Fixr: Mining and Understanding Bug Fixes for App-Framework Protocol Defects

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Kenneth M. Anderson

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Sriram Sankaranarayanan

Tom Yeh

Sergio Mover

Shawn Meier

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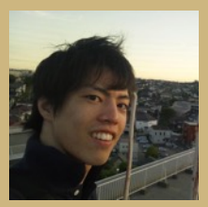


Ryo Suzuki

Rhys Braginton Pettee Olsen

Maxwell Russek

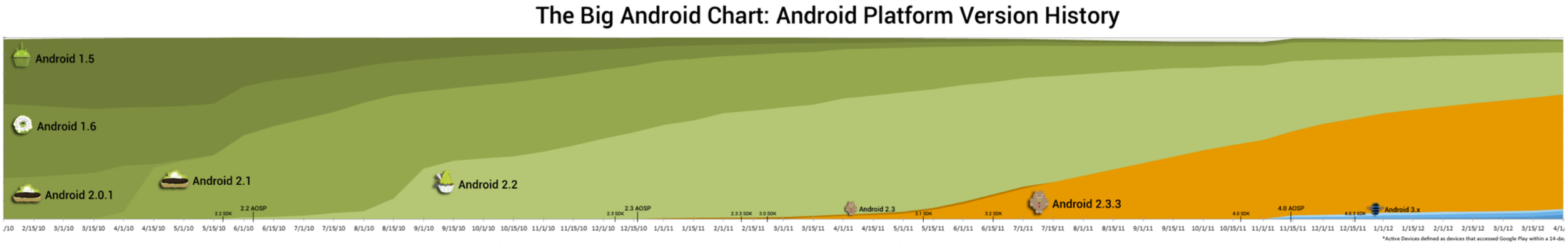
University of Colorado Boulder

PLV

MUSE Demonstration Workshop: Technical Talk

February 1, 2016

The Android framework is constantly changing



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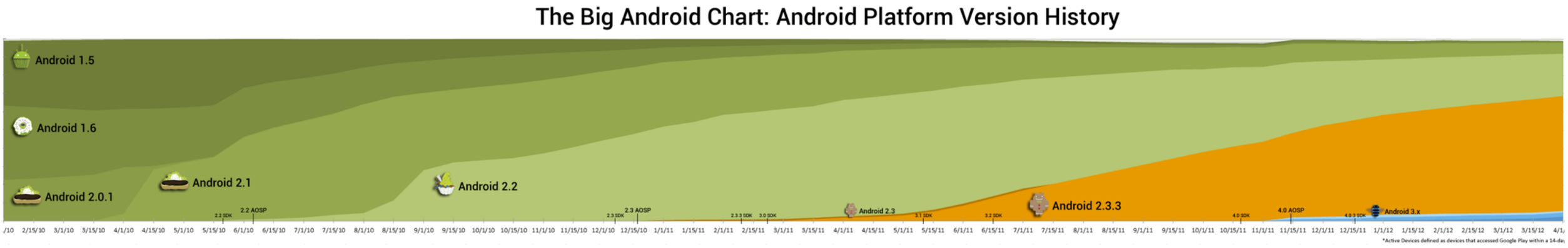

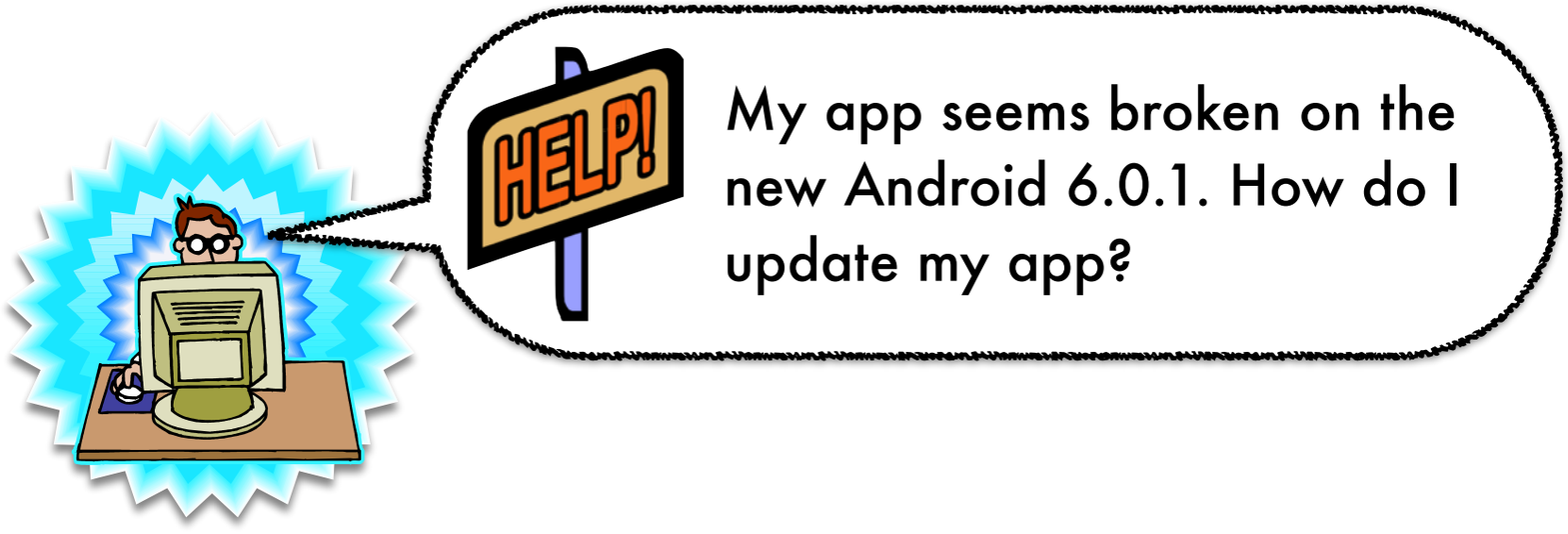

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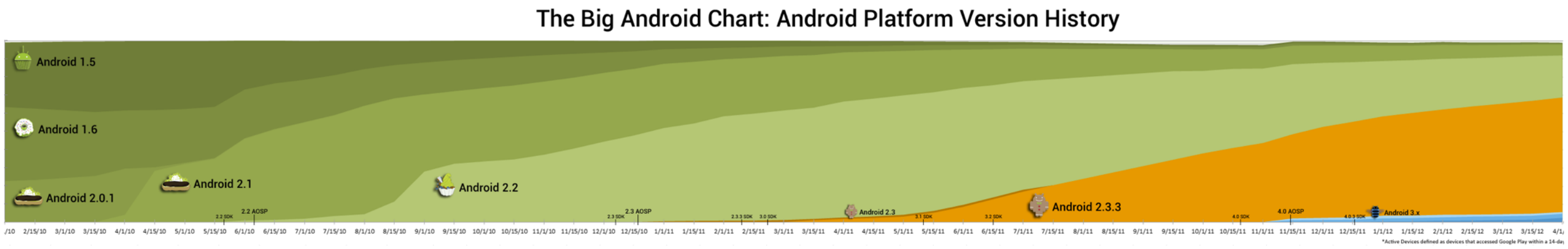

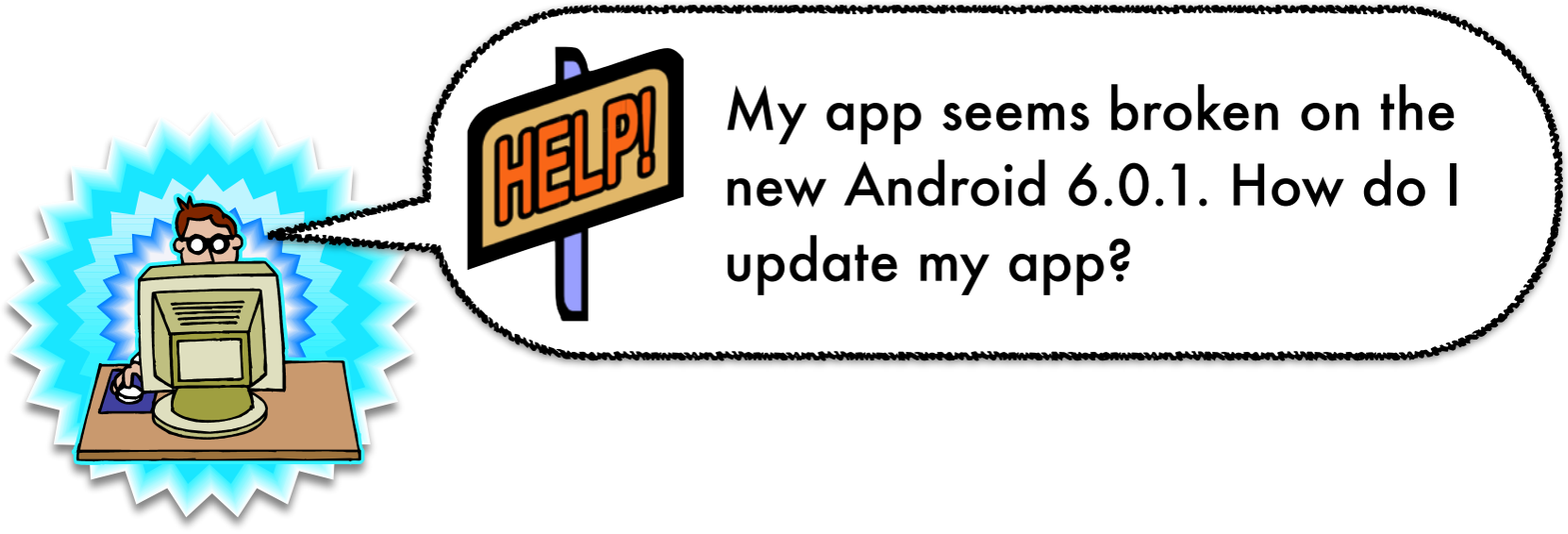

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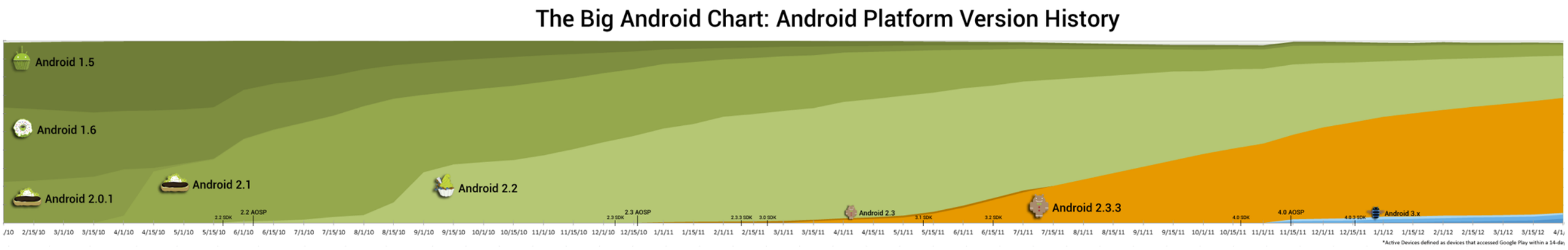
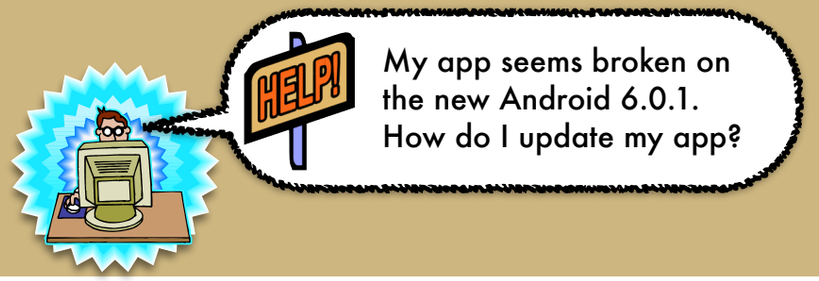


My app seems broken on the new Android 6.0.1. How do I update my app?

100s of API packages, 1,000s of API classes, 10,000s+ of API methods (as of API 23)

As an app developer, what happened in the last Android update that I need to be aware of now?

Do bugfixes trend?



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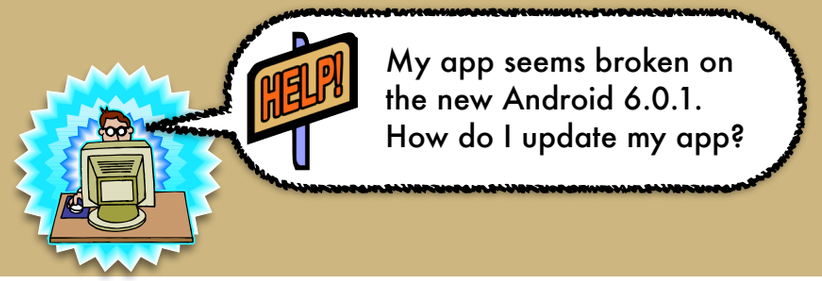

Hypothesis: App fixes for a framework update have a time signature

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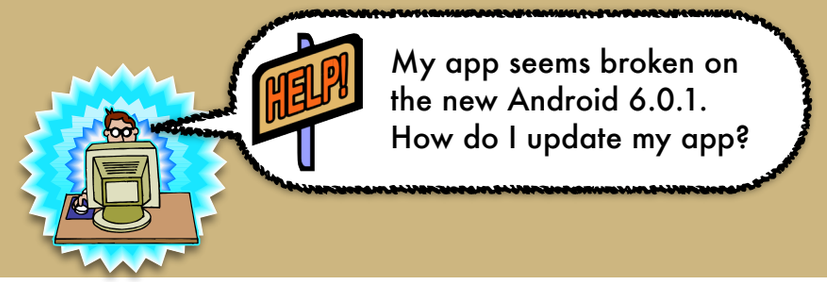

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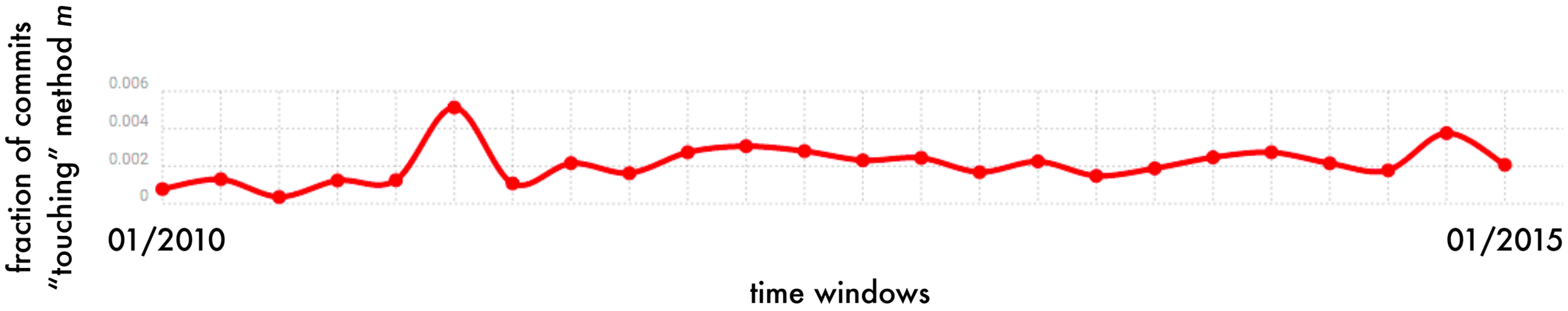

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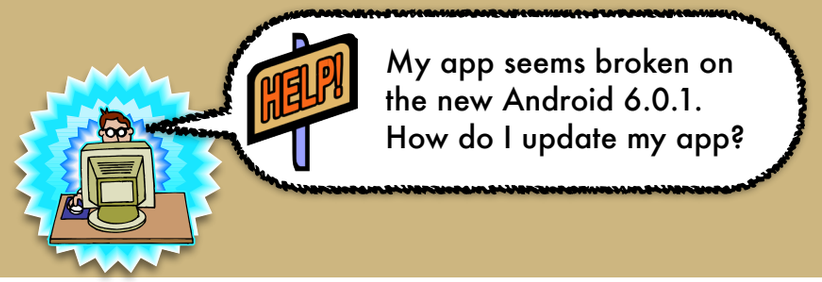

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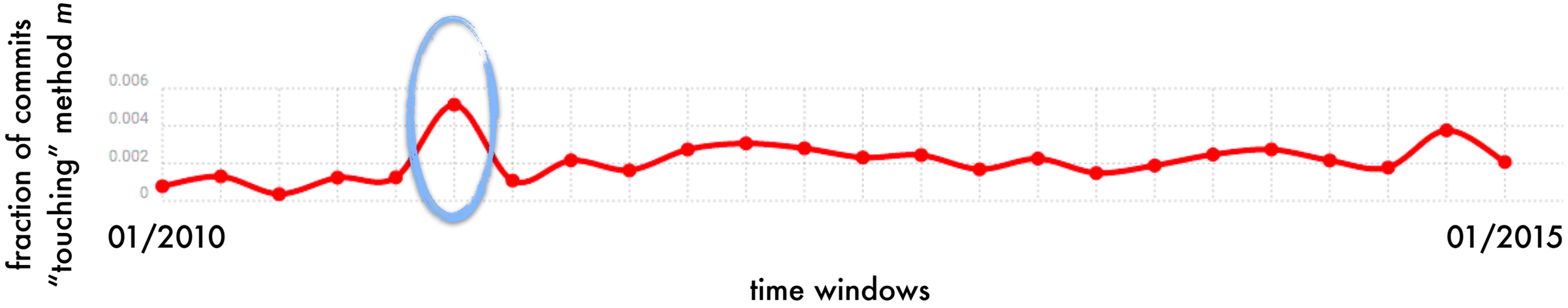

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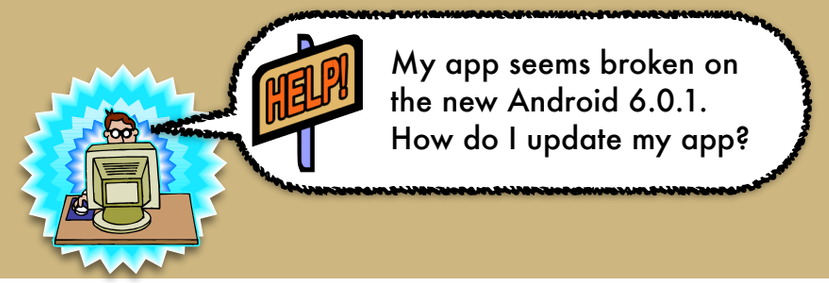

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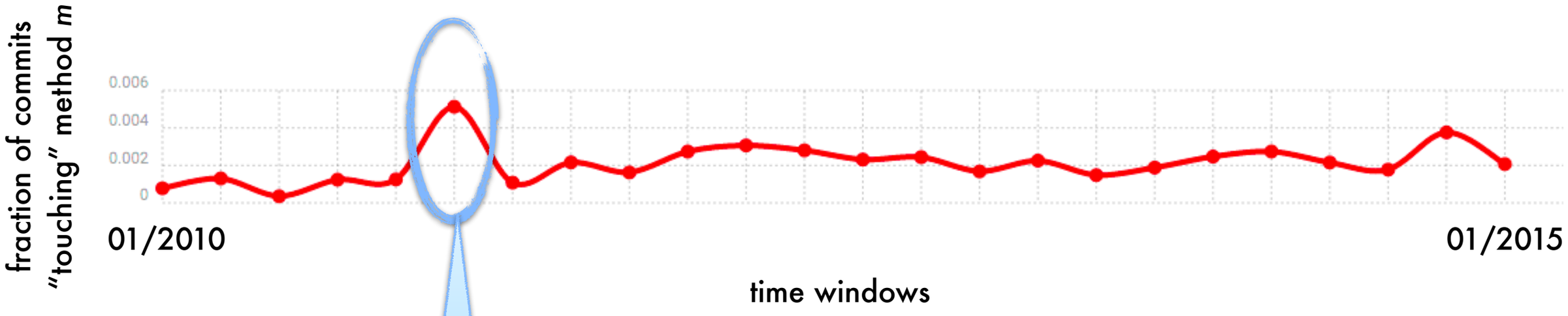
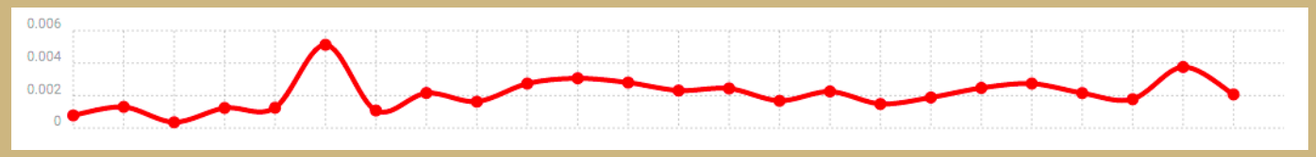


A bugfix pattern for changes in how an app should use method *m*?

API Usage Trend Analysis



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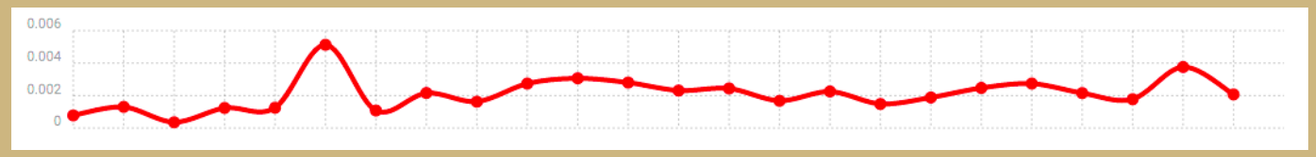

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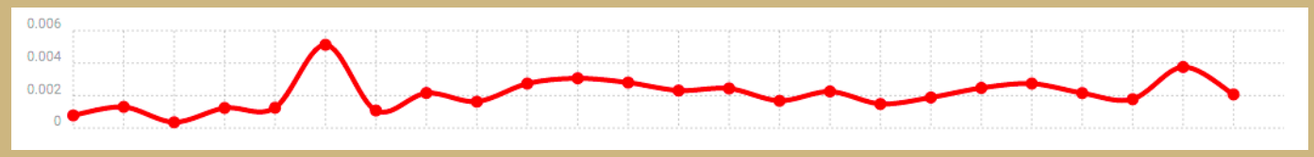

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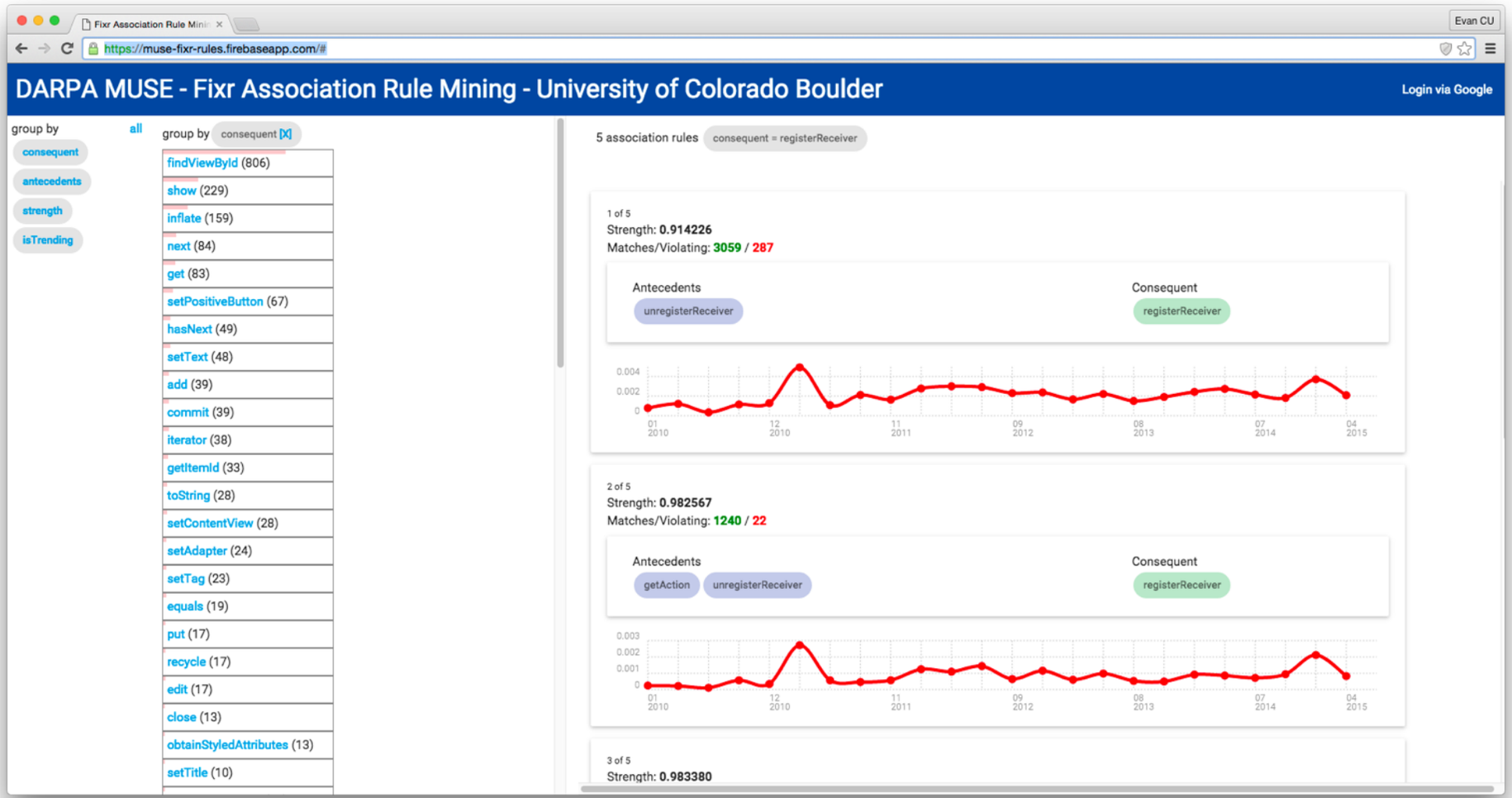

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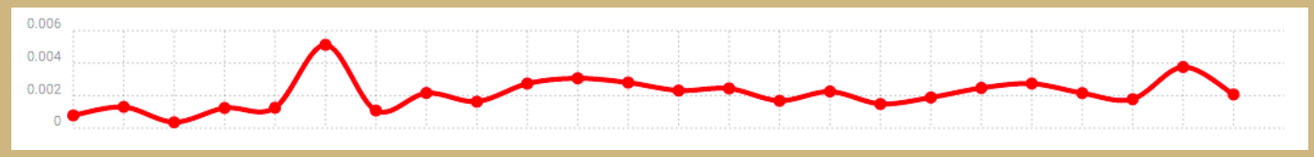

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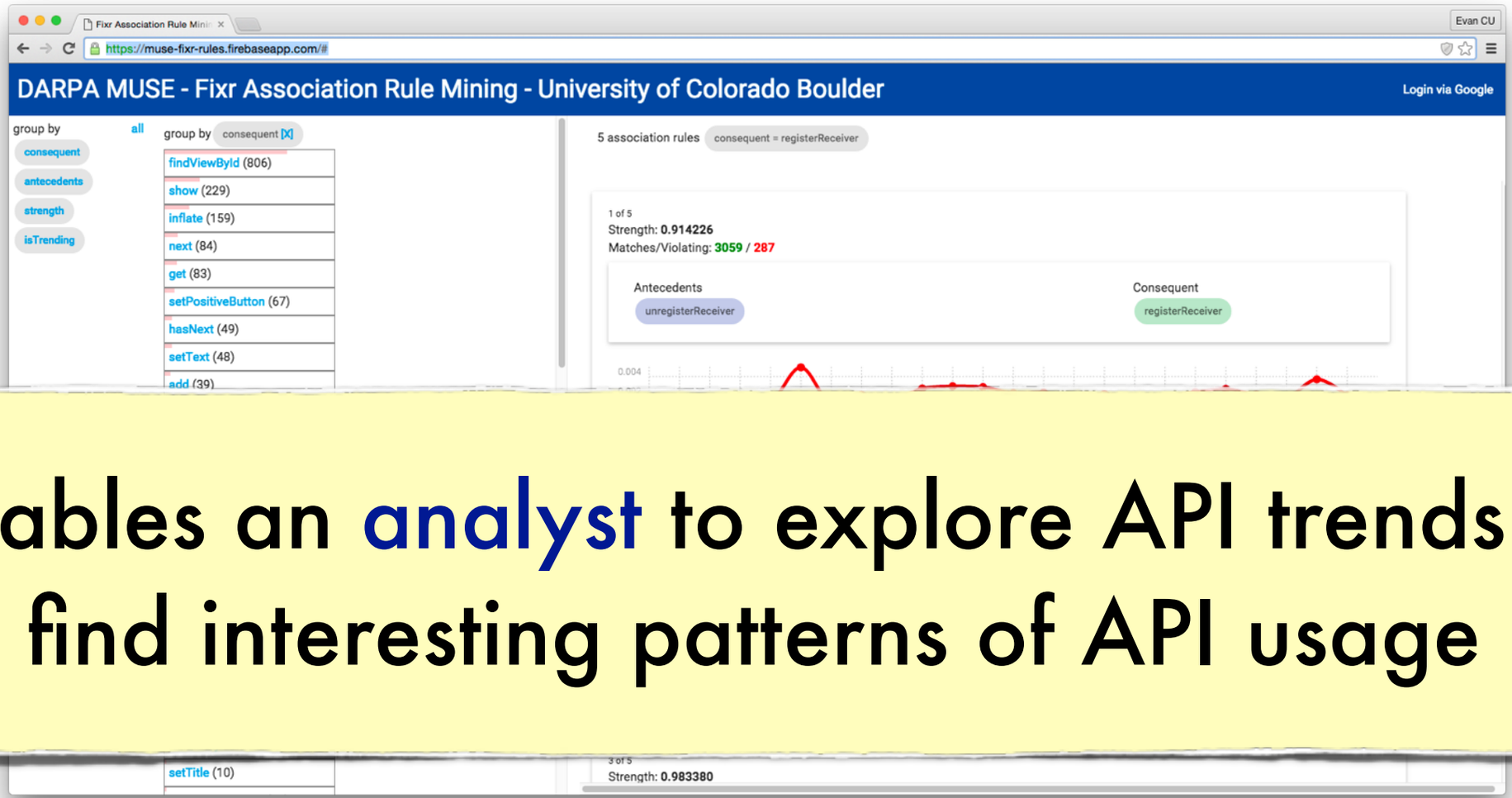

Enables an analyst to explore API trends to find interesting patterns of API usage

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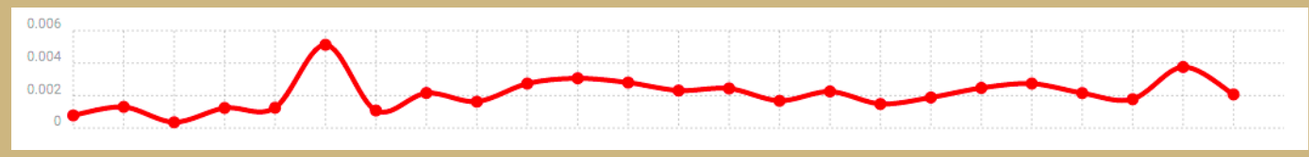

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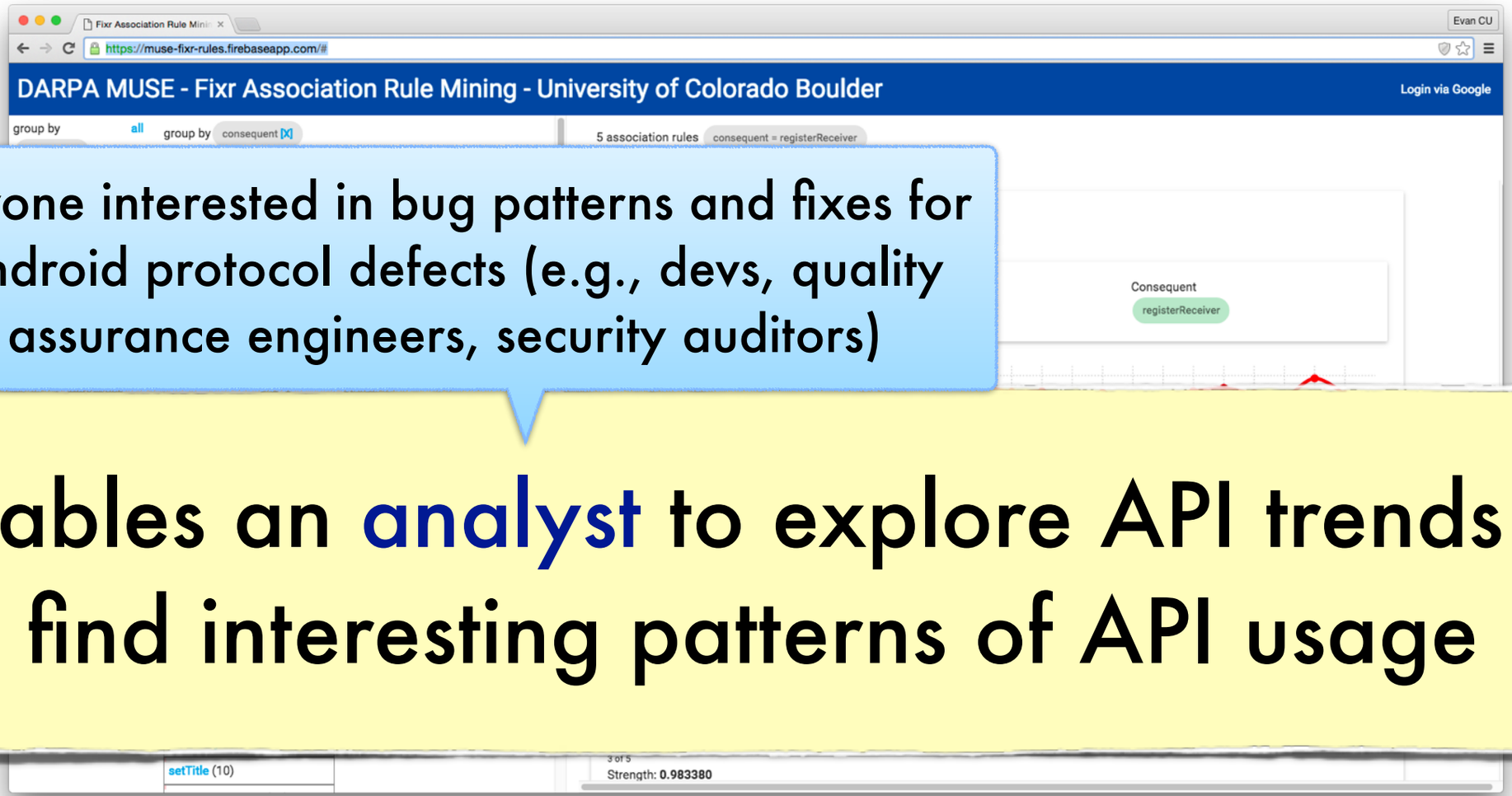

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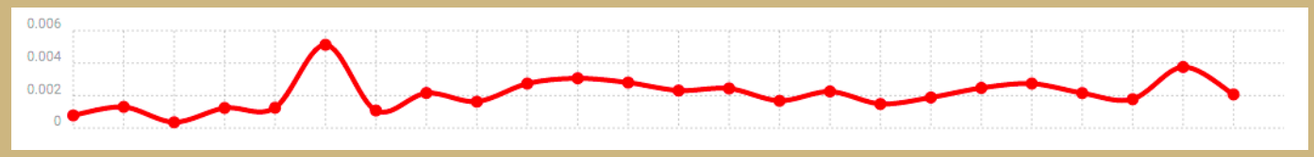

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Demonstration on Wednesday

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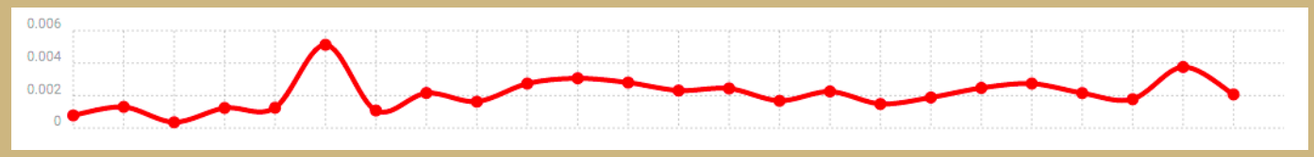

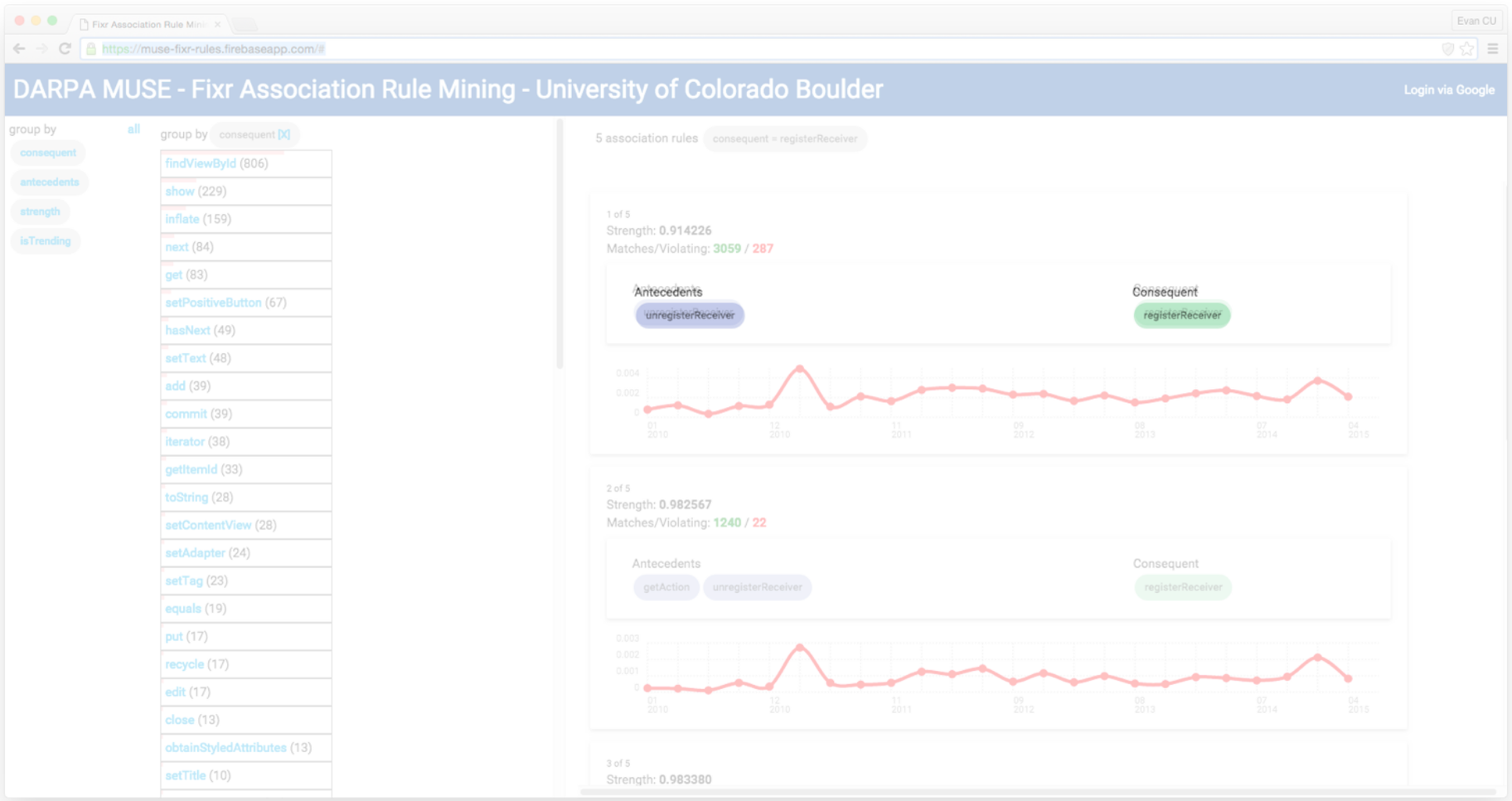

Is the trend relevant?

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Hypothesis: Bugfix commits can be found in the corpus

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Antecedents	Consequent
unregisterReceiver	registerReceiver

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Oh, I have in my code:

```
void onDestroy() {
  mContext.unregisterReceiver(this);
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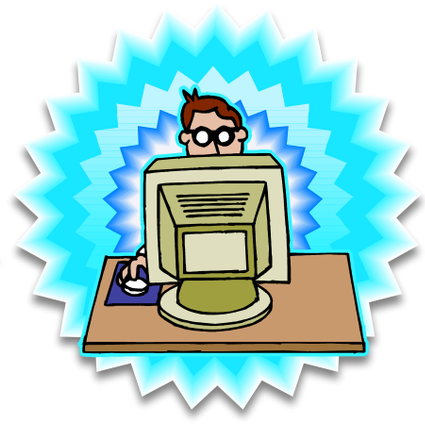

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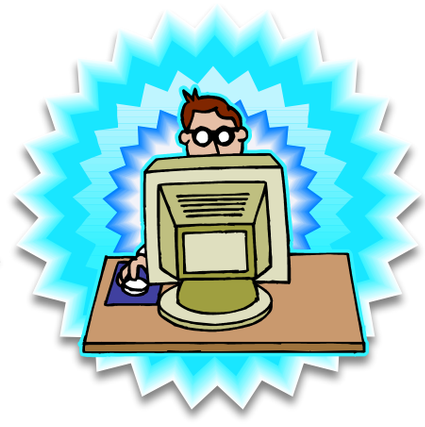

I want to find relevant commits, such as:

```
void onDestroy() {
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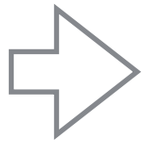

```
void onStop() {
  c.unregisterReceiver(this);
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Relevant Commit Search

```
void onDestroy() {
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Need: Find commits that are relevant to a code snippet

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Query.java — /Users/Admin/Documents/muse/muse_repos/FixrRelevantCodeSearch/evaluation/queries/MediaScannerConnection

Query.java

```
1  import android.media.MediaScannerConnection;
2
3  public class Query extends AppCompatActivity implements MediaS
4
5      private MediaScannerConnection mConnection;
6
7      protected void onCreate() {
8        MediaScannerConnection.scanFile(this,
9                                        new String[] { "" },
10                                       null,
11                                       null);
12     }
13 }
14
```

Query.java 1:1 LF UTF-8 Java master -7

[6] fasteque/rgb-tool

android-rgb-tool/src/main/java/com/fastebro/androidrgbtool/ui/MainActivity.java

Commit: @3a93e80 - fixed AOSP binder leak

Child: @3a93e80, Parent: @7ed5fc8

Diff or Source Code

```
            * Tell the media scanner about the new file so that it
         * immediately available to the user.
         */
-        MediaScannerConnection.scanFile(this,
+        MediaScannerConnection.scanFile(getApplicationContext(),
                new String[]{event.photoPath}, null,
                new MediaScannerConnection.OnScanCompletedListener()
                    public void onScanCompleted(String path, Uri uri)
```

Relevant Commit Search

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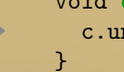

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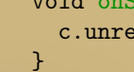

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Query.java 1:1

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Demonstration on Wednesday

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Demonstration on Wednesday

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repair specification

Relevant Commit Search

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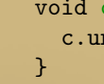

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Demonstration on Wednesday

Diff or Source Co

Specifies a bug condition and a fixing transformation

Enables an analyst to explore commits to find potential bugfixes

repair specification

Are repair specifications applicable?

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Hypothesis: API repairs are applicable "in the wild"

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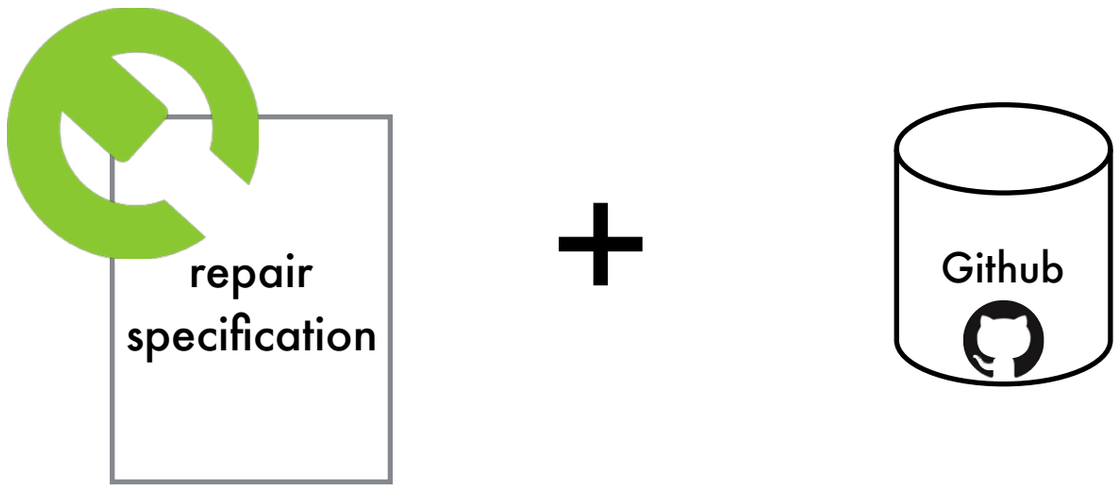

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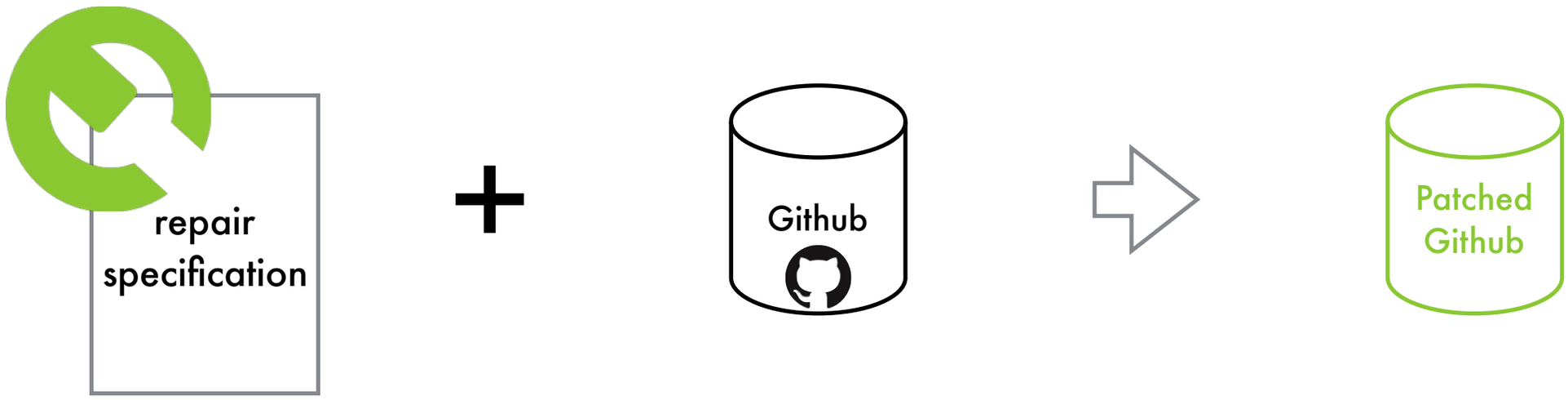

Semantic Code Search-and-Repair

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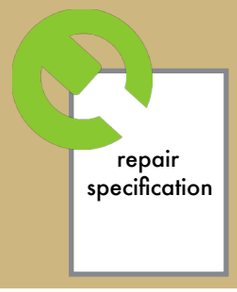

Need: Find repositories satisfying the (semantic) bug condition and patch

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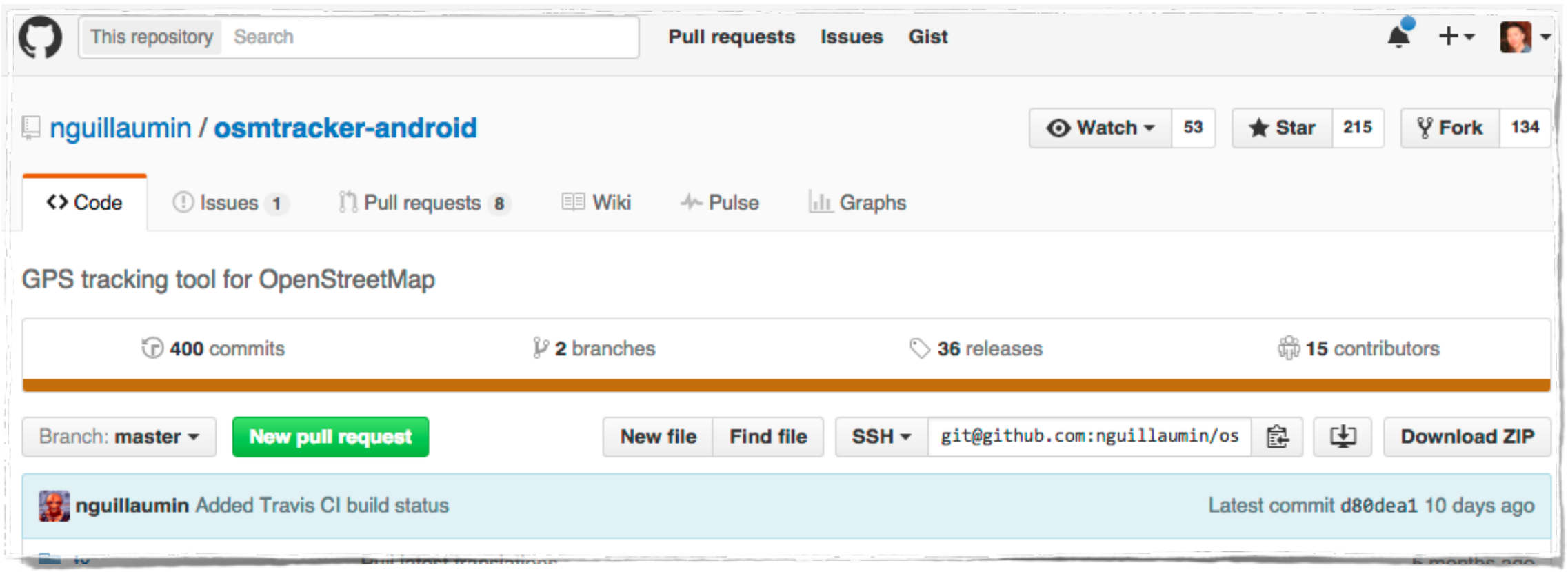


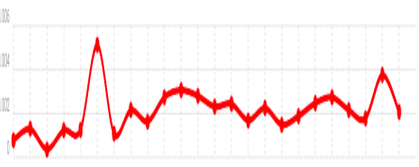
Semantic Code Search-and-Repair

Need: Find repositories satisfying the (semantic) bug condition and patch

Enables an analyst to apply repairs "in the wild"

Fixr Workflow

API Usage Trend Analysis



Relevant Commit Search

Semantic Search-and-Repair

Patched Github

Fixr Workflow

Inspect the trends to find common patterns of API usage

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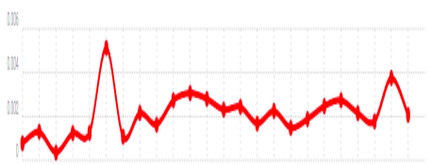


Relevant Commit Search

Semantic Search-and-Repair

Patched Github

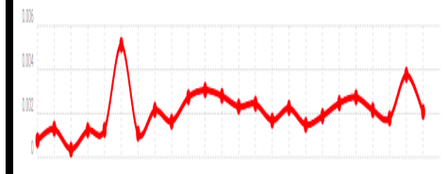
Write a query:
snippet of Java code that uses the API in a relevant way

Fixr Workflow

Inspect the trends to find common patterns of API usage

Inspect the commits to understand the bug and the fix

API Usage Trend Analysis



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Semantic Search-and-Repair

Patched Github

Write a query:
snippet of Java code that uses the API in a relevant way

Fixr Workflow

Inspect the trends to find common patterns of API usage

Inspect the commits to understand the bug and the fix

API Usage Trend Analysis

Relevant Commit Search

Semantic Search-and-Repair

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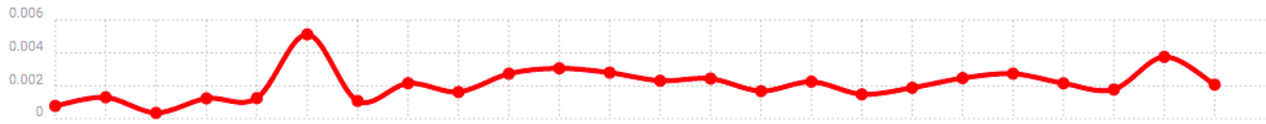
Feature Extraction on Commits

Feature Extraction on Commits

API Usage Trend Analysis



Relevant Commit Search

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void onDestroy() {
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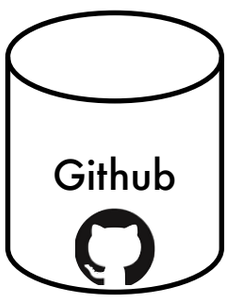
Semantic Search-and-Repair

Feature Extraction on Commits



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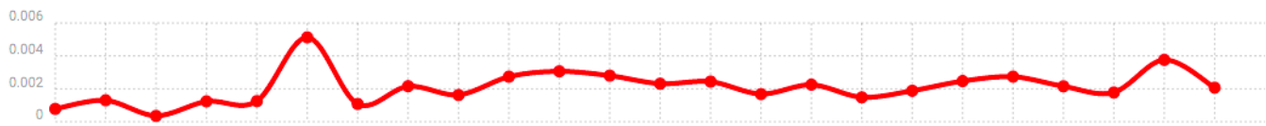

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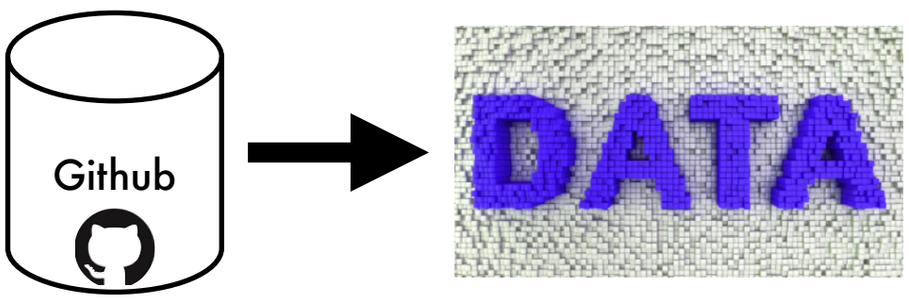

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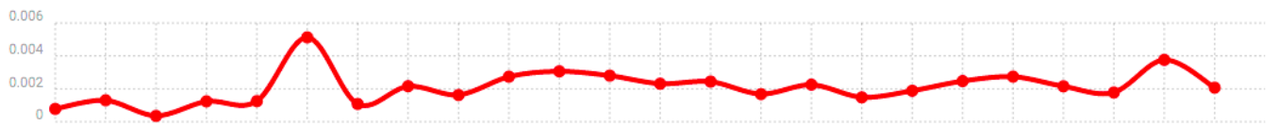

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Semantic Search-and-Repair

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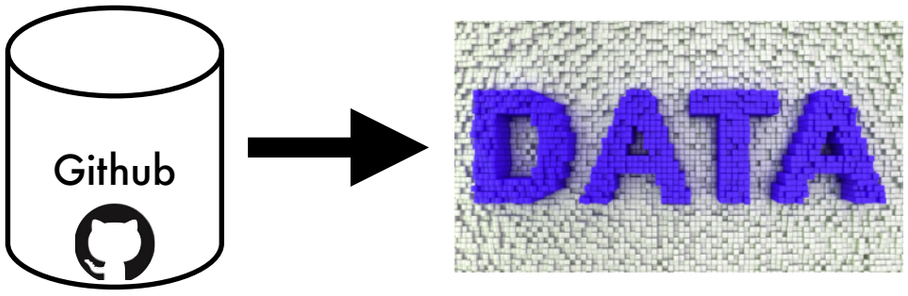

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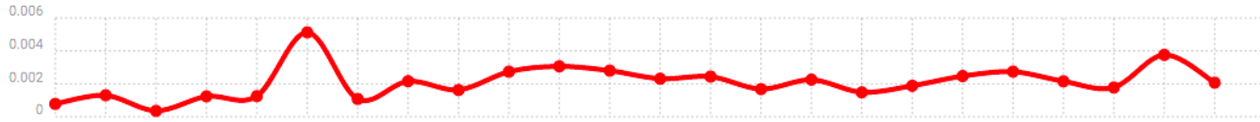

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Semantic Search-and-Repair

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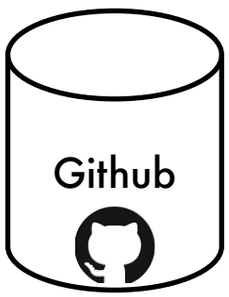

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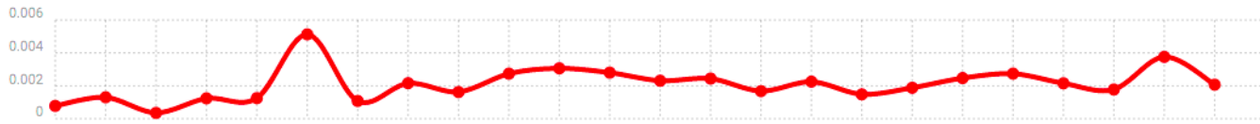

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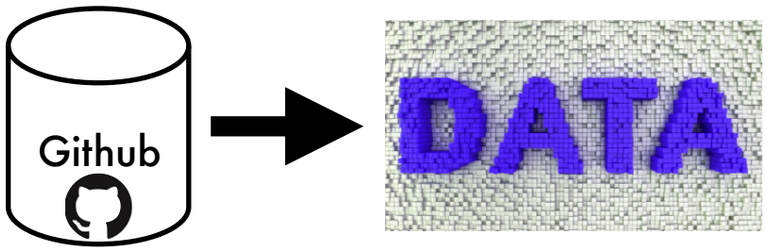
Semantic Search-and-Repair

Need: Extract features from code commits

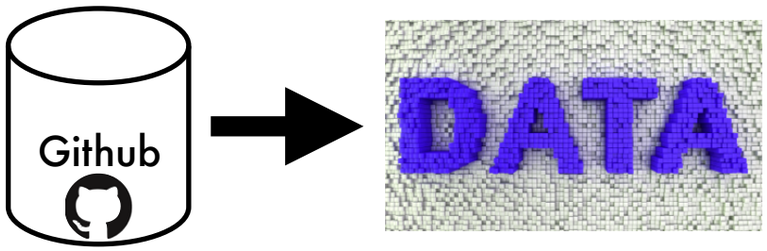
Fixr Contributions

Fixr Contributions



Extract commit features at scale

Fixr Contributions



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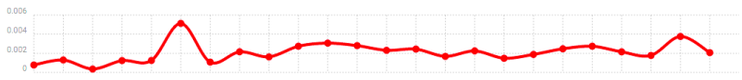
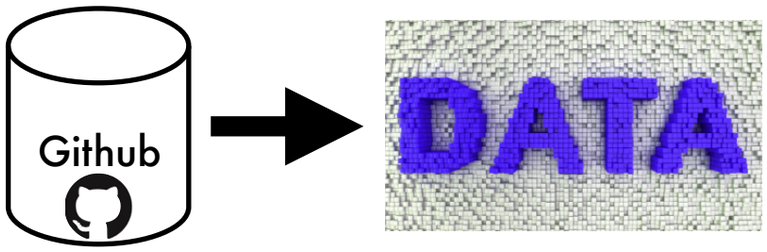


Find API usage patterns over time

Fixr Contributions



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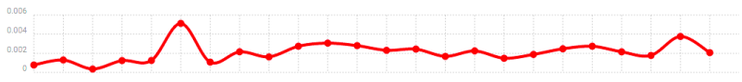
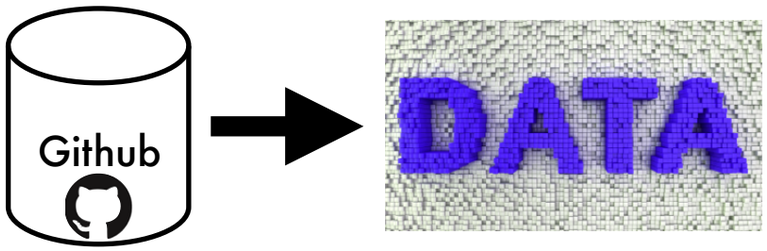


Find API usage patterns over time

Index commit feature documents

Fixr Contributions



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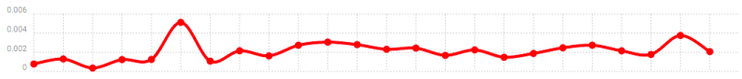


Find API usage patterns over time

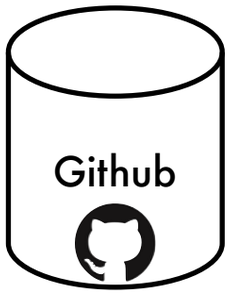
Index commit feature documents

Search-and-repair platform
for Android apps

Fixr Highlights

Fixr Highlights

Commits + Time Series = Trends



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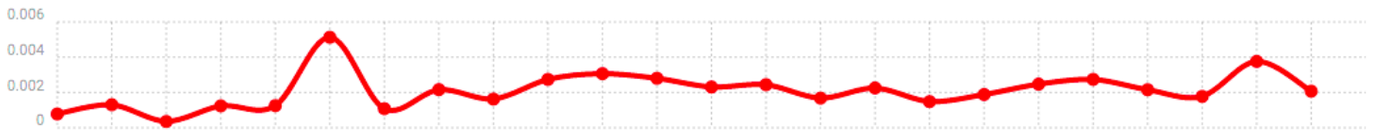

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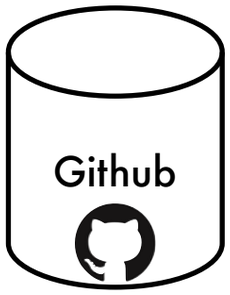

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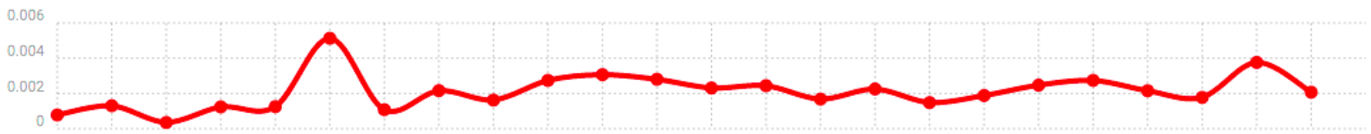
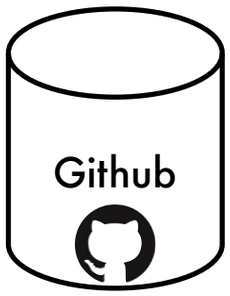


Semantic Repair Specification

Fixr Highlights

Commits + Time Series = Trends



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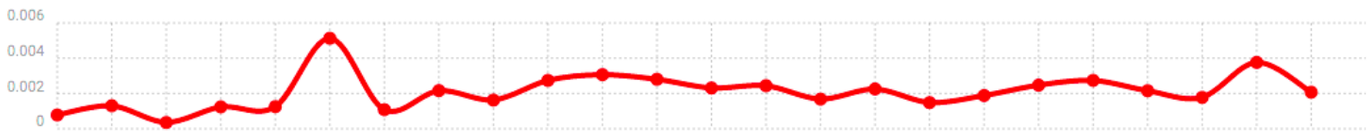
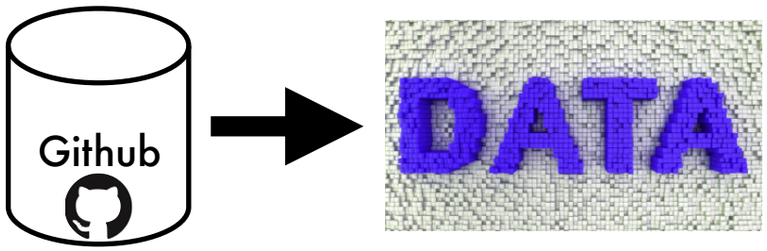


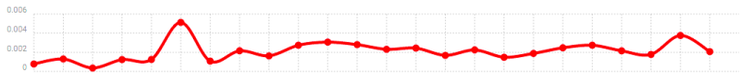
Semantic Repair Specification

Android API Evolution

Fixr Contributions



Extract commit features at scale



Find API usage patterns over time

Index commit feature documents

Search-and-repair platform
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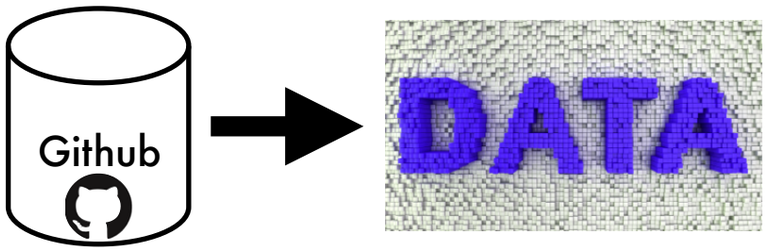

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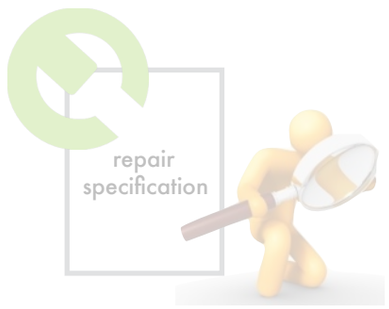

Search-and-repair platform
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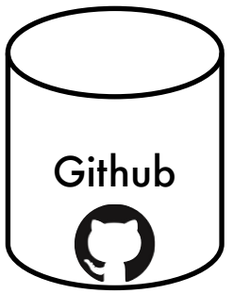
Approach



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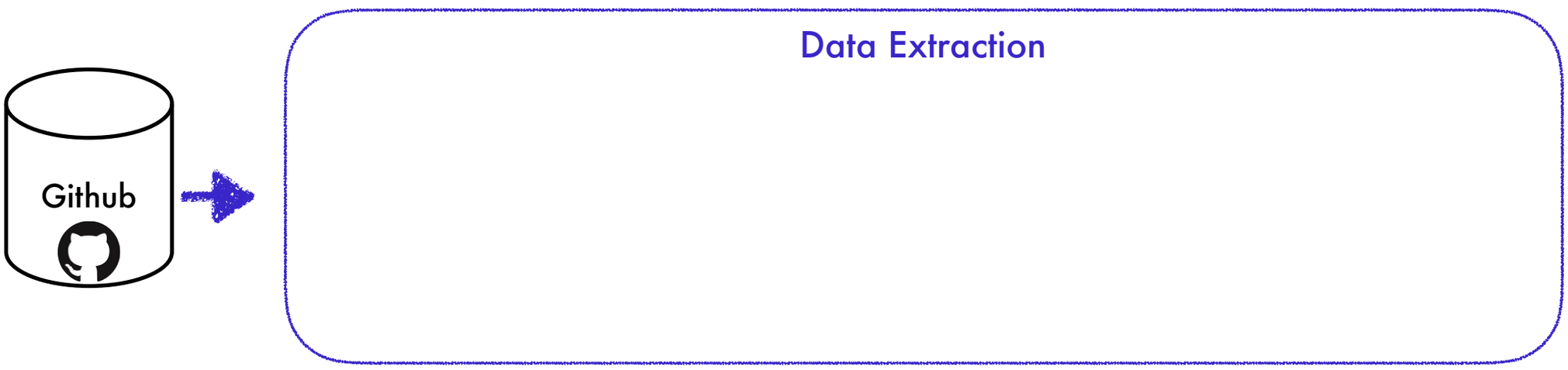

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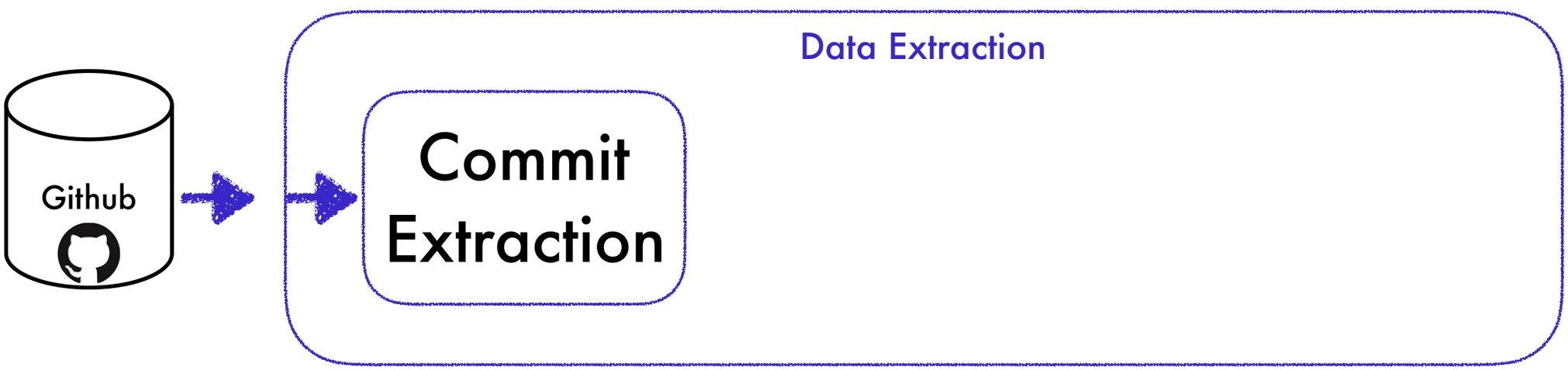

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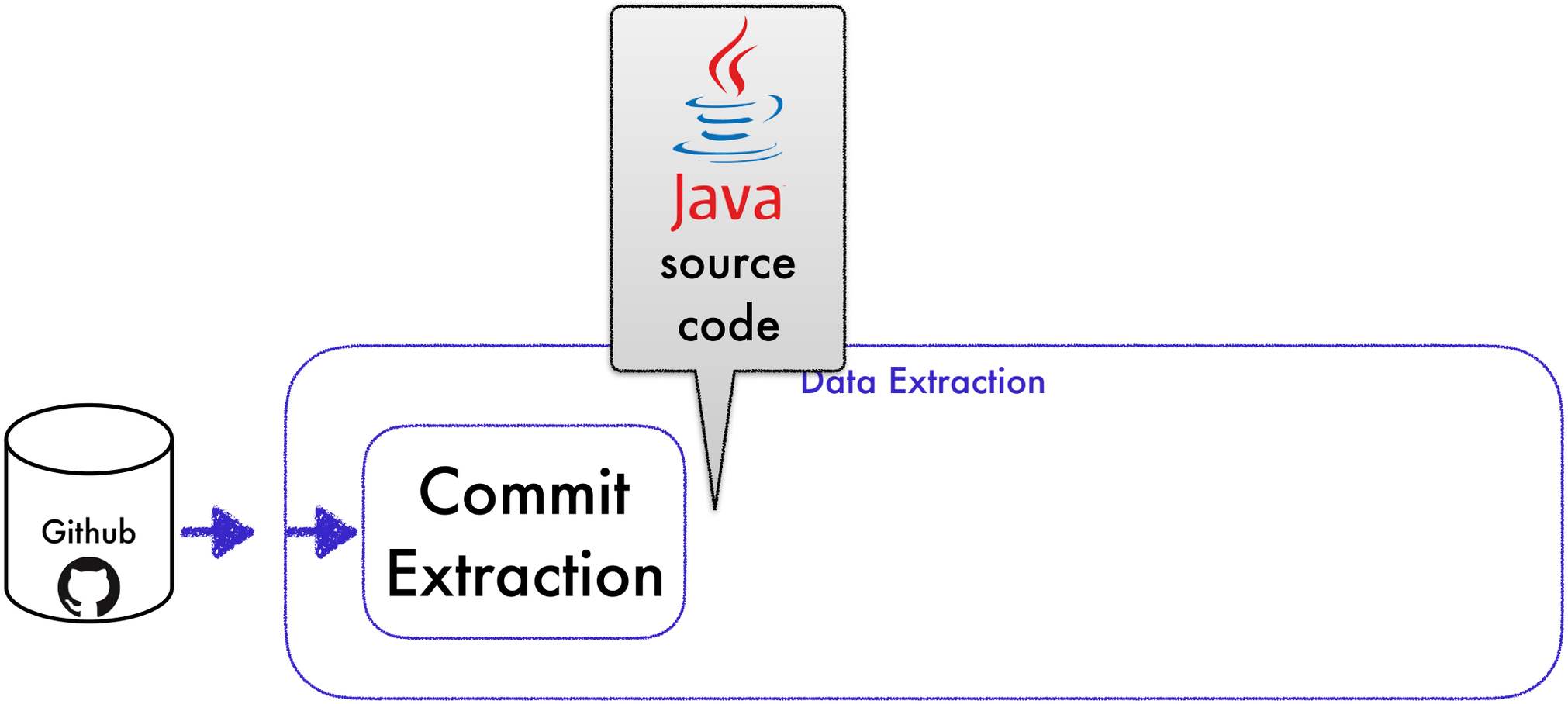

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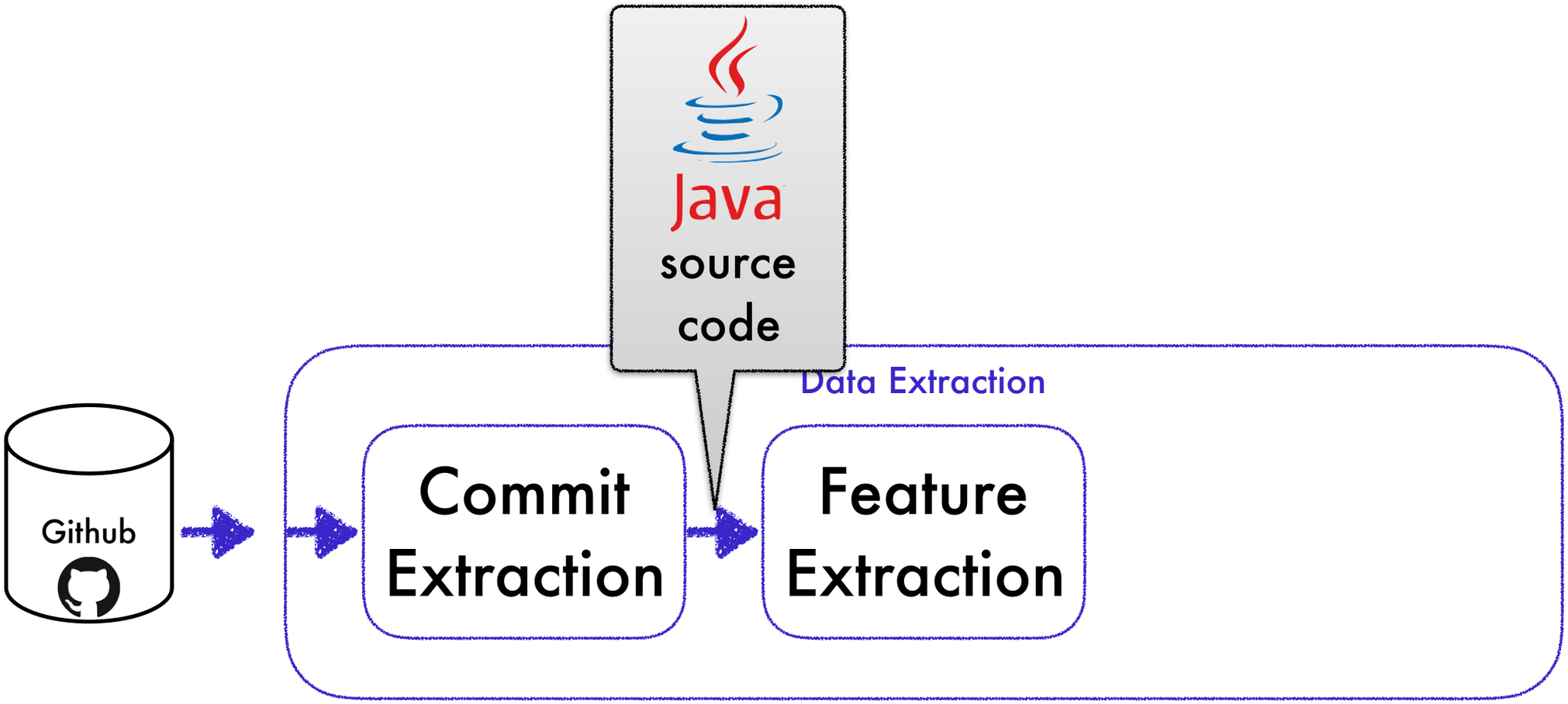

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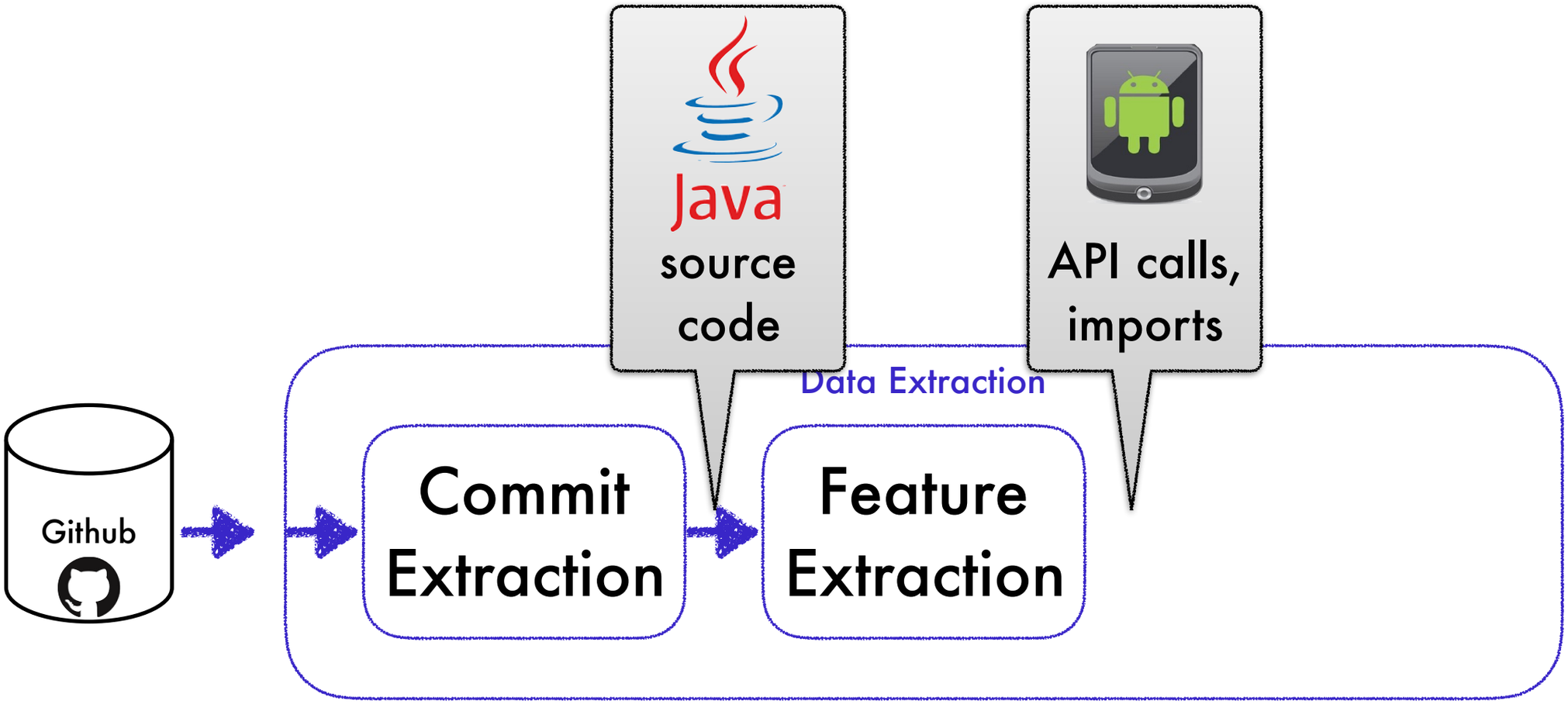

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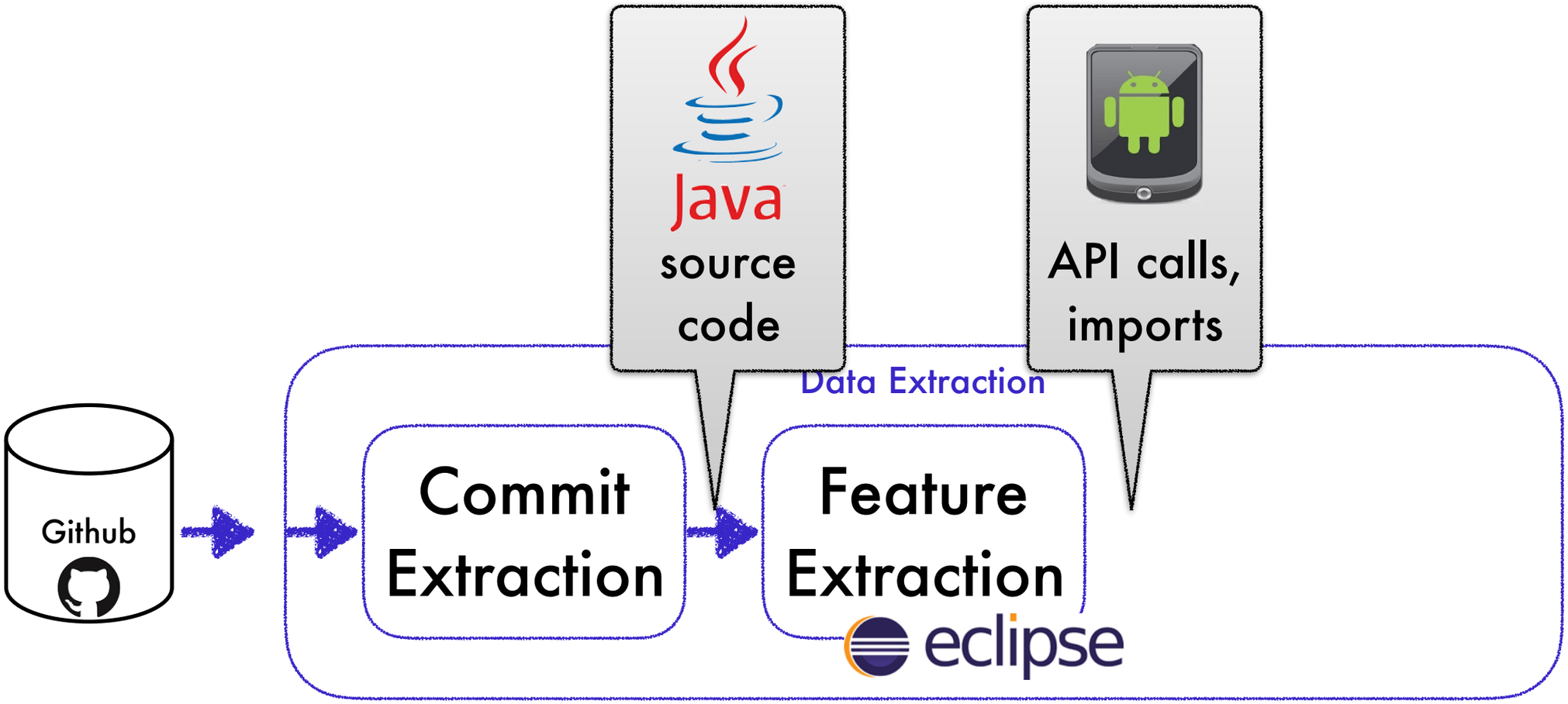

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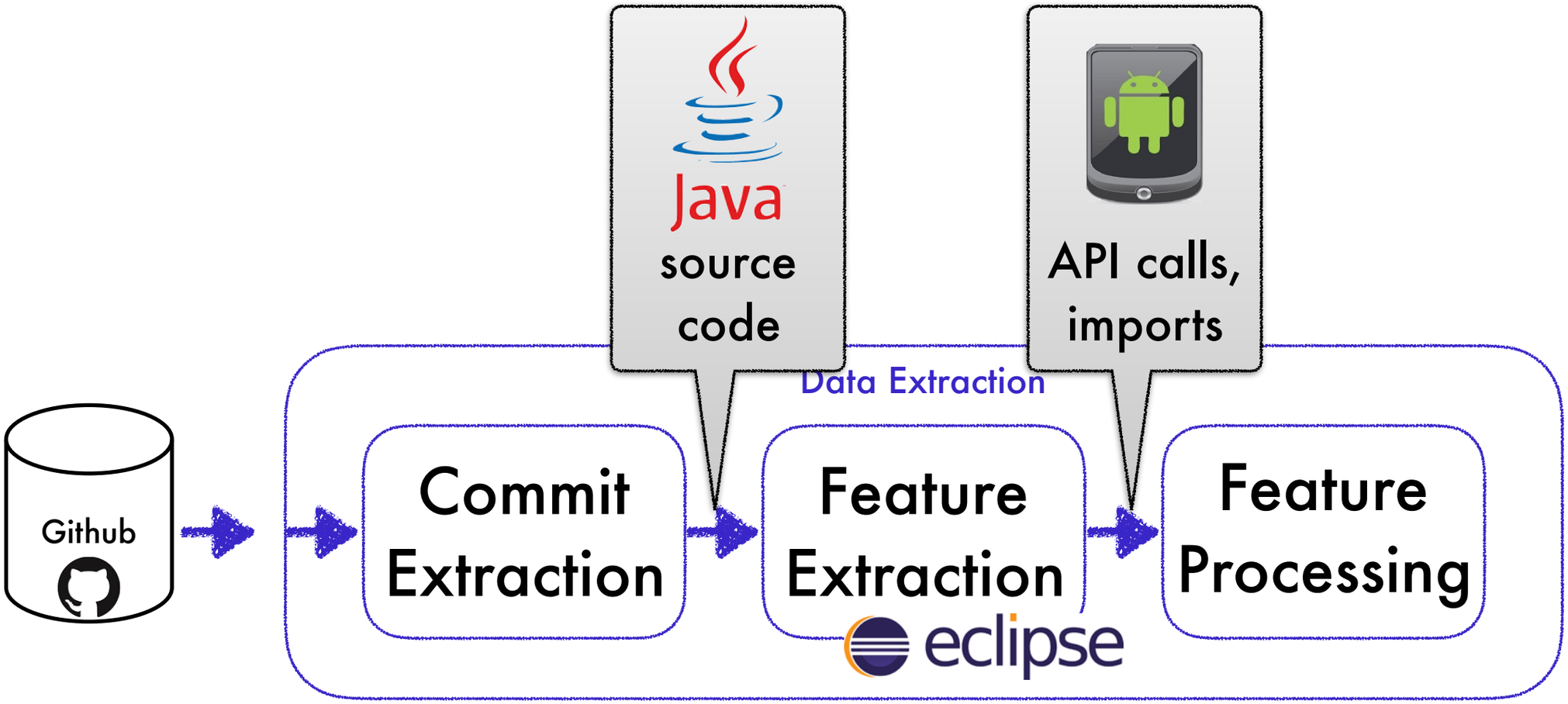

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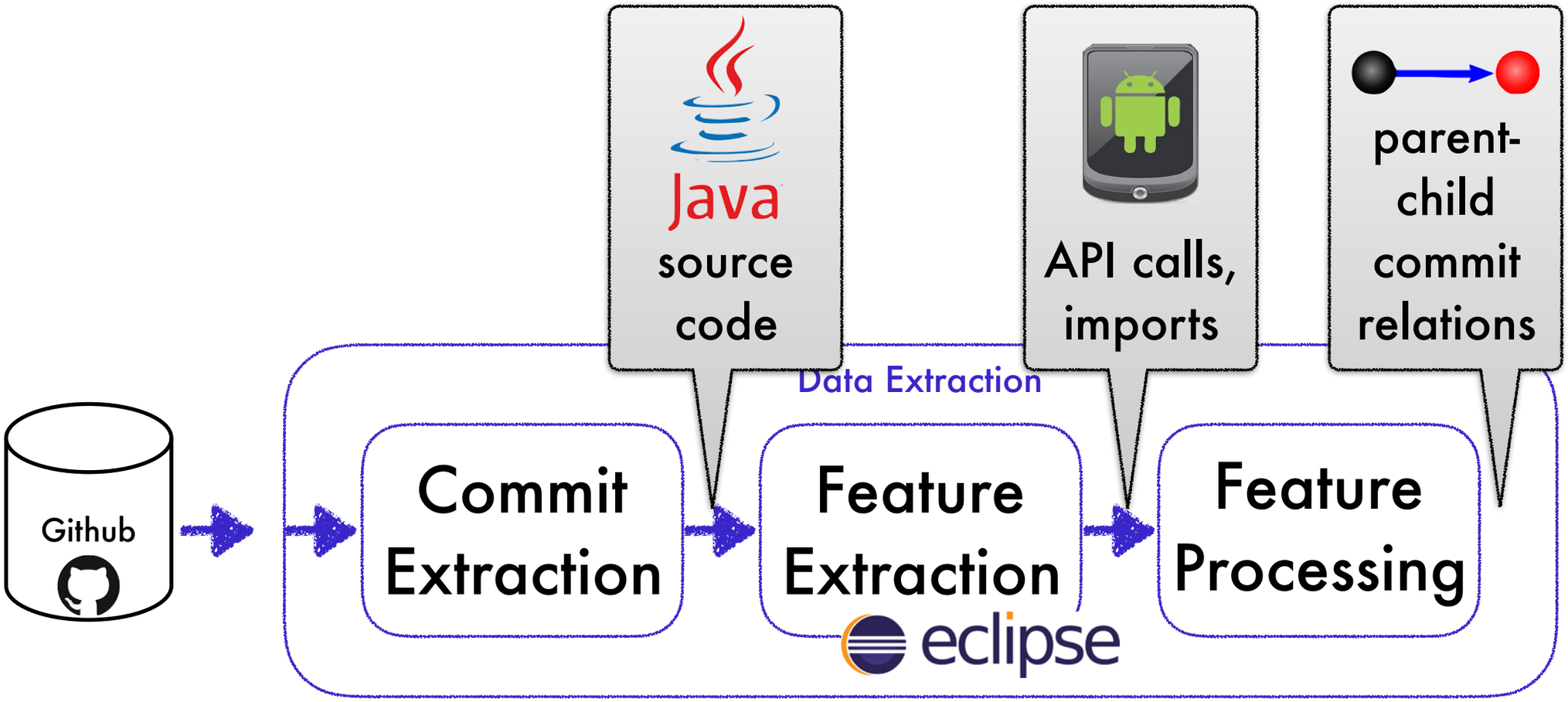

Extracting commit features
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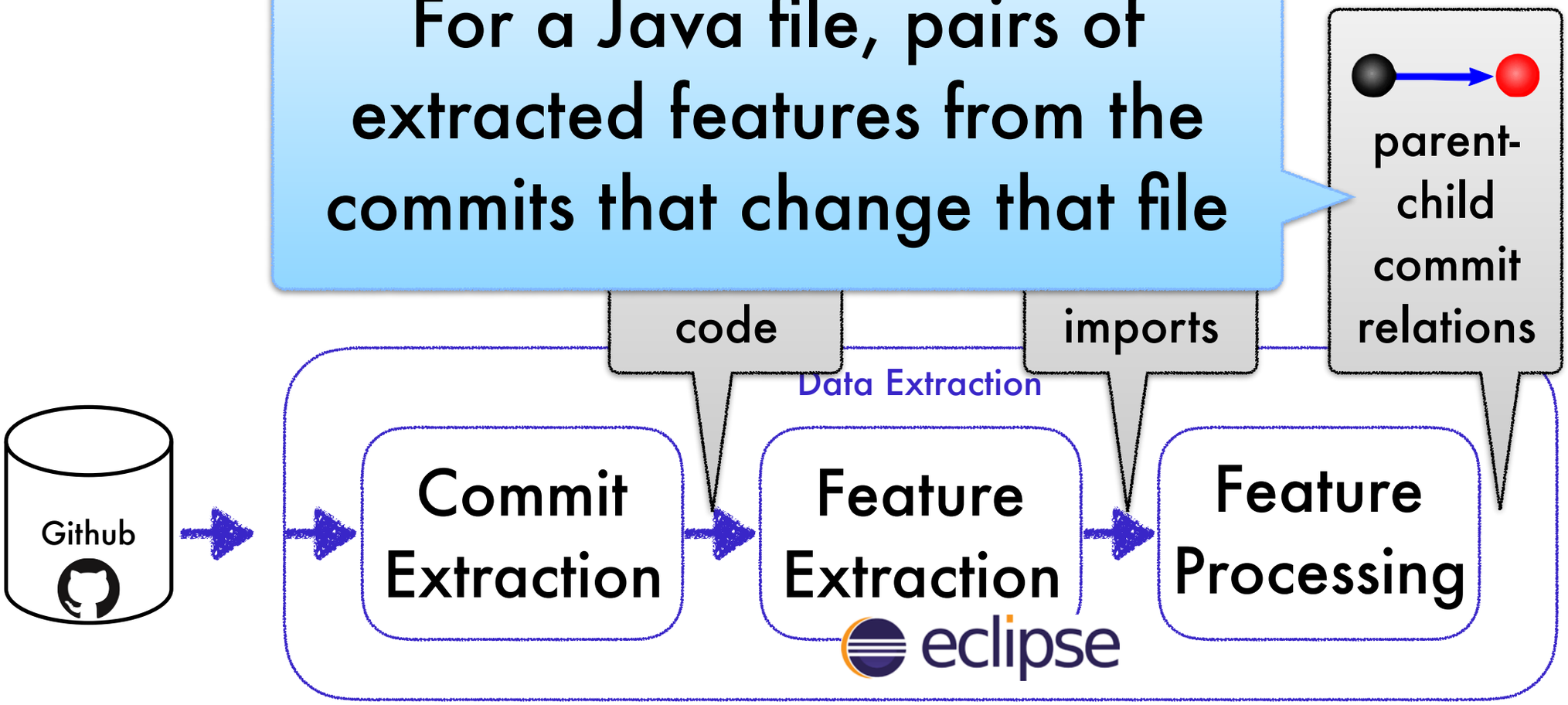

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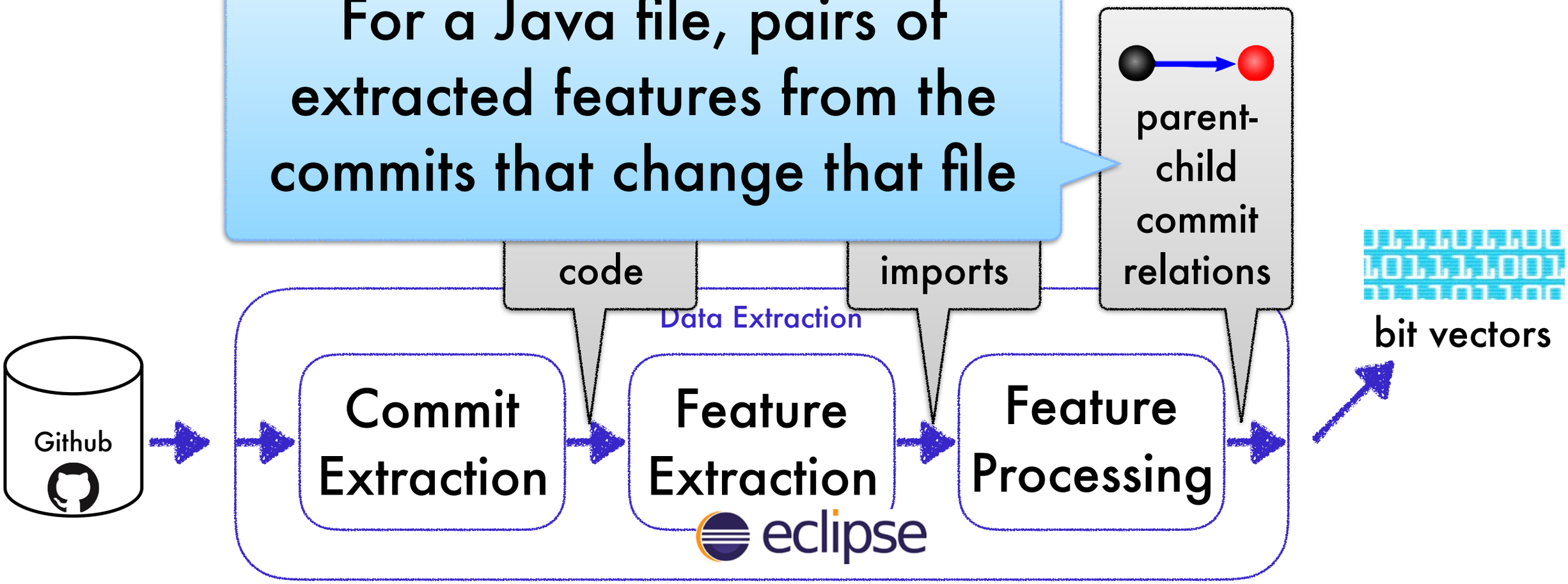

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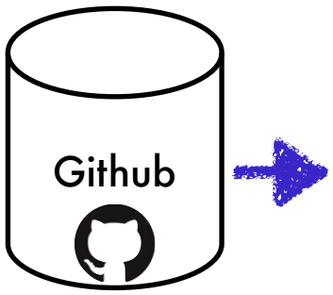

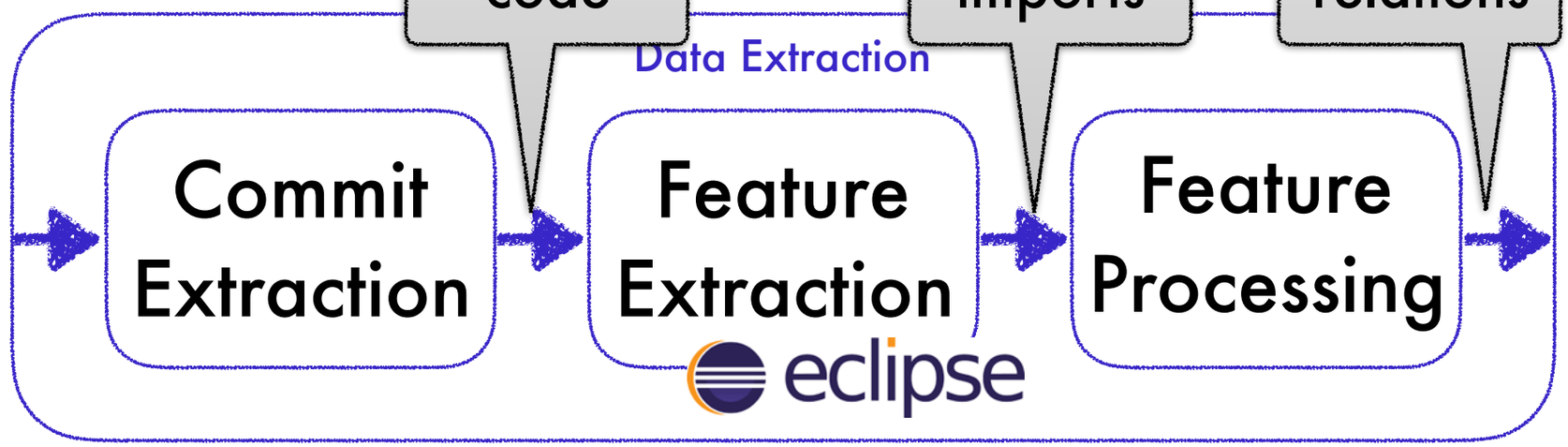

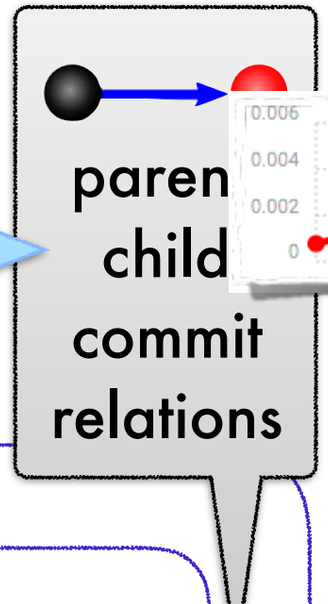

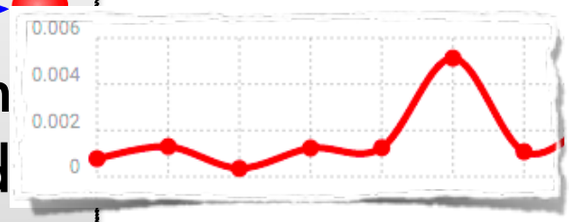

bit vectors

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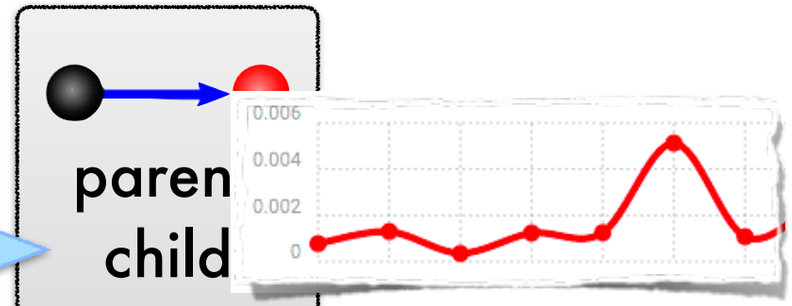

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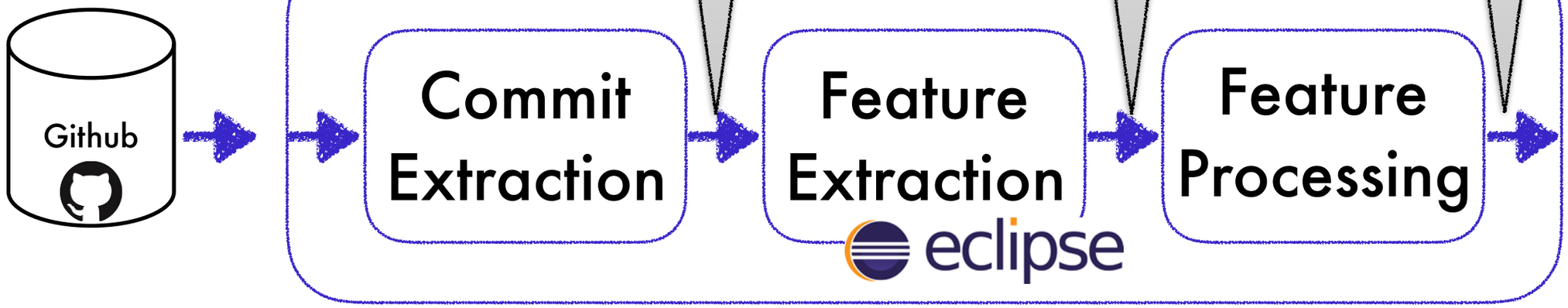

{JSON}

commit documents

Extracting commit features
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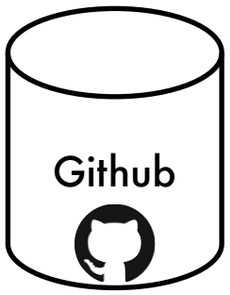


Data Extraction

Commit Extraction

Feature Extraction

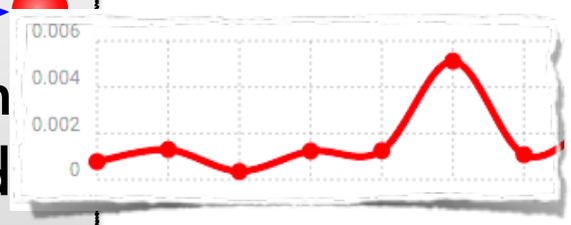
Feature Processing

eclipse

code

imports

paren
child
commit
relations



bit vectors

{JSON}

commit documents

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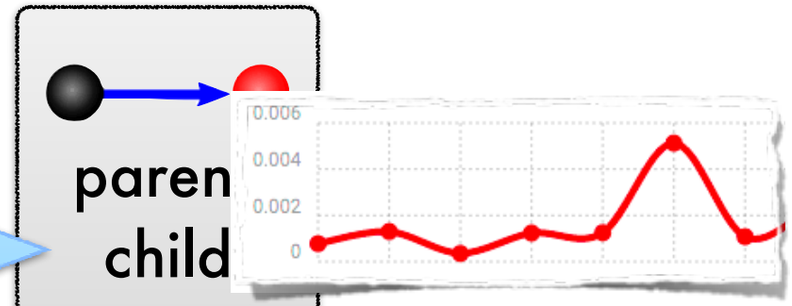

bit vectors

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Data Extraction

Commit Extraction

Feature Extraction

Feature Processing

eclipse

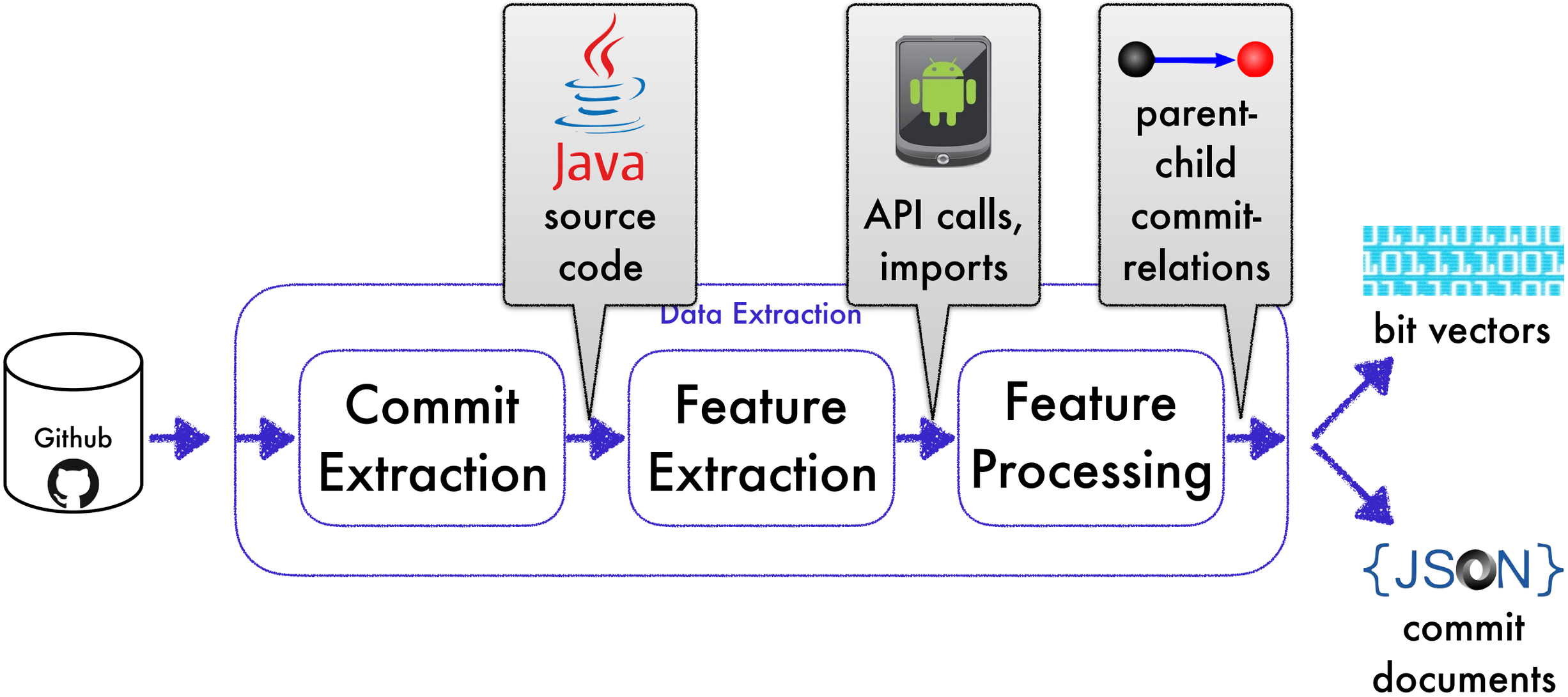
Spark

{JSON}

commit documents

A Spark-based data processing pipeline with custom data targets

The scale of feature processing



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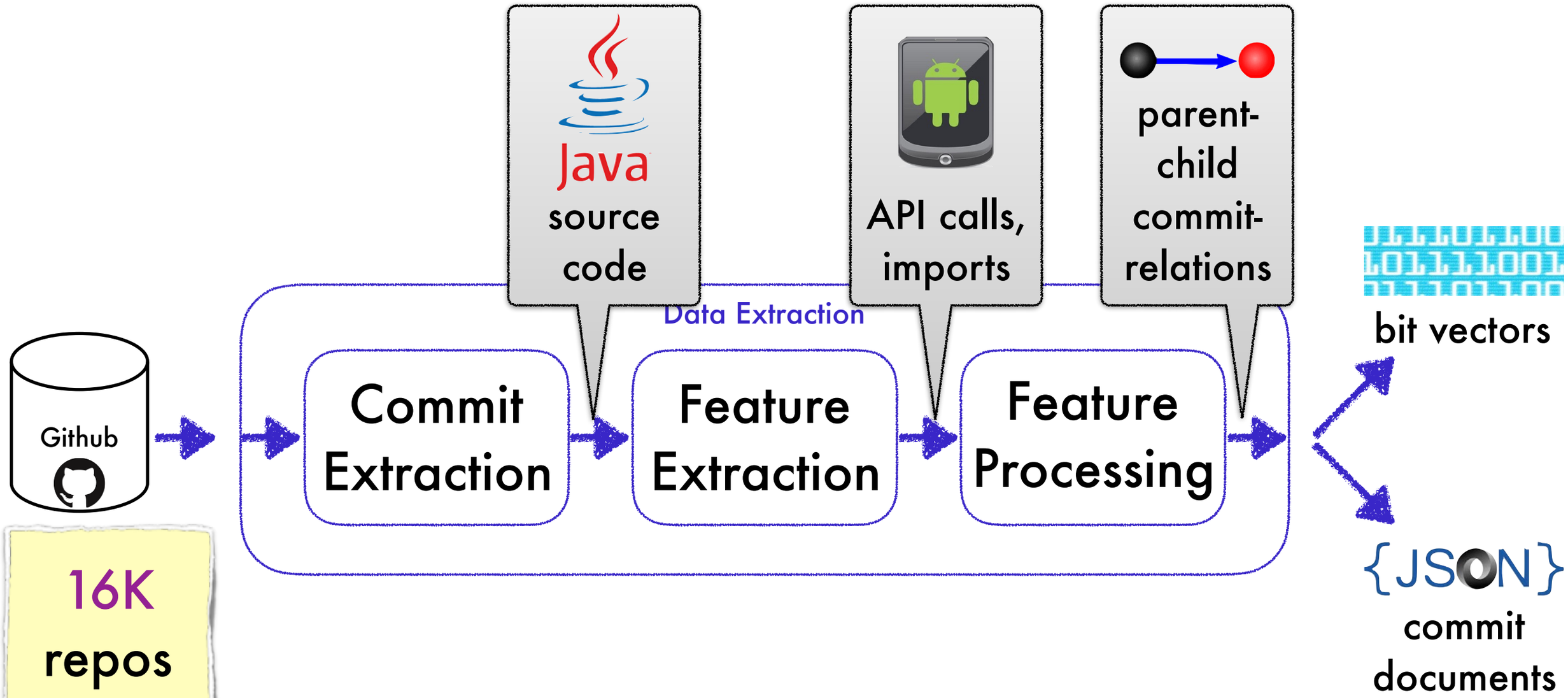


The scale of feature processing

2.83M changed files in 3 hours

Java source code

API calls, imports

parent-child commit-relations

Data Extraction

Github

Commit Extraction

Feature Extraction

Feature Processing

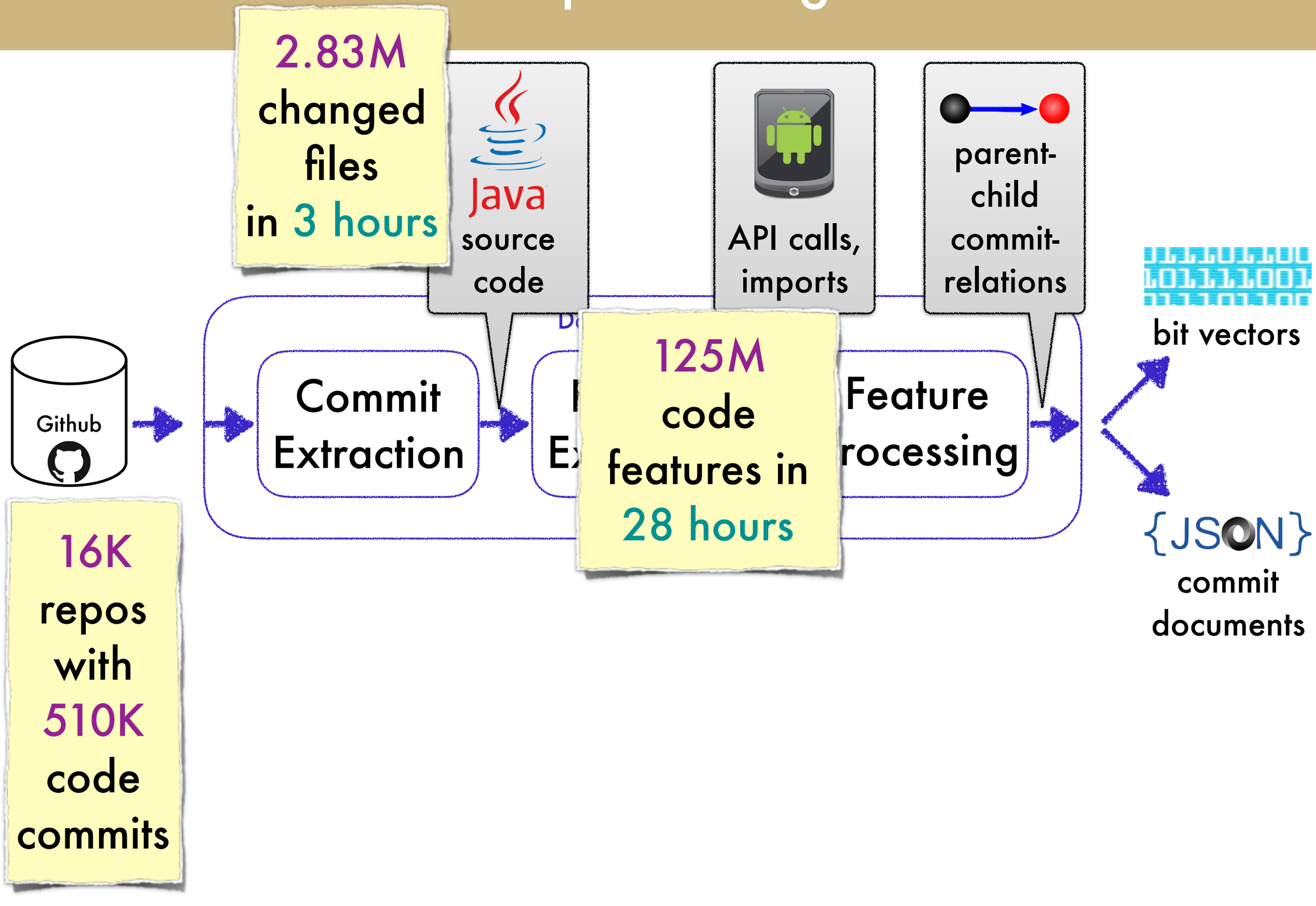
bit vectors

{JSON}

commit documents

16K repos with 510K code commits

The scale of feature processing



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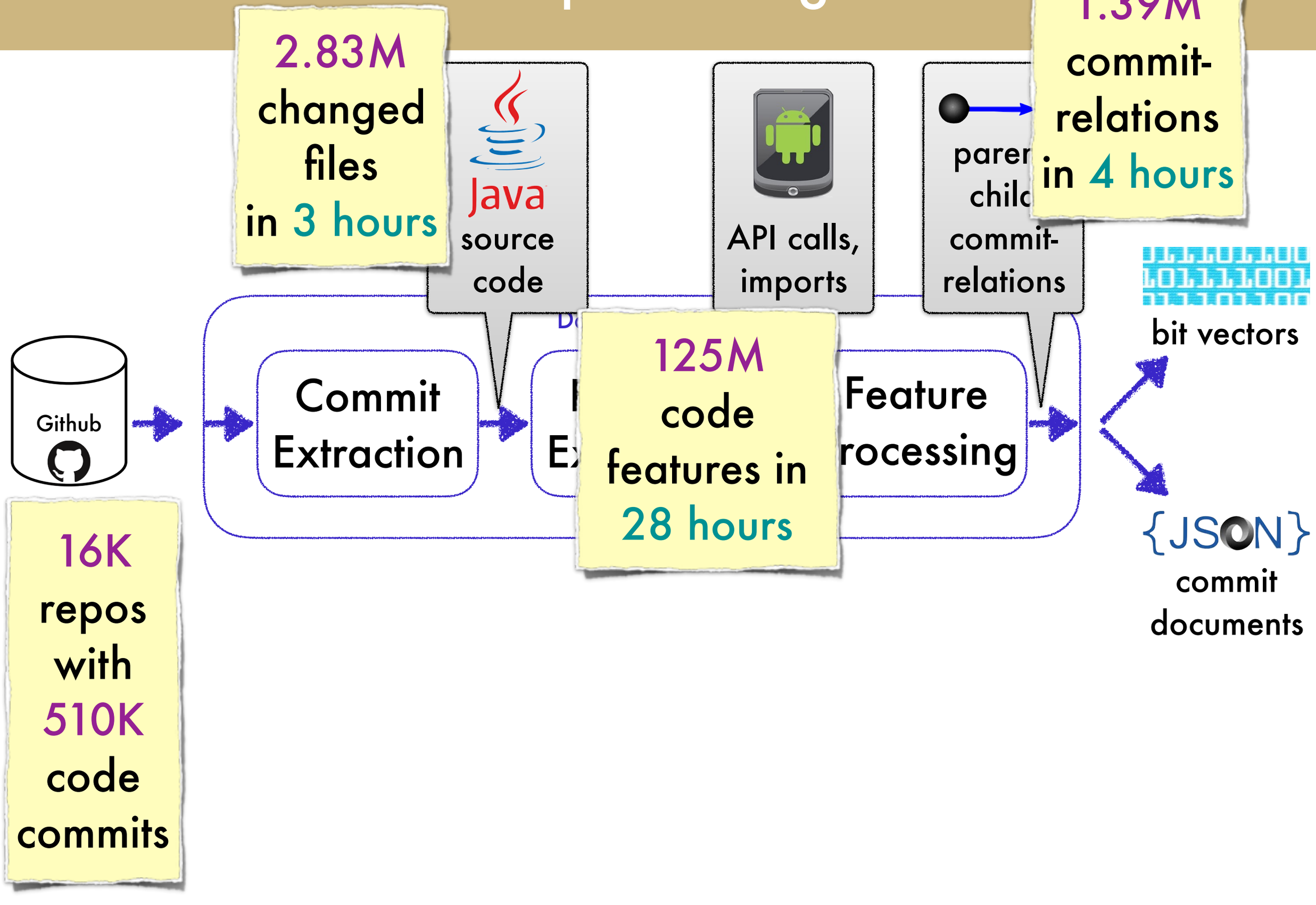

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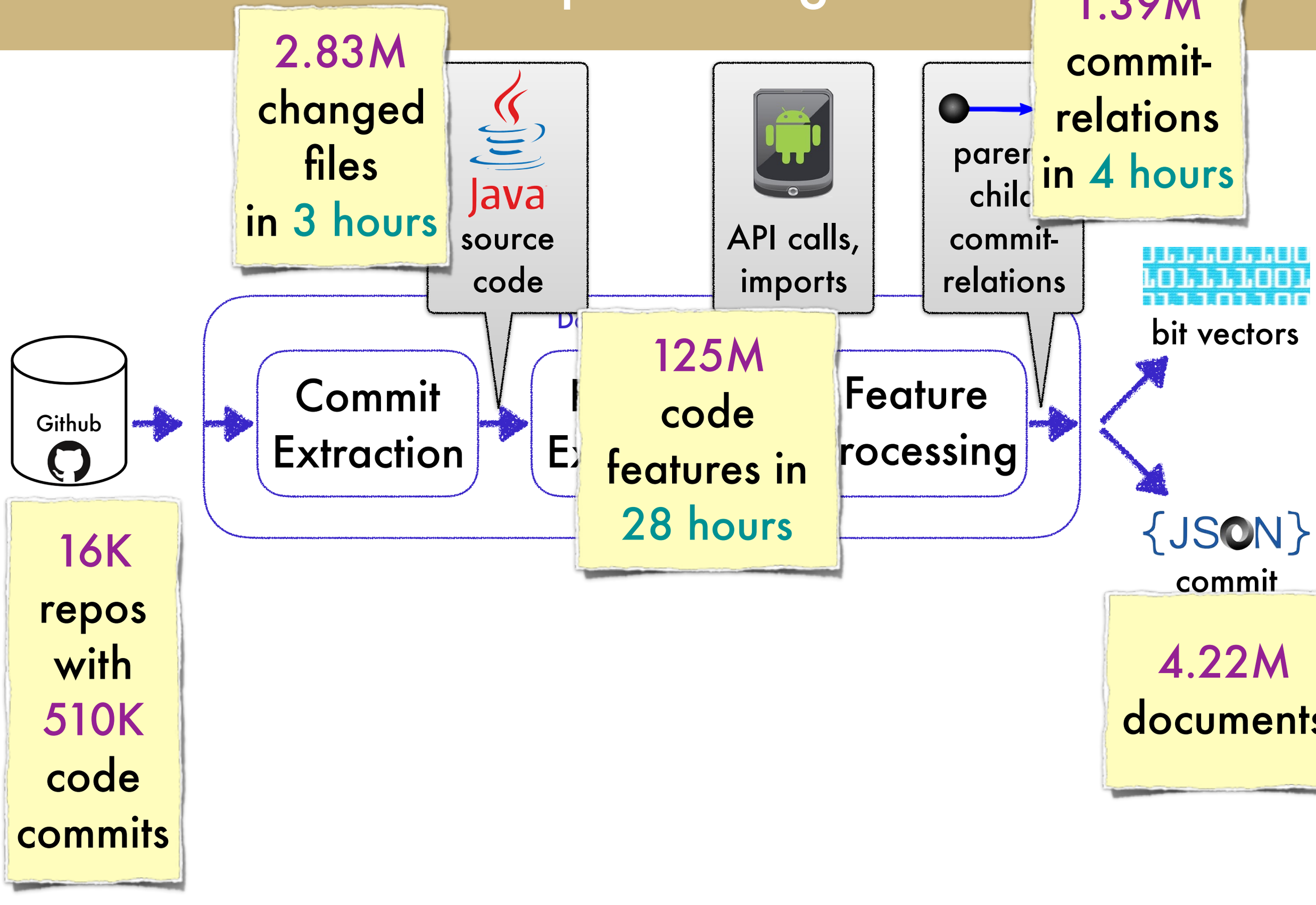


The scale of feature processing

2.83M changed files in 3 hours

1.39M commit-relations in 4 hours

Java source code

API calls, imports

parer
chilc
commit-relations

bit vectors

Github

16K repos with 510K code commits

Commit Extraction

E

125M code features in 28 hours

Feature rocessing

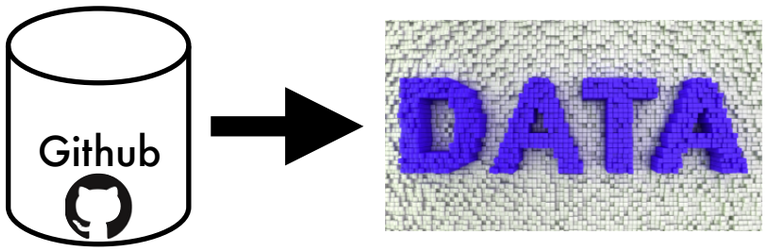
{JSON}

commit

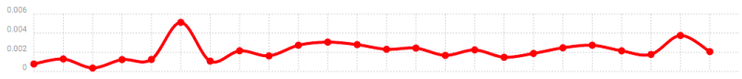
4.22M documents

Note: Measurements on a cluster with relatively limited resources (4 workers)

Fixr Contributions



Extract commit features at scale

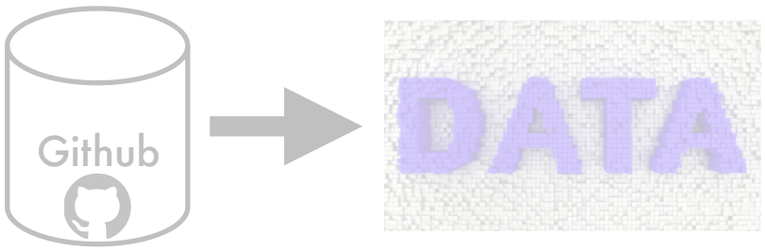


Find API usage patterns over time

Index commit feature documents

Search-and-repair platform
for Android apps

Fixr Contributions



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API Usage Trend Analysis Approach

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Approach

Research Question: Do bugfixes exhibit a time signature?

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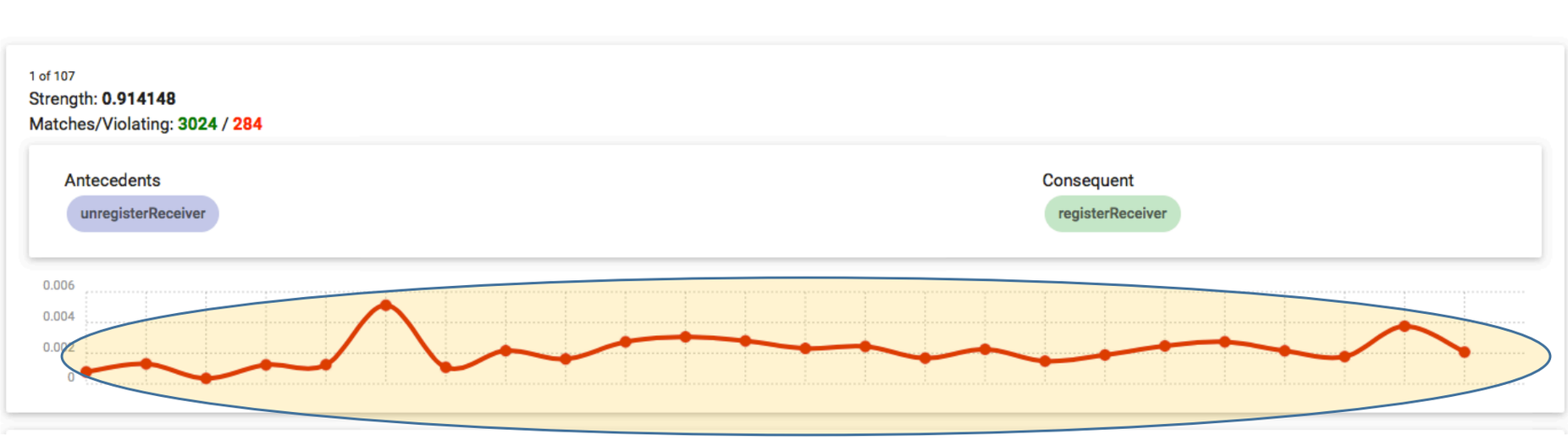
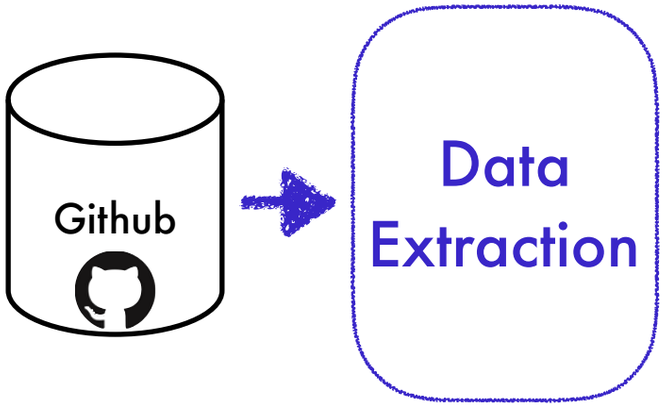
Fraction of commits matching a rule over time.



API Usage Trend Analysis
Status



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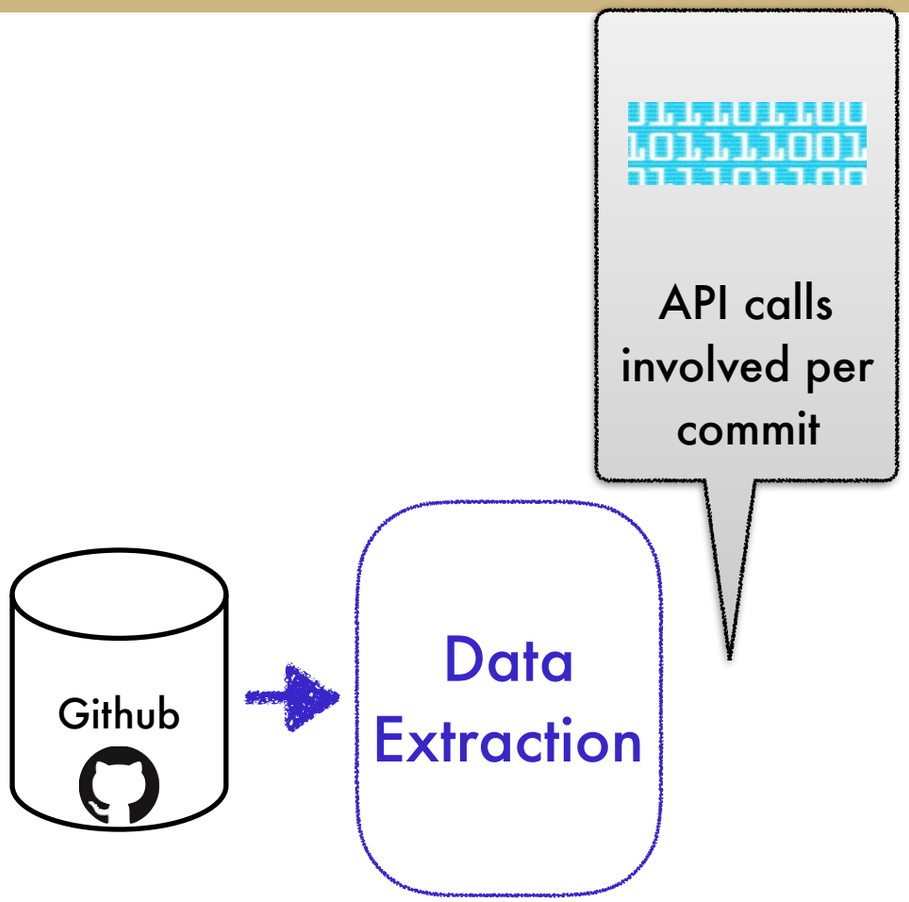


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API Usage Trend Analysis
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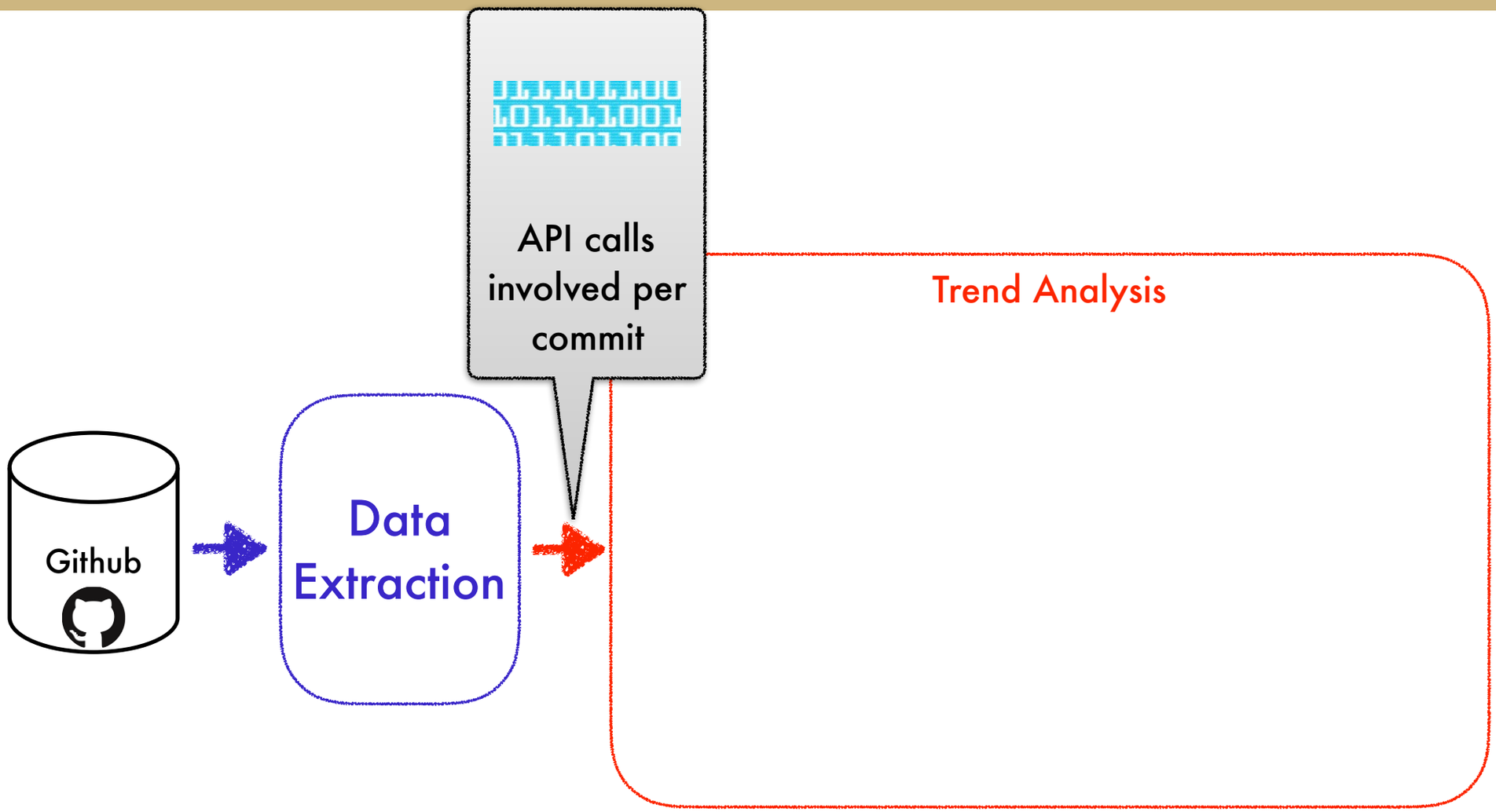


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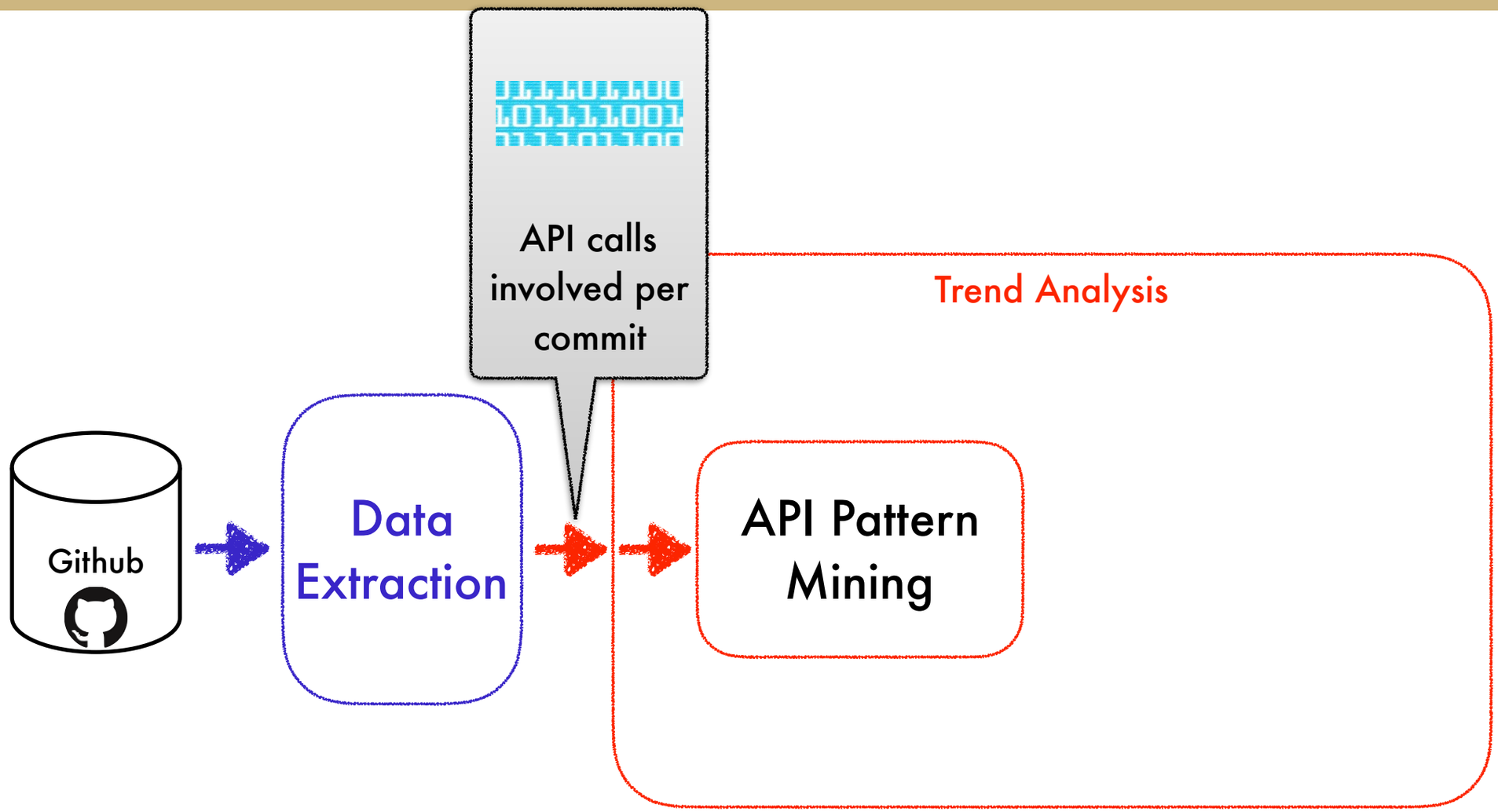


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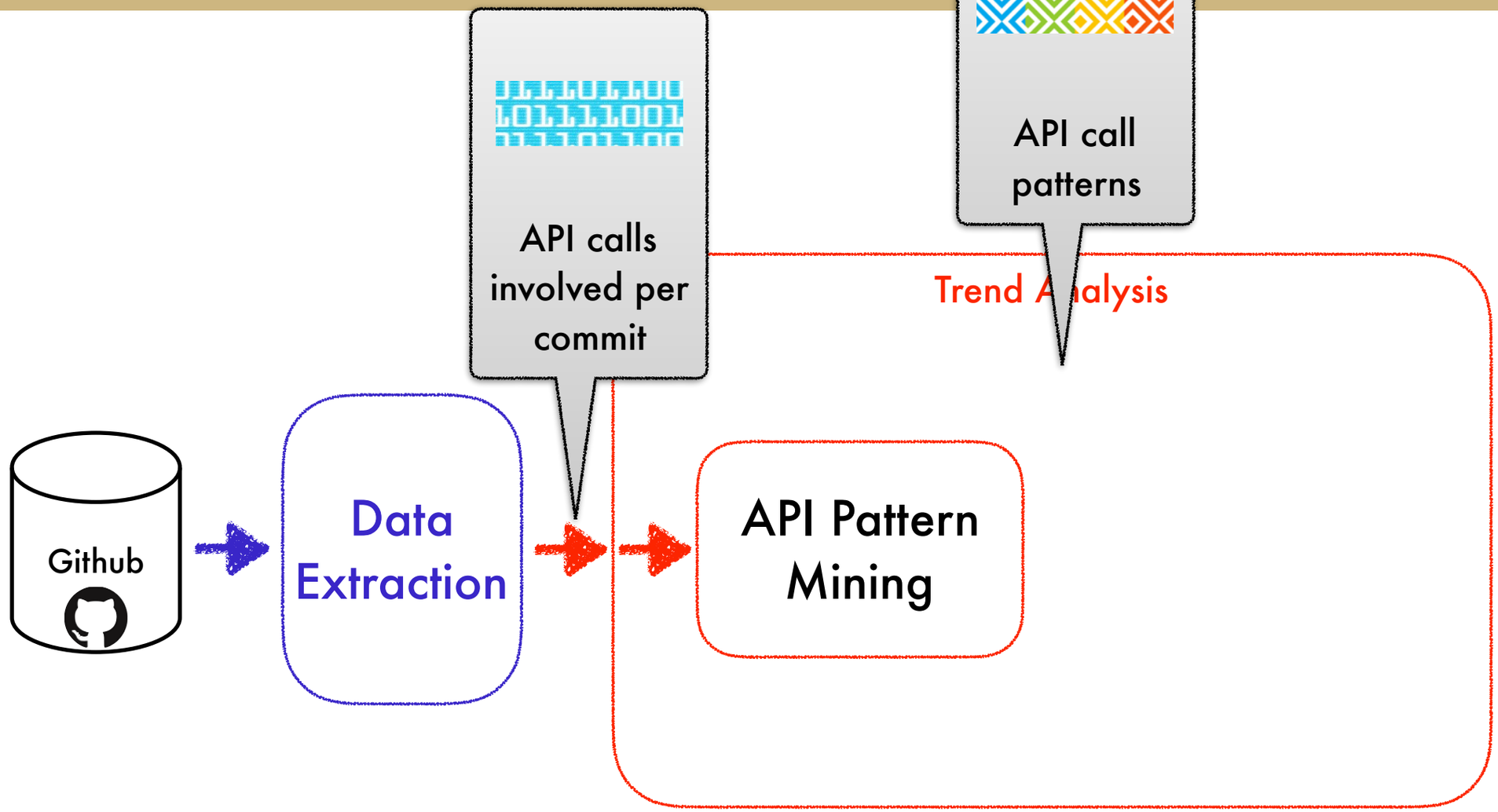


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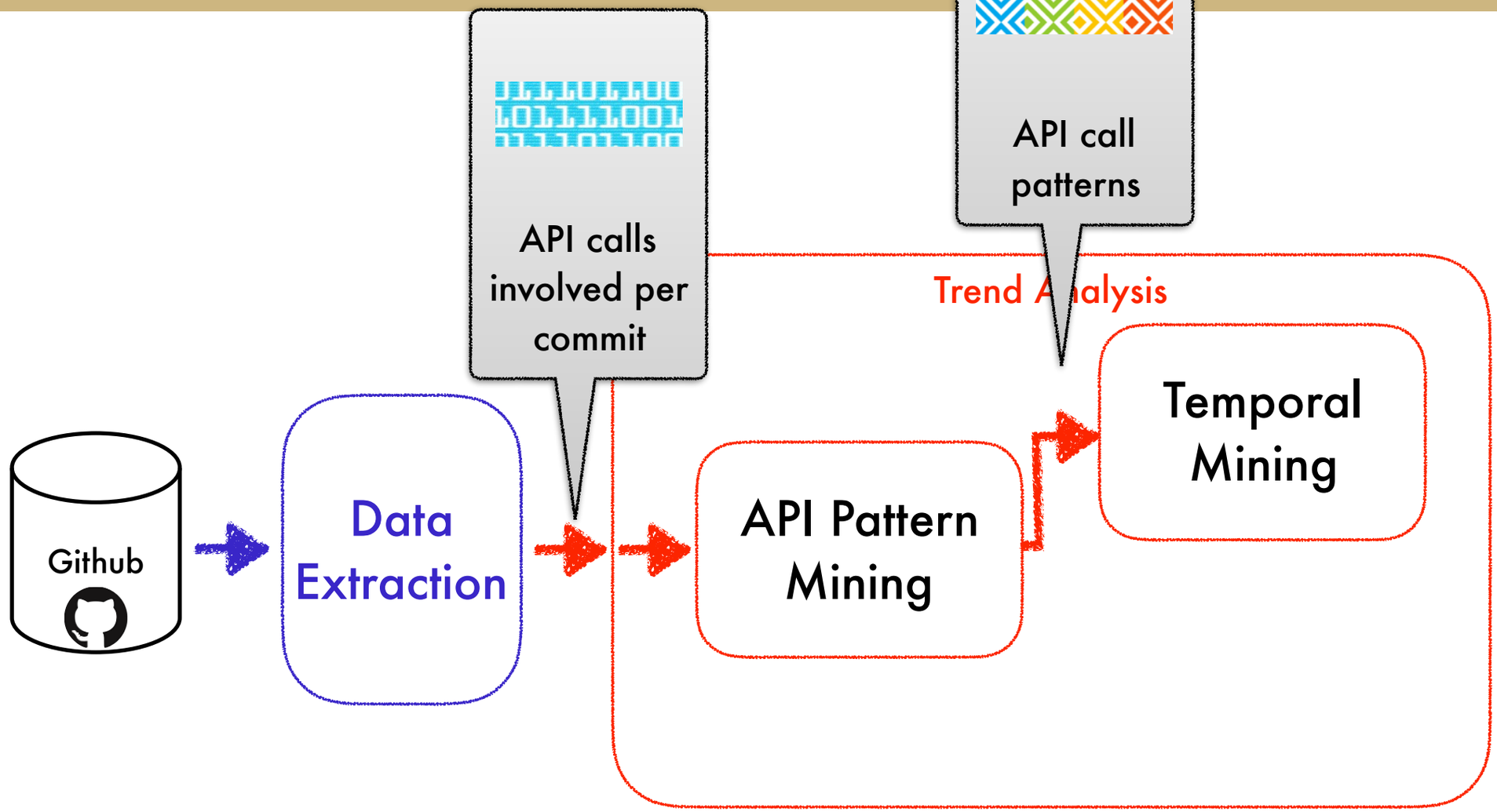


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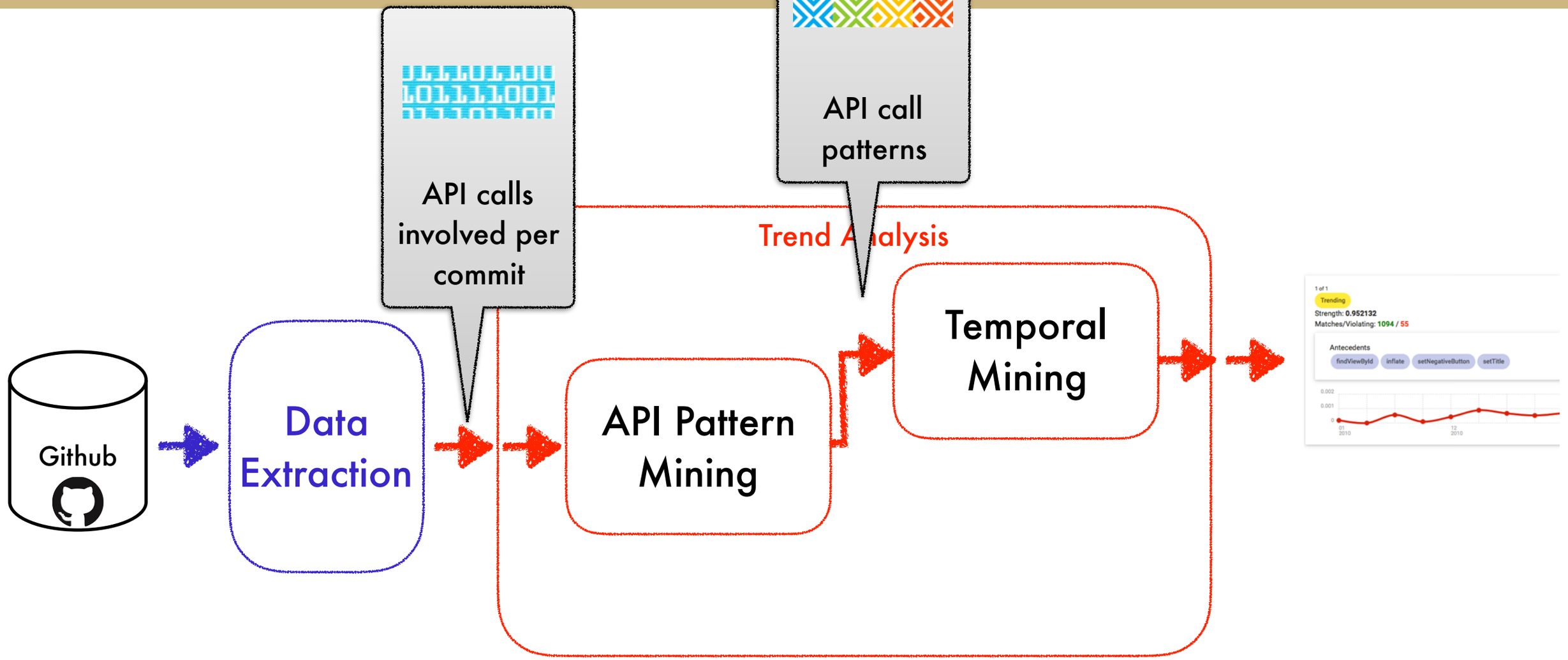


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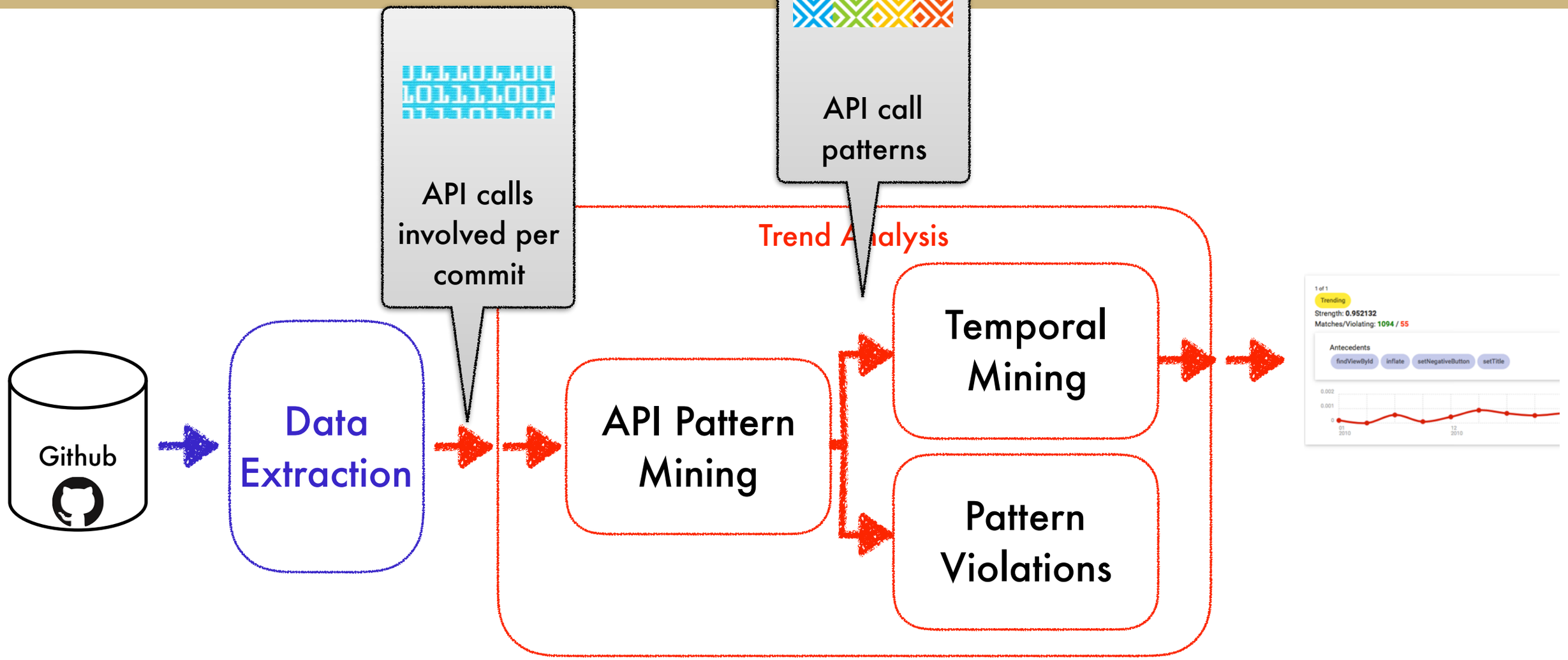


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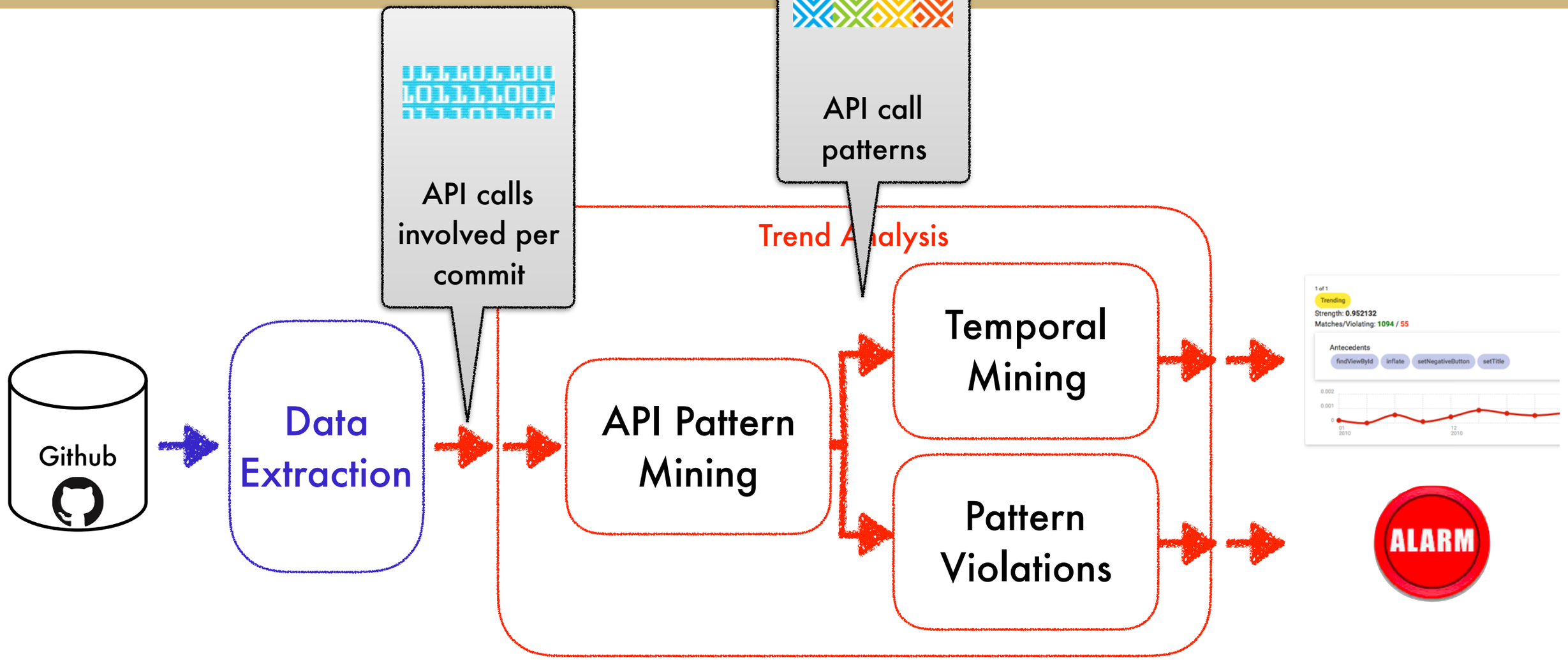


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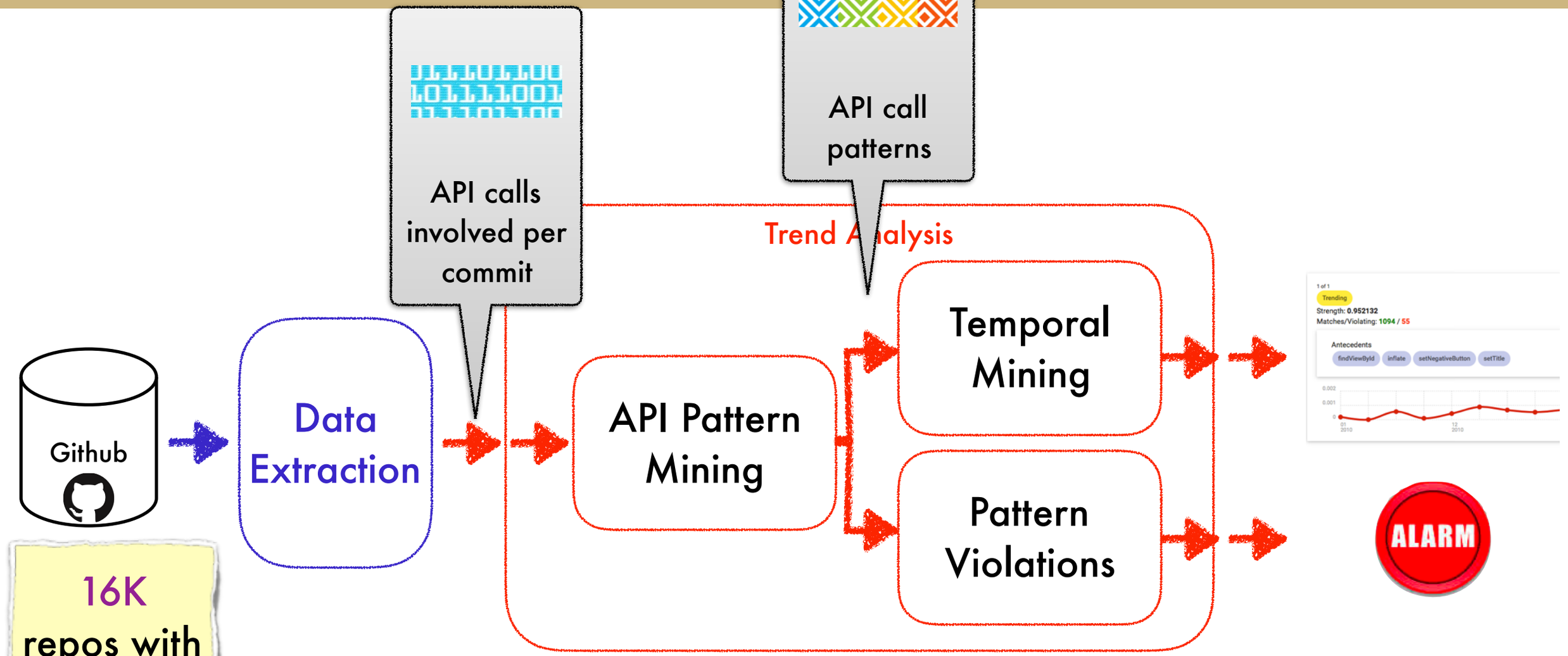

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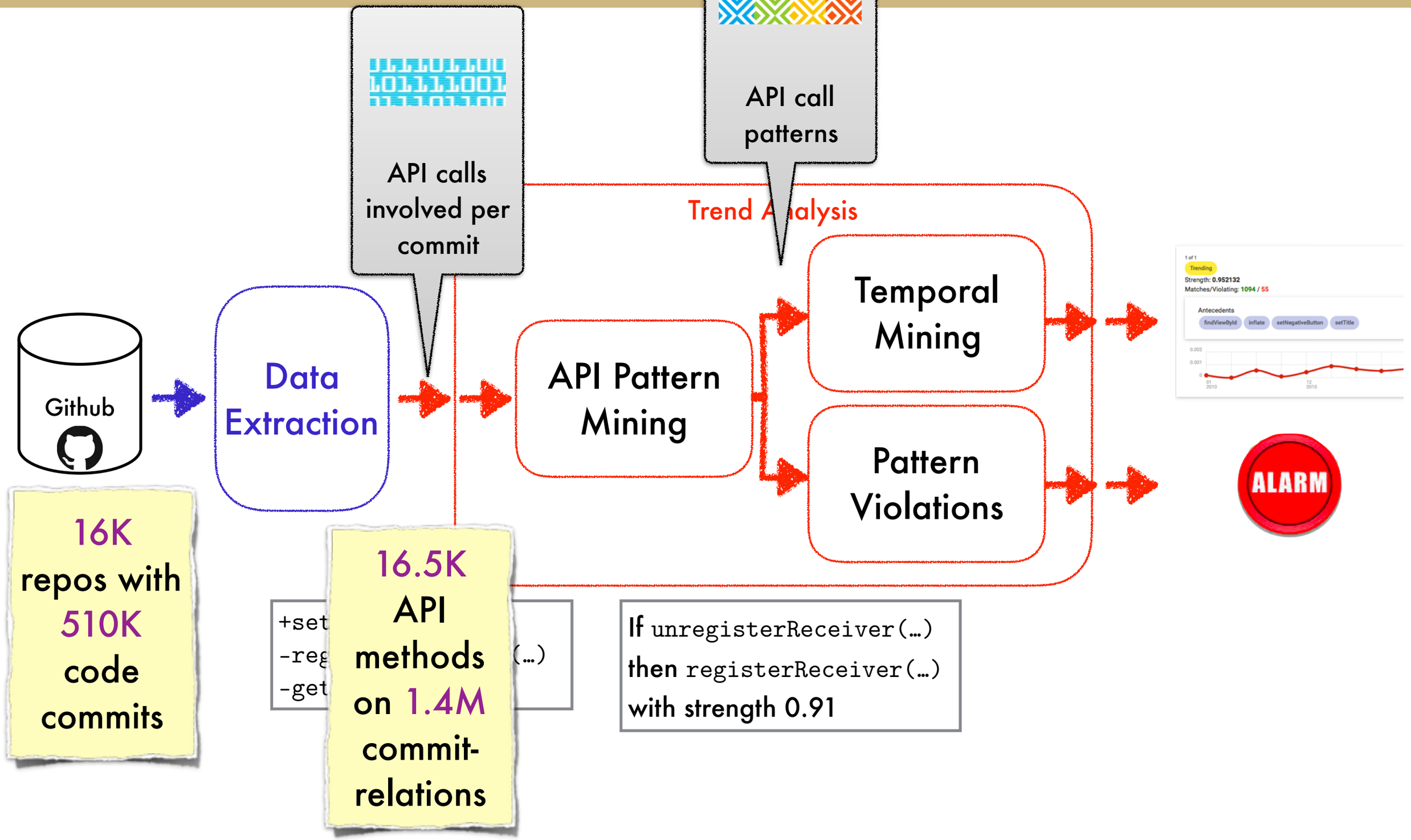

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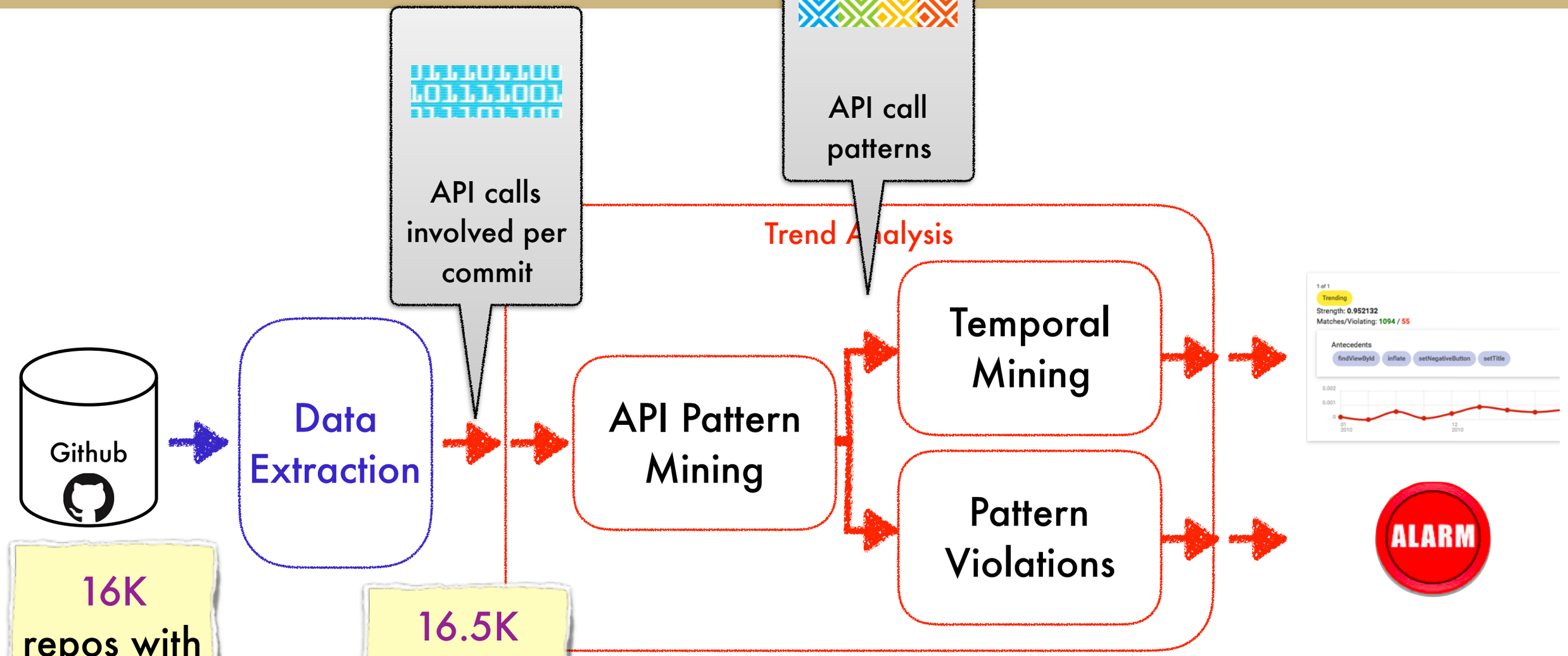
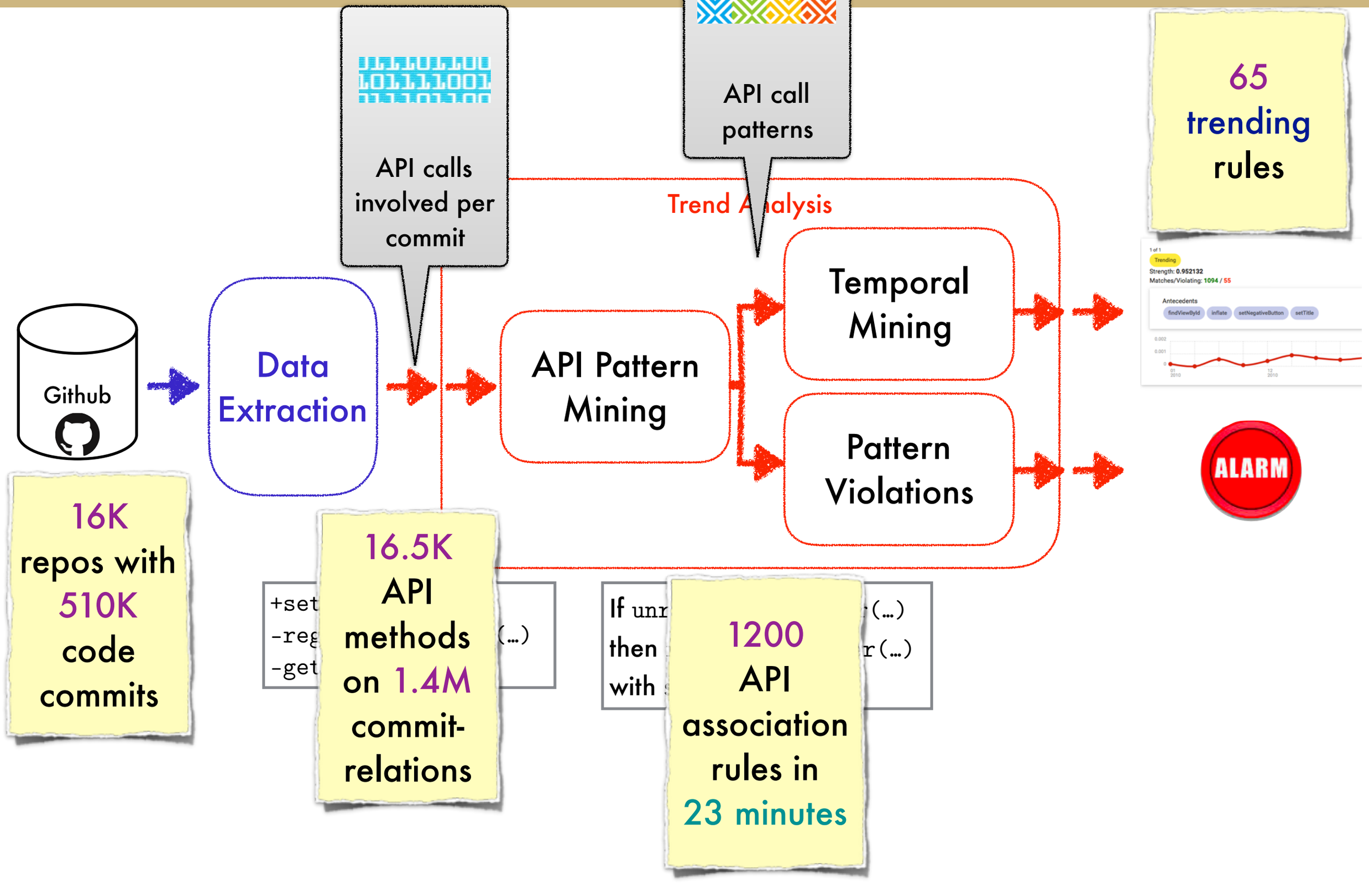


16K repos with 510K code commits

16.5K API methods on 1.4M commit-relations

1200 API association rules in 23 minutes

API Usage Trend Analysis Status



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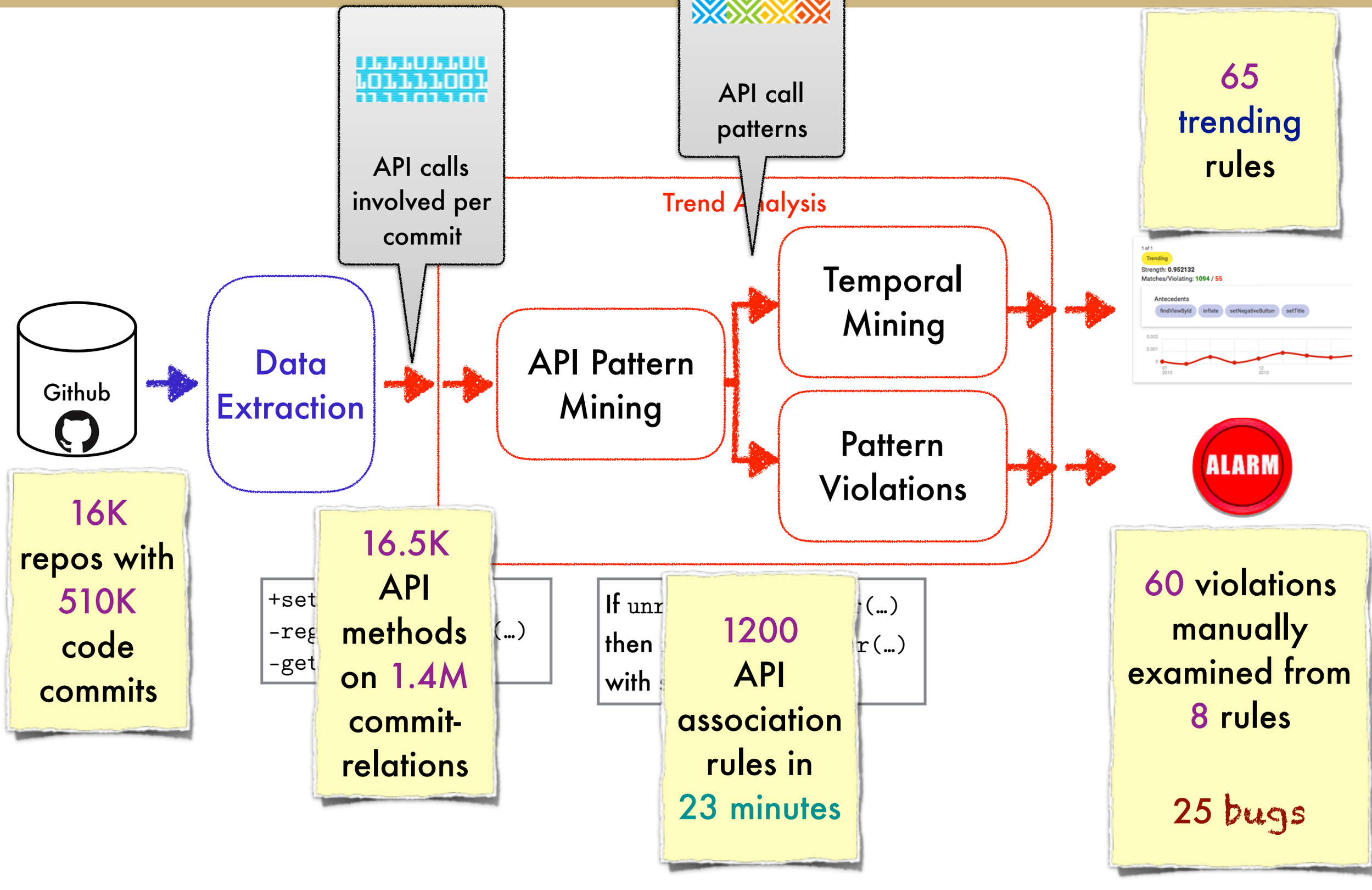

Alarm example:
A commit violating a mined association rule

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Rule: `setTransactionSuccessful → endTransaction`

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81 potential violations of this rule

5 manually identified bugs, 40 false alarms

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1102     * 同步用户,更新已存在的用户,插入未存在的用户
1103     */
1104    public void syncUsers(List<com.ch_linghu.fanfoudroid.data.User> users){
1105        SQLiteDatabase mDb = mOpenHelper.getWritableDatabase();
1106        mDb.beginTransaction();
1107        for(com.ch_linghu.fanfoudroid.data.User u:users){
1108                if(existsUser(u.id)){
1109                        updateUser(u);
1110                }else{
1111                        createUserInfo(u);
1112                }
1113        }
1114        mDb.setTransactionSuccessful();
1115    }
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https://github.com/fanfoudroid/fanfoudroid/blob/66d7f7d621cffd290f0d0291e49128b6bef109e4/src/com/ch_linghu/fanfoudroid/data/db/TwitterDatabase.java

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Bug: Missing call to `endTransaction` in a `try-finally` block. Database may end in an inconsistent state.

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4210 commits matching this rule.

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Android APIs — API level: 23

- android
- android.accessibilityservice
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- android.animation
- android.annotation
- android.app
- android.app.admin
- android.app.assist
- android.app.backup
- android.app.job
- android.app.usage

Interfaces

public class

Summary: Methods | Inherited Methods | [Expand All]
Added in API level 1

TypedArray

extends Object

java.lang.Object
↳android.content.res.TypedArray

Class Overview

Container for an array of values that were retrieved with `obtainStyledAttributes(AttributeSet, int[], int, int)` or `obtainAttributes(AttributeSet, int[])`. Be sure to call `recycle()` when done with them. The indices used to retrieve values from this structure correspond to the positions of the attributes given to obtainStyledAttributes.

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"Be sure to call `recycle` when done with …"

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52          super(context, attrs);
53
54          TypedArray array = context.getTheme()
55                  .obtainStyledAttributes(attrs, R.styleable.MaterialColorPalette, 0, 0);
56          int normalColorsResId =
57                  array.getResourceId(R.styleable.MaterialColorPalette_color_palette_normal, 0);
58          int pressedColorsResId =
59                  array.getResourceId(R.styleable.MaterialColorPalette_color_palette_pressed, 0);
60
61          if (normalColorsResId != 0) {
62              mNormalColorList = getResources().getIntArray(normalColorsResId);
63          }
64
65          if (pressedColorsResId != 0) {
66              mPressedColorList = getResources().getIntArray(pressedColorsResId);
67          } else {
68              mPressedColorList = mNormalColorList;
69          }
70
71          LinearLayoutManager layoutManager = new LinearLayoutManager(getContext());
72          layoutManager.setOrientation(LinearLayoutManager.HORIZONTAL);
73          setLayoutManager(layoutManager);
74          setAdapter(new ColorPaletteAdapter());
75      }
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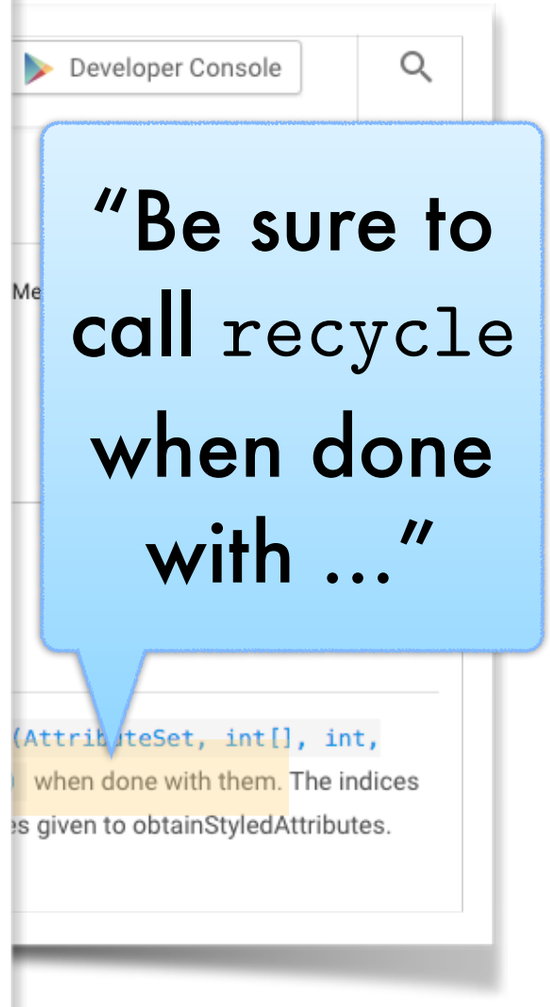

https://github.com/gustavomondron/twik/blob/389f88b8e21dfe146ababdb81f830dd18e4cefa3/app/src/main/java/com/reddyetwo/hashmypass/app/view/MaterialColorPalette.java

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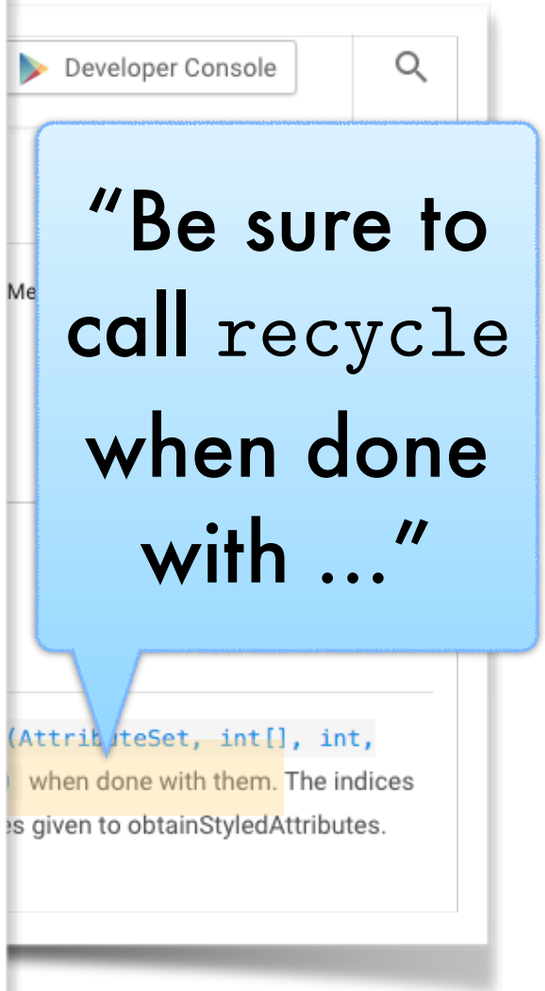

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Bug: Missing call to `array.recycle()` before `array` goes out of scope.

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Test time signatures for trends

1 of 2

Trending

Strength: **0.950519**

Matches/Violating: **1556** / **81**

Antecedents

setTransactionSuccessful

Consequent

endTransaction

Test time signatures for trends

1 of 2

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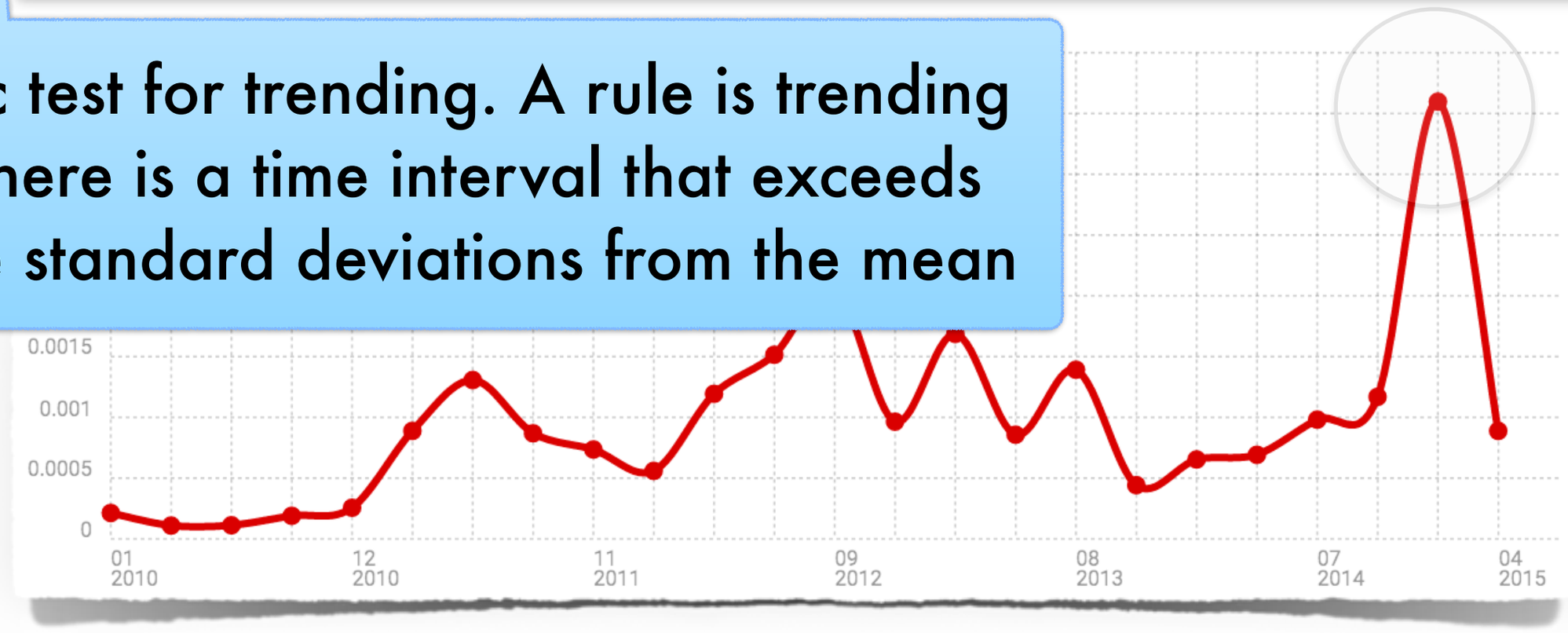


Basic test for trending. A rule is trending iff there is a time interval that exceeds three standard deviations from the mean

Test time signatures for trends

2 of 6

Strength: **0.921907**

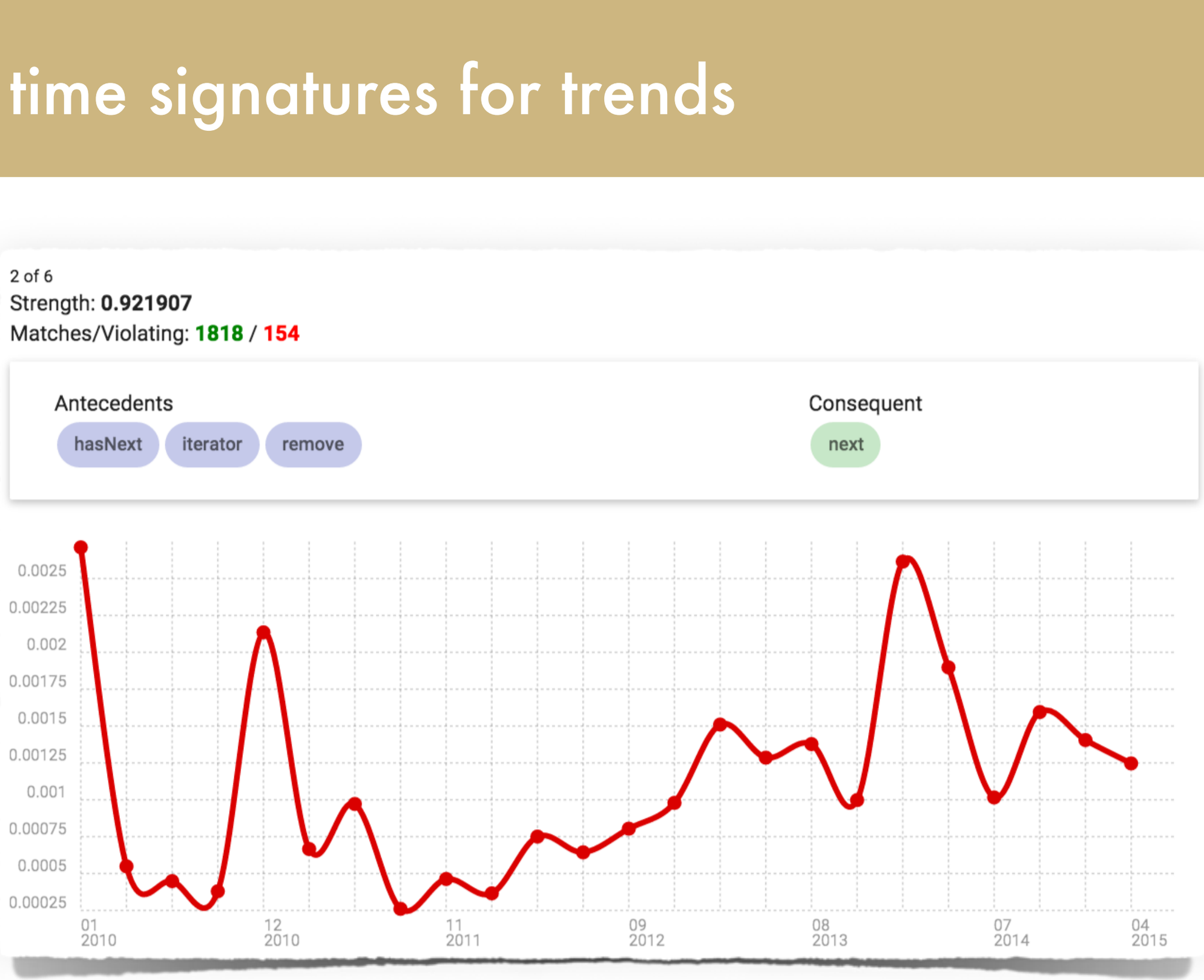
Matches/Violating: **1818** / **154**

Antecedents

hasNext iterator remove

Consequent

next



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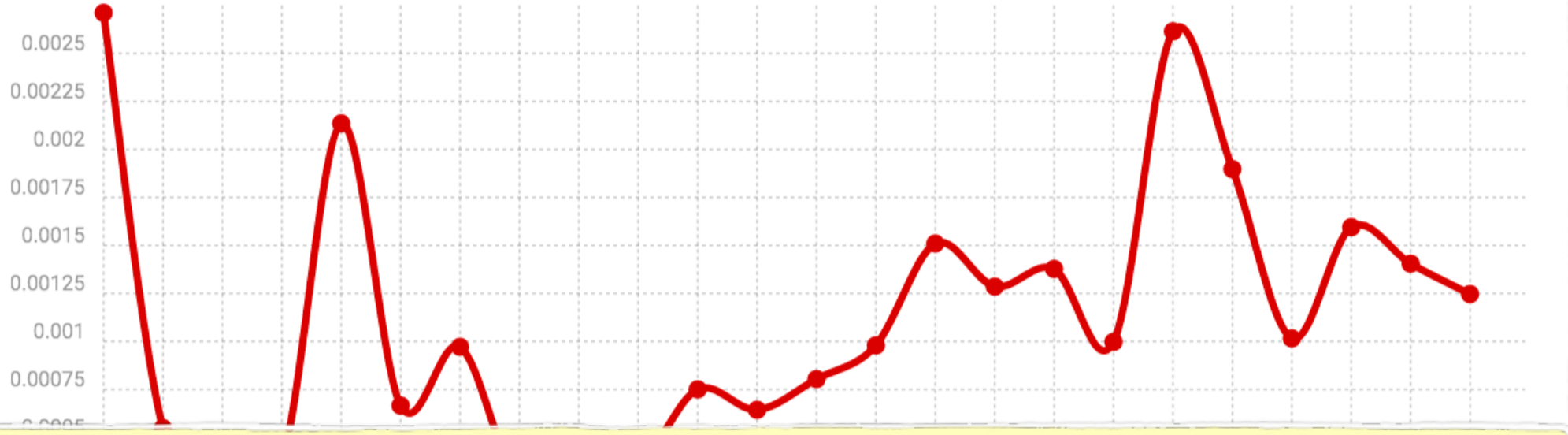
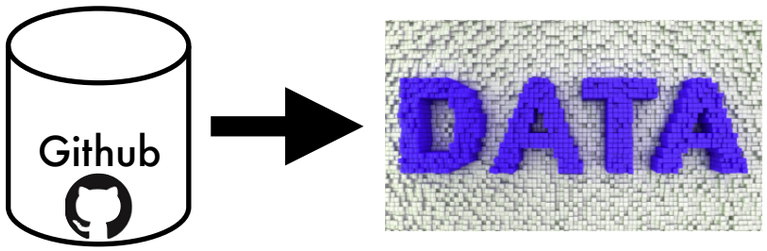


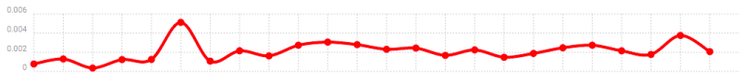
No clear trend for

{ `hasNext`, `iterator`, `remove` } ⇒ `next`

Fixr Contributions



Extract commit features at scale



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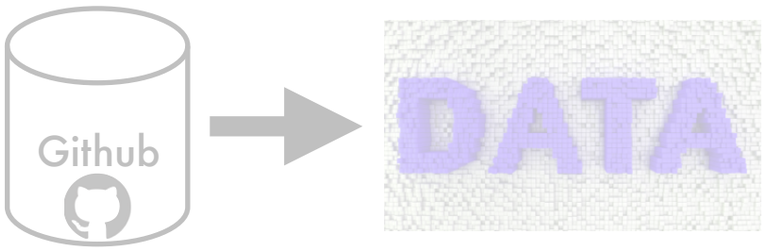
for Android apps

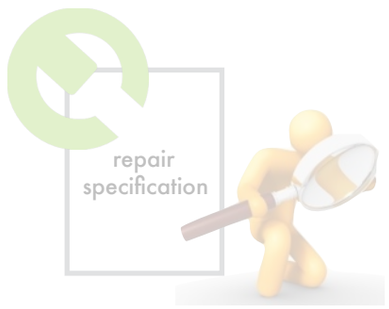
Fixr Contributions



Extract commit features at scale

Find API usage patterns over time

Index commit feature documents



Search-and-repair platform
for Android apps

Relevant Commit Search
A Use Case

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Research Question: Can bugfix commits be found in the corpus with indexed search?

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A Use Case

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MediaScannerConnection.scanFile(context, p, m, l)
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Relevant Commit Search
A Use Case

Research Question: Can bugfix commits be found in the corpus with indexed search?

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```

Query.java — /Users/Admin/Documents/muse/muse_repos/FixrRelevantCodeSearch/evaluation/queries/MediaScannerConnection

Query.java

```
1  import android.media.MediaScannerConnection;
2
3  public class Query extends AppCompatActivity implements MediaS
4
5      private MediaScannerConnection mConnection;
6
7      protected void onCreate() {
8        MediaScannerConnection.scanFile(this,
9                                        new String[] { "" },
10                                       null,
11                                       null);
12     }
13 }
14
```

[6] fasteque/rgb-tool

android-rgb-tool/src/main/java/com/fastebro/androidrgbtool/ui/MainActivity.java

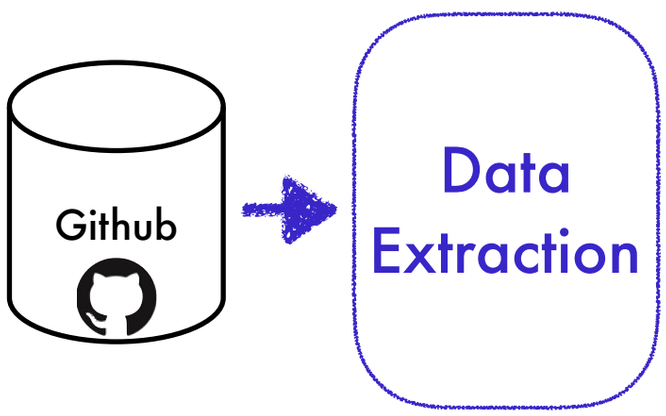
Commit: @3a93e80 - fixed AOSP binder leak

Child: @3a93e80, Parent: @7ed5fc8

Diff or Source Code

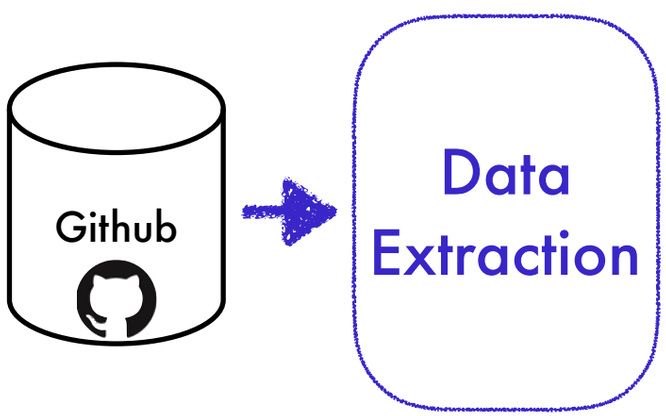
```
                * Tell the media scanner about the new file so that it
             * immediately available to the user.
             */
-            MediaScannerConnection.scanFile(this,
```

Relevant Commit Search



Relevant Commit Search

Idea: Create and index commit feature documents



Relevant Commit Search

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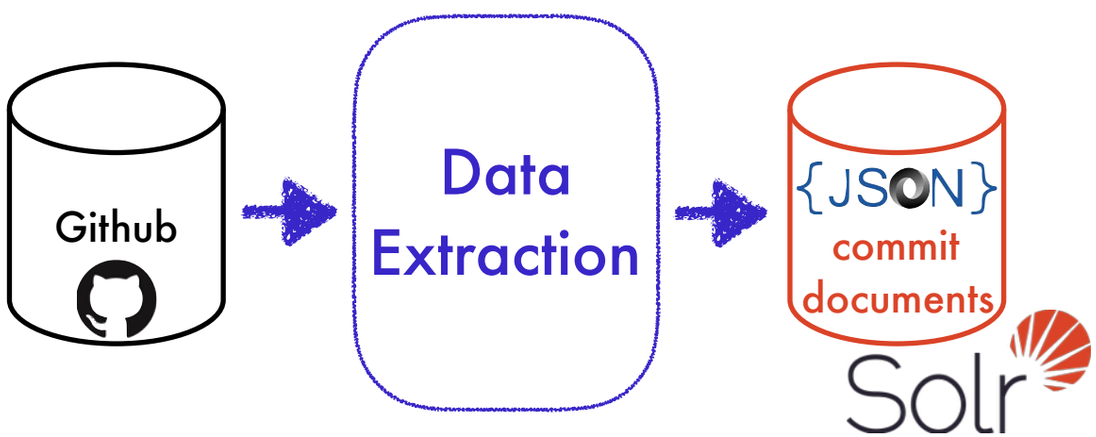

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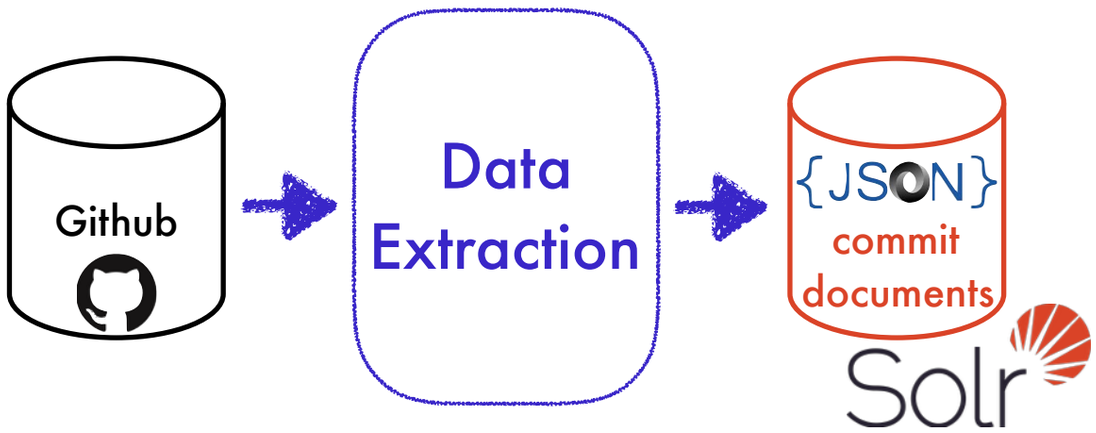

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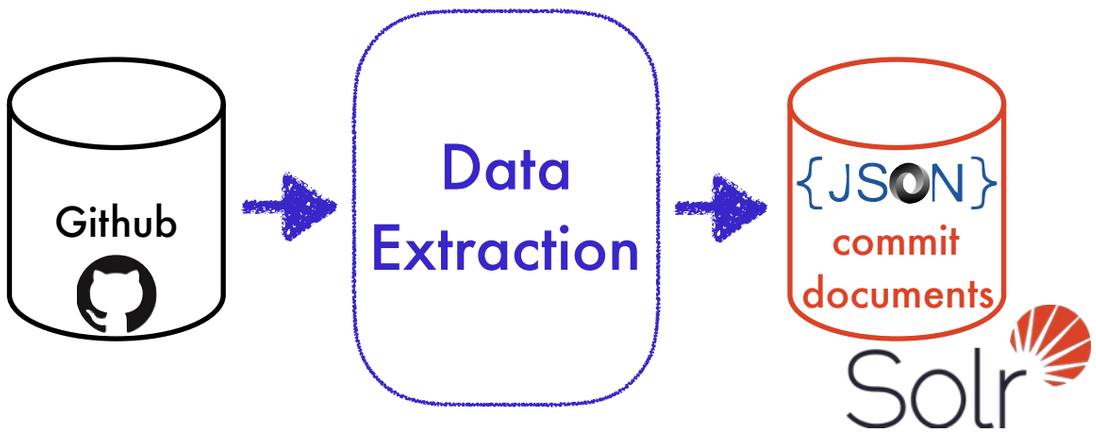
Relevant Commit Search



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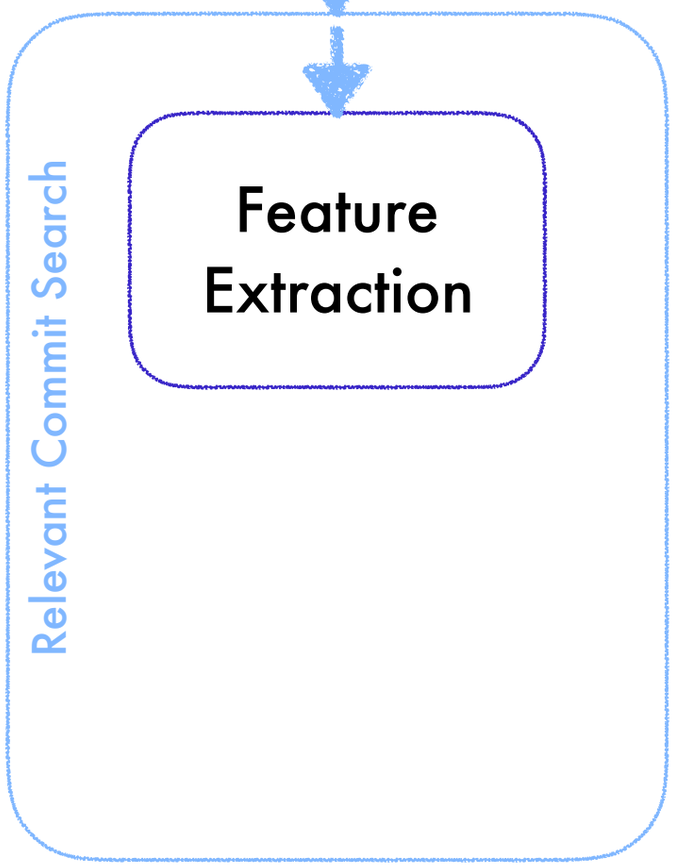

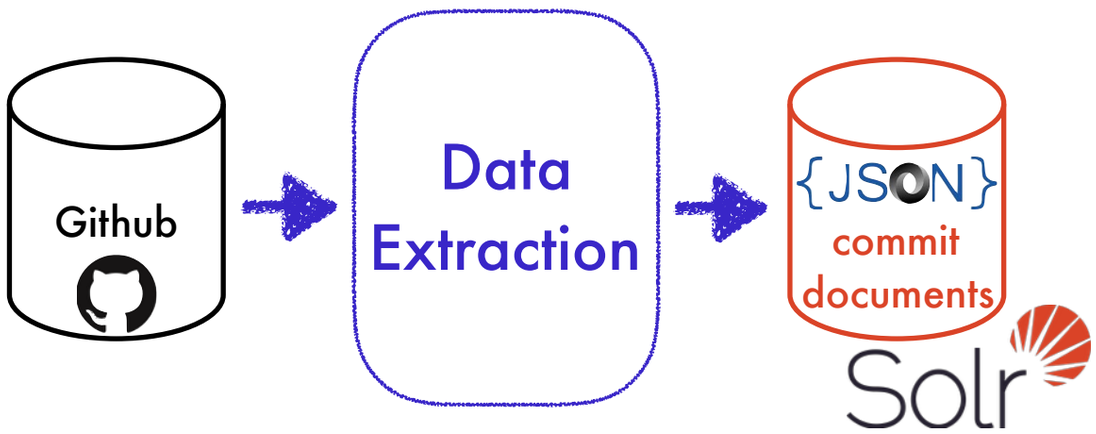

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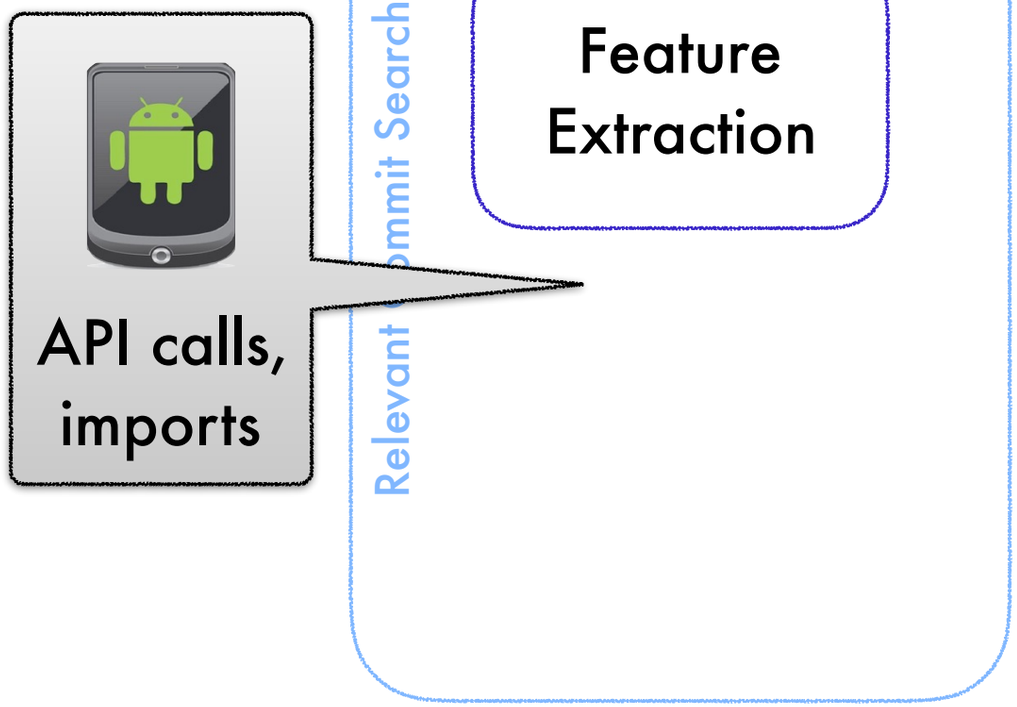
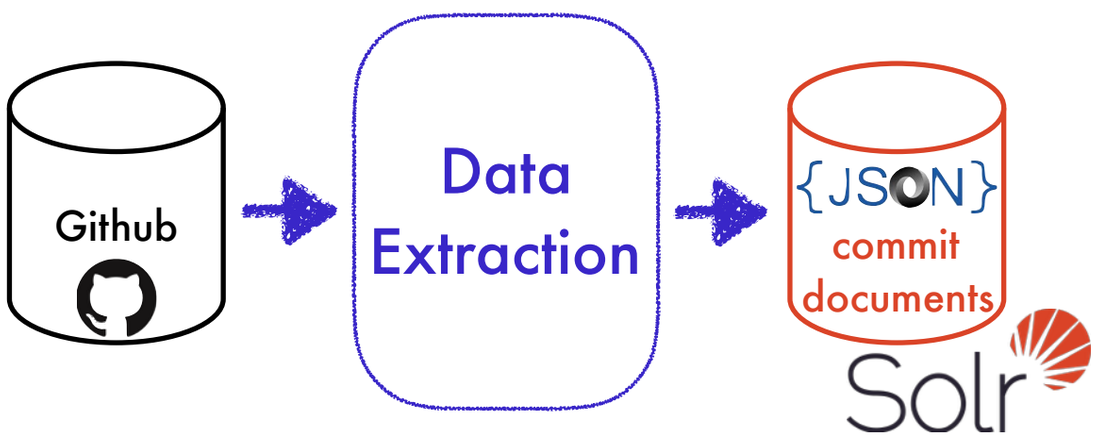




Relevant Commit Search

Oh, I have in my code:

```
MediaScannerConnection.scanFile(context, p, m, l)
```

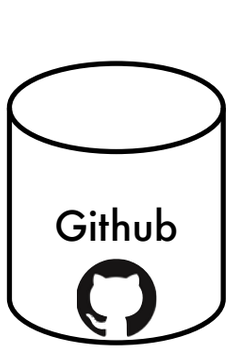
Idea: Create and index commit feature documents

API calls, imports

Relevant Commit Search

Feature Extraction

Search Term Construction



Data Extraction

Relevant Commit Search

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```
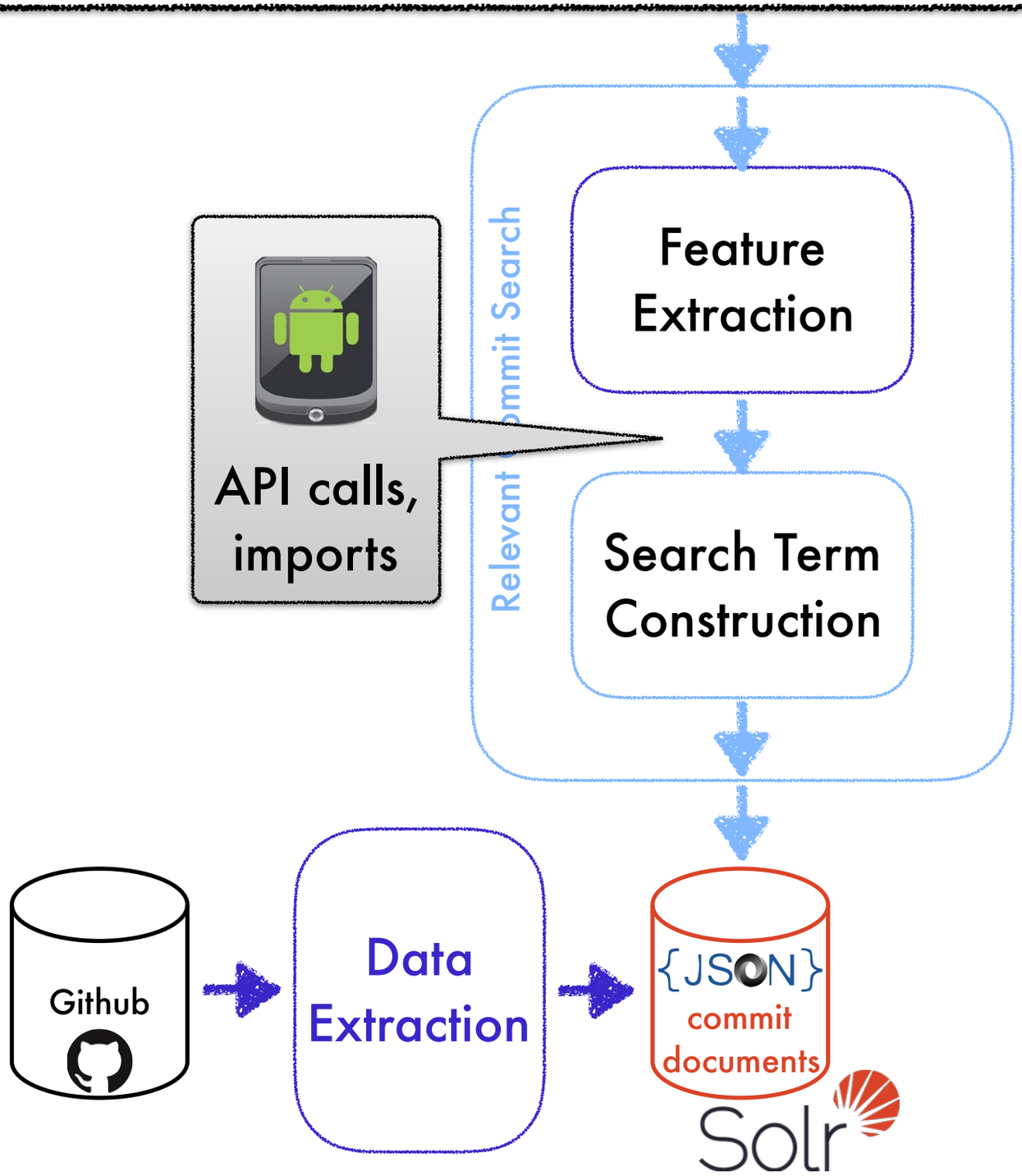

Idea: Create and index commit feature documents



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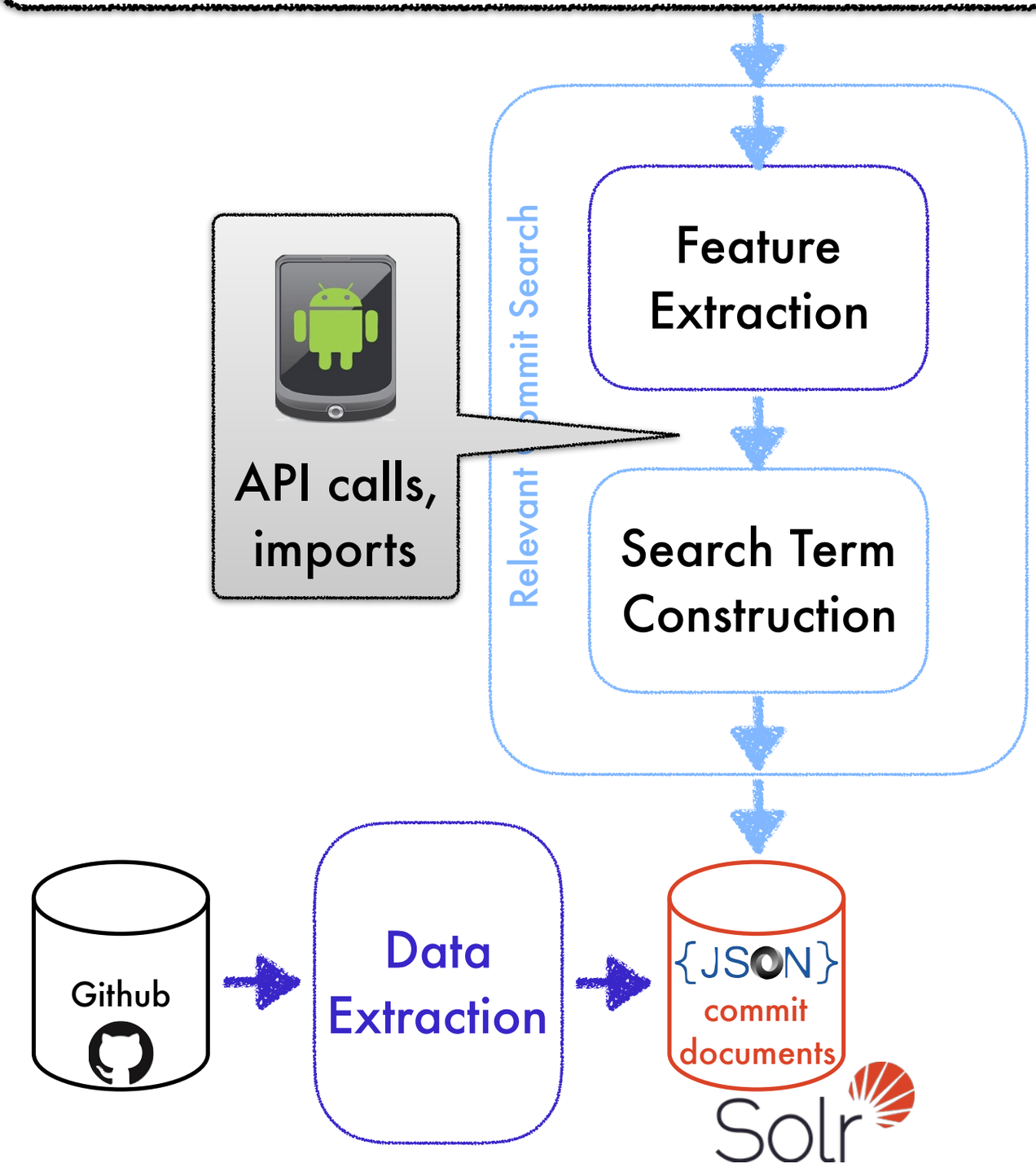

Idea: Create and index commit feature documents

Challenge: Index "useful" features

Relevant Commit Search

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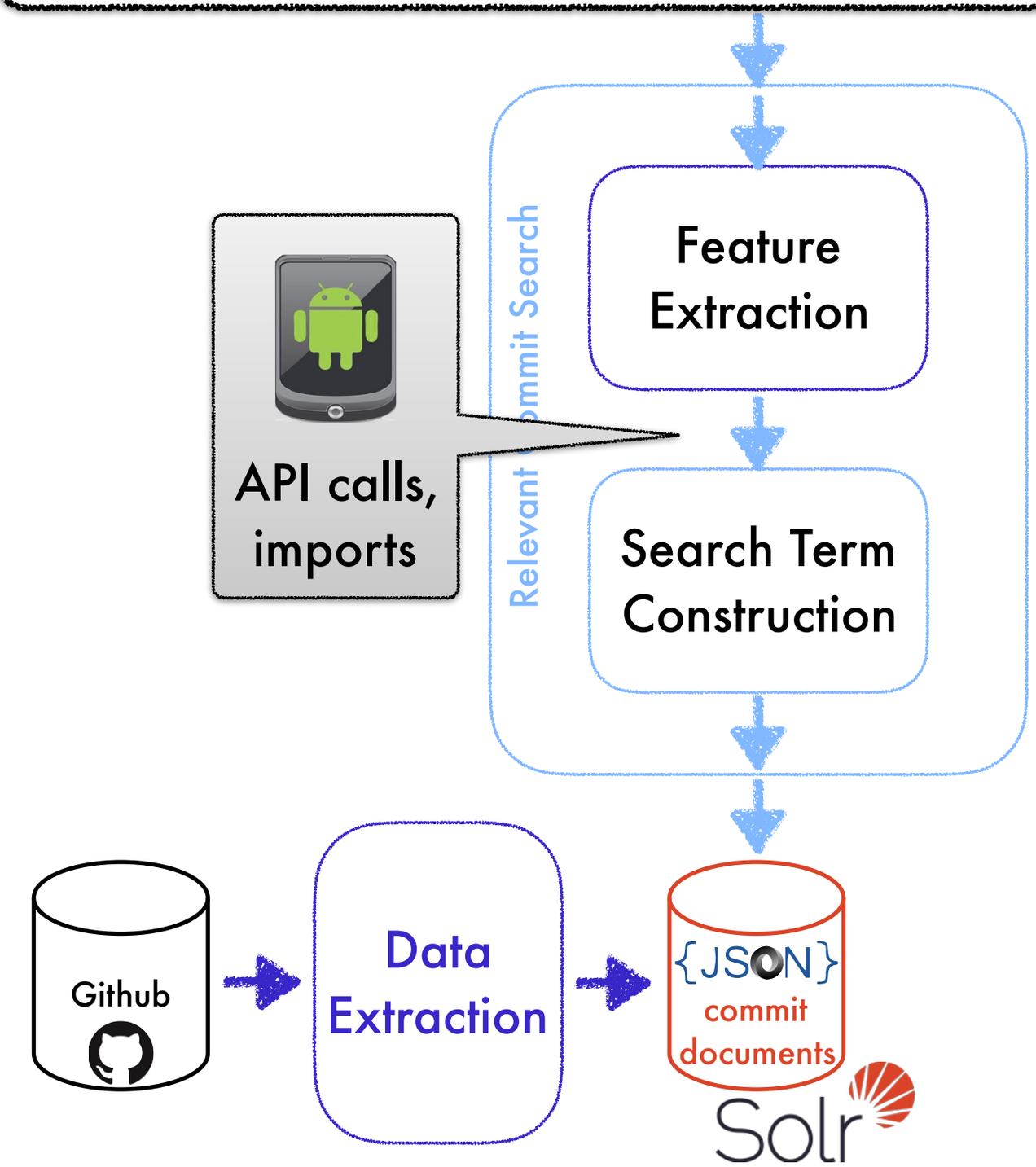


Idea: Create and index commit feature documents

Challenge: Index "useful" features

For each commit-relation, we index:

- Features of the parent commit
- Features of the child commit
- Parent-to-child patch
- Commit messages

Relevant Commit Search
Research Questions

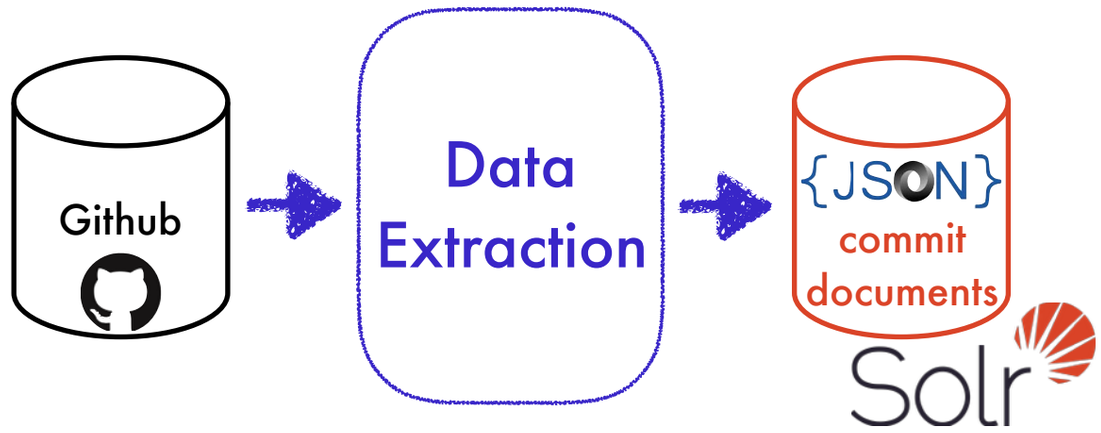
Can bugfix commits be found in the corpus with indexed search?

Relevant Commit Search
Research Questions

Can bugfix commits be found in the corpus with indexed search?

Do the results improve using more fine-grained features?

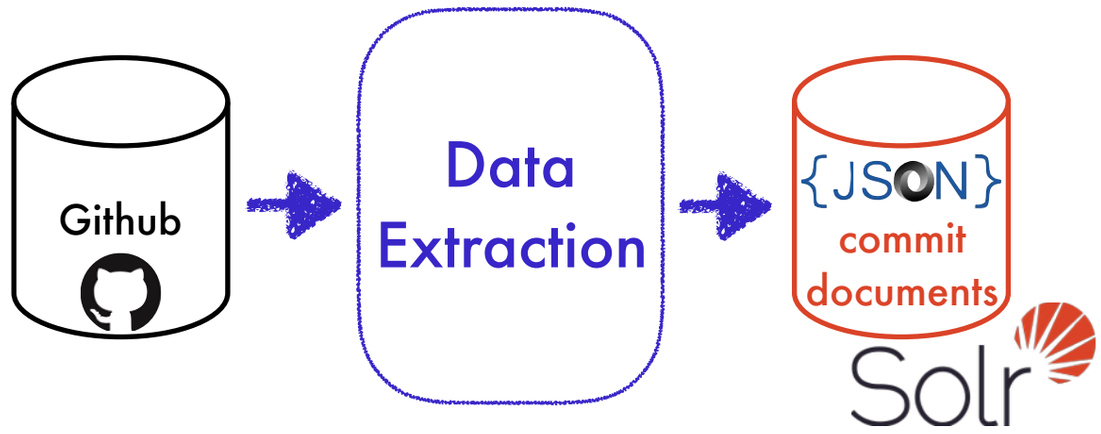
Relevant Commit Search
Experimental Setup



16K repos with 2.83M Java files

1.39M commit-relation documents

Relevant Commit Search
Experimental Setup



16K repos with 2.83M Java files

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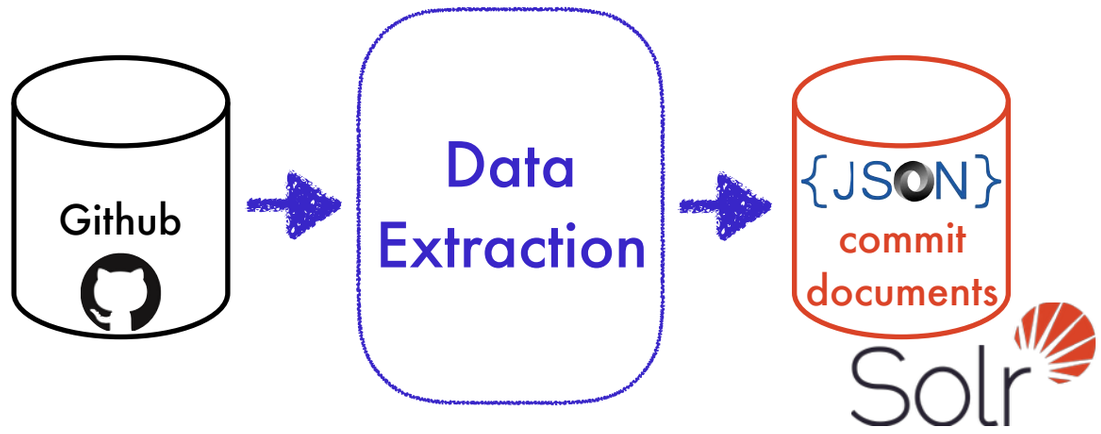
5 bug pattern queries

Relevant Commit Search
Experimental Setup



16K repos with 2.83M Java files

1.39M commit-relation documents

5 bug pattern queries

3 granularity levels

method names

method names + arity

method names + arity + “fix” in commit message

Empirical Evaluation

Empirical Evaluation

Bug Pattern
View.setTag
MediaScanner Connection.scanFile
getSystemService (CAMERA_SERVICE)
GoogleApiClient .Builder
MediaPlayer .setDataSource

Empirical Evaluation

Bug Pattern	Granularity
View.setTag	name
	+arity
	+"fix"
MediaScanner Connection.scanFile	name
	+arity
	+"fix"
getSystemService (CAMERA_SERVICE)	name
	+arity
	+"fix"
GoogleApiClient .Builder	name
	+arity
	+"fix"
MediaPlayer .setDataSource	name
	+arity
	+"fix"
	summary

Empirical Evaluation

Bug Pattern	Granularity	Query Time (sec)
View.setTag	name	14
	+arity	17
	+"fix"	16
MediaScanner Connection.scanFile	name	26
	+arity	30
	+"fix"	18
getSystemService (CAMERA_SERVICE)	name	24
	+arity	14
	+"fix"	23
GoogleApiClient .Builder	name	30
	+arity	10
	+"fix"	2
MediaPlayer .setDataSource	name	45
	+arity	15
	+"fix"	10
	summary	20

Empirical Evaluation

Bug Pattern	Granularity	Query Time (sec)
View.setTag	name	14
	+arity	17
	+"fix"	16
MediaScanner Connection.scanFile	name	26
	+arity	30
	+"fix"	18
getSystemService (CAMERA_SERVICE)	name	24
	+arity	14
	+"fix"	23
GoogleApiClient .Builder	name	30
	+arity	10
	+"fix"	2
MediaPlayer .setDataSource	name	45
	+arity	15
	+"fix"	10
	summary	20

dominated by feature extraction

Empirical Evaluation

Bug Pattern	Granularity	Query Time (sec)	Commits Retrieved (num)
View.setTag	name	14	138
	+arity	17	86
	+"fix"	16	19
MediaScanner Connection.scanFile	name	26	75
	+arity	30	51
	+"fix"	18	11
getSystemService (CAMERA_SERVICE)	name	24	82
	+arity	14	82
	+"fix"	23	139
GoogleApiClient .Builder	name	30	23
	+arity	10	10
	+"fix"	2	2
MediaPlayer .setDataSource	name	45	192
	+arity	15	135
	+"fix"	10	21
	summary	20	

dominated by feature extraction

Empirical Evaluation

Bug Pattern	Granularity	Query Time (sec)	Commits Retrieved (num)
View.setTag	name	14	138
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MediaPlayer .setDataSource	name	45	192
	+arity	15	135
	+"fix"	10	21
	summary	20	

out of 1.39M commit-relations

<0.01%

Empirical Evaluation

Bug Pattern	Granularity	Query Time (sec)	Commits Retrieved (num)	Bugs in First 10 (num)
View.setTag	name	14	138	3
	+arity	17	86	1
	+"fix"	16	19	1
MediaScanner Connection.scanFile	name	26	75	5
	+arity	30	51	2
	+"fix"	18	11	5
getSystemService (CAMERA_SERVICE)	name	24	82	1
	+arity	14	82	1
	+"fix"	23	139	1
GoogleApiClient .Builder	name	30	23	7
	+arity	10	10	8
	+"fix"	2	2	1
MediaPlayer .setDataSource	name	45	192	0
	+arity	15	135	0
	+"fix"	10	21	0
	summary	20		2

out of 1.39M commit-relations <0.01%

Empirical Evaluation

Bug Pattern	Granularity	Query Time (sec)	Commits Retrieved (num)	Bugs in First 10 (num)	Fixes in First 10 (num)
View.setTag	name	14	138	3	0
	+arity	17	86	1	1
	+"fix"	16	19	1	1
MediaScanner Connection.scanFile	name	26	75	5	1
	+arity	30	51	2	0
	+"fix"	18	11	5	2
getSystemService (CAMERA_SERVICE)	name	24	82	1	0
	+arity	14	82	1	0
	+"fix"	23	139	1	0
GoogleApiClient .Builder	name	30	23	7	0
	+arity	10	10	8	0
	+"fix"	2	2	1	0
MediaPlayer .setDataSource	name	45	192	0	0
	+arity	15	135	0	0
	+"fix"	10	21	0	0
	summary	20		2	1

out of 1.39M commit-relations

<0.01%

Empirical Evaluation

Bug Pattern	Granularity	Query Time (sec)	Commits Retrieved (num)	Bugs in First 10 (num)	Fixes in First 10 (num)
View.setTag	name	14	138	3	0
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	+"fix"	23	139	1	0
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	+"fix"	2	2	1	0
MediaPlayer .setDataSource	name	45	192	0	0
	+arity	15	135	0	0
	+"fix"	10	21	0	0
	summary	20		2	1

bugs and fixes in triaging first 10

Empirical Evaluation

Bug Pattern	Granularity	Query Time (sec)	Commits Retrieved (num)	Bugs in First 10 (num)	Fixes in First 10 (num)	Cumulative Score in the First 30% (%)
View.setTag	name	14	138	3	0	69
	+arity	17	86	1	1	51
	+"fix"	16	19	1	1	44
MediaScanner Connection.scanFile	name	26	75	5	1	69
	+arity	30	51	2	0	66
	+"fix"	18	11	5	2	67
getSystemService (CAMERA_SERVICE)	name	24	82	1	0	88
	+arity	14	82	1	0	88
	+"fix"	23	139	1	0	32
GoogleApiClient .Builder	name	30	23	7	0	65
	+arity	10	10	8	0	82
	+"fix"	2	2	1	0	0
MediaPlayer .setDataSource	name	45	192	0	0	53
	+arity	15	135	0	0	70
	+"fix"	10	21	0	0	57
	summary	20		2	1	

bugs and fixes in triaging first 10

Empirical Evaluation

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	+arity	30	51	2	0	66
	+"fix"	18	11	5	2	67
getSystemService (CAMERA_SERVICE)	name	24	82	1	0	88
	+arity	14	82	1	0	88
	+"fix"	23	139	1	0	32
GoogleApiClient .Builder	name	30	23	7	0	65
	+arity	10	10	8	0	82
	+"fix"	2	2	1	0	0
MediaPlayer .setDataSource	name	45	192	0	0	53
	+arity	15	135	0	0	70
	+"fix"	10	21	0	0	57
	summary	20		2		

fraction of score in first 30%

Empirical Evaluation

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	+arity	14	82	1	0	88
	+"fix"	23	139	1	0	32
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	+arity	10	10	8	0	82
	+"fix"	2	2	1	0	0
MediaPlayer .setDataSource	name	45	192	0	0	53
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	+"fix"	10	21	0	0	57
	summary	20		2	1	

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	+arity	17	86	1	1	51
	+"fix"	16	19	1	1	44
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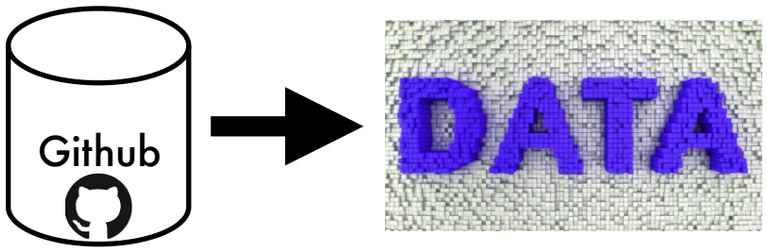
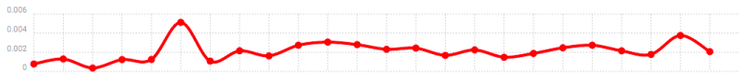
	+arity	30	51	2	0	66
	+"fix"	18	11	5	2	67
getSystemService (CAMERA_SERVICE)	name	24	82	1	0	88
	+arity	14	82	1	0	88
	+"fix"	23	139	1	0	32
GoogleApiClient .Builder	name	30	23	7	0	65
	+arity	10	10	8	0	82
	+"fix"	2	2	1	0	0
MediaPlayer .setDataSource	name	45	192	0	0	53
	+arity	15	135	0	0	70
	+"fix"	10	21	0	0	57
	summary	20		2	1	

Bugs and fixes can be found in the first 10 results with feature-based document search

Fixr Contributions



Extract commit features at scale

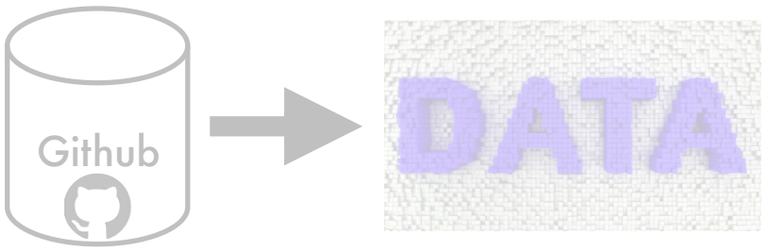


Find API usage patterns over time

Index commit feature documents

Search-and-repair platform
for Android apps

Fixr Contributions



Extract commit features at scale

Find API usage patterns over time

Index commit feature documents

Search-and-repair platform for Android apps

Are repair specifications applicable?

Hypothesis: API repairs are applicable "in the wild"

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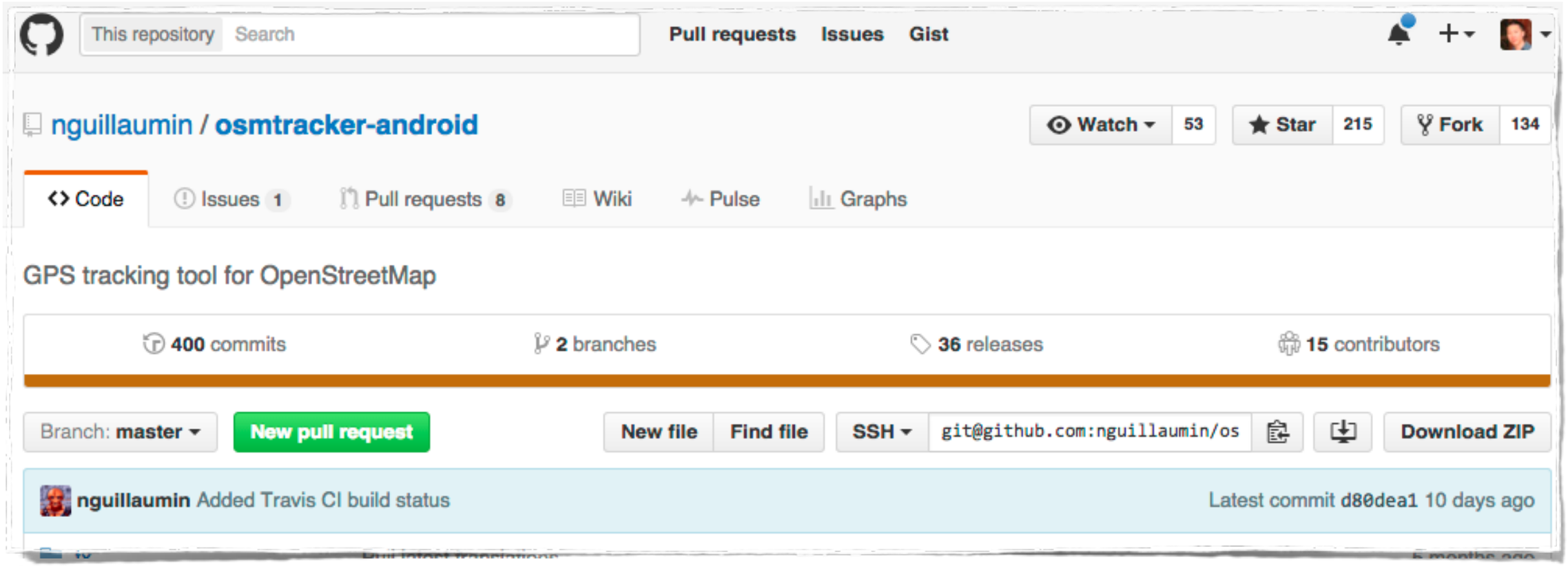
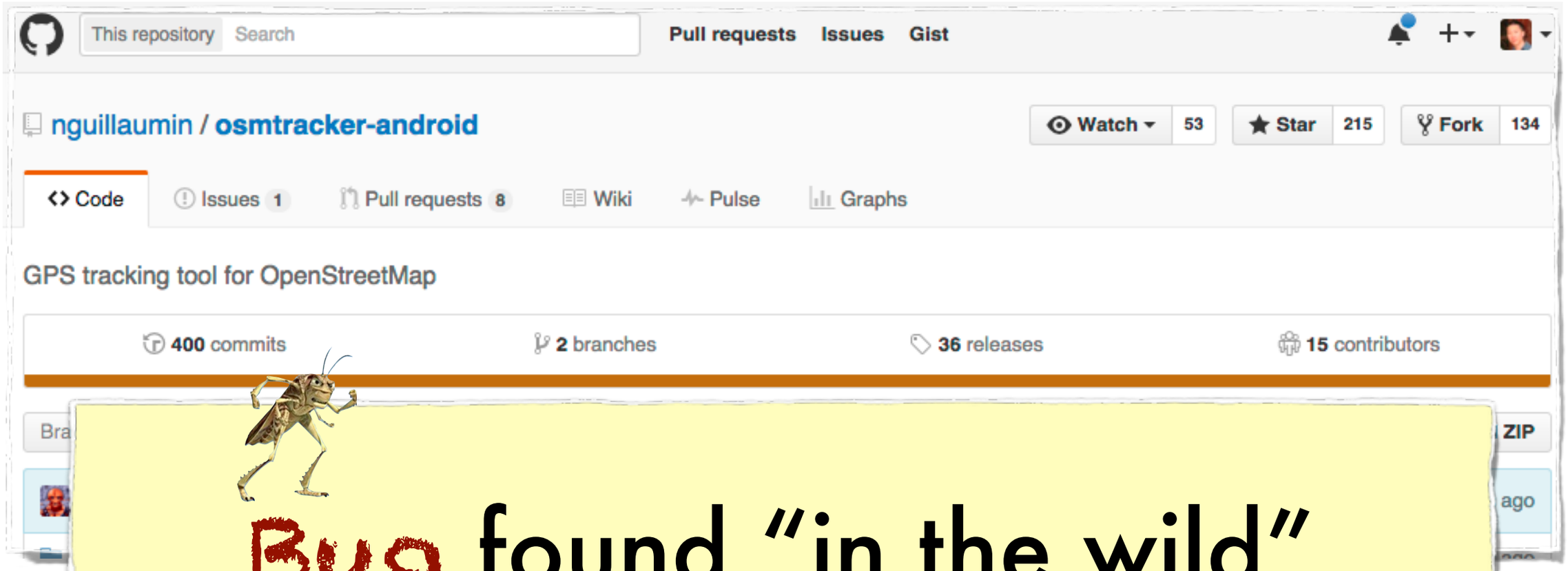
Hypothesis: API repairs are applicable "in the wild"



Are repair specifications applicable?

Hypothesis: API repairs are applicable "in the wild"



Bug found "in the wild"

(at HEAD as of January 2016 in a project active as of August 2015)

Bug

Bug

```
MediaScannerConnection.scanFile(context, p, m, l)
```

Bug

```
MediaScannerConnection.scanFile(context, p, m, l)
```

if `context` points to an object of type Activity or `l` can reach an Activity

Bug

```
MediaScannerConnection.scanFile(context, p, m, l)
```

bug condition

if `context` points to an object of type Activity or `l` can reach an Activity

Bug

```
MediaScannerConnection.scanFile(context, p, m, l)
```

bug condition

if `context` points to an object of type Activity or `l` can reach an Activity

Repair

Bug

```
MediaScannerConnection.scanFile(context, p, m, l)
```

if `context` points to an object of type Activity or `l` can reach an Activity

bug condition

Repair

```
-MediaScannerConnection.scanFile({{context}}, {{p}}, {{m}}, {{l}})

+final {{MSCCWrapper}} {{fresh w}} = new {{MSCCWrapper}}({{context}}, {{p}}, {{m}});
+final MediaScannerConnection {{fresh msc}} = new {{MSCWrapper}}({{l}}, {{w}});
+{{w}}.startConnection({{msc}});
```

Bug

```
MediaScannerConnection.scanFile(context, p, m, l)
```

if `context` points to an object of type Activity or `l` can reach an Activity

bug condition

Repair

```
-MediaScannerConnection.scanFile({{context}}, {{p}}, {{m}}, {{l}})

+final {{MSCCWrapper}} {{fresh w}} = new {{MSCCWrapper}}({{context}}, {{p}}, {{m}});
+final MediaScannerConnection {{fresh msc}} = new {{MSCWrapper}}({{l}}, {{w}});
+{{w}}.startConnection({{msc}});
```

syntactic transformation language

Bug

```
MediaScannerConnection.scanFile(context, p, m, l)
```

if `context` points to an object of type Activity or `l` can reach an Activity

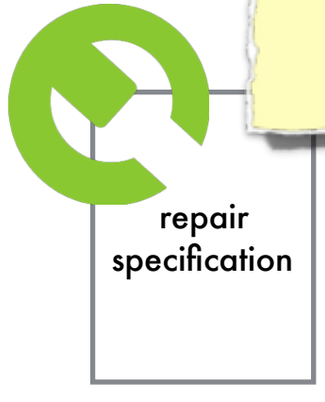
bug condition

Repair

```
-MediaScannerConnection.scanFile({{context}}, {{p}}, {{m}}, {{l}})

+final {{MSCCWrapper}} {{fresh w}} = new {{MSCCWrapper}}({{context}}, {{p}}, {{m}});
+final MediaScannerConnection {{fresh msc}} = new {{MSCWrapper}}({{l}}, {{w}});
+{{w}}.startConnection({{msc}});
```

repair specification



syntactic transformation language

Bug

```
MediaScannerConnection.scanFile(context, p, m, l)
```

if `context` points to an object of type Activity or `l` can reach an Activity

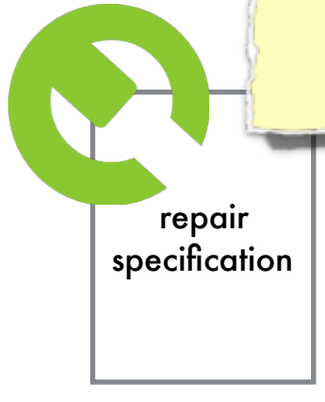
bug condition

Repair

```
-MediaScannerConnection.scanFile({{context}}, {{p}}, {{m}}, {{l}})

+final {{MSCCWrapper}} {{fresh w}} = new {{MSCCWrapper}}({{context}}, {{p}}, {{m}});
+final MediaScannerConnection {{fresh msc}} = new {{MSCWrapper}}({{l}}, {{w}});
+{{w}}.startConnection({{msc}});
```

syntactic transformation language

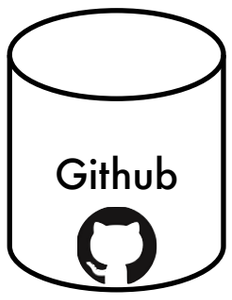


repair specification

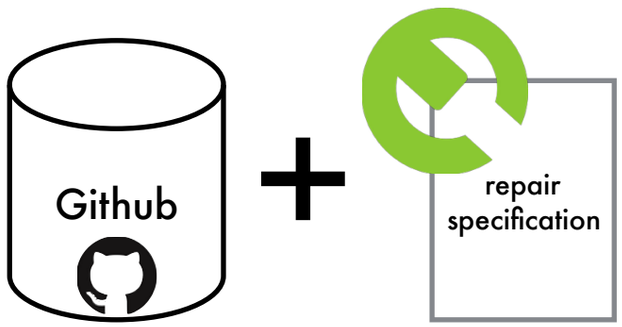
generic for all apps satisfying the bug condition

Search-and-repair platform for Android apps
Approach

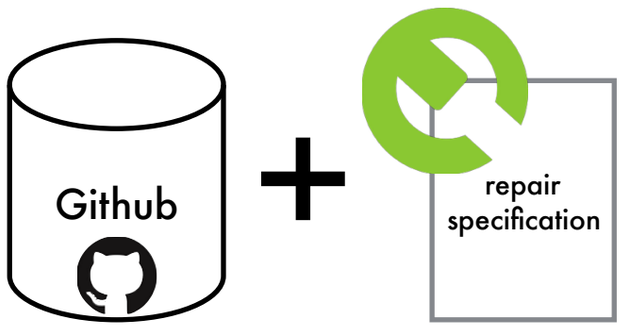
Search-and-repair platform for Android apps
Approach



Search-and-repair platform for Android apps
Approach

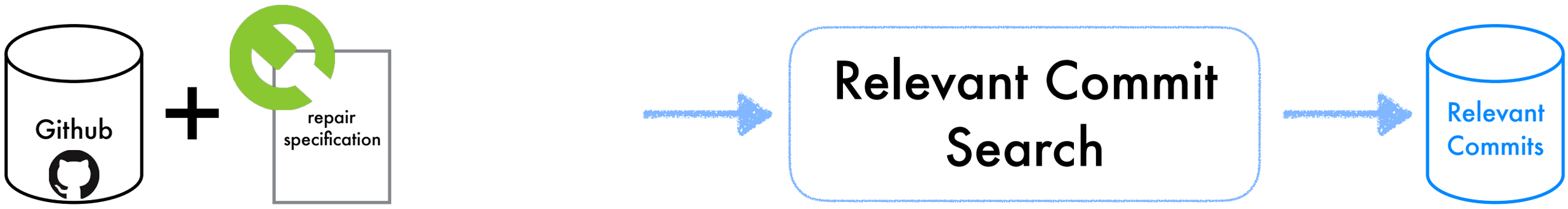


Search-and-repair platform for Android apps
Approach

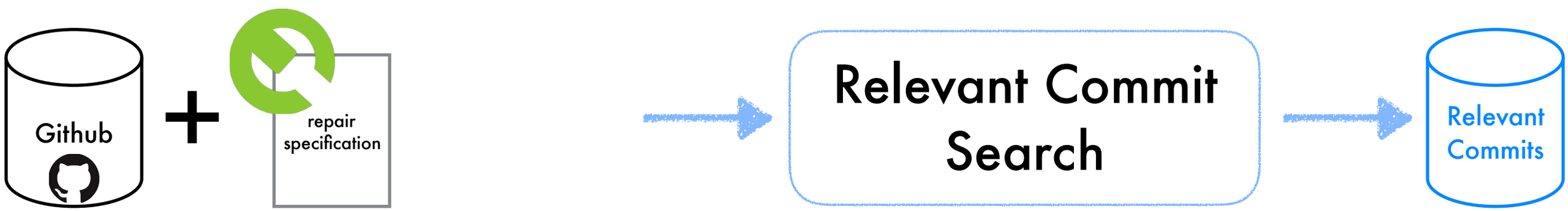


Relevant Commit Search

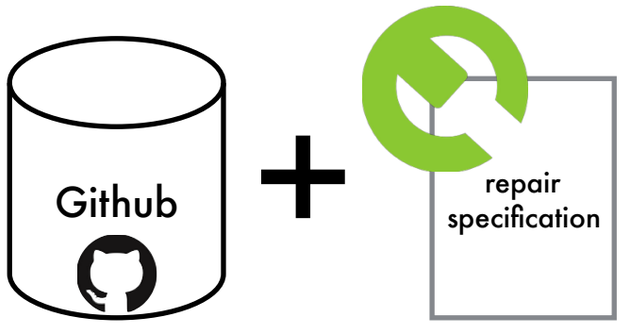
Search-and-repair platform for Android apps
Approach

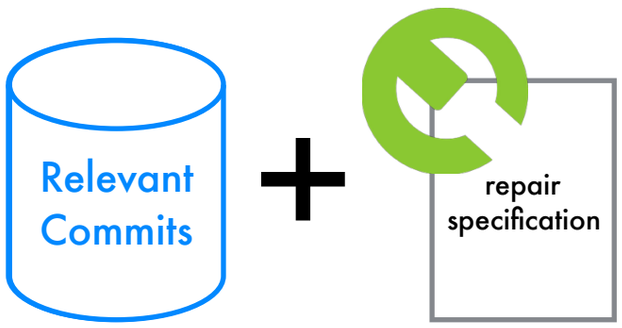


Search-and-repair platform for Android apps
Approach

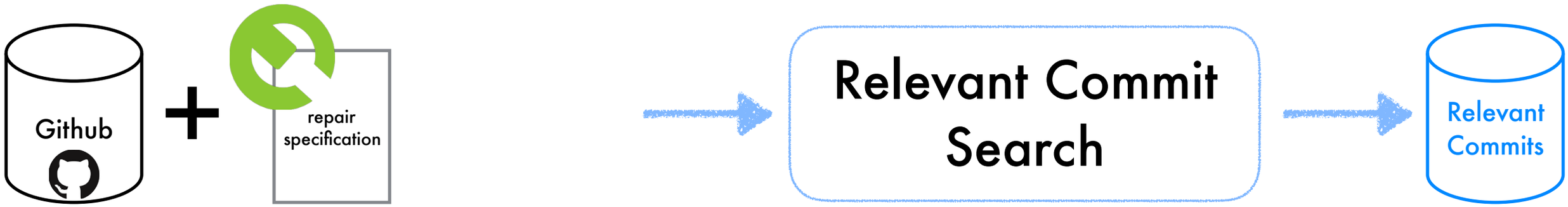


Search-and-repair platform for Android apps
Approach

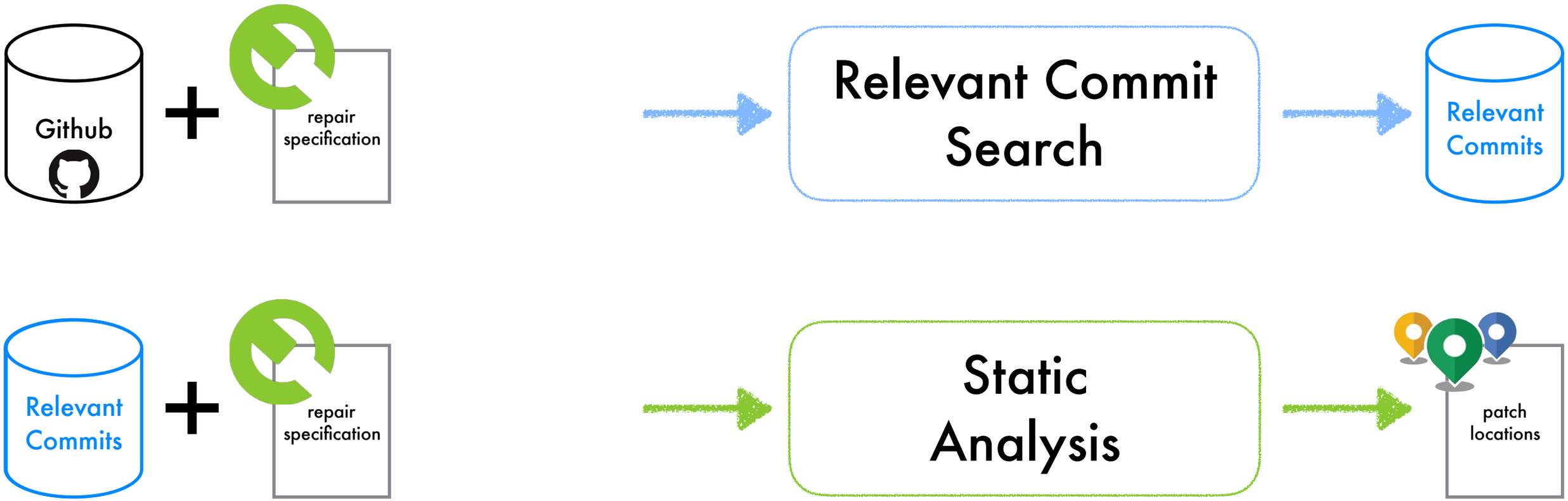




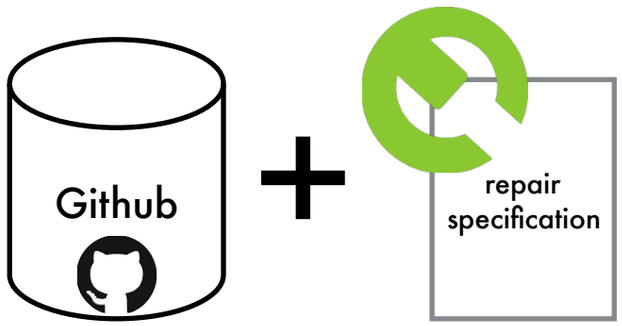
Search-and-repair platform for Android apps
Approach

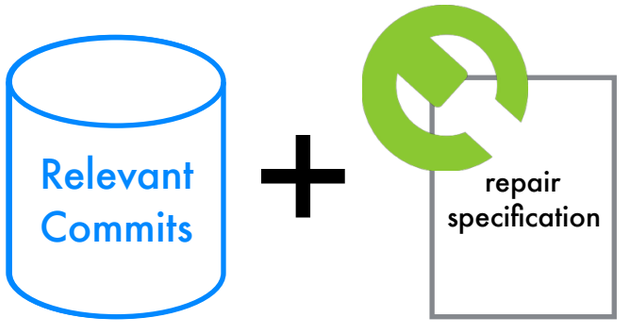


Search-and-repair platform for Android apps
Approach

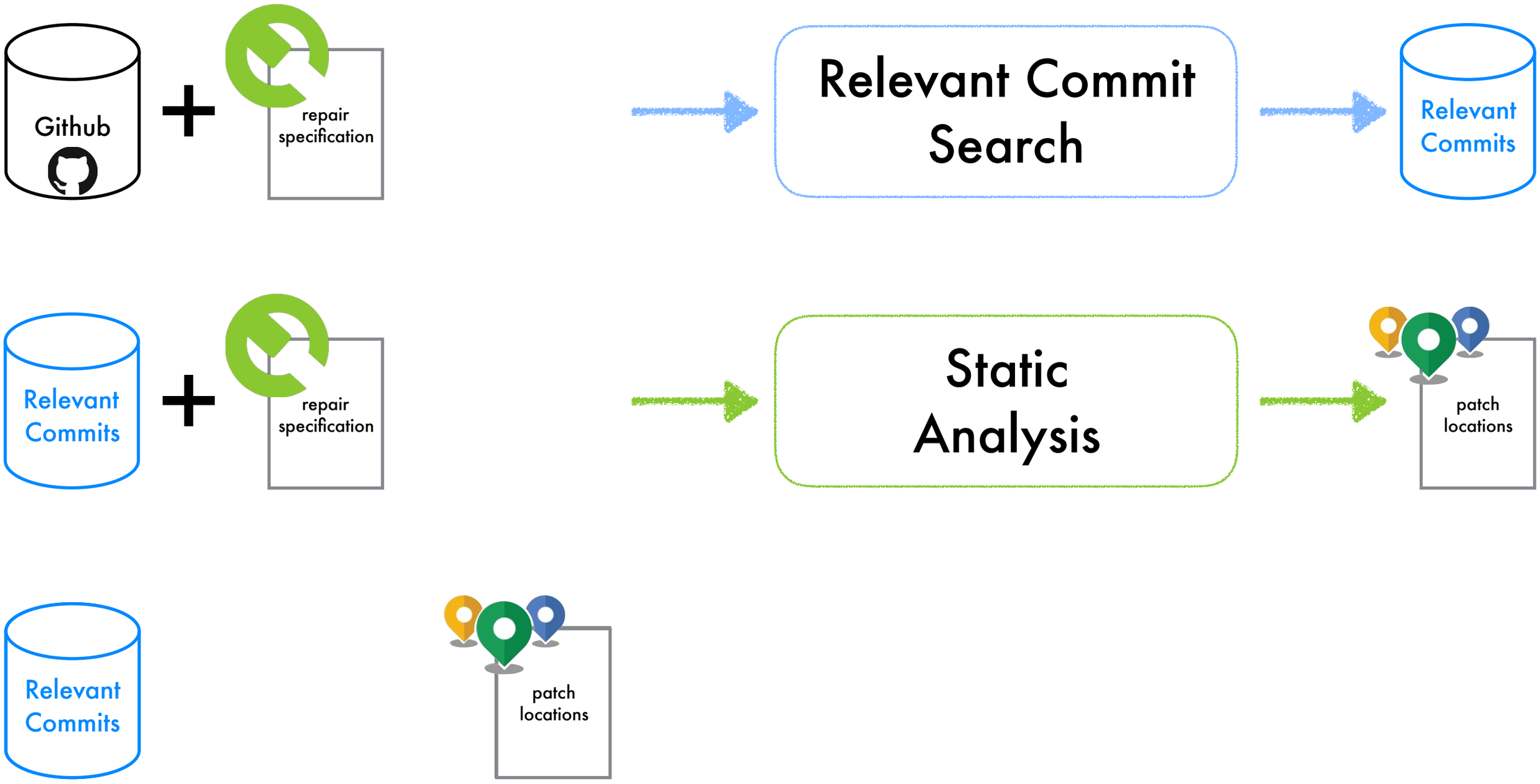


Search-and-repair platform for Android apps
Approach

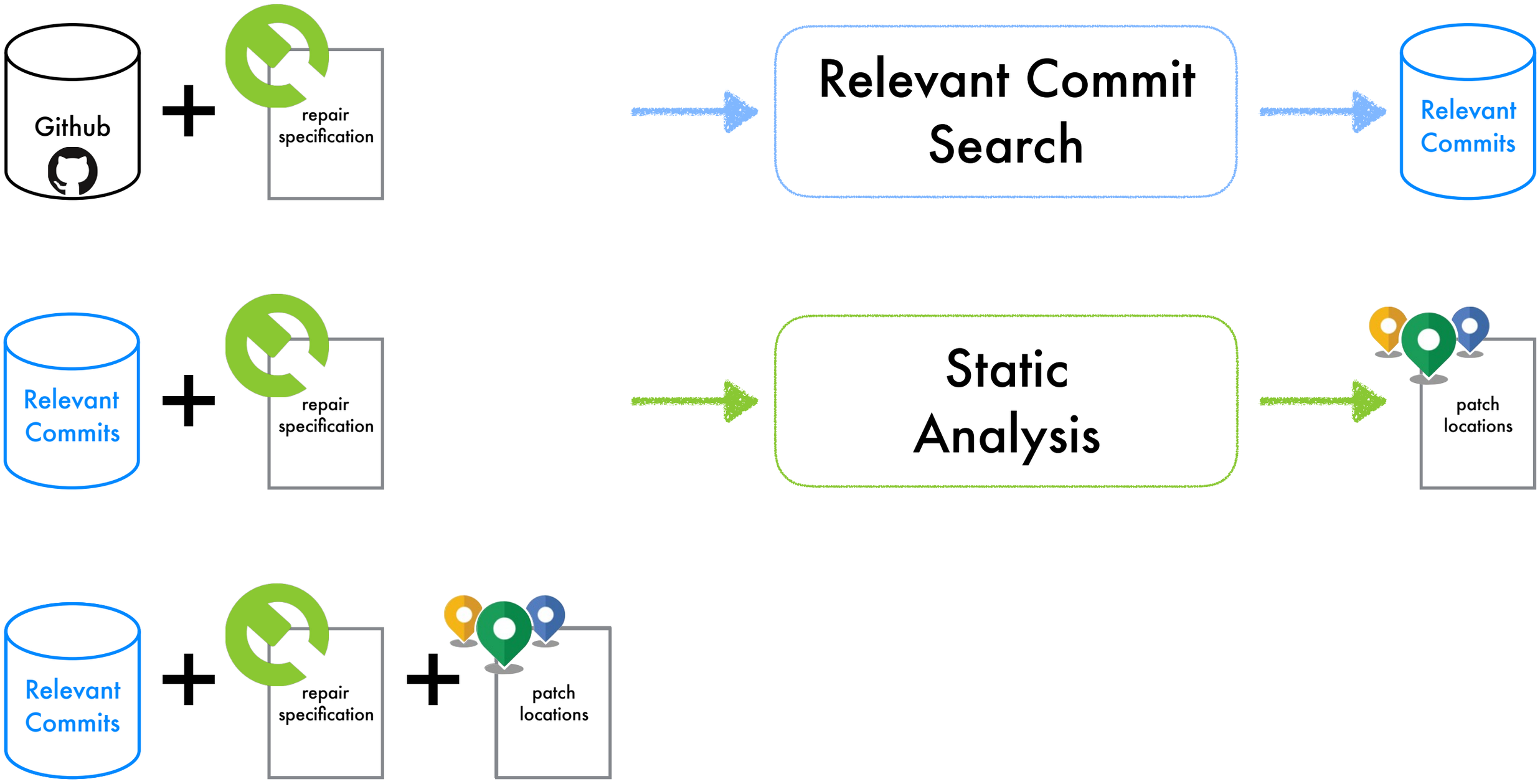




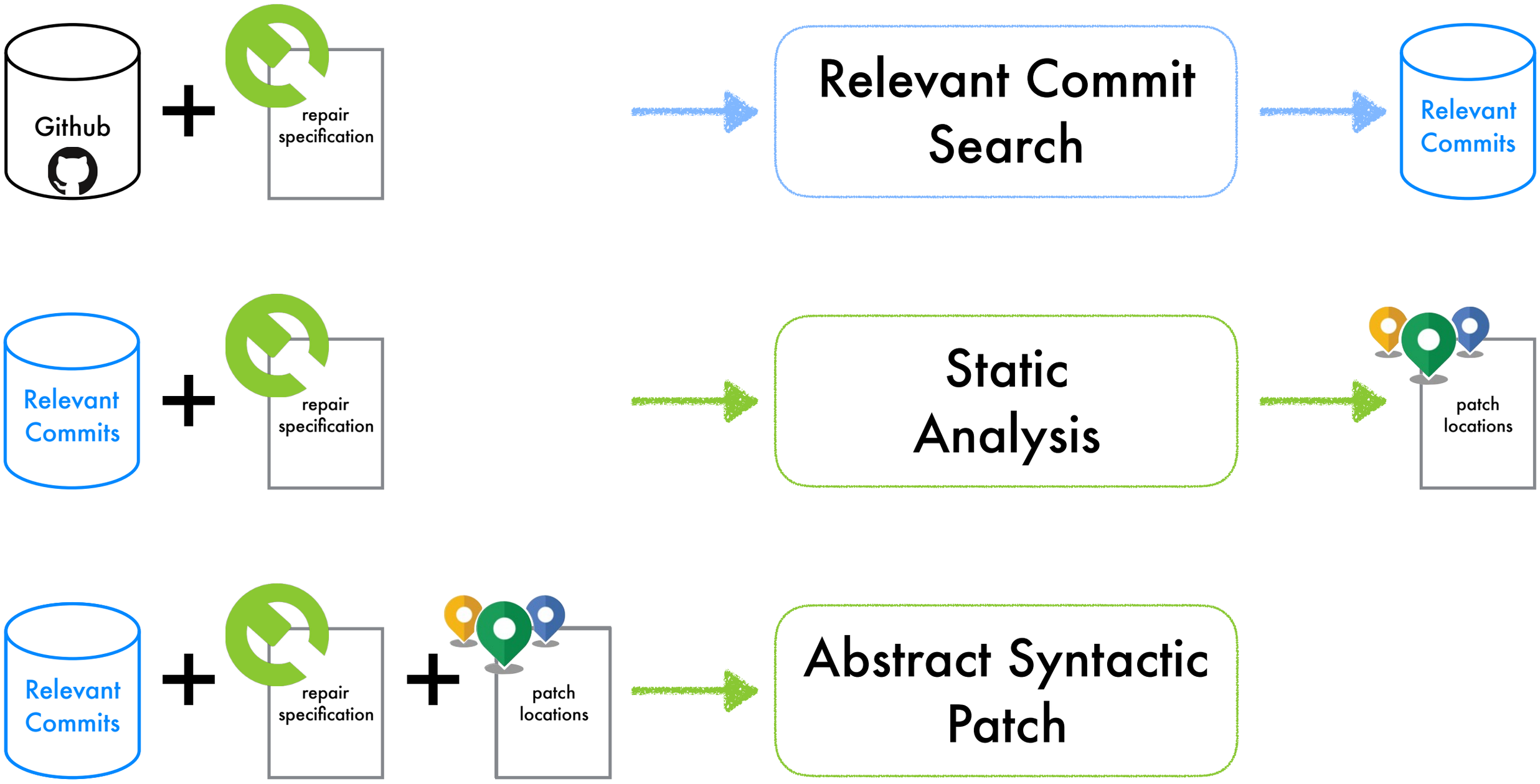
Search-and-repair platform for Android apps
Approach



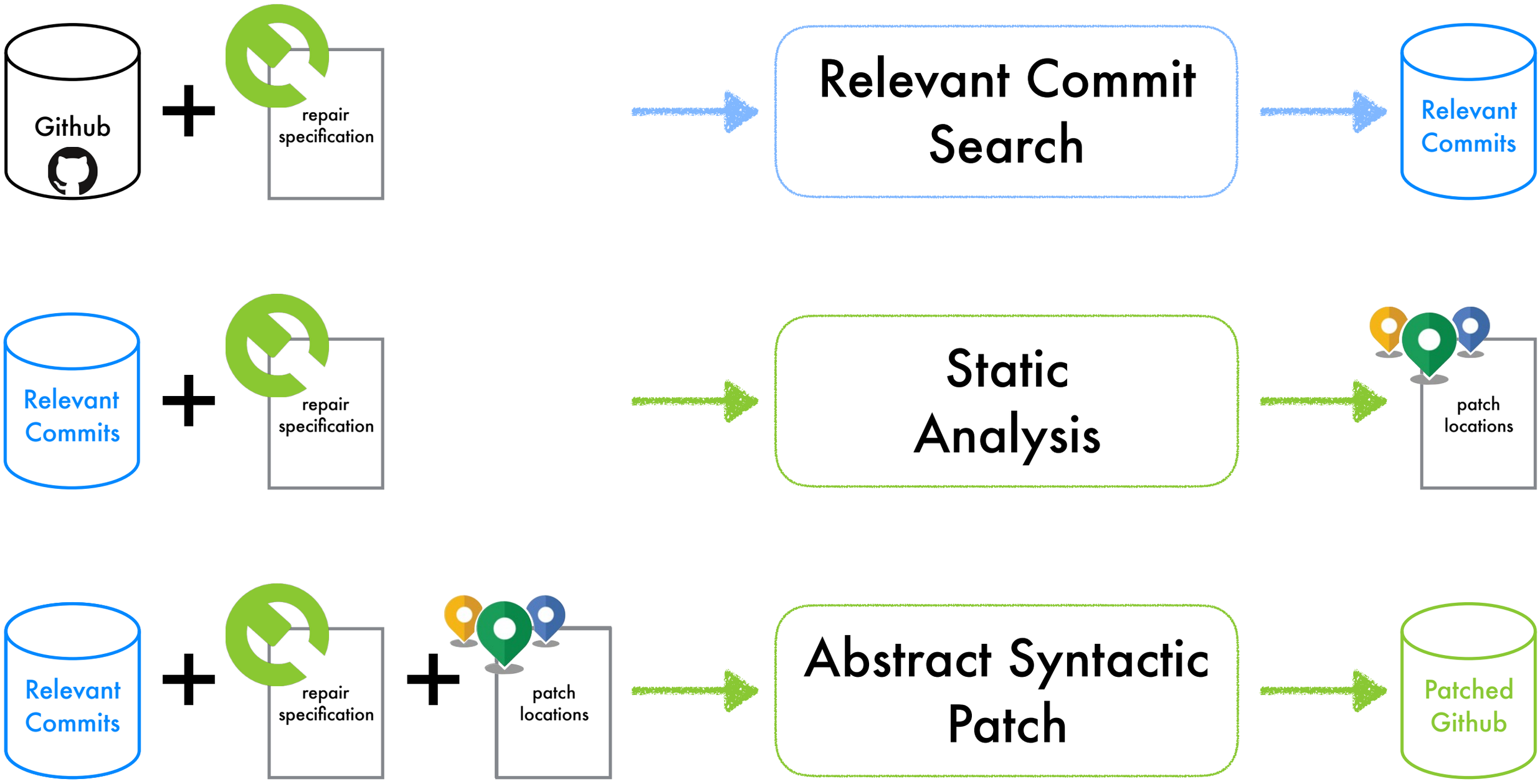
Search-and-repair platform for Android apps
Approach



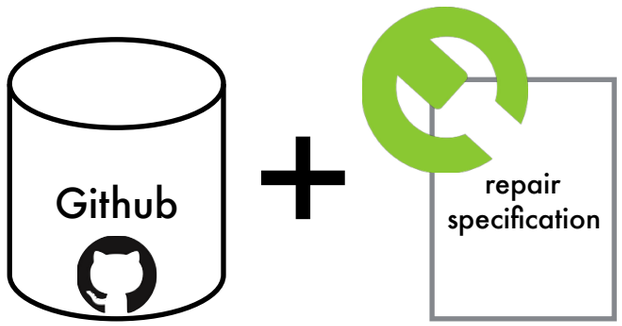
Search-and-repair platform for Android apps
Approach

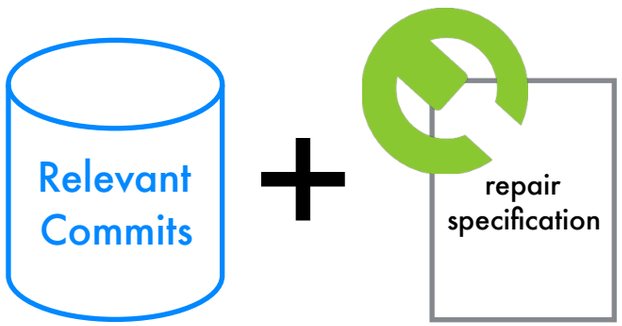


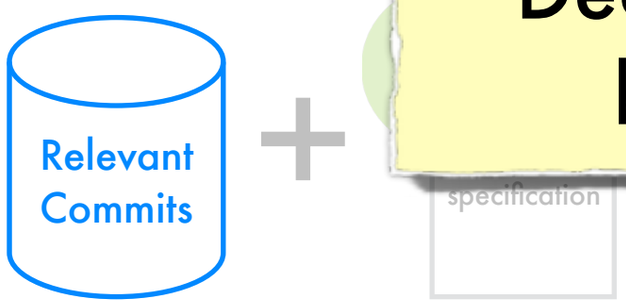
Search-and-repair platform for Android apps
Approach



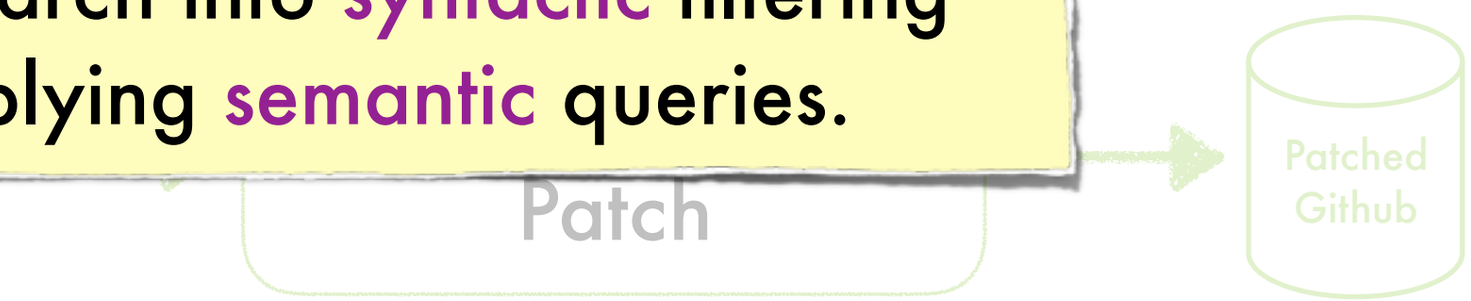
Search-and-repair platform for Android apps
Approach



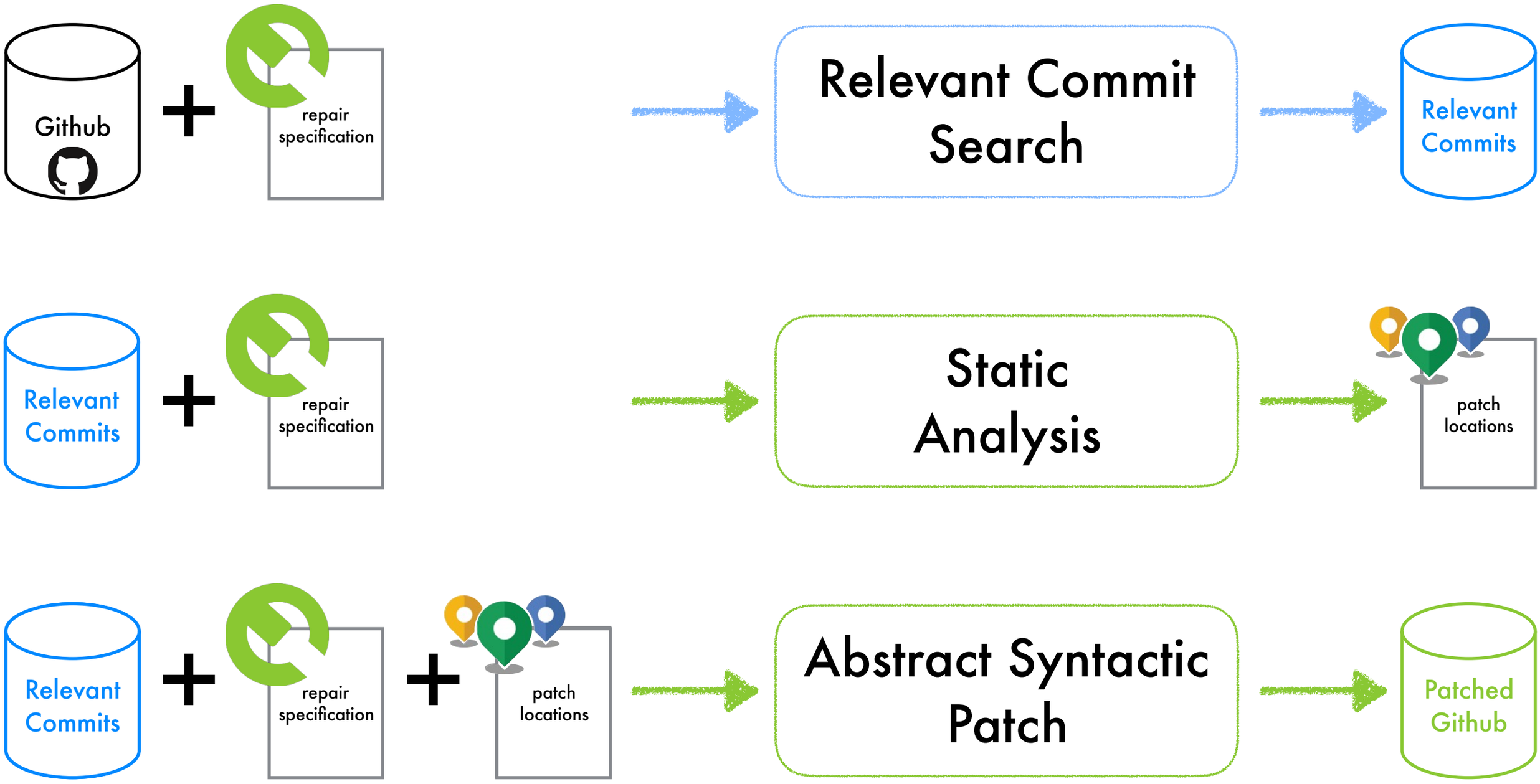




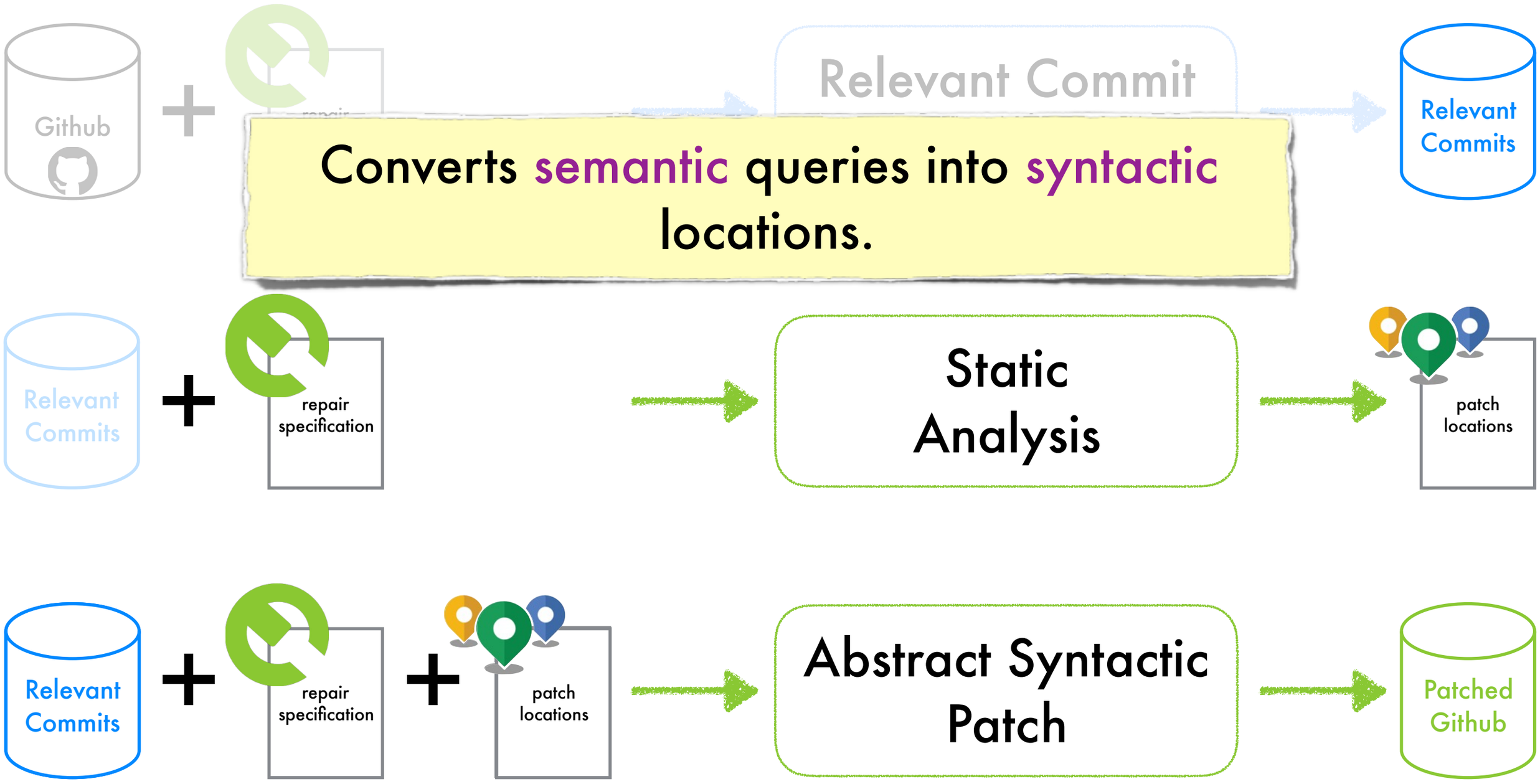
Decouples search into syntactic filtering before applying semantic queries.



Search-and-repair platform for Android apps
Approach

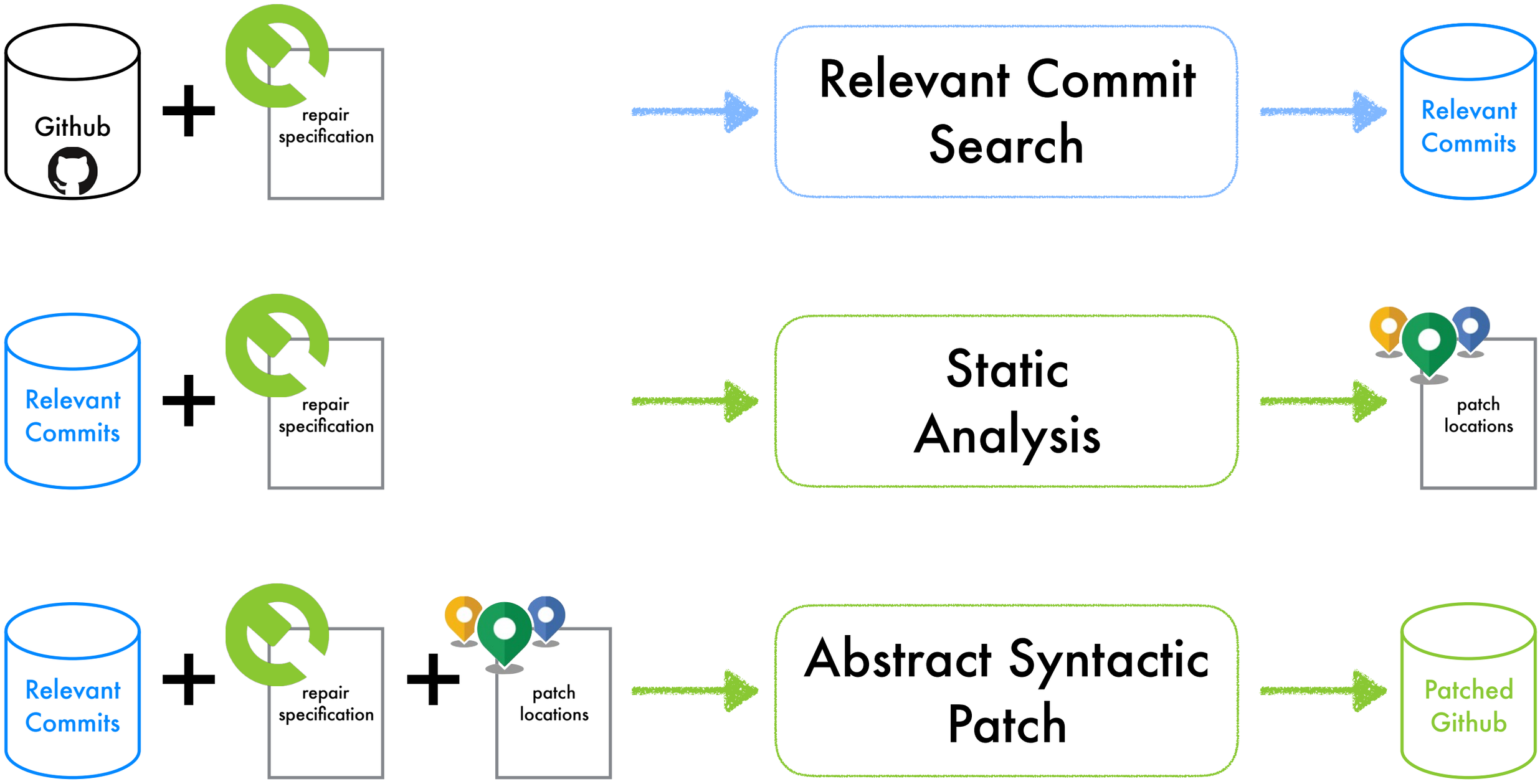


Search-and-repair platform for Android apps
Approach



Search-and-repair platform for Android apps

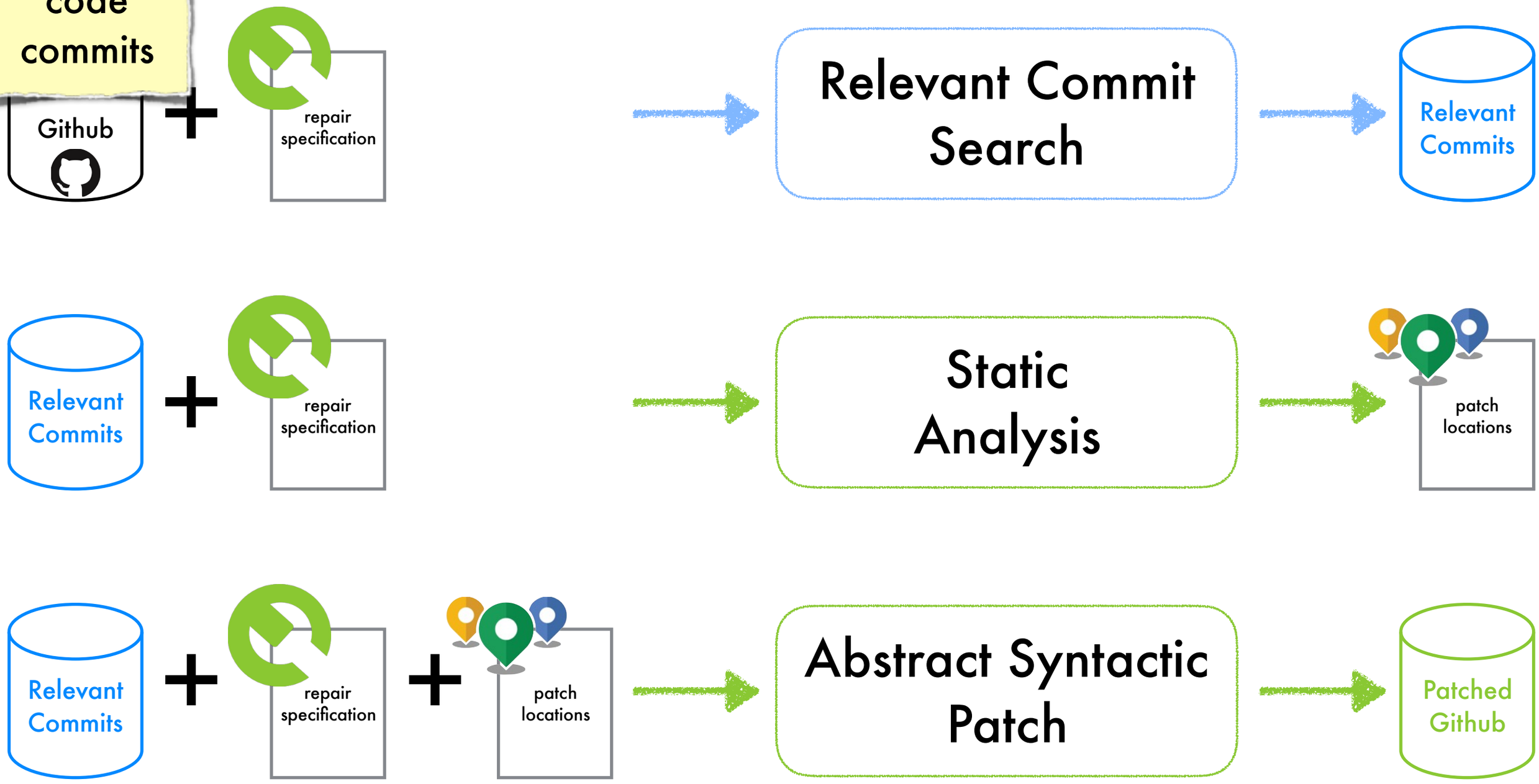
Status: API repairs applicable "in the wild" today?



-and-repair platform for Android apps

16K repos with 510K code commits

: API repairs applicable "in the wild" today?



-and-repair platform for Android apps

: API repairs applicable "in the wild" today?

16K repos with 510K code commits

Github

+

3 repair specifications

Relevant Commit Search

Relevant Commits

Relevant Commits + repair specification

Static Analysis

patch locations

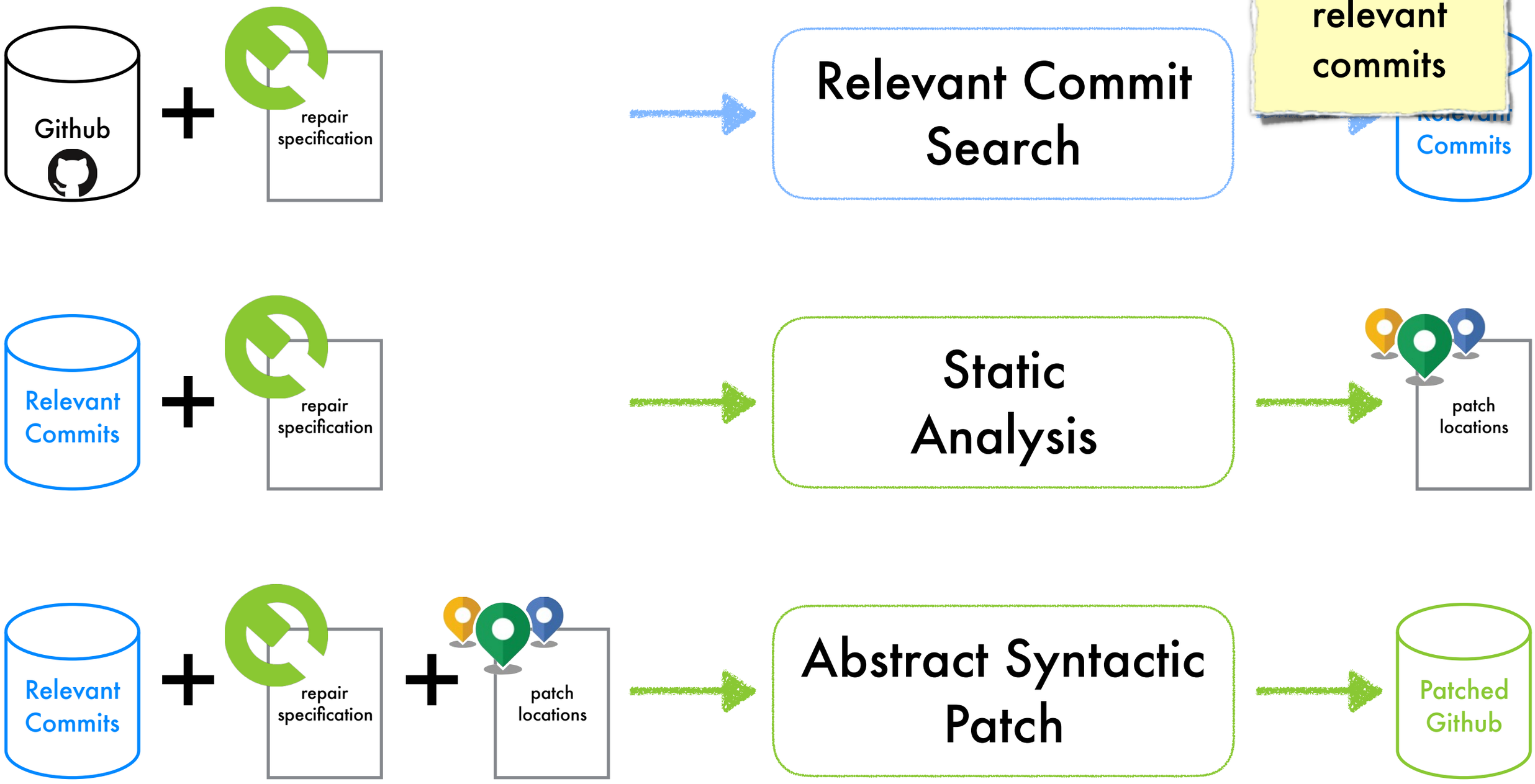
Relevant Commits + repair specification + patch locations

Abstract Syntactic Patch

Patched Github

Search-and-repair platform for Android apps

Status: API repairs applicable "in the wild" today?



Search-and-repair platform for Android apps

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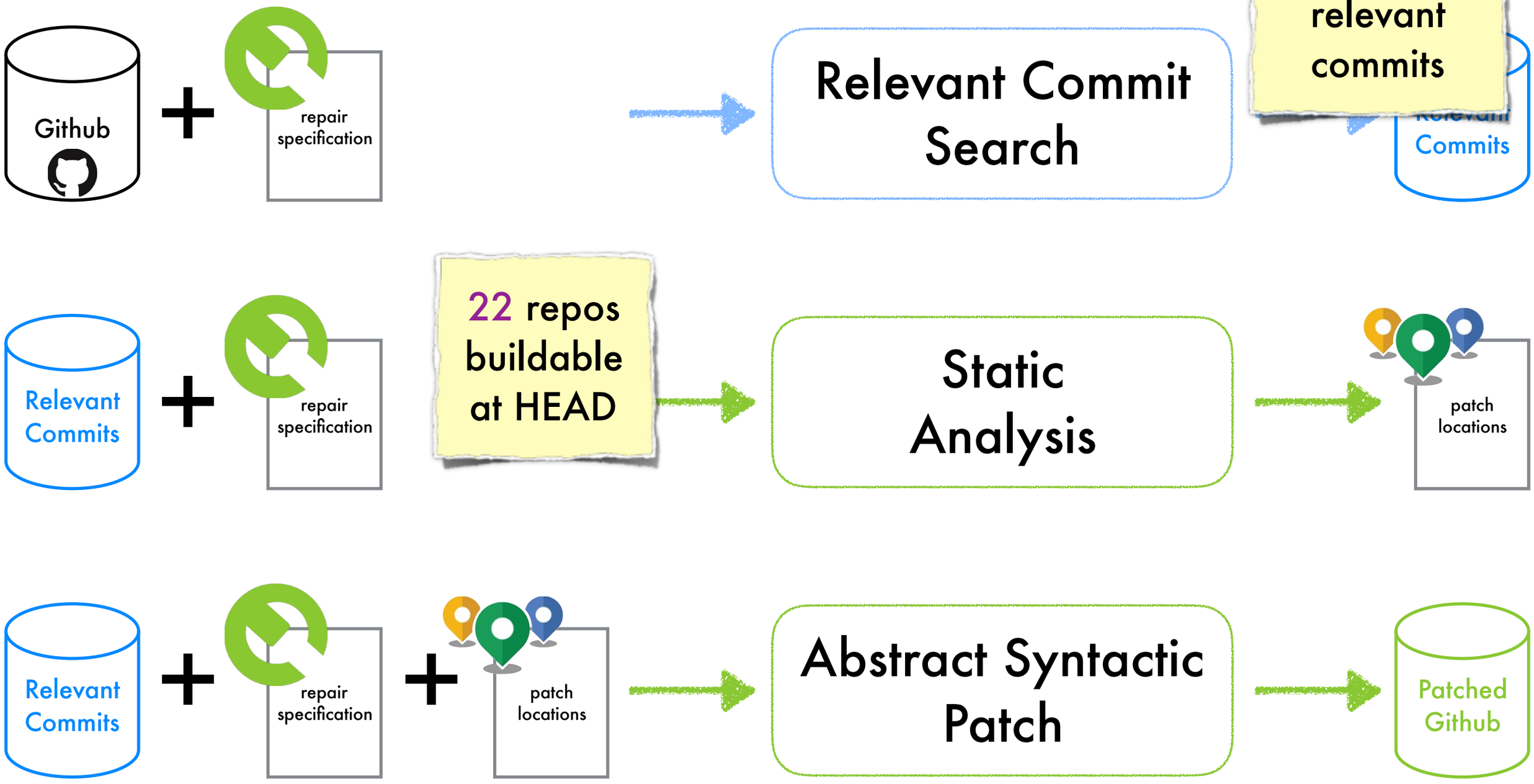

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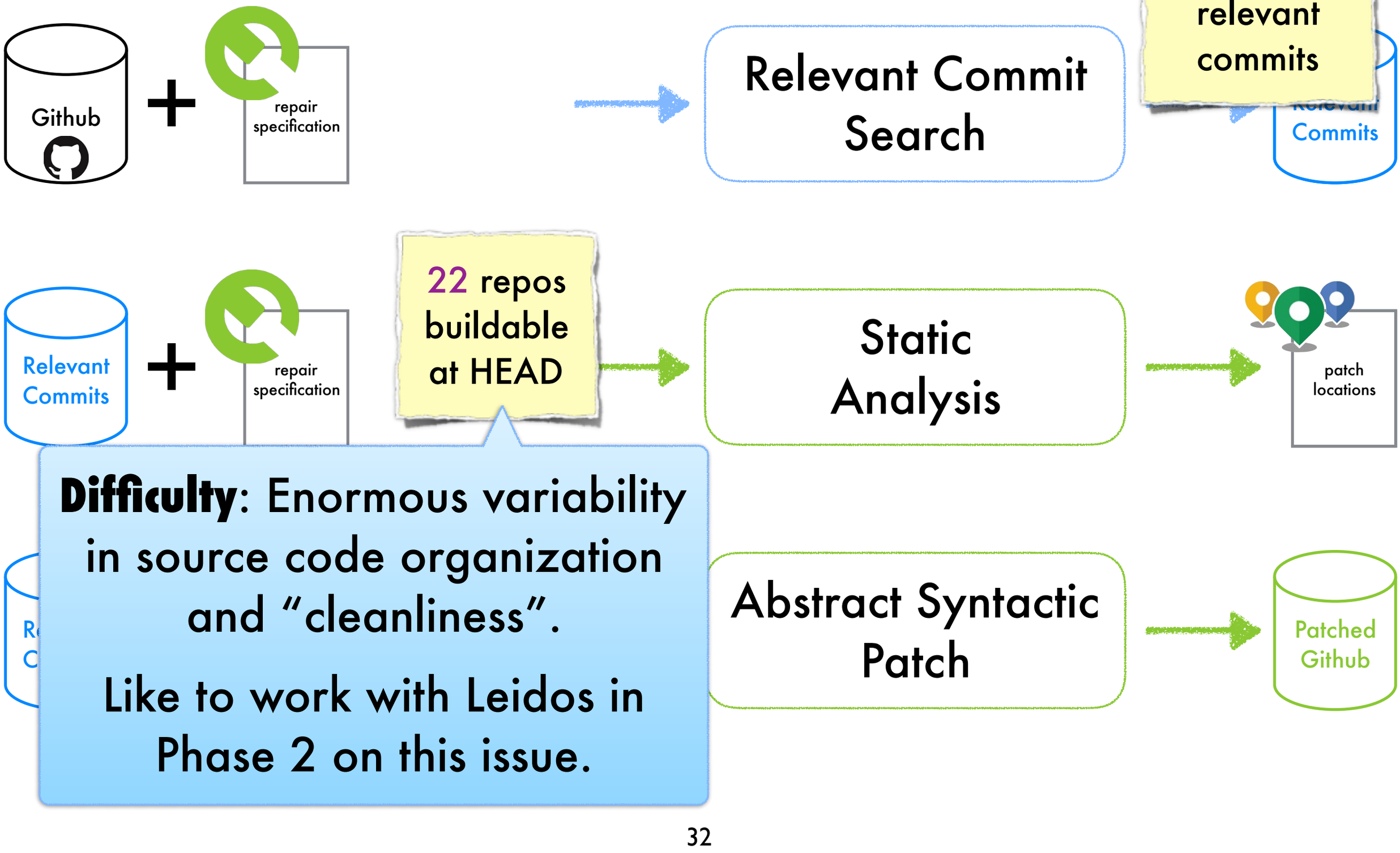

Difficulty: Enormous variability in source code organization and "cleanliness".

Like to work with Leidos in Phase 2 on this issue.

Search-and-repair platform for Android apps

Status: API repairs applicable "in the wild" today?

Github + repair specification → Relevant Commit Search → 48 repos with relevant commits → Relevant Commits

Relevant Commits + repair specification → 22 repos buildable at HEAD → Static Analysis → 6 alarms in 5 repos with 5 bugs

Abstract Syntactic Patch → Patched Github

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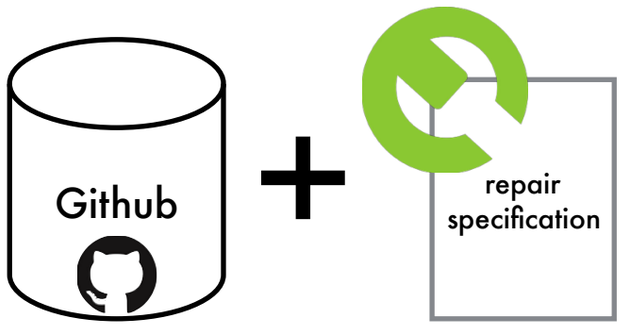
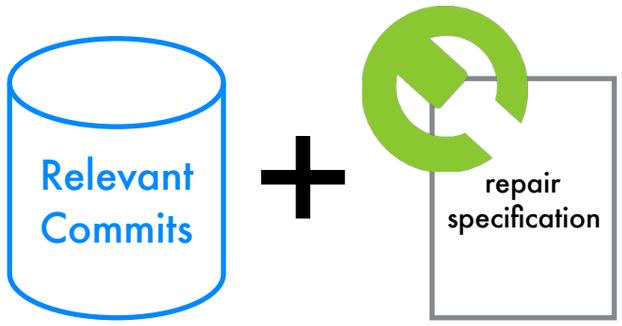


Relevant Commit Search

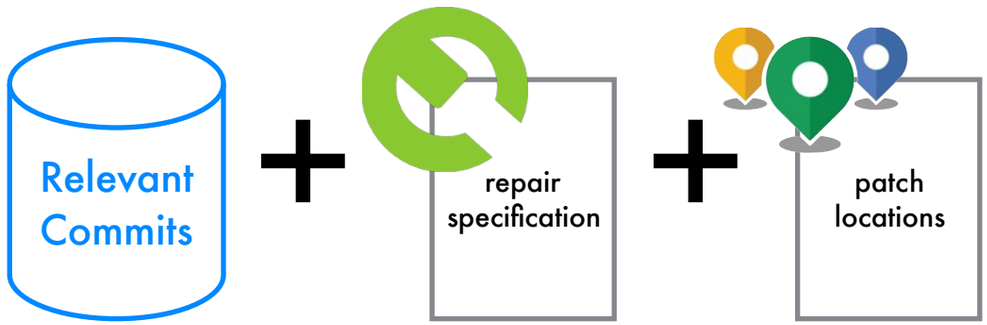
48 repos with relevant commits



22 repos buildable at HEAD

Static Analysis

6 alarms in 5 repos with 5 bugs



Abstract Syntactic Patch

Search-and-repair platform for Android apps

Status: API repairs applicable "in the wild" today?

Github + repair specification → Relevant Commit Search → Relevant Commits

48 repos with relevant commits

Relevant Commits + repair specification → Static Analysis → 6 alarms in 5 repos with 5 bugs

22 repos buildable at HEAD

Relevant Commits + repair specification + patch locations → Abstract Syntactic Patch → Patched

5 repos patchable

Search-and-repair platform for Android apps

Status: API repairs applicable "in the wild" today?

Github + repair specification → Relevant Commit Search → Relevant Commits

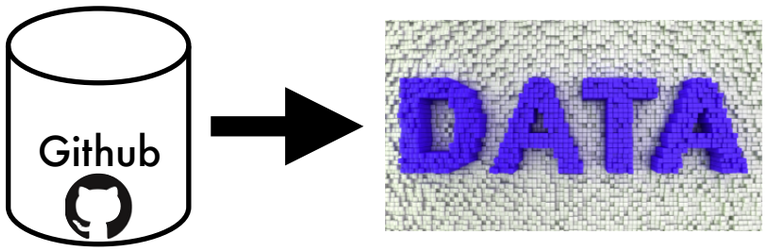
48 repos with relevant commits

Relevant Commits + repair specification → 22 repos buildable at HEAD → Static Analysis → 6 alarms in 5 repos with 5 bugs

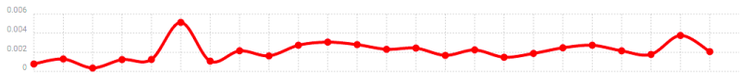
Relevant Commits + repair specification + patch locations → Abstr → compiles and loads without crash → Patched

5 repos patchable

Fixr Contributions



Extract commit features at scale

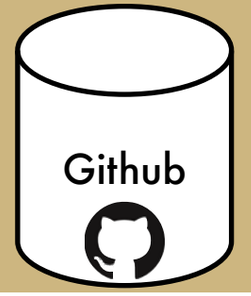


Find API usage patterns over time

Index commit feature documents

Search-and-repair platform
for Android apps

Experience with the Corpus

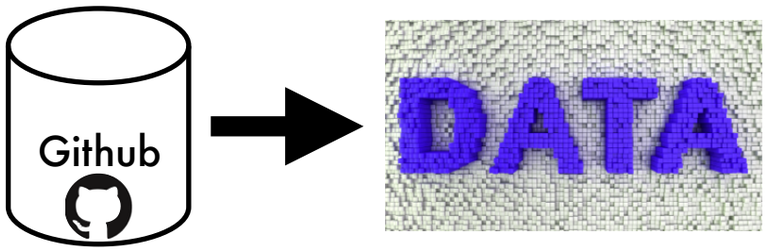


We transitioned our scripts and corpus with Android Github repos to Leidos in April 2015

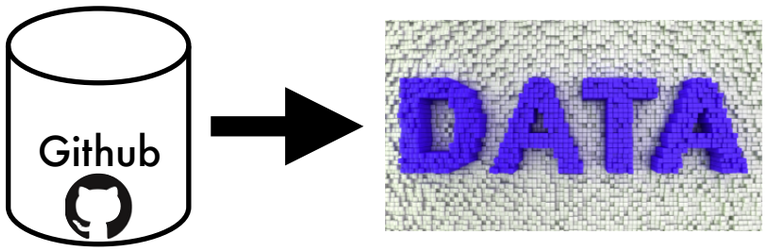
- Need to have full git repos

Using corpus from a crawl in June 2015

Fixr Lessons Learned, Challenges, and Improvement Goals



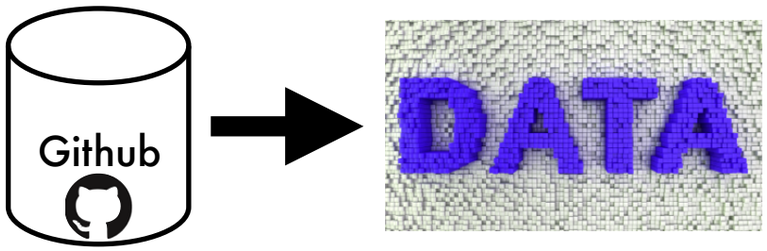
Fixr Lessons Learned, Challenges, and Improvement Goals



Feature extraction time is compute intensive.

Goal: Incrementalize commit processing

Fixr Lessons Learned, Challenges, and Improvement Goals



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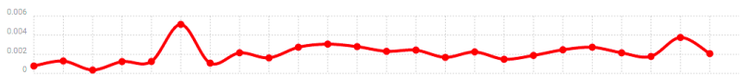
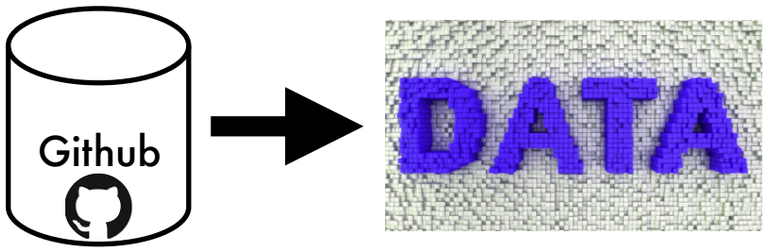


Manual interpretation of rules needed.
Goal: Richer online tool to examine and analyze rules.
File-by-file extraction of API associations.
Goal: Richer association of local method context with API changes.

Fixr Lessons Learned, Challenges, and Improvement Goals



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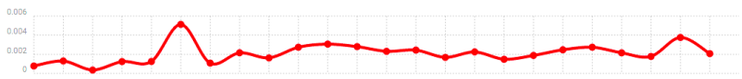

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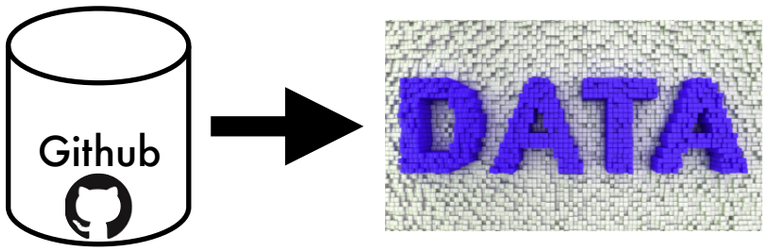
Kinds of extracted features limits kinds of queries.
Goal: Investigate finer-grained features.

Fixr Lessons Learned, Challenges, and Improvement Goals



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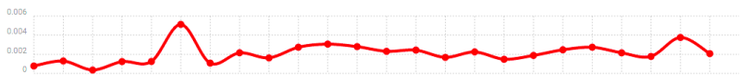

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File-by-file extraction of API associations.
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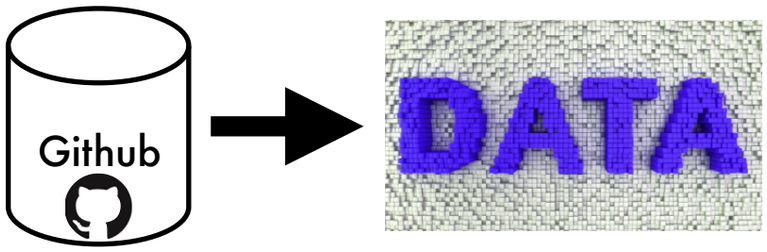
Kinds of extracted features limits kinds of queries.
Goal: Investigate finer-grained features.

Variance in source code organization limits buildability and thus analysis.
Goal: Investigate normalized build systems.

Fixr Lessons Learned, Challenges, and Improvement Goals



Feature extraction time is compute intensive.
Goal: Incrementalize commit processing

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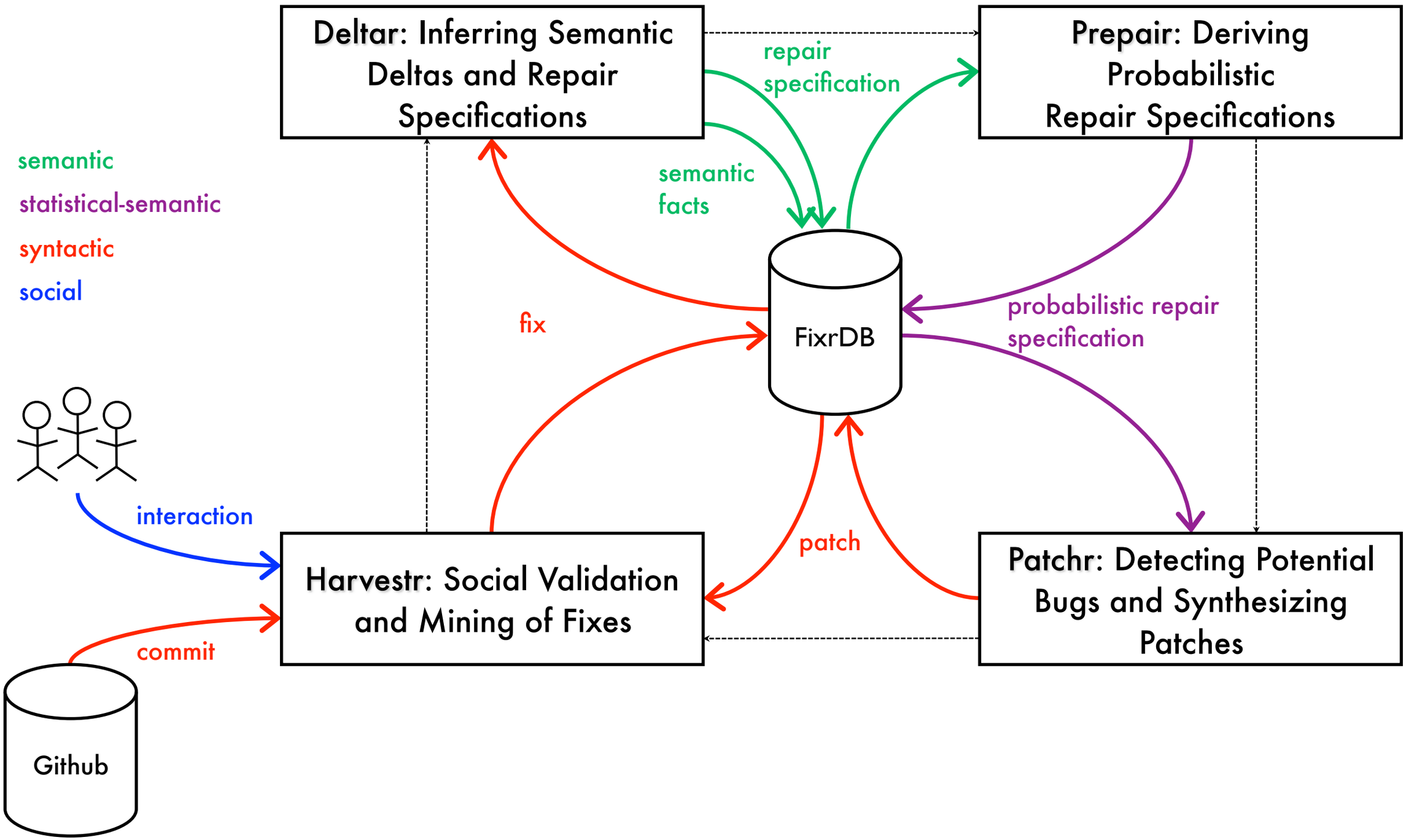
File-by-file extraction of API associations.
Goal: Richer association of local method context with API changes.

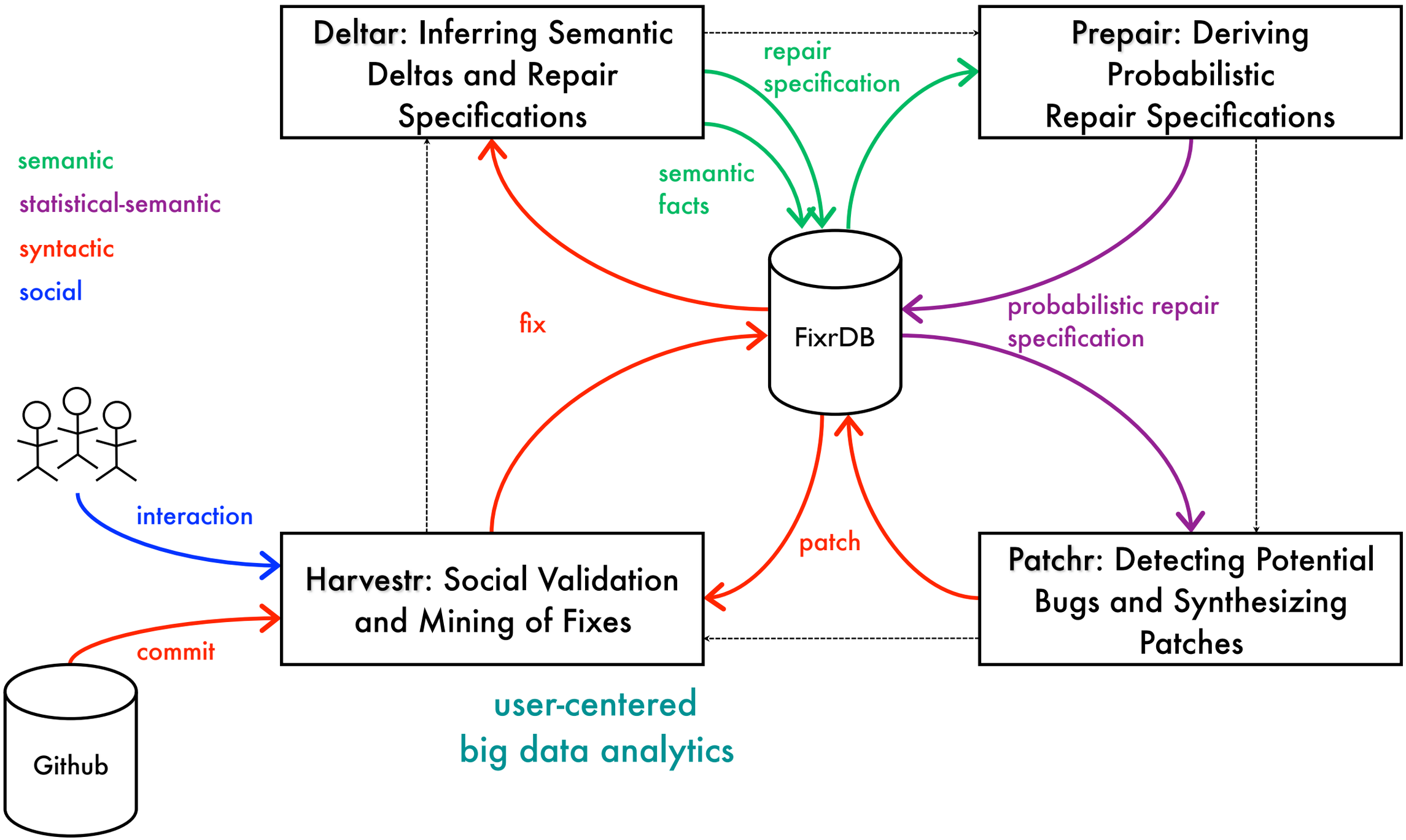
Kinds of extracted features limits kinds of queries.
Goal: Investigate finer-grained features.

Most difficulties anticipated but the magnitude of challenge with *Big Data* not necessarily expected

Overall status of the **Fixr** project



Overall status of the **Fixr** project



Overall status of the **Fixr** project

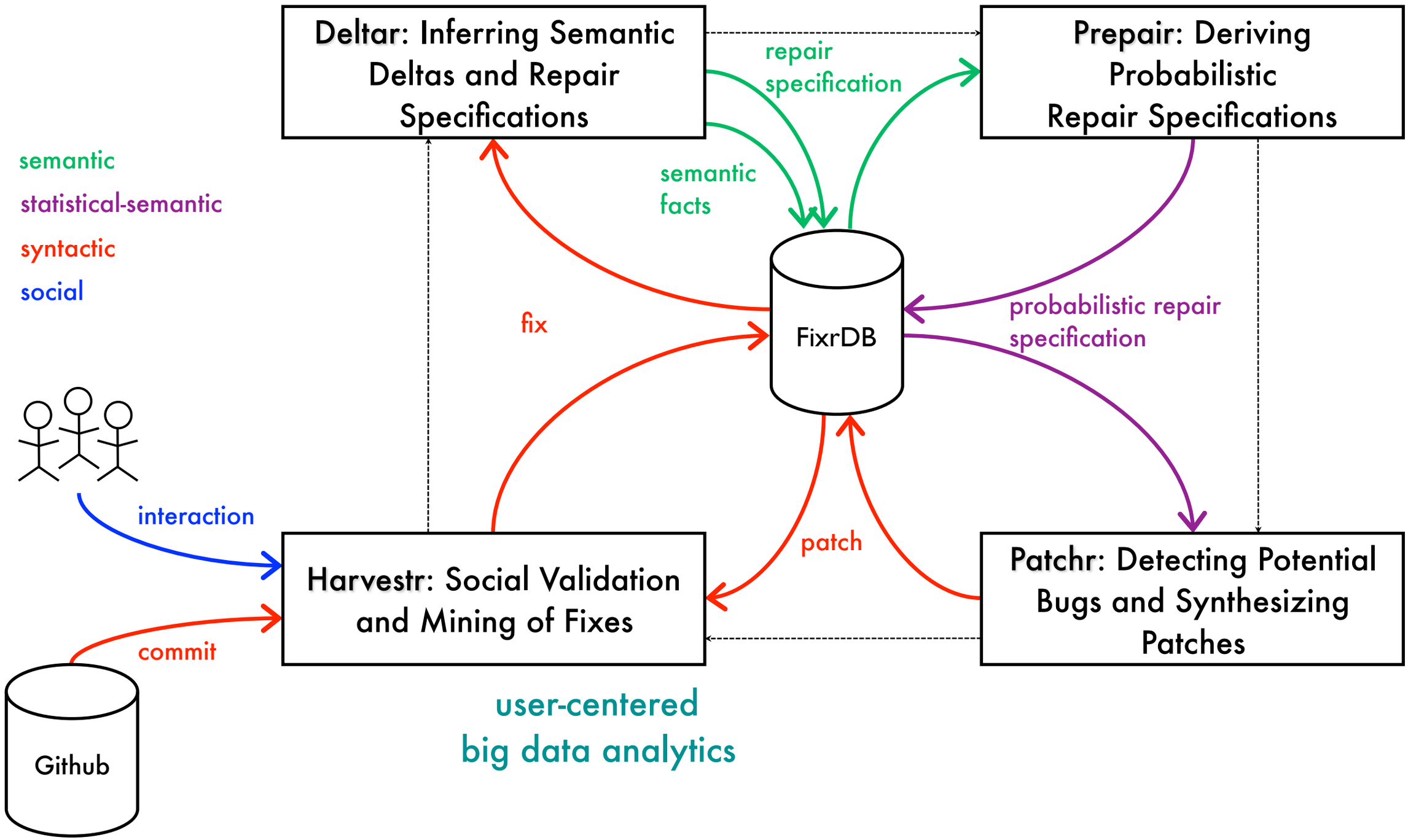
symbolic
program analysis

semantic

statistical-semantic

syntactic

social



user-centered
big data analytics

Overall status of the **Fixr** project

symbolic
program analysis

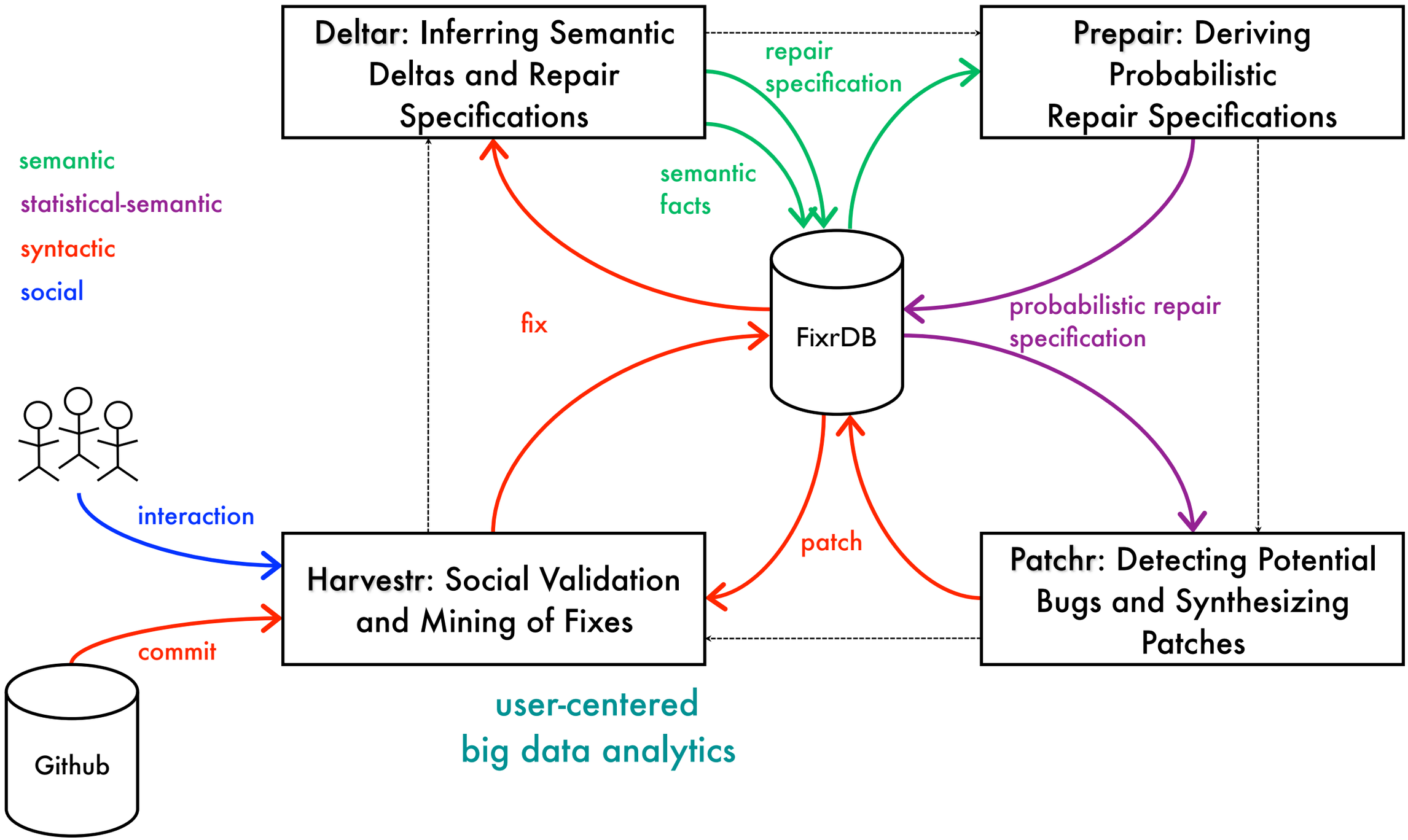
numerical-probabilistic
program analysis

semantic

statistical-semantic

syntactic

social



user-centered
big data analytics

Overall status of the **Fixr** project

symbolic
program analysis

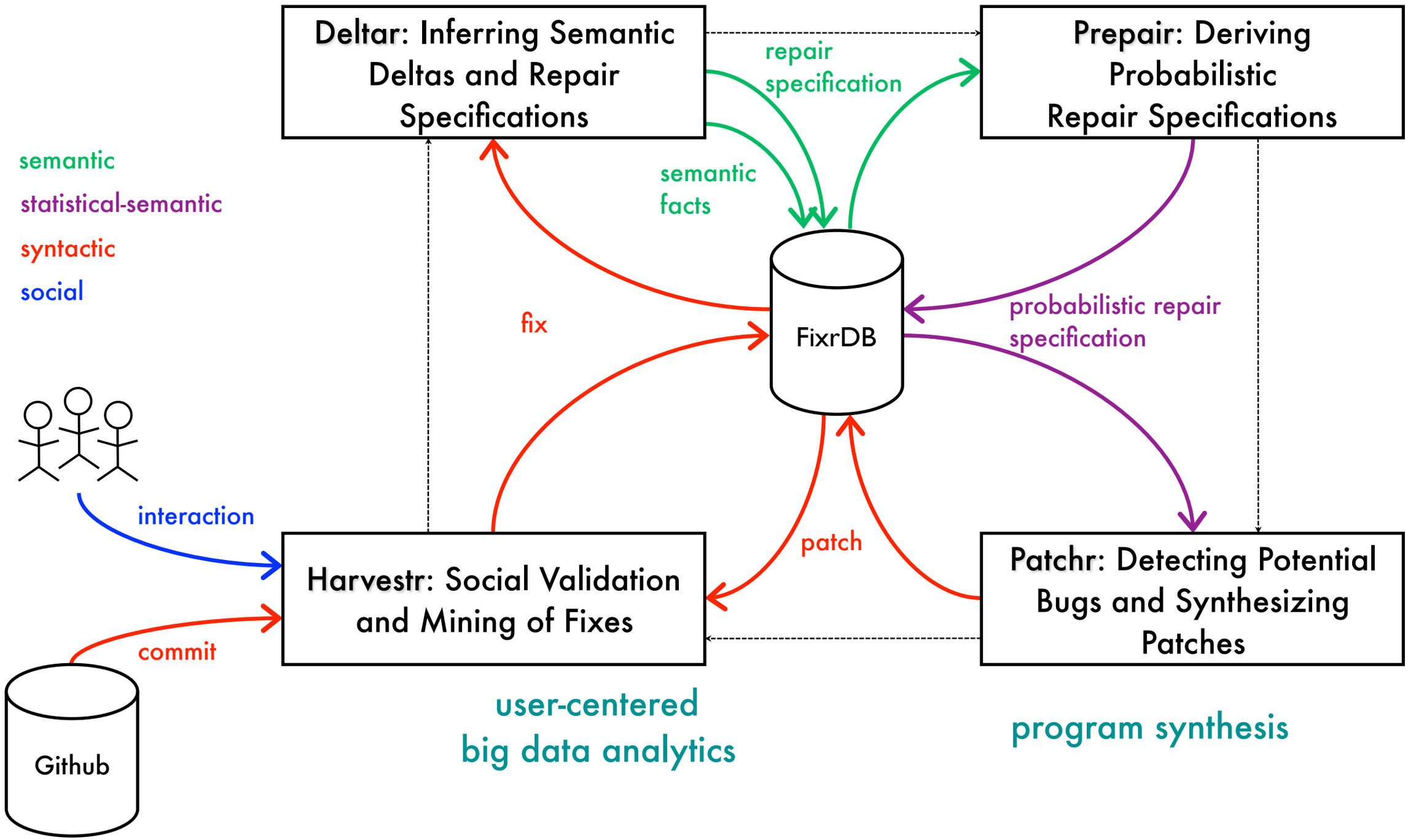
numerical-probabilistic
program analysis

semantic

statistical-semantic

syntactic

social



user-centered
big data analytics

program synthesis

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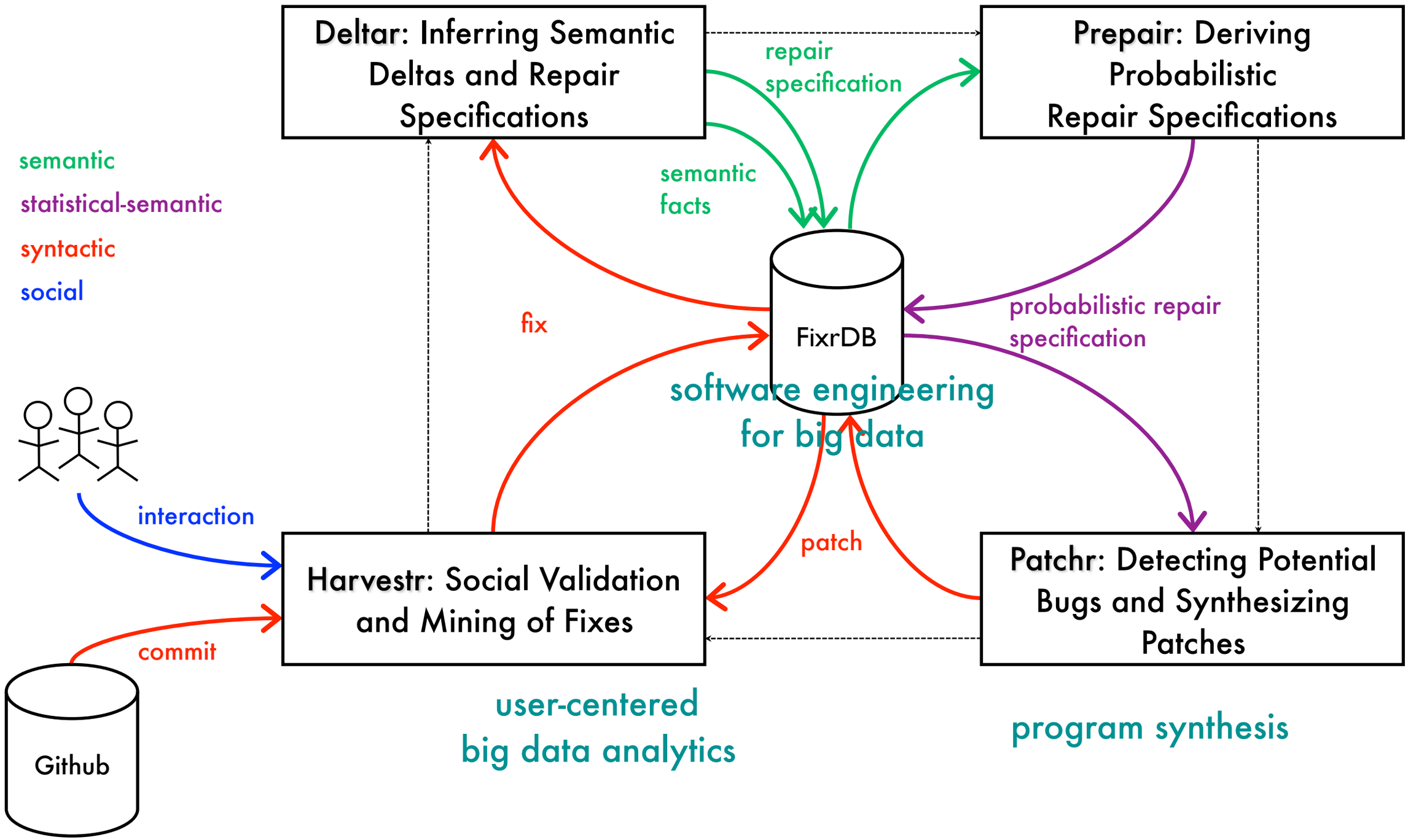

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Deltar: Inferring Semantic Deltas and Repair Specifications

repair specification

Prepair: Deriving Probabilistic Repair Specifications

semantic facts

fix

FixrDB

probabilistic repair specification

software engineering for big data

interaction

commit

Github

Harvestr: Social Validation and Mining of Fixes

patch

Patchr: Detecting Potential Bugs and Synthesizing Patches

user-centered big data analytics

program synthesis

Phase 1

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Ongoing to Phase 2

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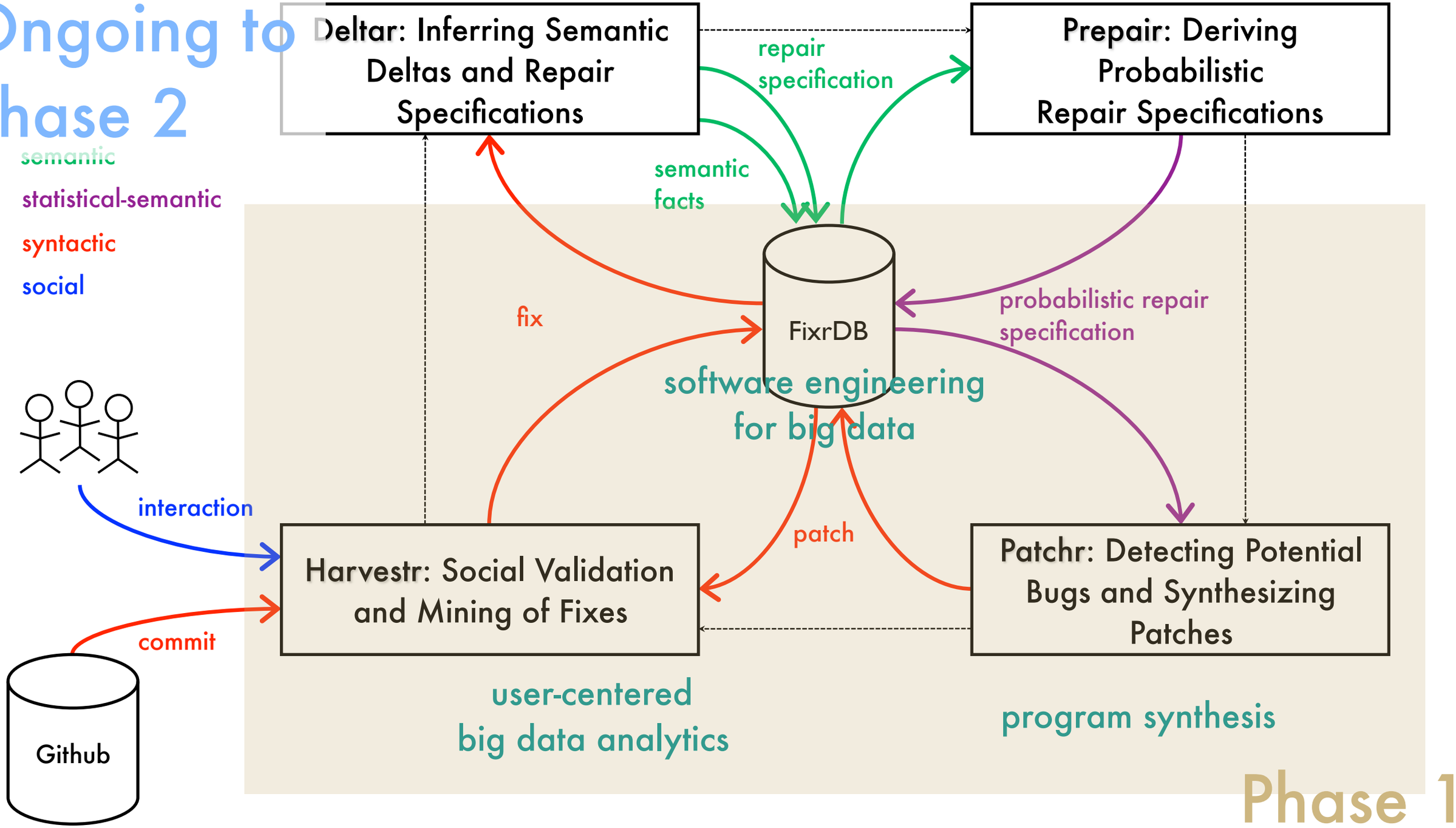

Phase 1

Overall status of the **Fixr** project

semantic differencing for bug conditions

Ongoing to Phase 2

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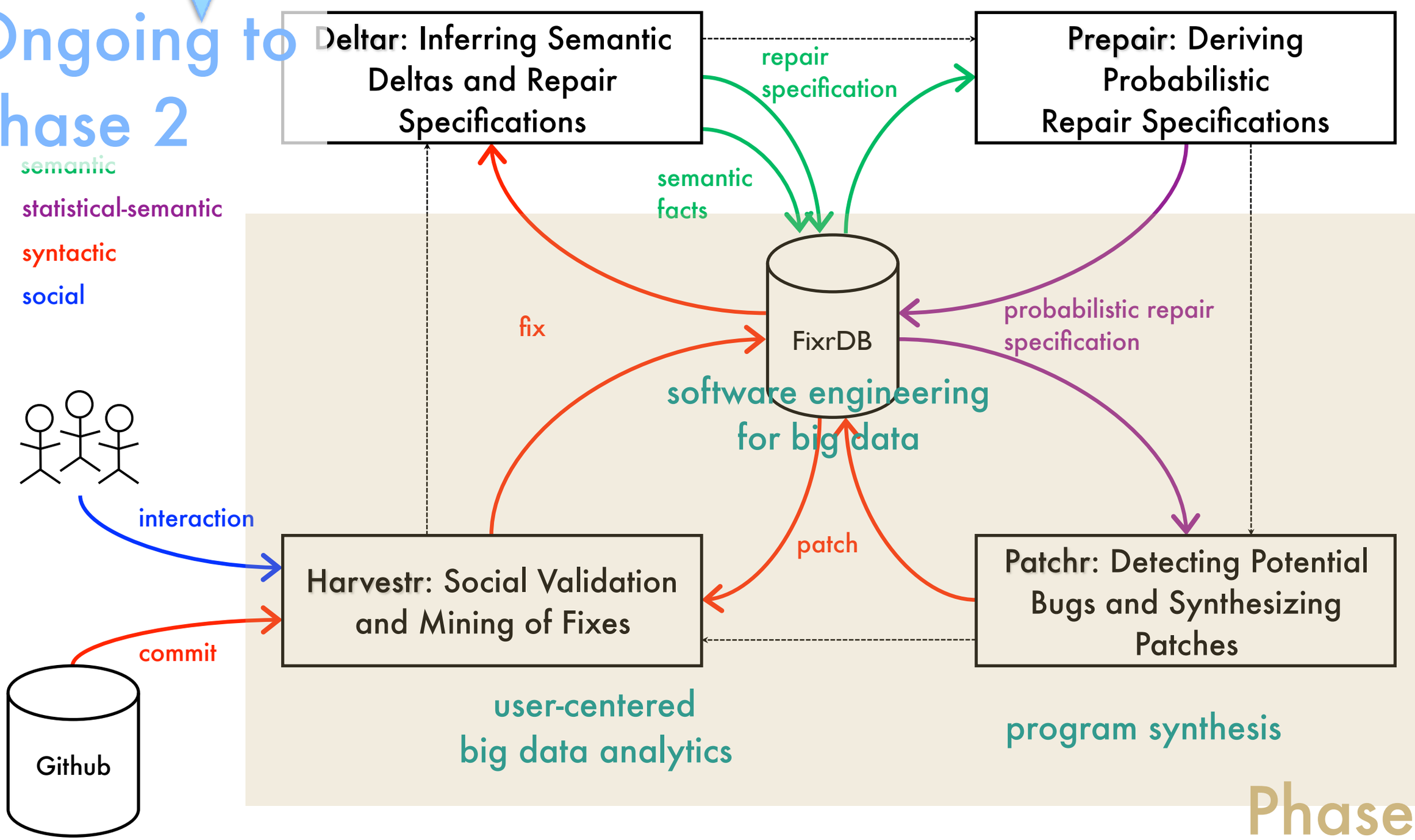

Phase 1

Overall status of the **Fixr** project

semantic differencing for bug conditions

spec mining callback orderings

numerical-probabilistic program analysis

Ongoing to Phase 2

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statistical-semantic

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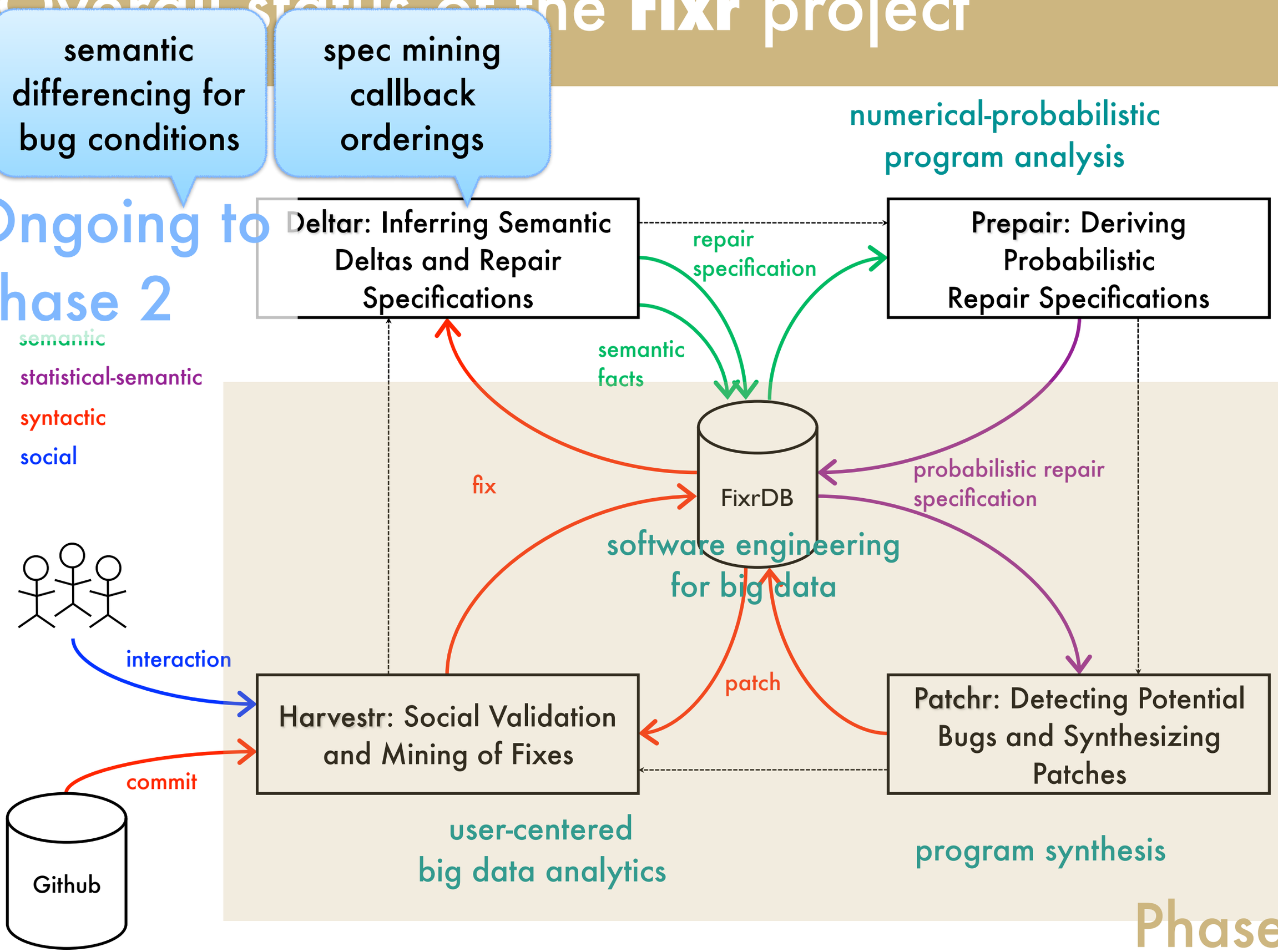

Phase 1

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inferring app-specific event control-flow

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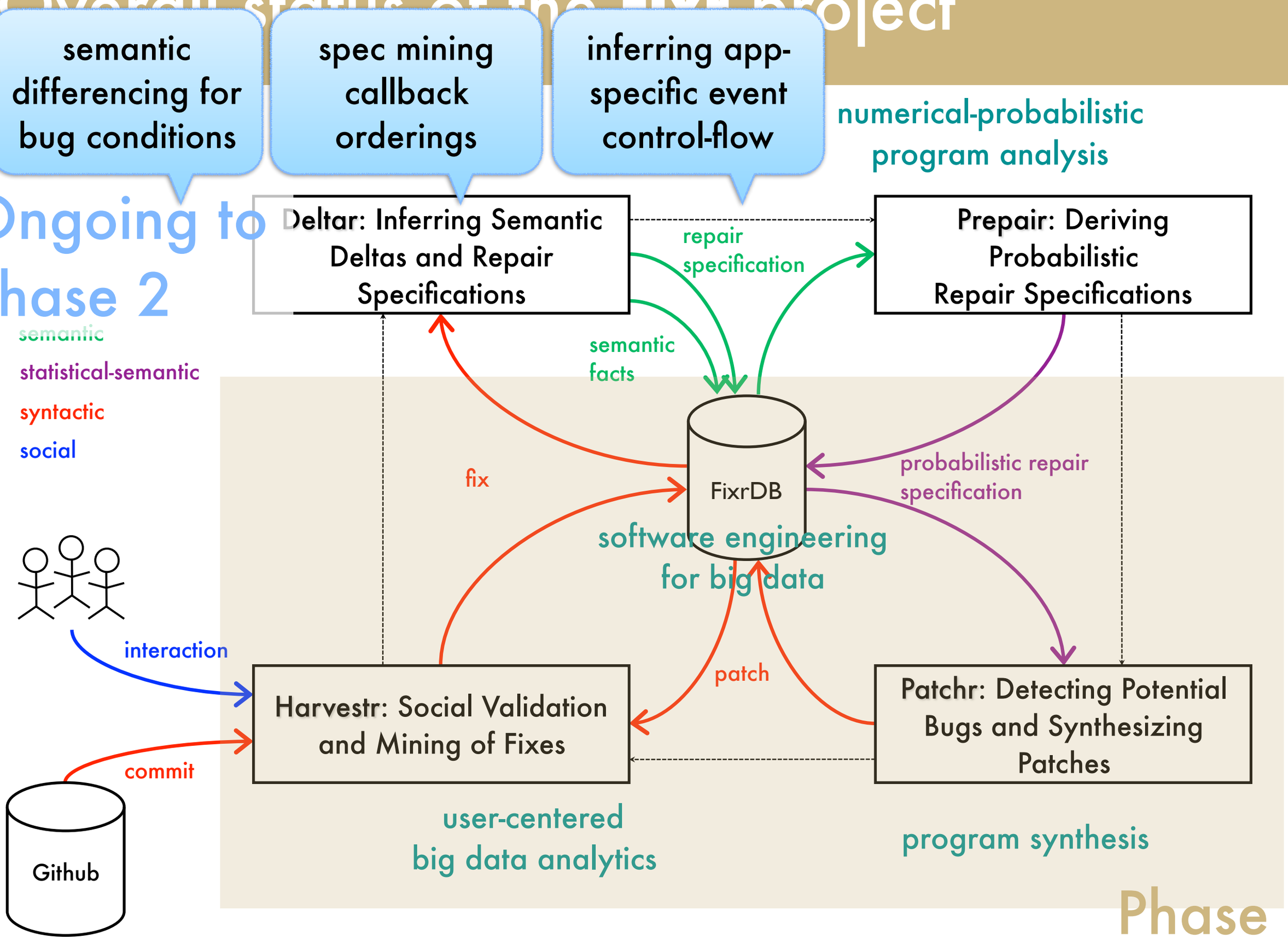

Phase 1

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inferring app-specific event control-flow

spec mining fix transformations

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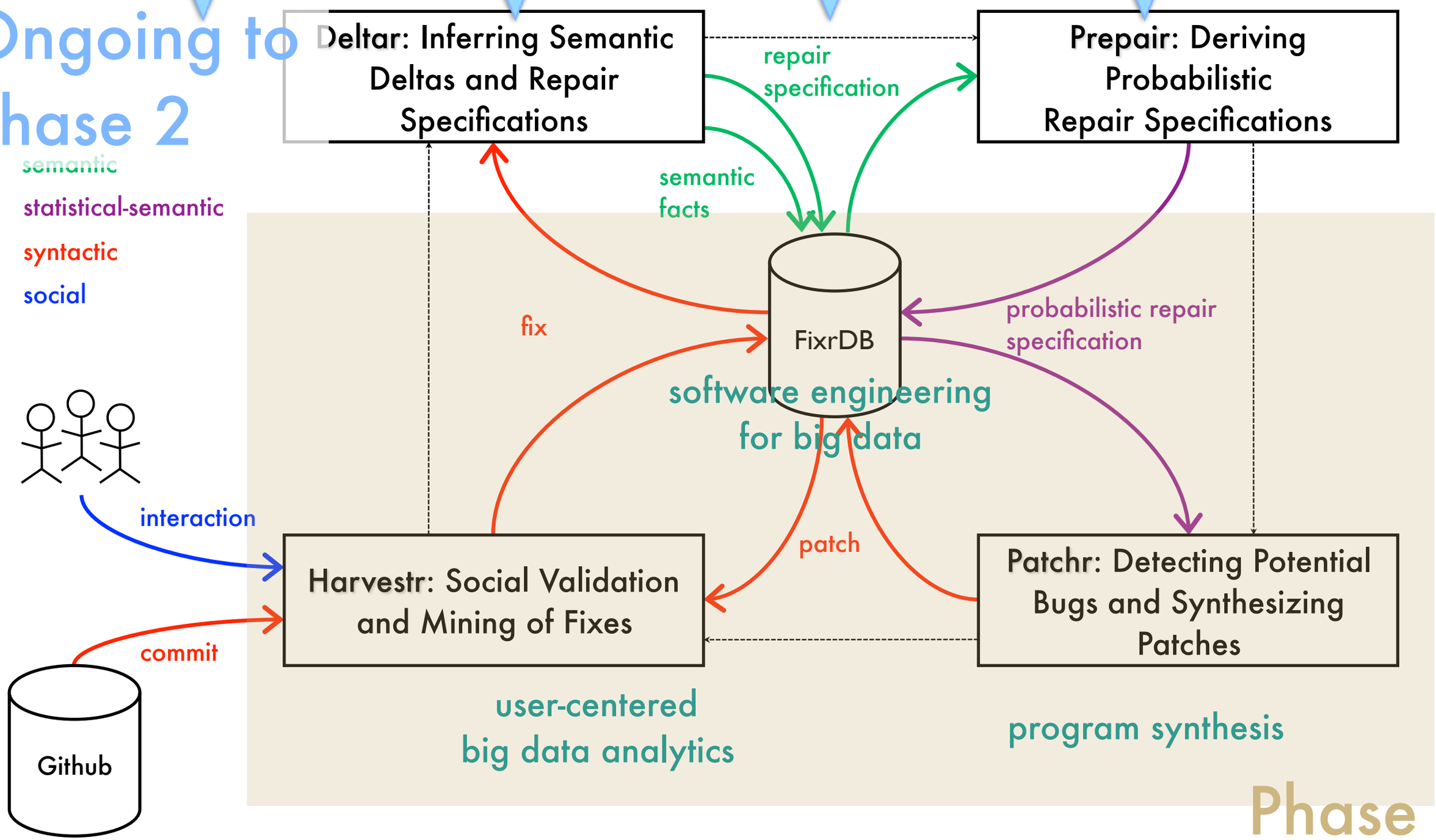

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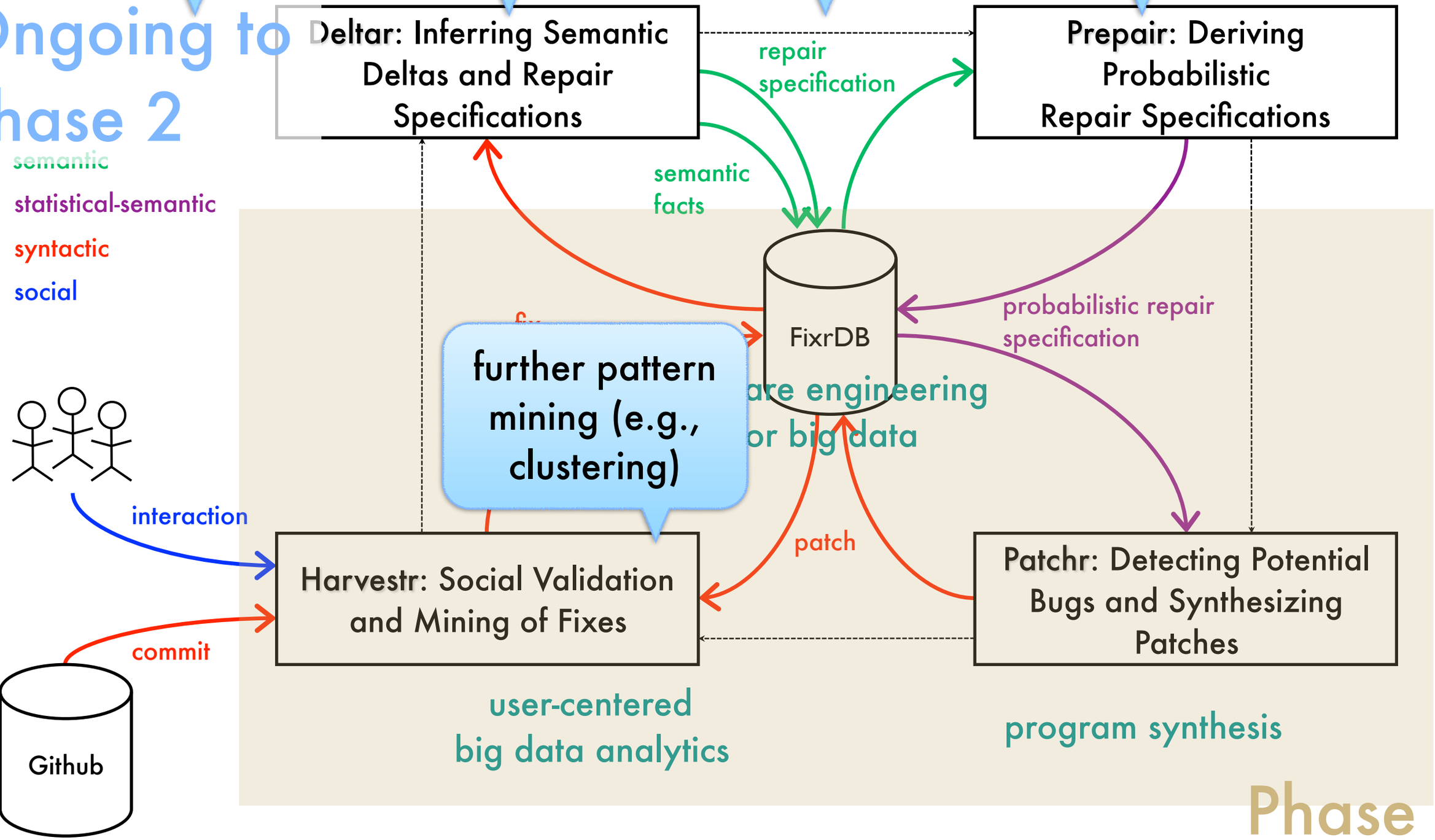
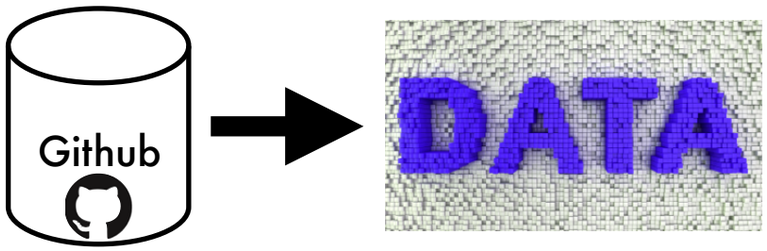
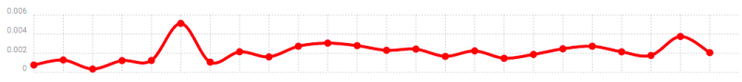


Phase 1

Fixr Phase 1



Extract commit features at scale

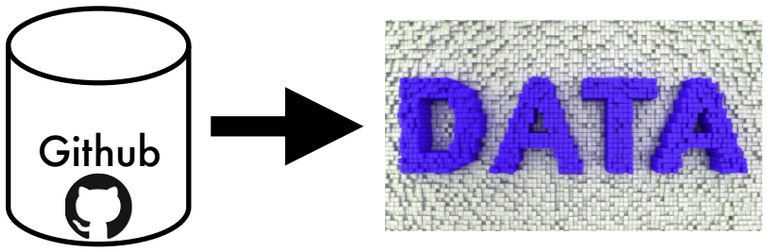


Find API usage patterns over time

Index commit feature documents

Search-and-repair platform for Android apps

Fixr Phase 1



Extract commit features

ime

commit feature documents

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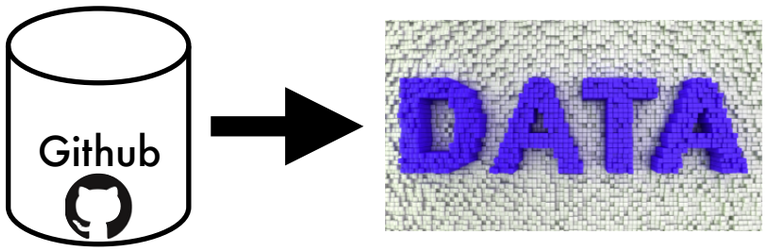

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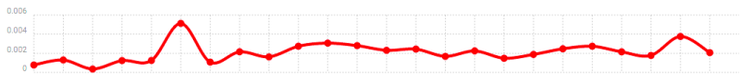

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