An Empirical Evaluation of Method Signature Similarity in Java Codebases

Mohammad Taha Khan, Mohamed Elhussiny, Billy Tobin and Muhammad Ali Gulzar

Method Signatures in Java

A method signatures uniquely identify methods within a class

It includes the method name, its parameters, and return type

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```
package java.util;
public class Arrays {

 @param a the array to be sorted */
 public static void parallelSort(short[] a) {
   int n = a.length;
   if (n <= MIN_ARRAY_SORT_GRAN) {
       . . .
   }
. . .
}
```

Implementation of the **`parallelSort`** method from the **`java.util.Arrays`** class in the Java Standard Library.

Method Signatures in Java

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Class Name	Arrays
Method Name	parallelSort
Return Type	void
Input Parameters	[short[] a]

Method Signature

```
package java.util;
public class Arrays {

    @param a the array to be sorted */
    public static void parallelSort(short[] a) {
        int n = a.length;
        if (n <= MIN_ARRAY_SORT_GRAN) {
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        }
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```

Implementation of the **`parallelSort`** method from the **`java.util.Arrays`** class in the Java Standard Library.

Method Signature Similarity

Overloaded Methods

```
class Array {
// . . .
 public static void parallelSort (short [] a) {
  int n = a.length , p , g ;
  if ( n <= MIN_ARRAY_SORT_GRAN || // . . .
}

 public static void parallelSort (int [] a) {
  int n = a.length , p , g ;
  if ( n <= MIN_ARRAY_SORT_GRAN || // . . .
}
```

Method Signature Similarity

Overloaded Methods

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class Array {
// . . .
 public static void parallelSort (short [] a) {
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 public static void parallelSort (int [] a) {
  int n = a.length , p , g ;
  if ( n <= MIN_ARRAY_SORT_GRAN || // . . .
}
```

Textually Similar Methods

```
public class ClearOperation {
 @Override
 public int getSyncBackupCount () {
  return
mapServiceContext.getMapContainer(name).getBackupCount();
 }


 @Override
 public int getAsyncBackupCount () {
  return
mapServiceContext.getMapContainer(name).getAsyncBackupCount()
;
}
```

Method Signature Similarity

Overloaded Methods

Textually Similar Methods

Methods with similar names or ones overloaded frequently can lead to **confusion** and increased **cognitive load** for developers.

This leads to potential **misuse** of these methods, leading to **errors** that are hard to **identify** and **debug**.

Method Signature Similarity

```
public class ClearOperation {
 @Override
 public int getSyncBackupCount () {
  return
mapServiceContext.getMapContainer(name).getBackupCount();
 }


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 public int getAsyncBackupCount () {
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mapServiceContext.getMapContainer(name).getAsyncBackupCount()
;
}
```

Research Goals

Assess how **widespread** method signature similarity in real-world Java codebases

Explore the effects of both overloaded and textually similar methods on code **quality**, **maintainability** and developer **productivity**

Research Questions

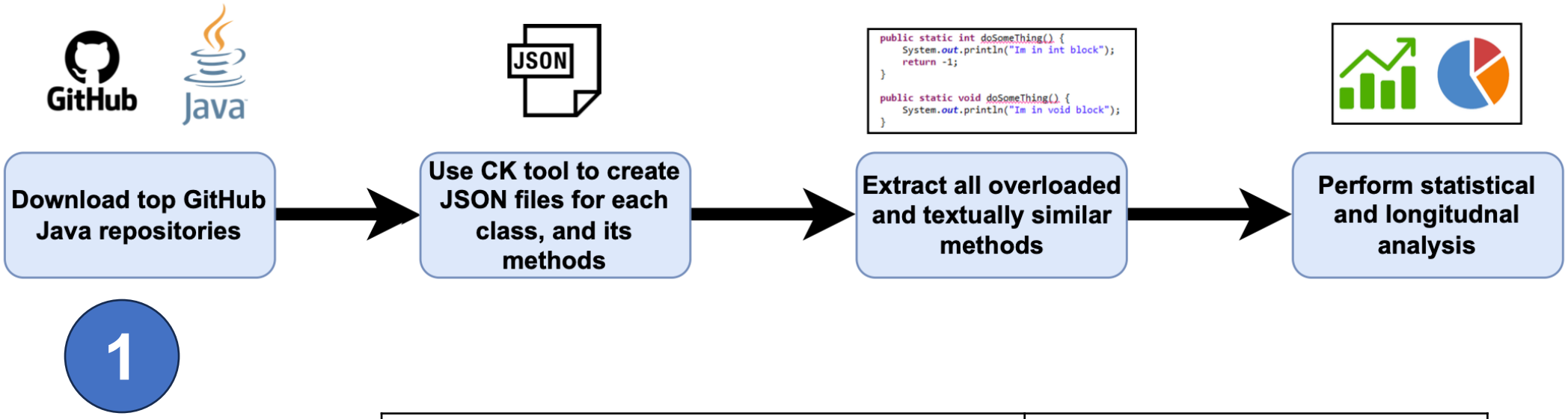
How **prevalent** are methods with similar signatures in large scale codebases?

How **frequently** developers use methods with similar signatures?

Do methods with similar signatures have **strong correlation** with certain **codebase** characteristics?

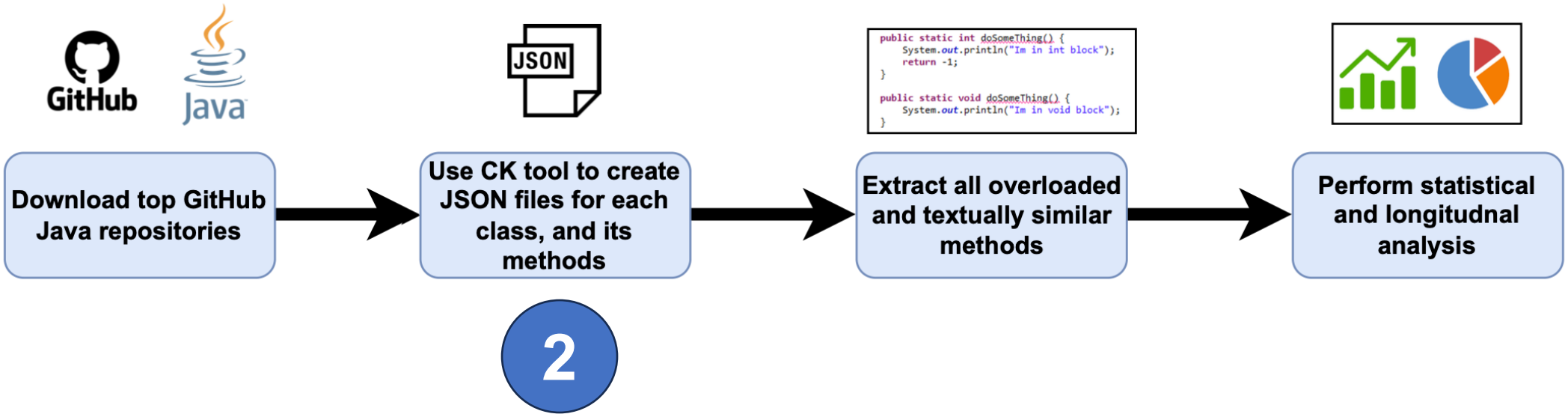
How do methods with similar signatures **evolve** as software matures?

Methodology



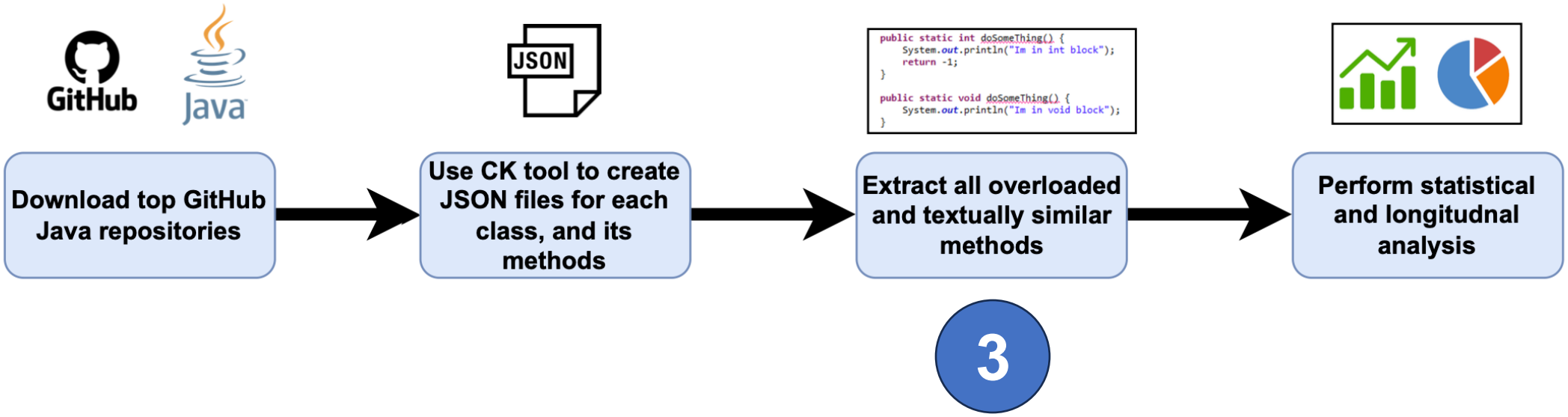
Total Repositories Collected	167 Repositories
Github Stars Range	>3500 Stars
Total Lines of Code Analyzed	~6,400,000 LOC
Total Methods	~1,900,000 Methods
Average Age of Repositories	~ 9 years

Methodology



CK Java analysis tool is an **open-source** tool that specializes in **measuring** software **metrics** in Java codebases

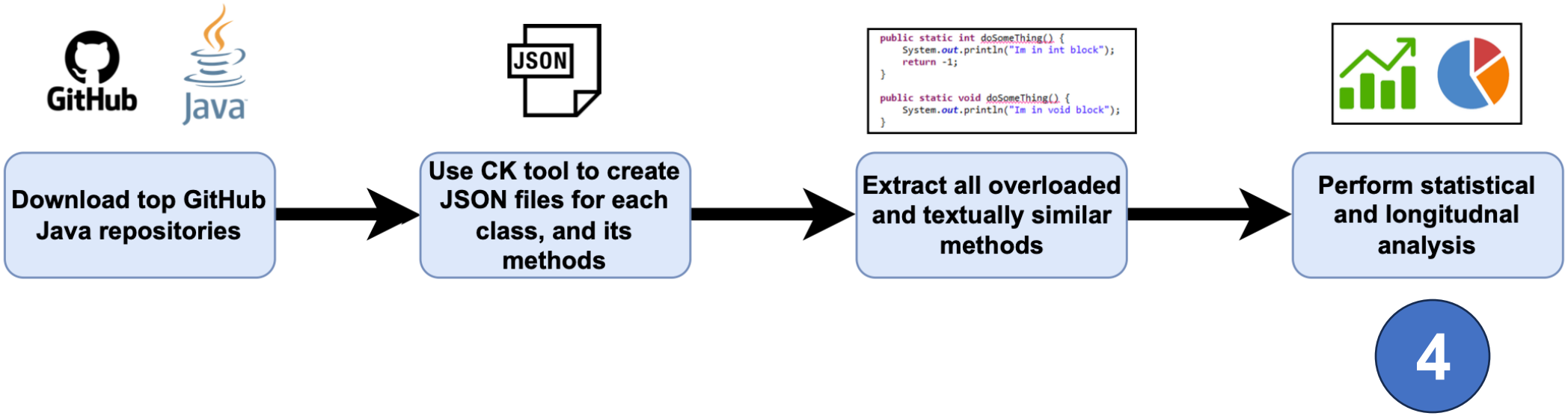
Methodology



Extracting **overloaded** methods was **straightforward**

To identify **textually similar methods**, used the **edit distance** between method names

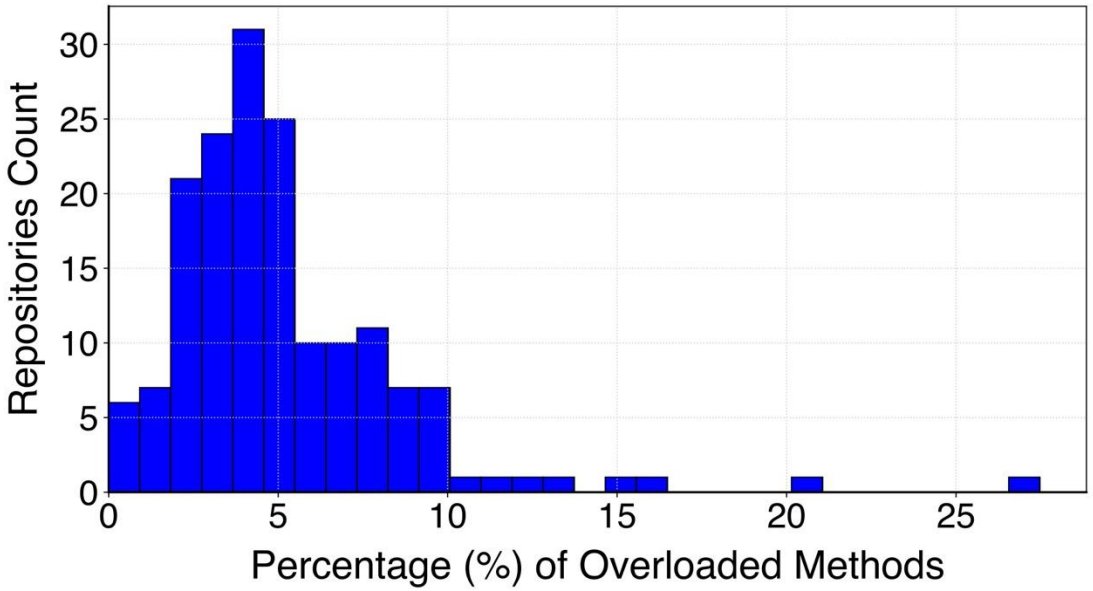
Methodology



For **longitudinal analysis** we filtered out **40** repositories at random

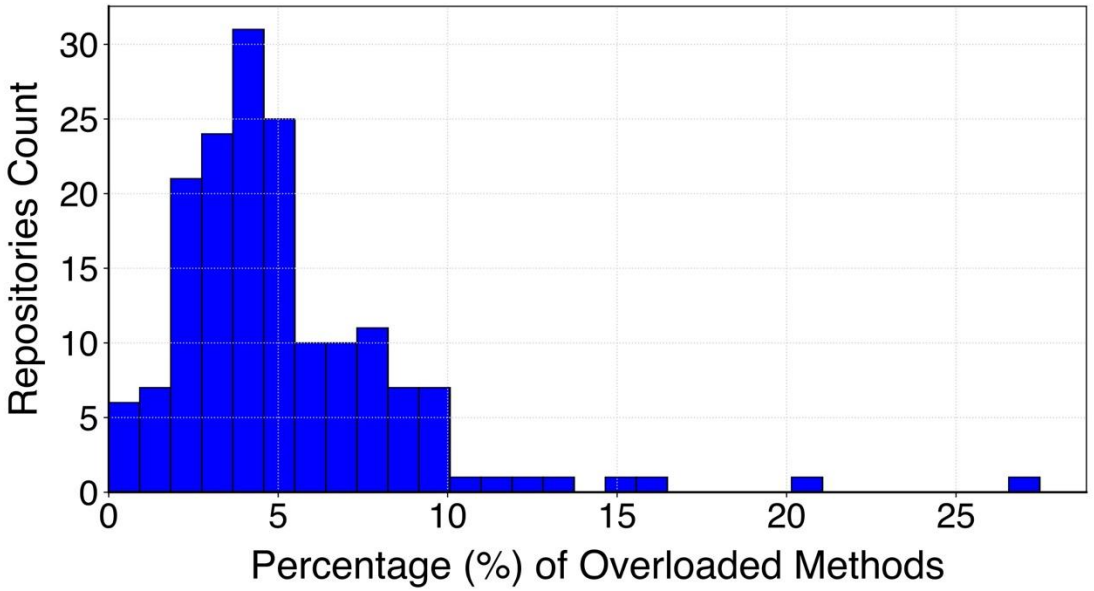
Collected **25 snapshots** evenly distributed across the repository **lifetime**

Prevalence of Methods

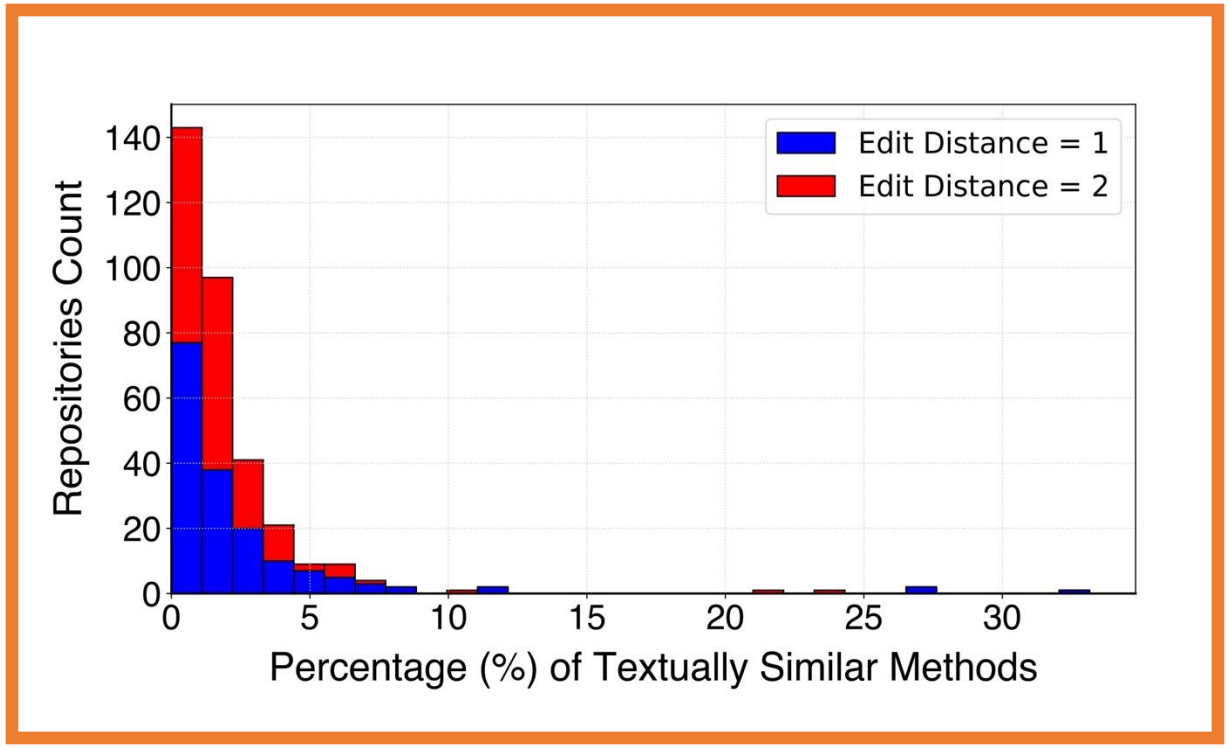


Overloaded Methods

Prevalence of Methods

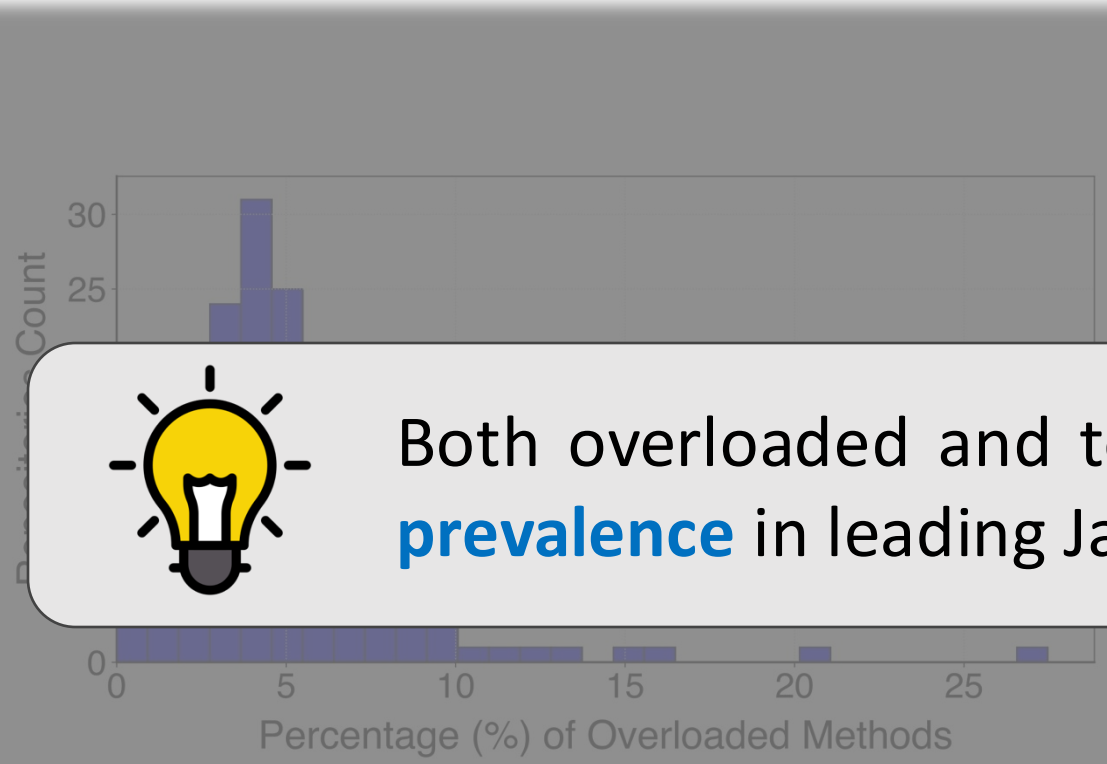


Overloaded Methods

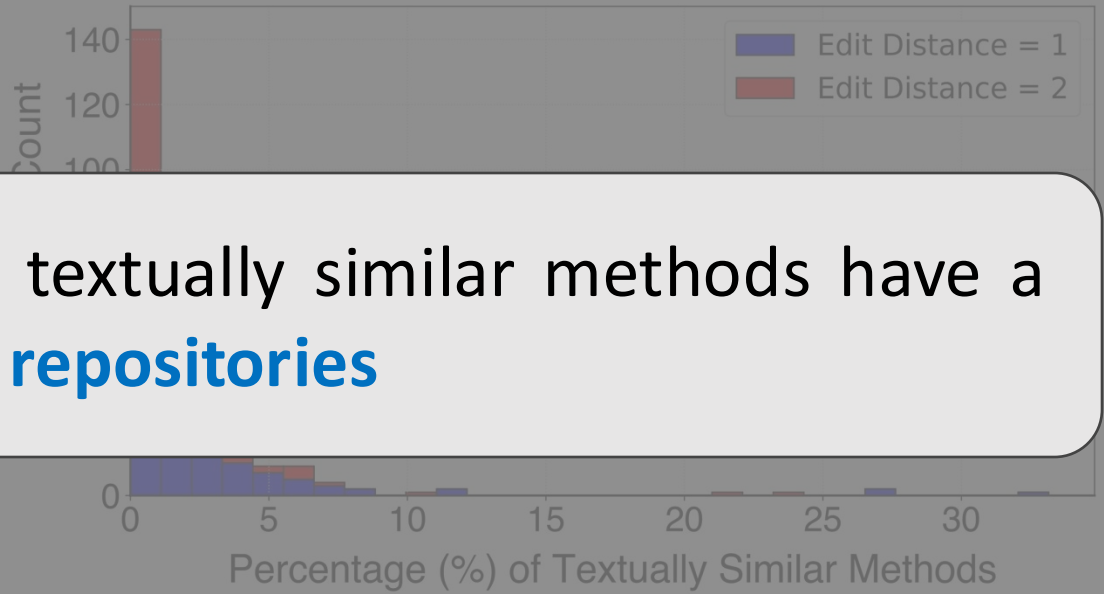


Textually Similar Methods

Prevalence of Methods



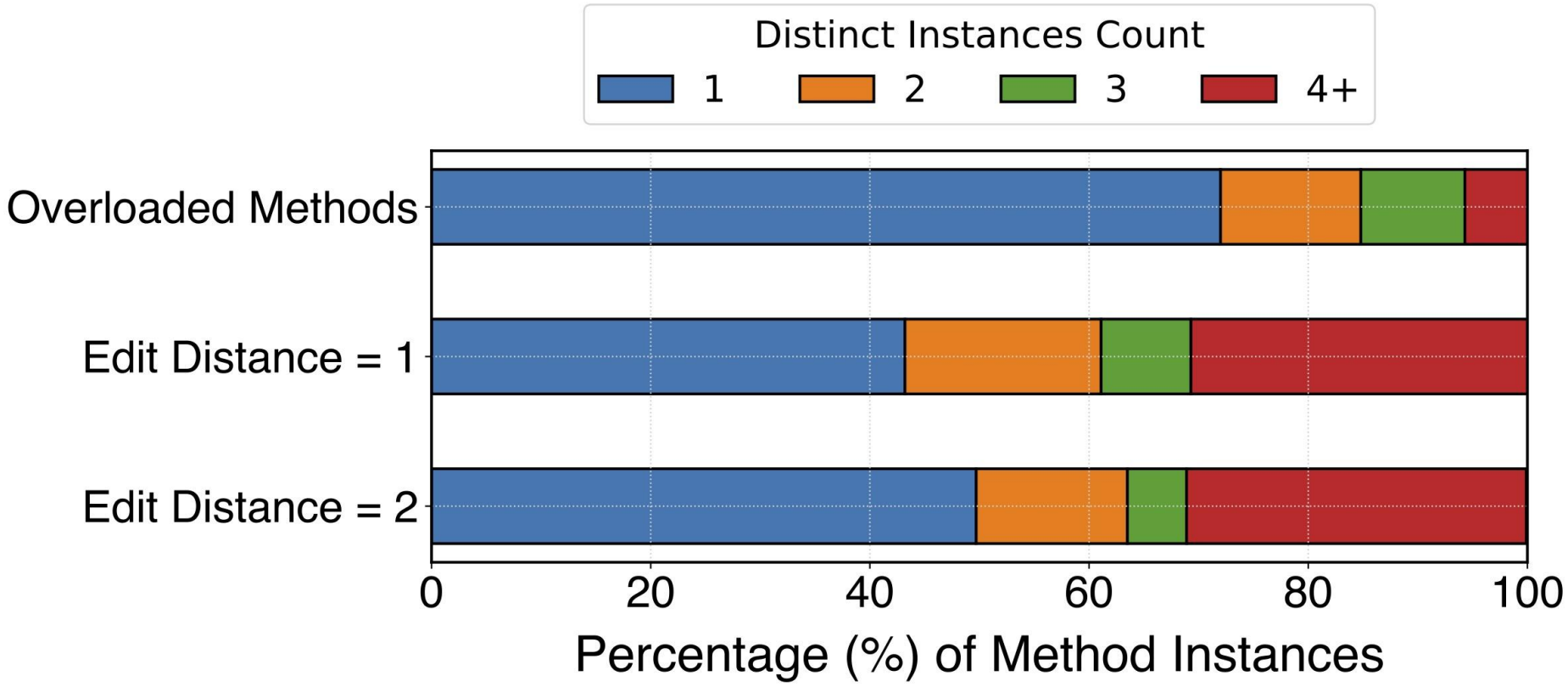
Overloaded Methods



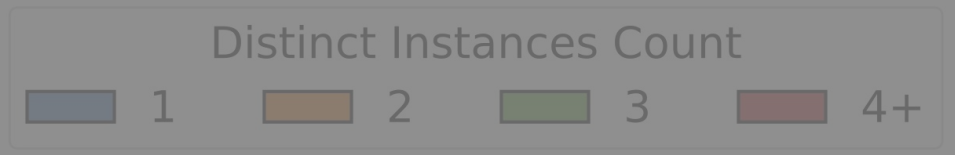
Textually Similar Methods

Both overloaded and text textually similar methods have a **prevalence** in leading Java **repositories**

Frequency of Methods



Frequency of Methods

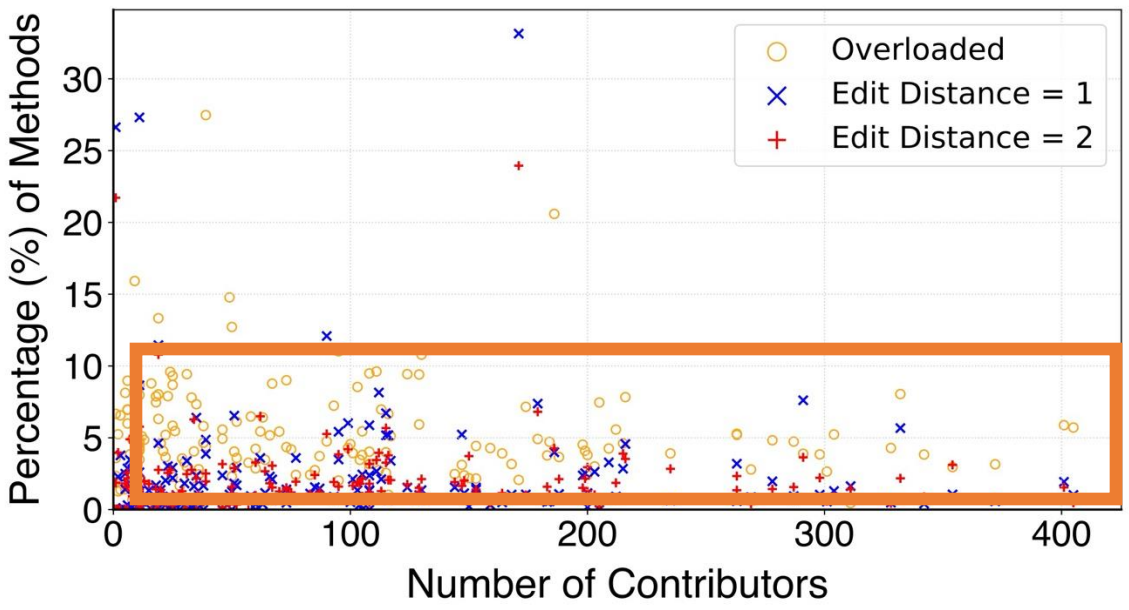


It is **uncommon** for a method to be **overloaded** more than **three times**

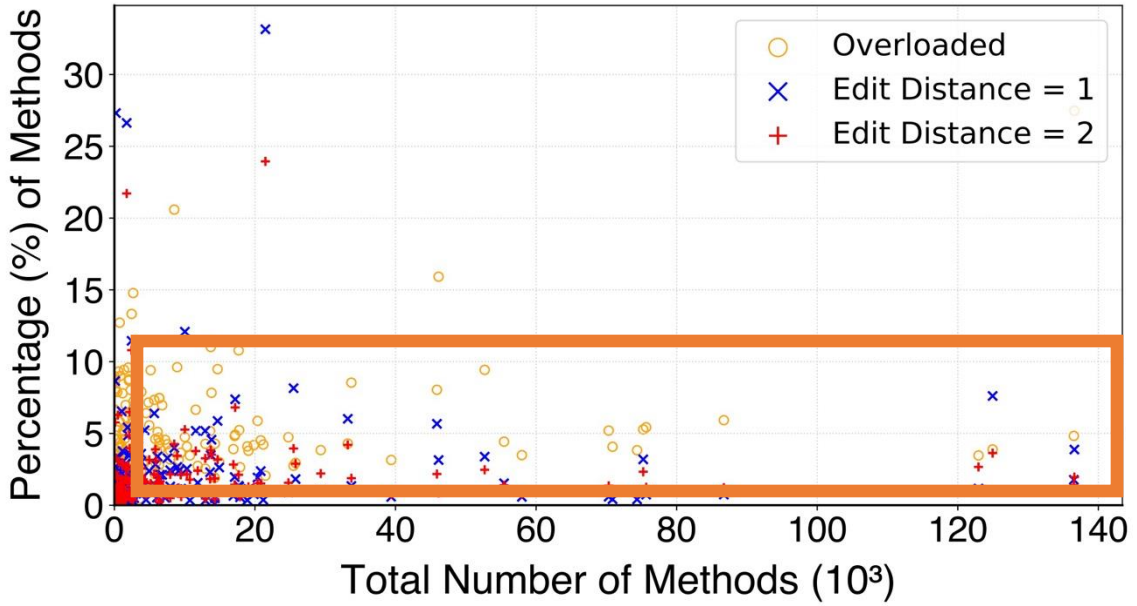
Method **variations** with small **edit distances** are more **widespread**

Percentage (%) of Method Instances

Correlation with Repository Attributes

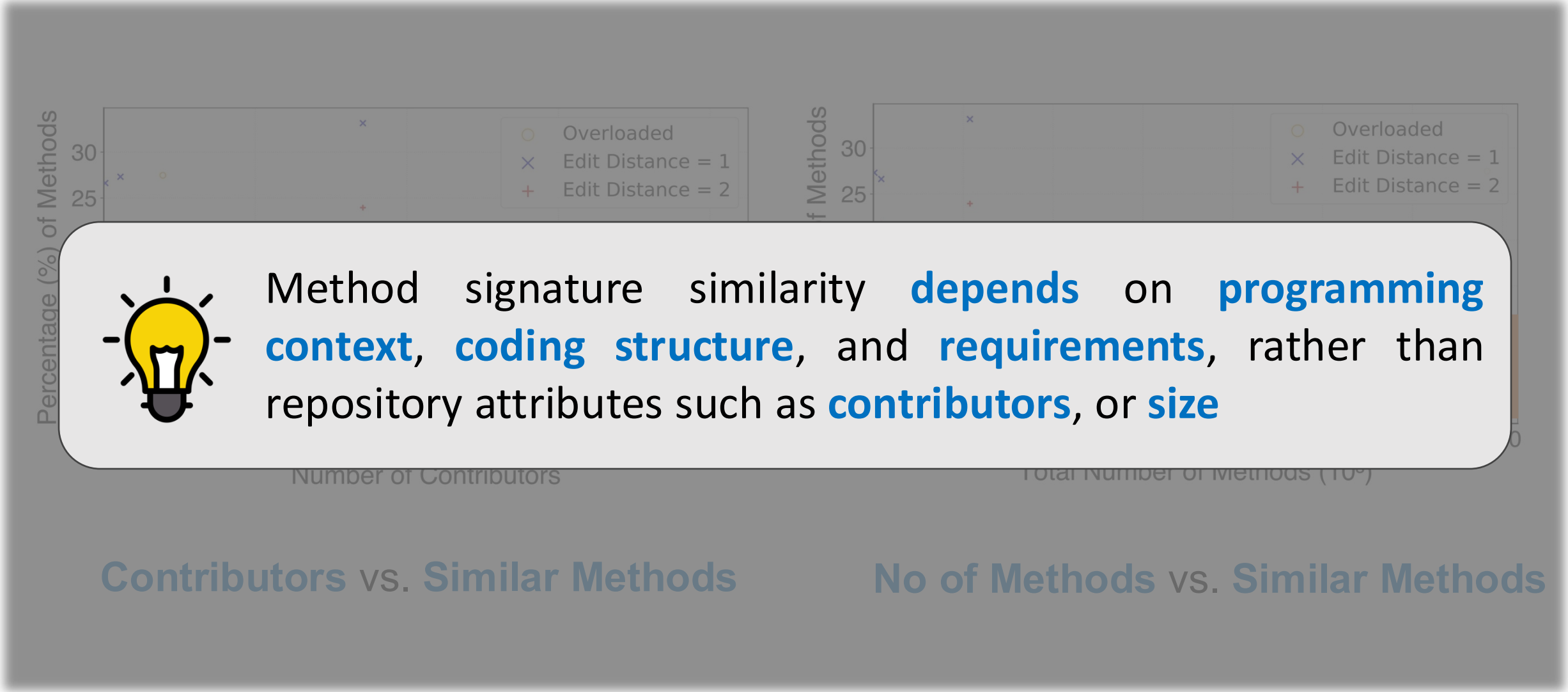


Contributors vs. **Similar Methods**



No of Methods vs. **Similar Methods**

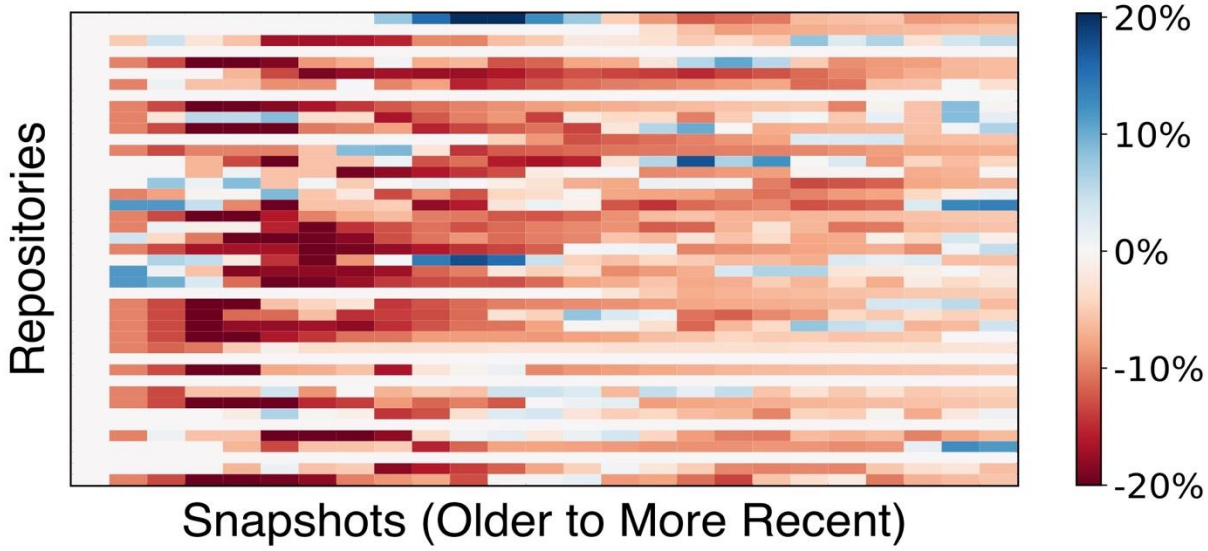
Correlation with Repository Attributes



Method signature similarity **depends** on **programming context**, **coding structure**, and **requirements**, rather than repository attributes such as **contributors**, or **size**

Evolution of Methods

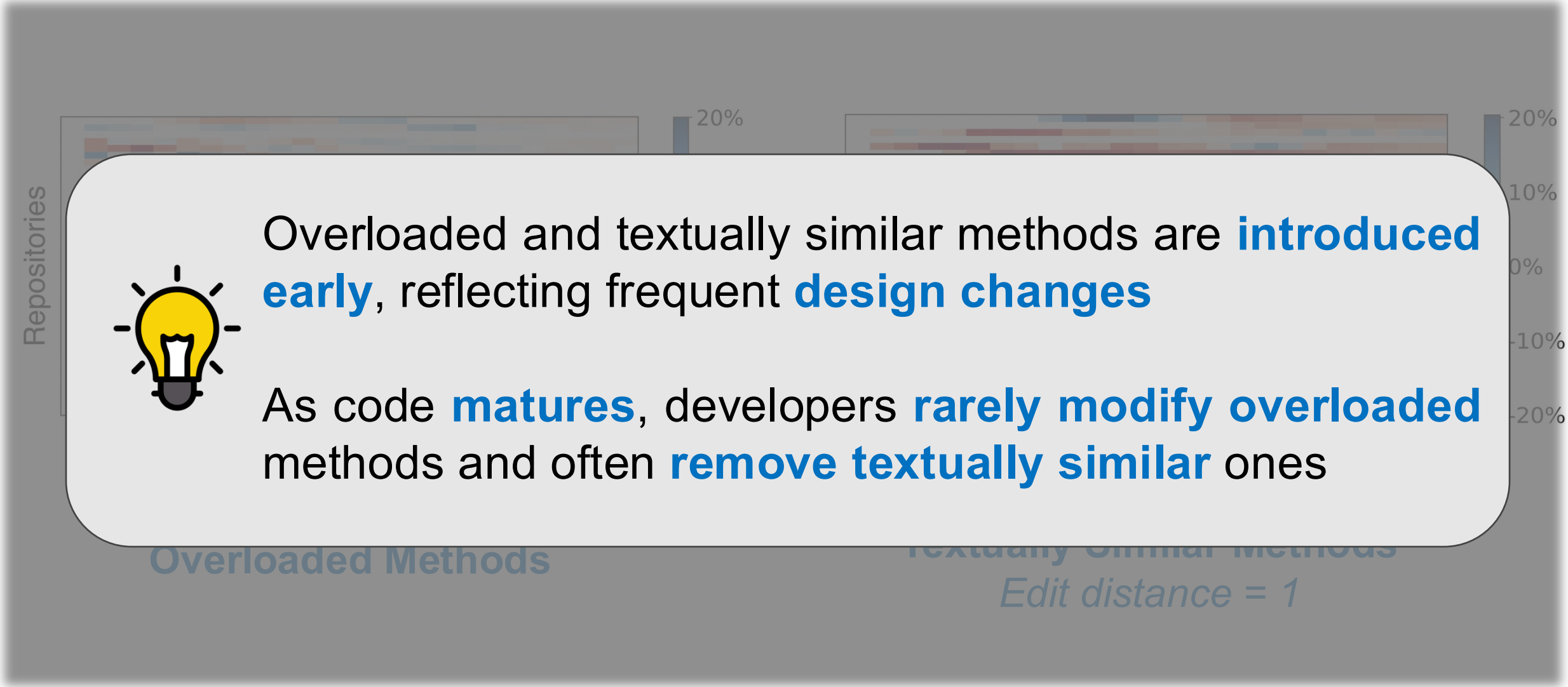
Overloaded Methods



Textually Similar Methods

Edit distance = 1

Evolution of Methods



Overloaded and textually similar methods are **introduced early**, reflecting frequent **design changes**

As code **matures**, developers **rarely modify overloaded** methods and often **remove textually similar** ones

Takeaways and Future Work

Methods with similar signatures are **context dependent** and arise from project requirements

Developer teams should establish naming **conventions** early to avoid confusion and cleanup later.

Use tools like **Maven** and **CheckStyle** to enforce naming conventions automatically.

Future Work: Focus on user studies and deeper investigation into commit notes, issues where we see a significant change

Conclusion

Our study reveals the **prevalence** and **evolution** of method signature similarity in **Java** and its **impact** on **development** practices.

Call to Action: Developers should manage method names carefully to enhance code maintainability, productivity, and prevent errors.

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