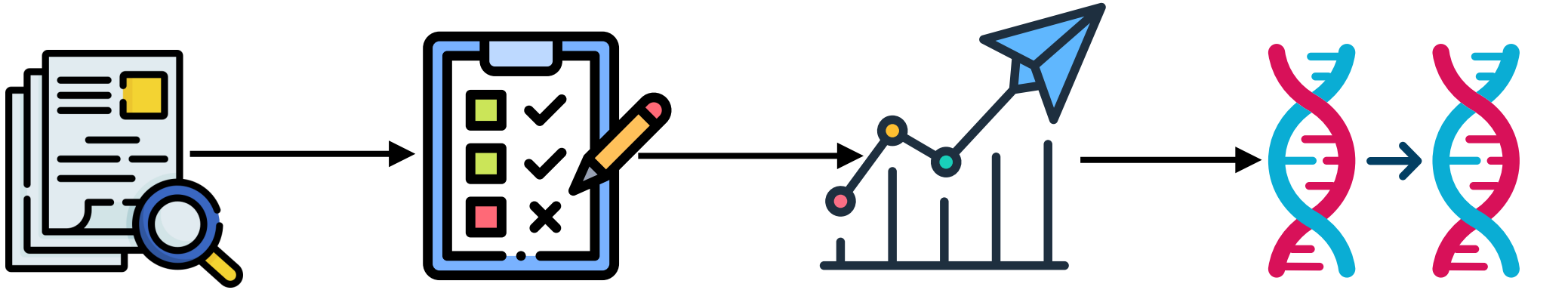

Systematic LR*

Comparison Criteria (MQ1)

Evolution (MQ2)

Replication (MQ3)

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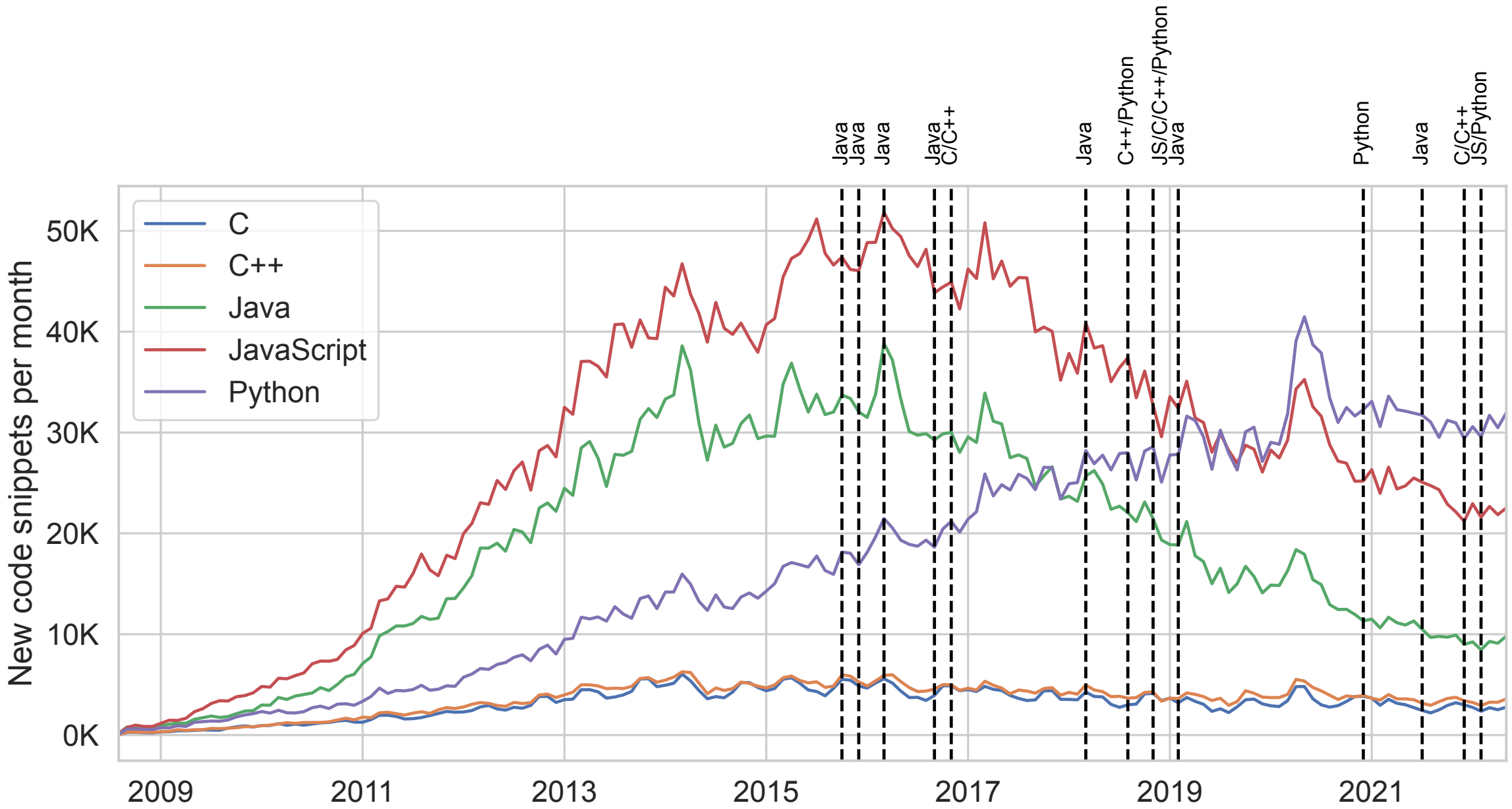
MQ2: Evolution on Stack Overflow



MQ2: Evolution on Stack Overflow

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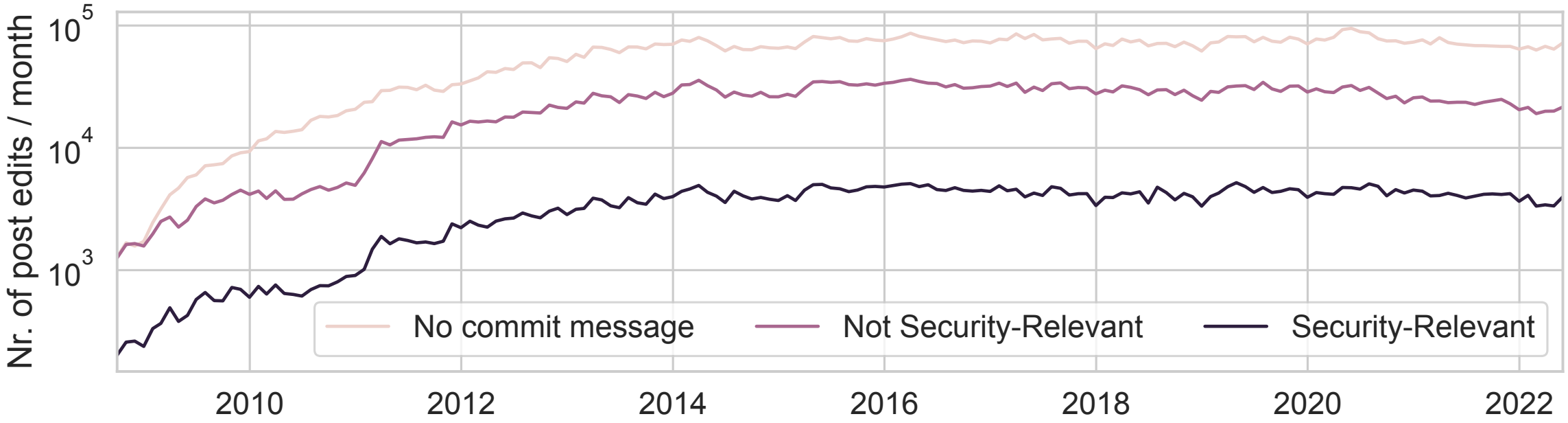

Number of monthly (30-day interval) post edits categorized by their **security relevance**.

MQ2: Evolution on Stack Overflow

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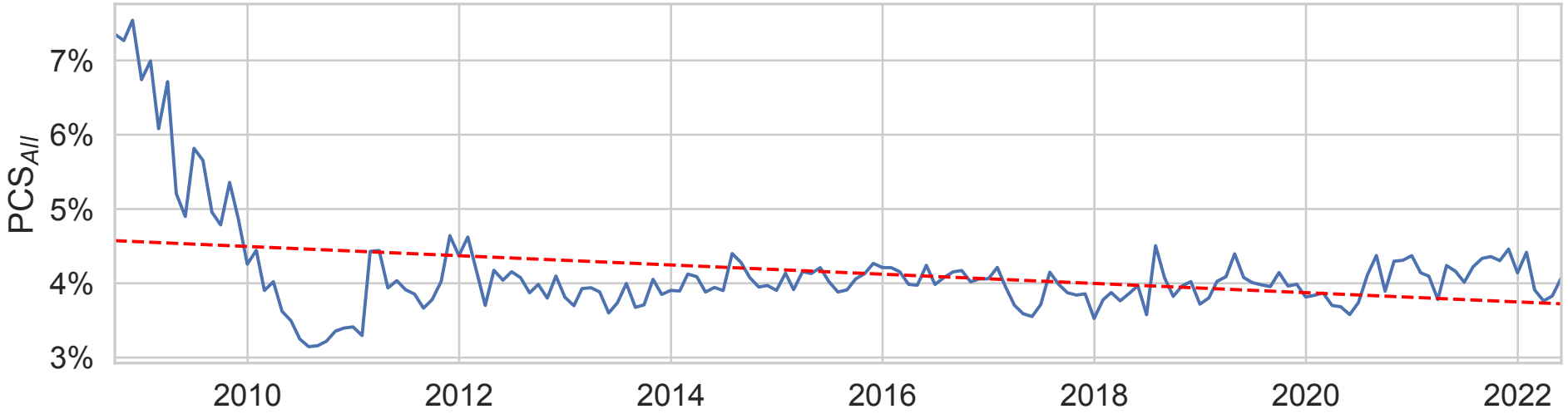
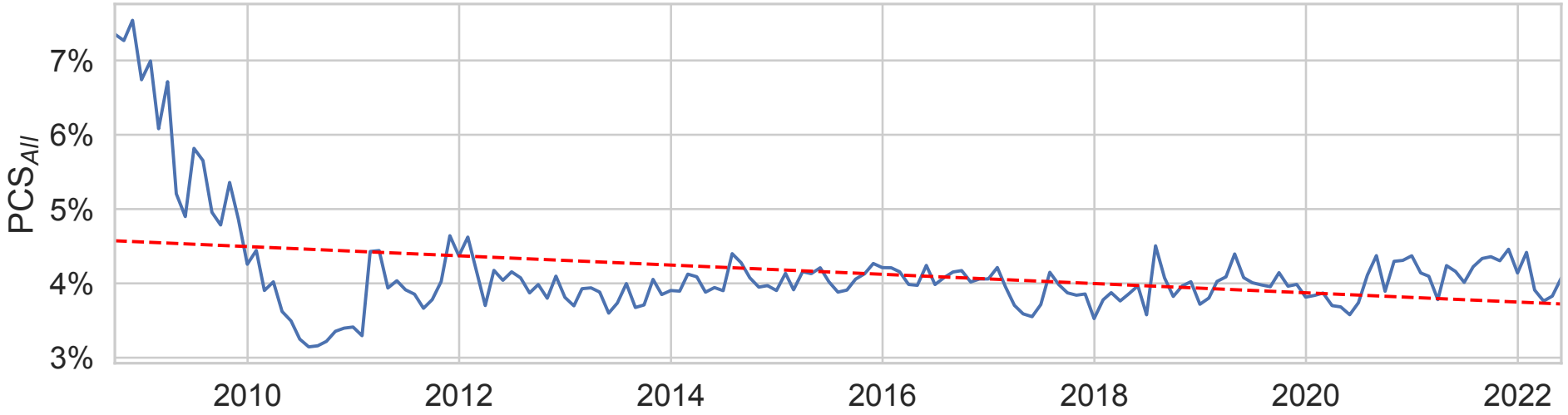


Including empty commit messages

MQ2: Evolution on Stack Overflow



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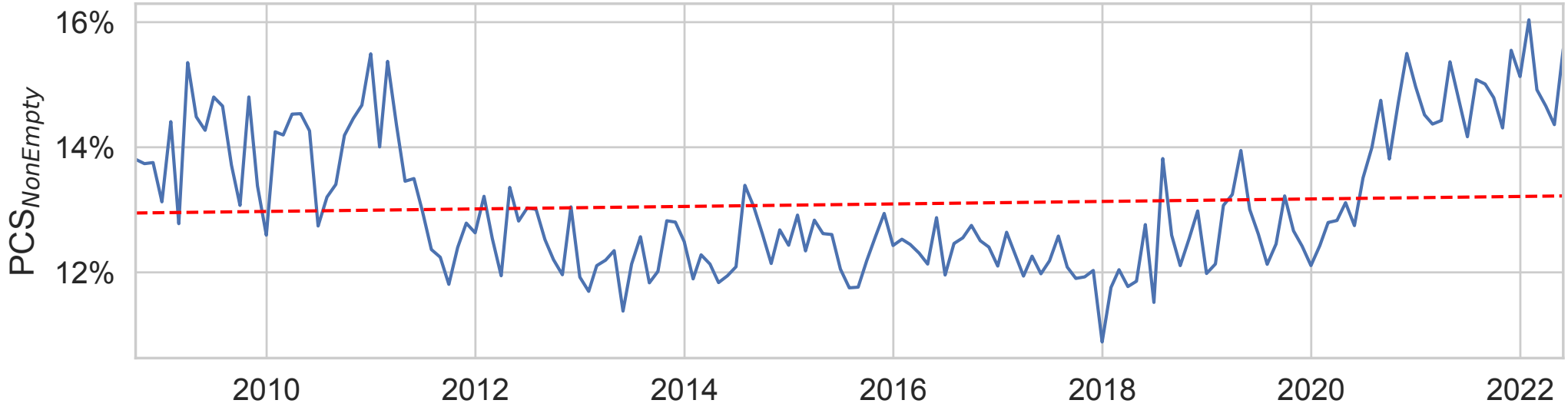

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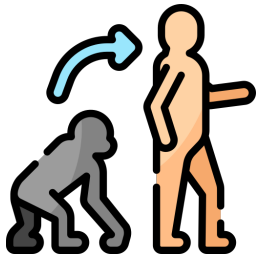

Programming languages trend differently on Stack Overflow and many comments raised security-relevant issues.

Case Study 1: C/C++ Code Weaknesses

Zhang et al.* studied whether revisions to C/C++ snippets increase or decrease the snippets' security

- **RQ1**: What are the types of code weaknesses that are detected in C/C++ code snippets on Stack Overflow?
- **RQ2**: How do code with weaknesses evolve through revisions?
- **RQ3**: What are the characteristics of the users who contributed code with weaknesses?

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$Answer_W$ = 11,235, $Code_W$ = 11,748, $Version_W$ = 14,934

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Case Study 1: Replication Results

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As the number of revisions to *Code*$_W$ increased from 1 to 3+, the proportion of improved *Code*$_W$ rose from **30.1% to 41.8%**.

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Detailed results in the paper

Recommendations

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1. **Adopt Longitudinal Analyses with Stack Overflow Data**
   - Cross-sectional snapshots limit understanding of whether security issues are persistent or transient
   - Longitudinal analysis helps distinguish short-lived trends from long-term patterns
   - Use Stack Overflow's versioned data to track changes and trends over time

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   - Use Stack Overflow's versioned data to track changes and trends over time
2. **Promote Open Science Practices**
   - Release code and data artifacts to enable reproducibility and replication
   - Report exact software versions; use Docker or similar containers for consistency
   - We commend USENIX'25/'26 for requiring artifact availability

Conclusion

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Thank you!