

Investigating the Validity of Ground Truth in Code Reviewer Recommendation Studies

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What is Code Review, Who is a Code Reviewer?



Introduction •

Code Review: A systematic examination of source code in order to highlight bugs and enhance the code quality.

Code Reviewer: The developer performing a code review who ensures the quality of the code.

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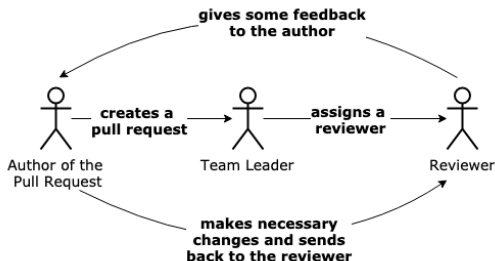
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A typical code review scenario

How to find an ideal code reviewer?



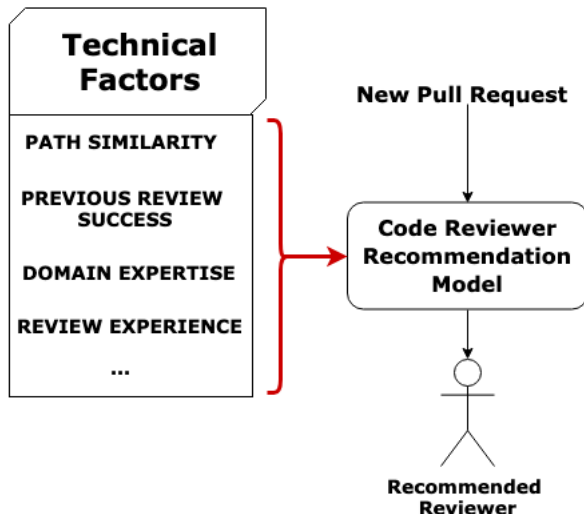
Introduction •

- Code reviewer recommendation models/tools help us to choose ideal reviewers.
- These tools help software teams:
 - to find reviewers who can find more(critical) bugs in the source code.
 - to speed up the code review process.

Reviewer Selection in Recommendation Models



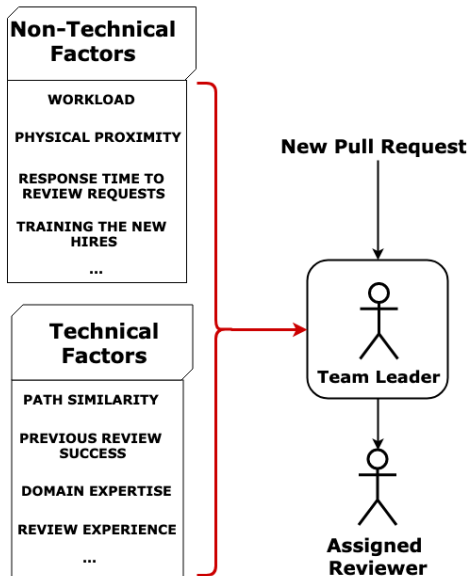
Real Life vs Algorithms •



Reviewer Selection in Real Life



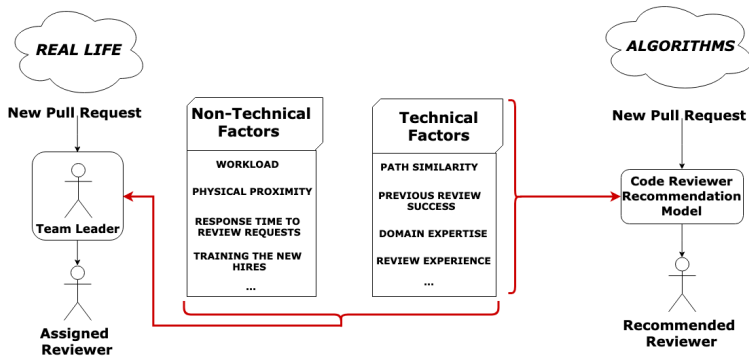
Real Life vs Algorithms •



Comparison of Real Life and Algorithms



Real Life vs Algorithms •



Notice:

- There exists a discrepancy between real life and algorithm based reviewer selection process.
- This discrepancy creates a **ground truth problem** in code reviewer recommendation studies and datasets.

Ground Truth:

- Factual data that has been observed or measured.
- If data stands on some assumptions which is subject to opinion, then it cannot be **ground truth data**.

Ground Truth in Software Engineering:

- The more human aspects involved, the more tendency to the ground truth problems.
- Many fields of empirical software engineering research suffer from the ground truth problem. (i.e. code reviewer recommendation, bug report assignee recommendation, etc.)

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Ground Truth in Code Reviewer Recommendation Studies:

- Recommendation models rely on the real-life assignments.
- These assignments are assumed to be ideal.
- Studies in real-life projects show that code reviewers are not usually assigned with the aim of finding the ideal one.

Who is an ideal reviewer?

Ground Truth •

Ideal Reviewer:

The theoretical best possible reviewer in the team that would improve or preferably perfect (such as pointing out all the defects) the pull request under review.

Warning:

- Ideal reviewer is selected by considering **only technical factors**.
- I.e., If a developer is considered as the ideal reviewer for a pull request but is not available for a review at that moment, he/she is still the ideal reviewer.

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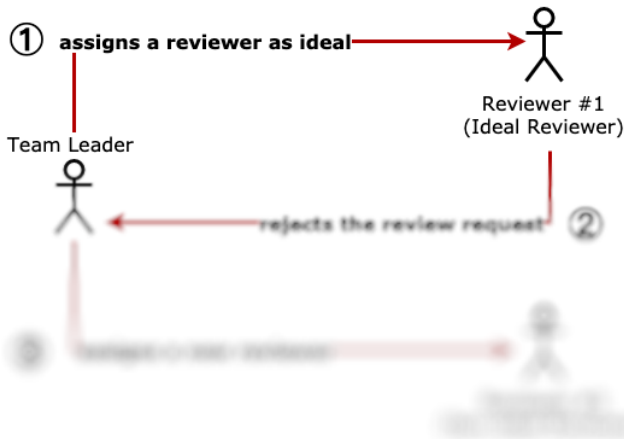
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Problematical Reviewer Selection Scenario



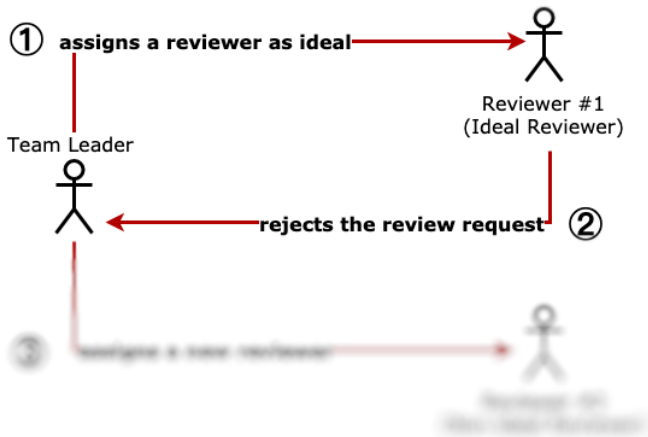
Example Scenario •



Problematical Reviewer Selection Scenario



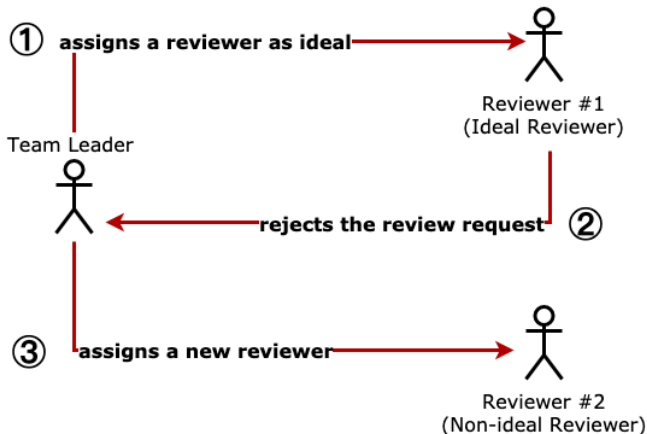
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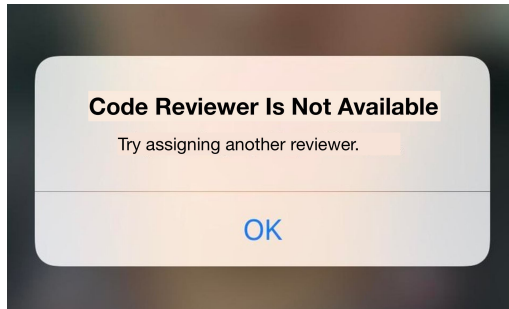
What causes a non-ideal reviewer assignment?

Reasons of Non-Ideality •

Availability Reasons:

The ideal reviewer might be...

- physically absent from work, so he/she cannot review the pull request.
- busy with some other tasks, so he/she declines to review the pull request.
- busy with some other tasks and is late to reply the review request.





Project Name	Total Number of Pull Requests	Number of PRs with at least one non-responsive reviewer	The ratio of PRs having at least one non-responsive reviewer
Android	36,771	24,367	66%
LibreOffice	18,716	3,039	16%
Open Stack	108,788	24,589	23%
Qt	65,815	30,630	47%
TOTAL	230,090	82,625	36%

Table: An Analysis of Pull Request Reviews from 4 Large OSS Projects¹

Notice

The results illustrate that 36% of pull requests suffer from the *availability reasons*.

¹S. Ruangwan, P. Thongtanunam, A. Ihara, and K. Matsumoto, "The impact of human factors on the participation decision of reviewers in modern code review," *Empirical Software Engineering*, vol. 24, no. 2, pp. 973–1016, 2019. pp. 973–1016, 2019.  

What causes a non-ideal reviewer assignment?

Quantitative Evidence •

Cognitive Bias:

A systematic pattern of deviation from norm or rationality in judgment.

Attribute Substitution:

It occurs when an individual has to make a **computationally complex judgment**, and instead substitutes a **more easily calculated heuristic attribute**.

The team leader prefers to assign...

- a volunteer for the review.
- a reviewer based on their work schedule.
- a new hire as a reviewer for educational purposes.
- a developer based on their relative response time to review requests.



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Thank you



Conclusion •

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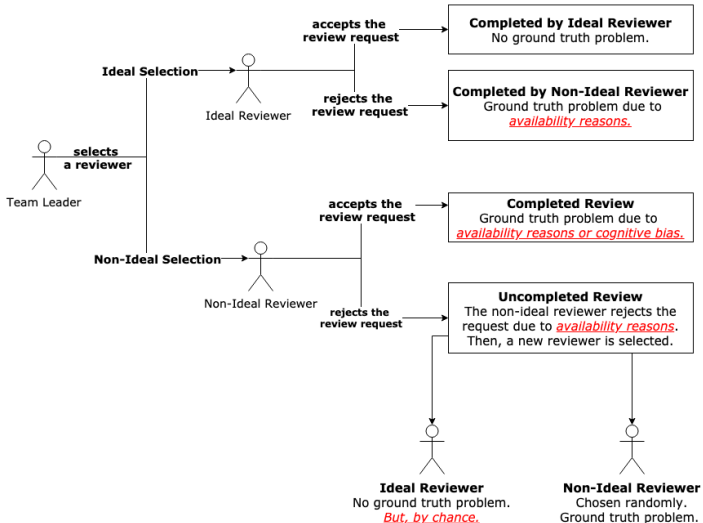
Backup Slides



After the Presentation •

Possible Reviewer Assignment Scenarios

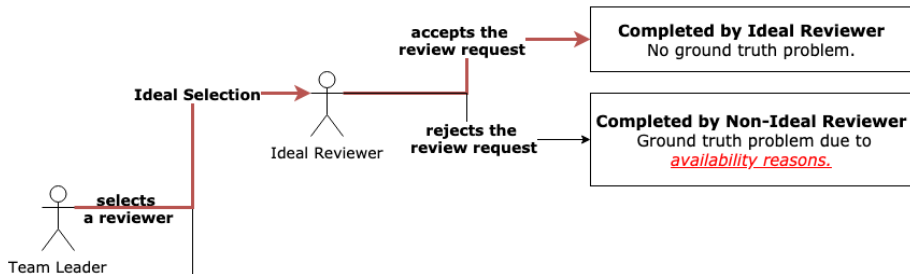
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Scenario 1



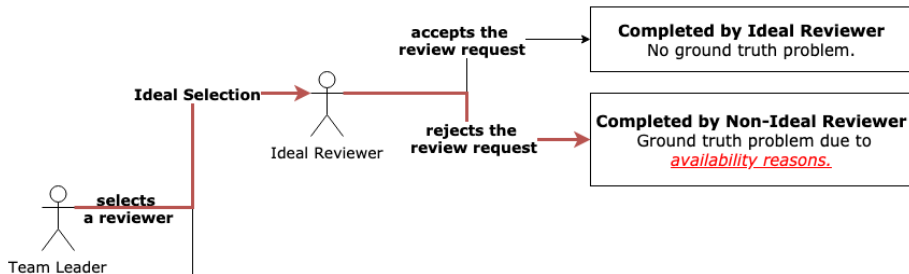
After the Presentation •



Scenario 2



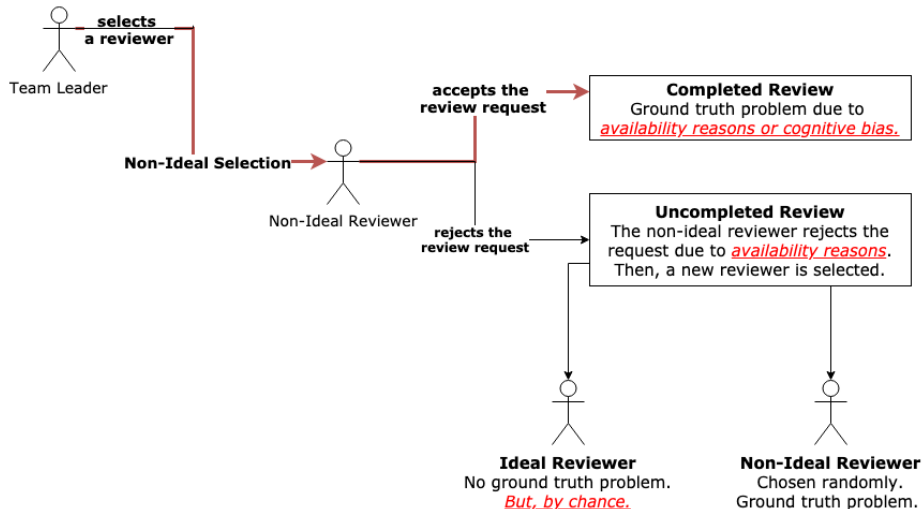
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Scenario 3



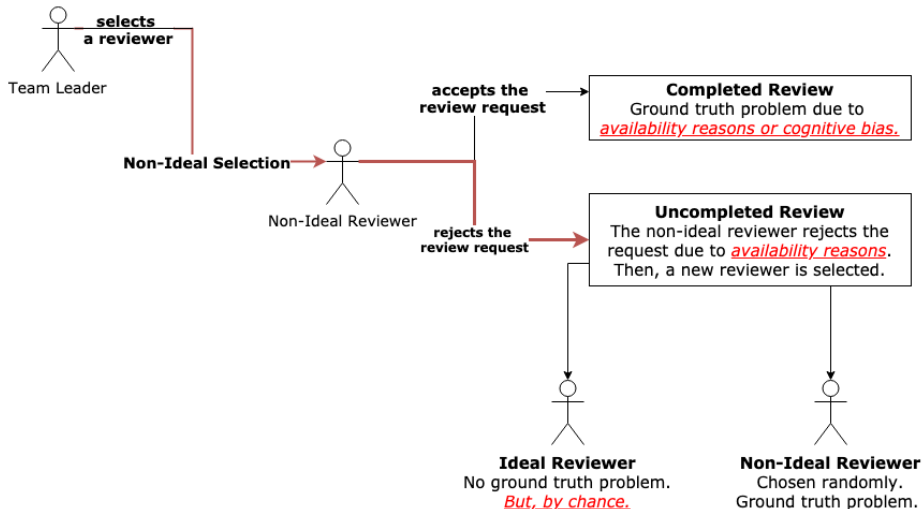
After the Presentation •



Scenario 4



After the Presentation •

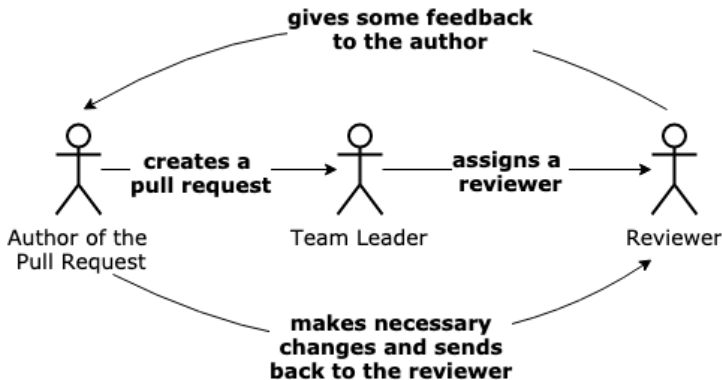


- I - Setting up an Experiment in Real Life
- II - Forward-Looking Mining

Solution I- Setting up an Experiment in Real Life



After the Presentation •



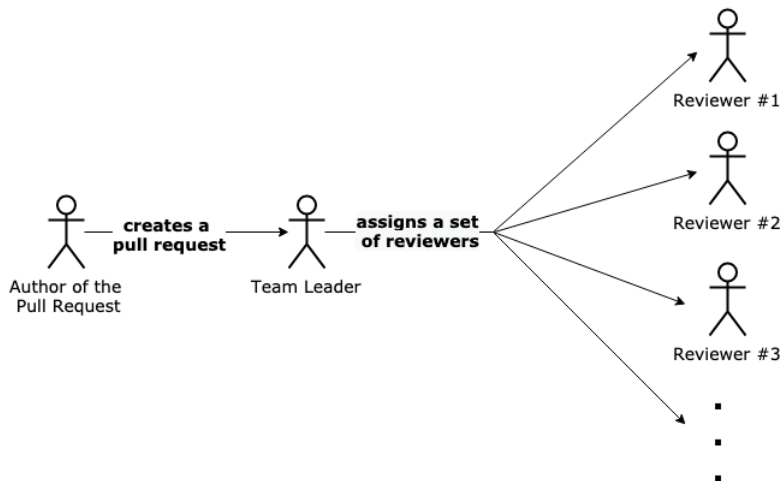
A Typical Reviewer Assignment Scenario

What if...



After the Presentation •

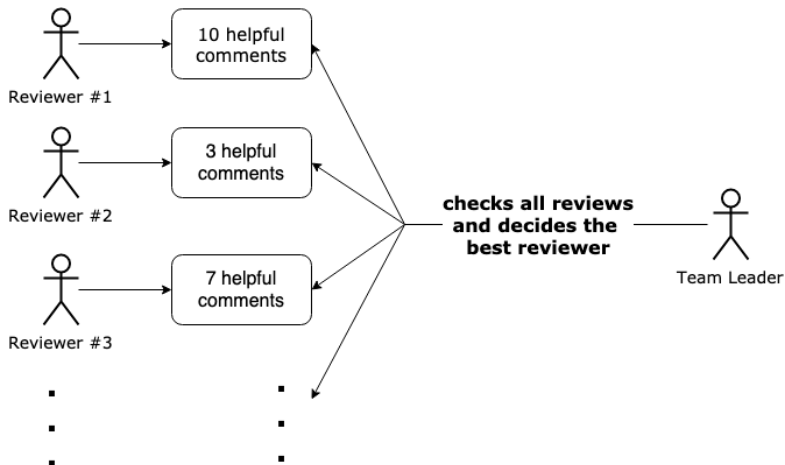
... we assign the same review to multiple reviewers simultaneously?



Then, choose the best one

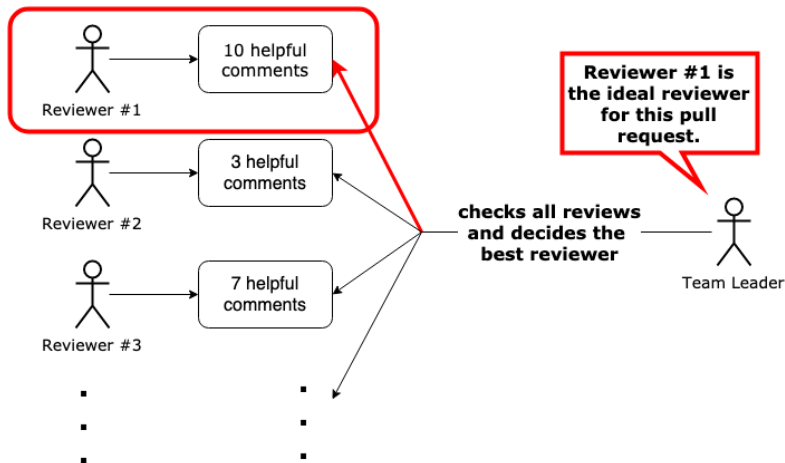


After the Presentation •



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After the Presentation •



What is wrong with this method?



After the Presentation •

Expensive!

Making multiple developers spend time on a single review task is impractical and expensive.

Hard to evaluate!

It is not a straightforward task for the team leader to check all reviews and choose the best one.

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After the Presentation •

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Solution II - Forward-Looking Mining



After the Presentation •

Idea:

Reopened bugs might indicate a bad code review.

How?

Consider the following scenario.

Solution II - Forward-Looking Mining



After the Presentation •

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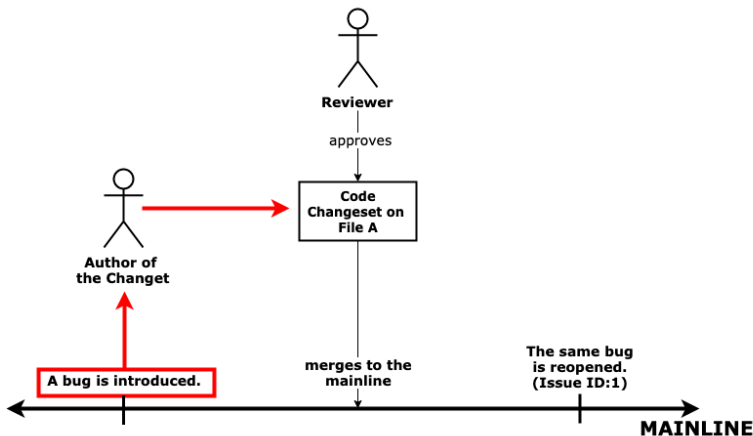
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After the Presentation •

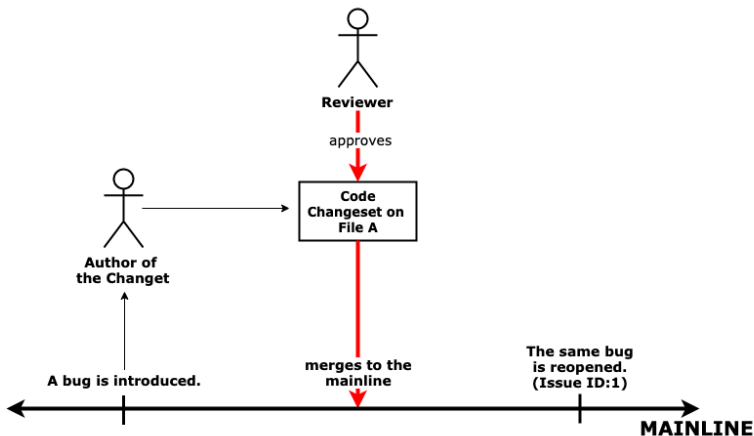


To fix a bug, a developer creates a pull request.

Consider the following scenario:



After the Presentation •

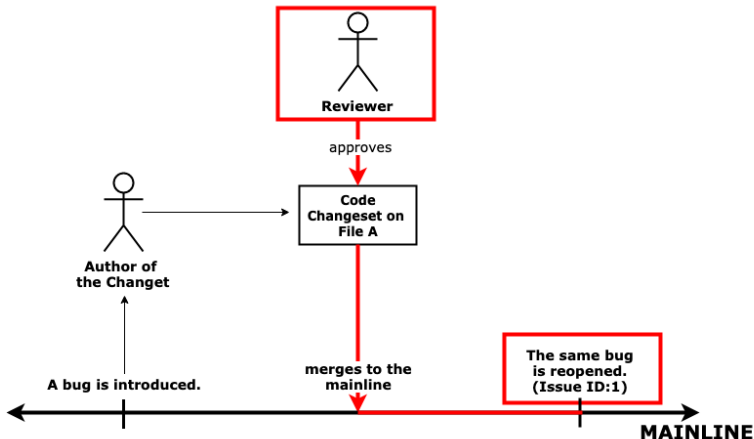


The assigned reviewer approves the pull request and the bug is closed.

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After the Presentation •

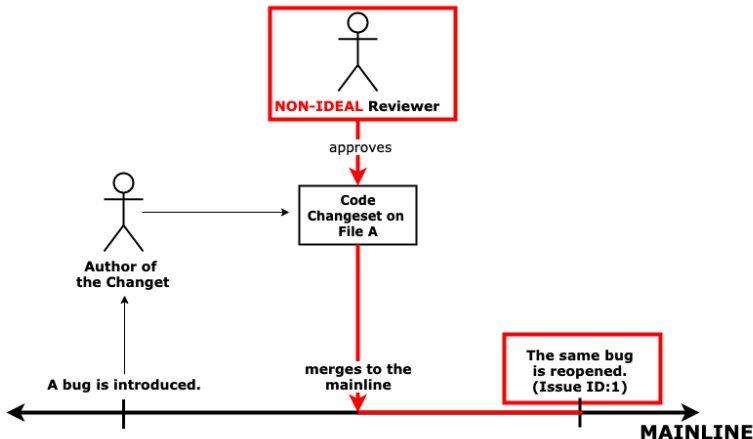


If the same bug is reopened later, it is a potential indicator that the pull request is not conducted properly and the reviewer is not ideal.

Consider the following scenario:



After the Presentation •



Removing these instances from the dataset will increase the validity of ground truth.