

# Documenting APIs with Source Code Examples

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# Agenda

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- ① Introduction
- ① Proposed Solution
- ② Android APIMiner
- ③ Evaluation
- ① Conclusions

# Introduction

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# Motivation

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Software projects increasingly rely on APIs

Reuse

Maintainability

Modularity

# Successful APIs

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# Problem

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## APIs are **hard** to **learn**



27,000 methods



14,000 methods

```
public void setDuration (int duration)
```

Set how long to show the view for.

See Also

`LENGTH_SHORT`

`LENGTH_LONG`

Gravity...

```
public void setGravity (int gravity, int xOffset, int yOffset)
```

Set the location at which the notification should appear on the screen.

See Also

`Gravity`

`getGravity()`

What can be done?

???

The **documentation** is, in many scenarios, **insufficient**:

- ① Incomplete
- ② Poorly written
- ③ Too complex

```
public void setDuration (int duration)
```

Set how long to show the view for.

#### See Also

`LENGTH_SHORT`

`LENGTH_LONG`

```
public void setGravity (int gravity, int xOffset, int yOffset)
```

Set the location at which the notification should appear on the screen.

#### See Also

`Gravity`

`getGravity()`

```
public void setMargin (float horizontalMargin, float verticalMargin)
```

Set the margins of the view.

#### Parameters

```
String storageState = Environment.getExternalStorageState();  
if (!storageState.equals(Environment.MEDIA_MOUNTED)) {  
    Toast toast = Toast.makeText(this, R.string.storage_warning,  
                                Toast.LENGTH_LONG);  
    toast.setGravity(Gravity.CENTER, 0, 0);  
}
```

*resId* The new text for the Toast.



# Why Examples?

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*“code examples are an **essential element of API learning**”*

Robillard e DeLine, Empirical  
Software Engineering – 2011

## **Benefit**

✓ Show WHEN and HOW TO  
use API elements

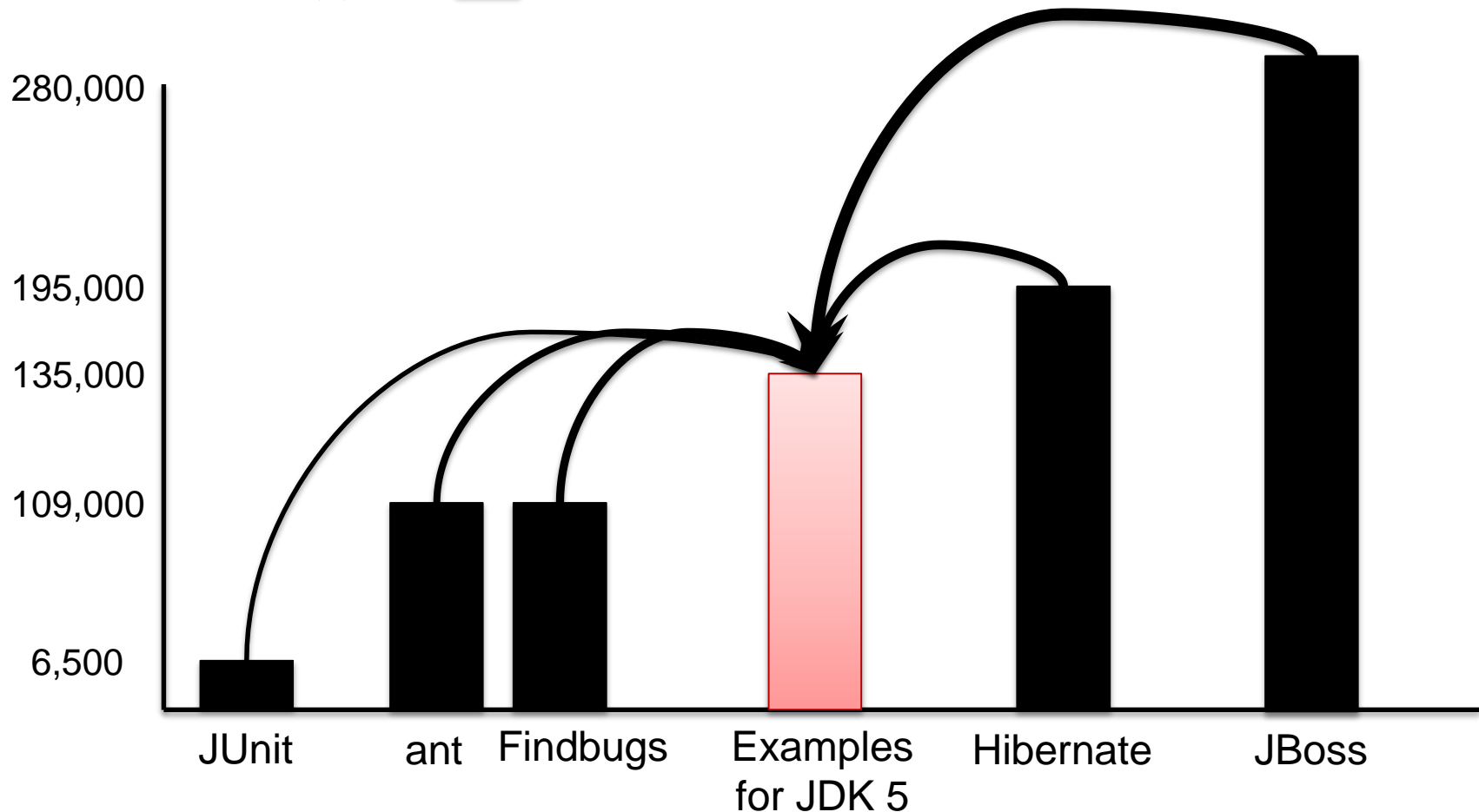
## **Challenge**

✗ Hard to create manually

# Why Examples?

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27,000 ✖ 5 = 135,000 lines



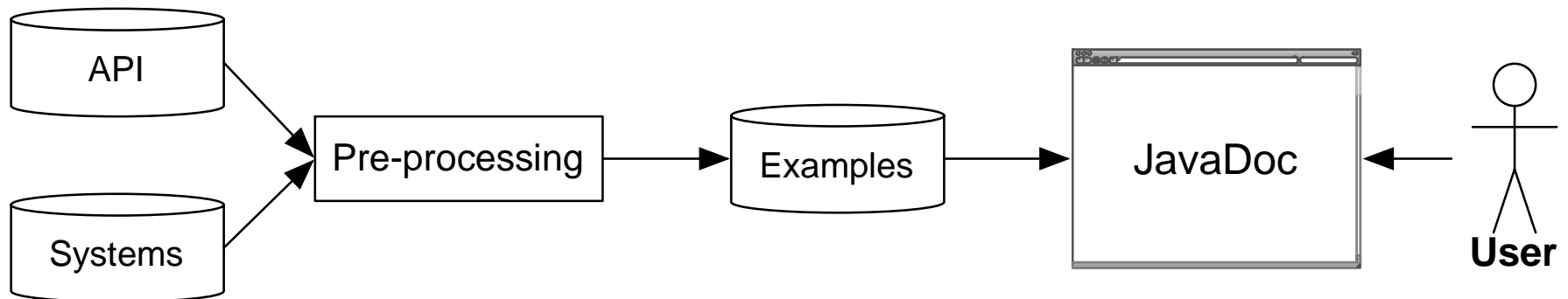
# Proposed Solution

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# APIMiner: Our Approach

## Goal

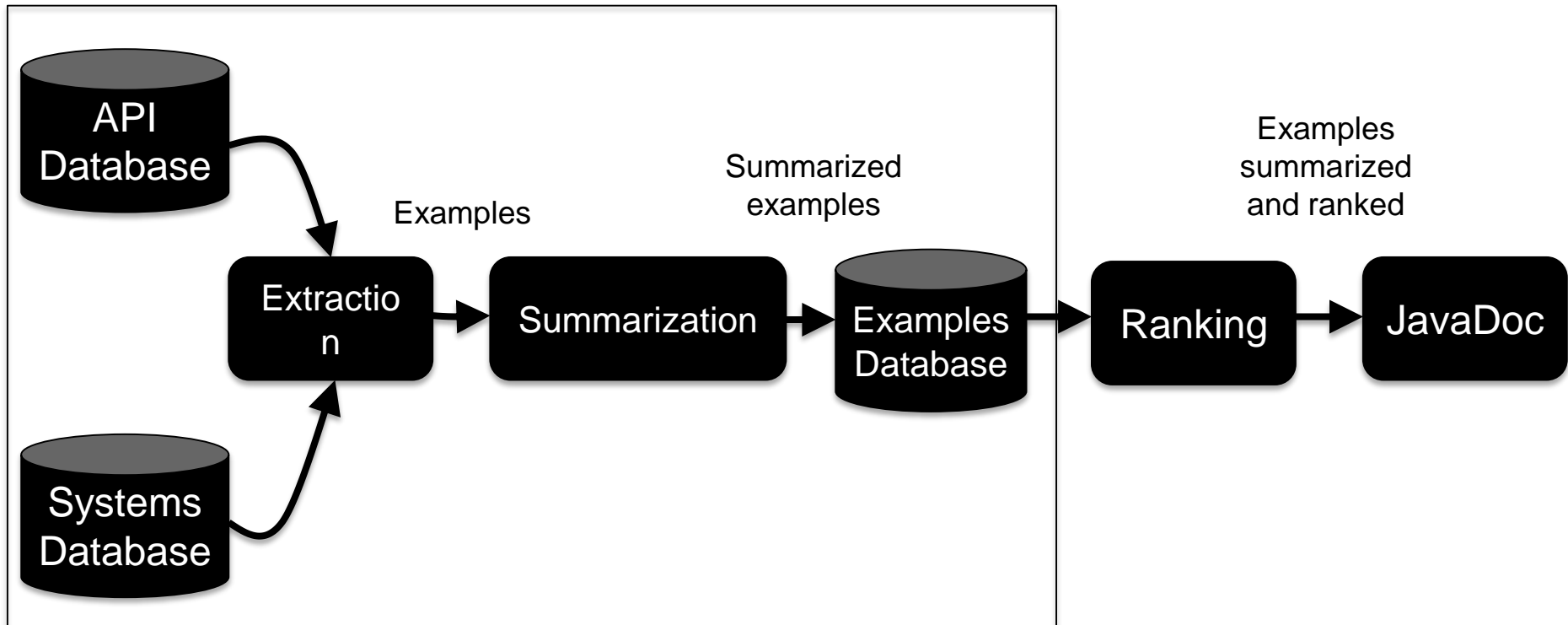
To design, implement and evaluate an approach to instrument JavaDocs with source code examples



# APIMiner: Structure

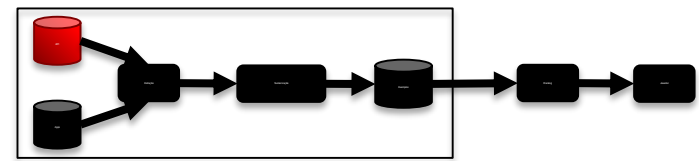
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Pre-processing



# API Database

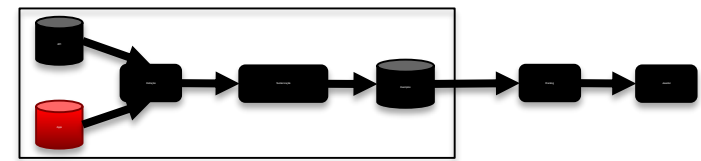
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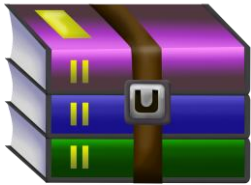
List of API elements: class + method signature

API Class	API Method
String	void toString()
String	String subString(int, int)
Integer	Integer parseInt(String)
String	valueOf(Double)
.....	.....

# Systems Database



Source code of the systems using the API

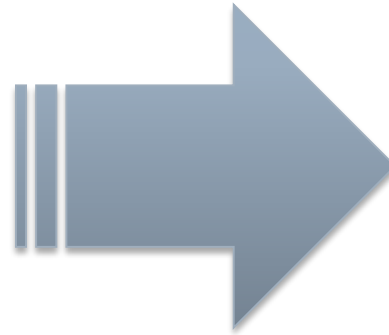


sourceforge

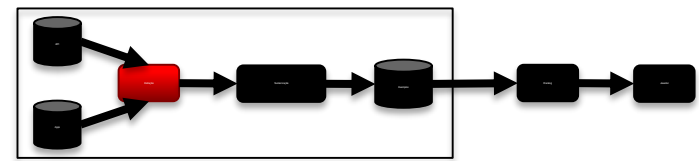
Google<sup>™</sup>  
code



github  
SOCIAL CODING



# Extraction



Parses each file and searches for API methods calls



String.substring(int, int)

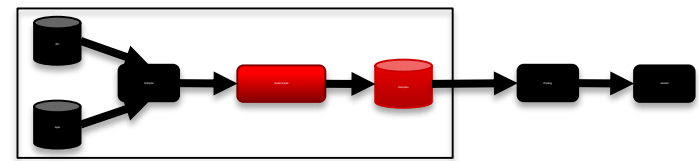


```
public void index() {
    public static void main(String args[]) {
        private void logout() {
            public void welcome() {
                String client = "Smith, John";
                Calendar cal = Calendar.getInstance();
                int hour = cal.get(Calendar.HOUR_OF_DAY);
                int ini = 0;
                int end = client.indexOf(",");
                if (end >= 0) {
                    String surname = client.substring(ini, end);
                    System.out.println("Welcome back Mr." + surname);
                    System.out.println("Now, it is: " + hour + " hour(s)");
                }
            }
        }
    }
}
```



# Summarization

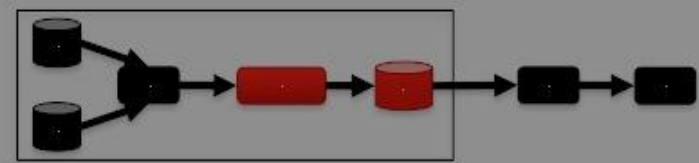
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*“It’s tough to know the **context of the example** and yet it has to be **very small**, and only **highlight exactly what the concept in the API!**”*

Robillard and DeLine, Empirical Software Engineering – 2011

# Summarization



Based on *static slicing*

```
public void welcome() {
```

```
    String client = "Smith, John";
```

```
        int ini = 0;
```

```
    int end = client.indexOf(",");
```

```
    if (end >= 0) {
```

```
        String surname = client.substring(ini, end);
```

```
        System.out.println("Welcome back Mr." +
```

```
        surname);
```

```
    }
```

```
}
```

Selected

Summarized

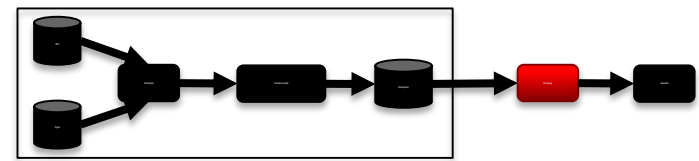
Read

Write

Control

# Ranking

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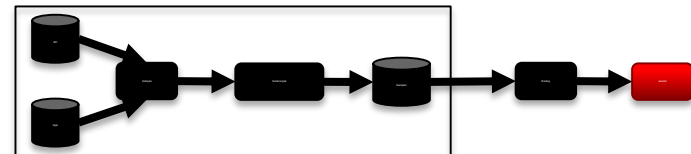


Based on four metrics:

- ① Lines of Code
- ② Commits
- ③ Downloads
- ④ Users' feedbacks

Score is calculated by a weighted average

# JavaDoc



## Original JavaDoc + Examples Buttons

Public Methods		
<a href="#">Example</a> 3 Examples	abstract void	<a href="#">cancel()</a> Turn the vibrator off.
<a href="#">Example</a> 0 Examples	abstract boolean	<a href="#">hasVibrator()</a> Check whether the hardware has a vibrator.
<a href="#">Example</a> 4 Examples	abstract void	<a href="#">vibrate(long[] pattern, int repeat)</a> Vibrate with a given pattern.
<a href="#">Example</a> 9 Examples	abstract void	<a href="#">vibrate(long milliseconds)</a> Vibrate constantly for the specified period of time.

# Android APIMiner

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# Android APIMiner

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Particular configuration for the Android API

## Why Android?

- ✓ Large community ( > 1M activations/day)
- ✓ Widely dependent from the API (30% ~ 50%)
- ✓ Hard to learn (300K threads at Stack Overflow)
- ✓ Complex API
- ✓ JavaDoc lacks examples

Version: 4.1 1,814 classes 14,258 methods
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# APIMiner

## Documenting APIs with source code examples

[Home](#)[How it Works](#)[Android APIMiner](#)[More Info](#)

APIMiner is a platform that automatically instruments Javadoc documentation with examples of usage. Currently, we are providing 79.732 examples for the Android API.

Public Methods		
<a href="#">Example</a> 3 Examples	abstract void	<a href="#">cancel()</a> Turn the vibrator off.
<a href="#">Example</a> 0 Examples	abstract boolean	<a href="#">hasVibrator()</a> Check whether the hardware has a vibrator.
<a href="#">Example</a> 4 Examples	abstract void	<a href="#">vibrate(long[] pattern, int repeat)</a> Vibrate with a given pattern.
<a href="#">Example</a> 9 Examples	abstract void	<a href="#">vibrate(long milliseconds)</a> Vibrate constantly for the specified period of time.

Check out some classes that have examples for their methods:

- [android.text.format.DateFormat](#)
- [android.view.MenuInflater](#)

   63 points Like 22 Tweet 31 +1 14

# A Few Numbers...

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79,732 examples:

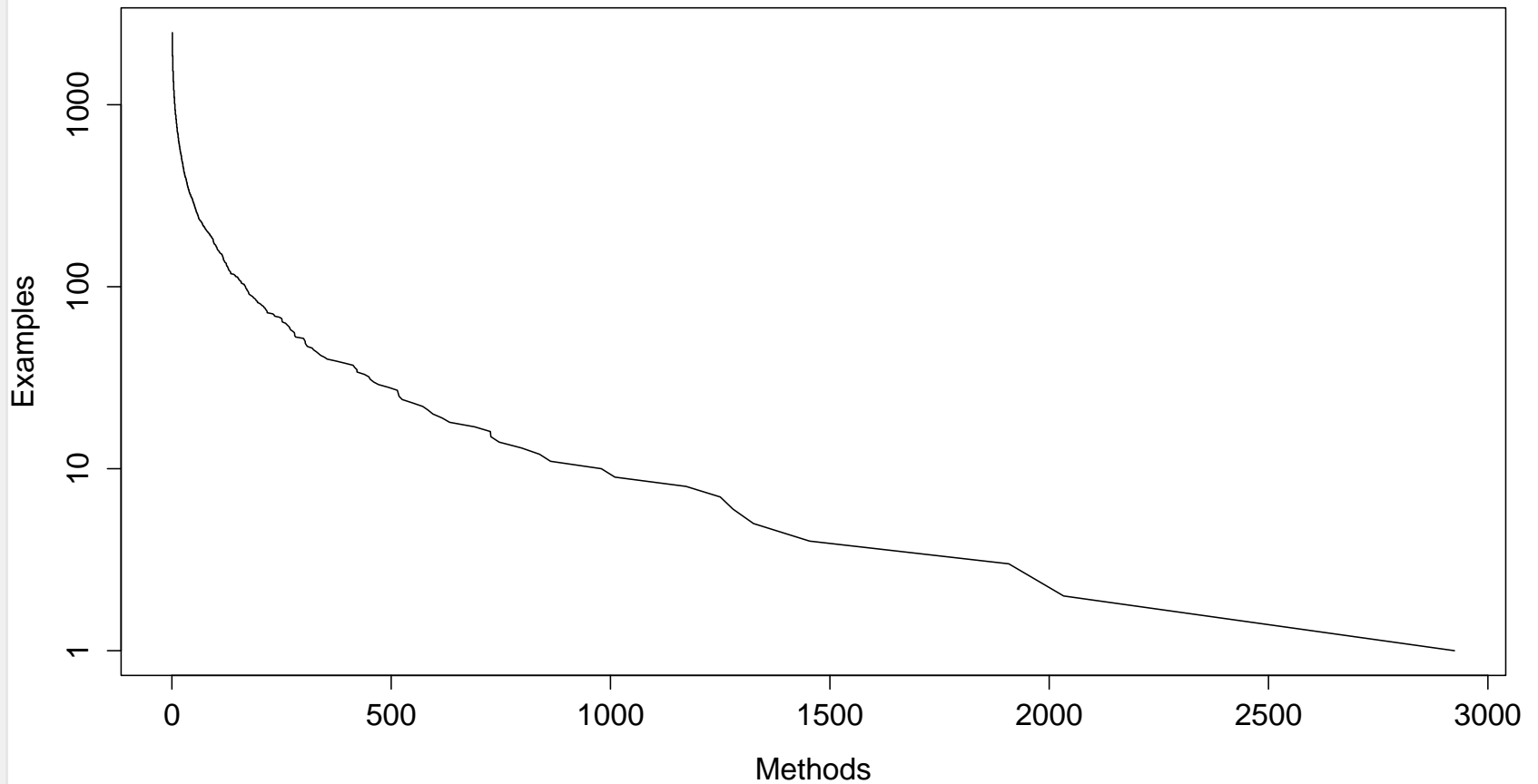
- Extracted from 103 open-source apps
- Distributed in 2,494 methods
- 60,094 with at most 10 LOC (75%)
  
- Top 10 packages: 72,900 (91%)
- Top 10 classes: 43,288 (54%)
- Top 10 methods: 15,293 (19%)

<http://apiminer.org/treemap-examples.html>



# Heavy-tail Distribution

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# Evaluation

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# Two Studies

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- ① Large-scale field study
- ② Controlled study

# Field Study

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Data collected from Sep. 14<sup>th</sup> to Jan. 18<sup>th</sup>

- Google analytics service
- Private logging service

# Field Study

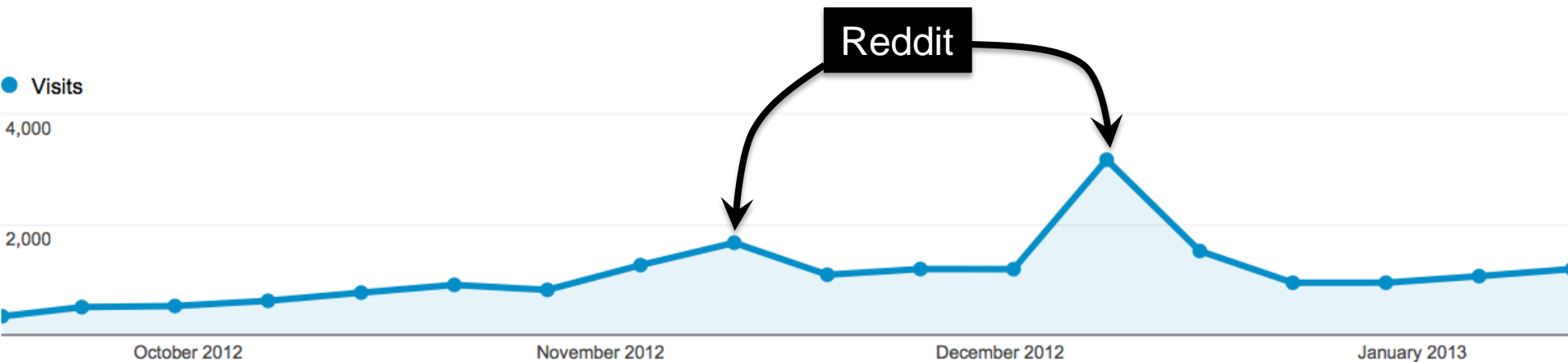
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- ① How many users did access the Android APIMiner?
- ② Where was the website most accessed?
- ③ How many examples did Android APIMiner provide?
- ④ Do developers really search for examples?

# Number of Visits

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Traffic Origin	# Visits	% Visits
Organic search	14,412	72
Referral traffic	3,393	17
Direct access	2,233	11
Total	20,038	100



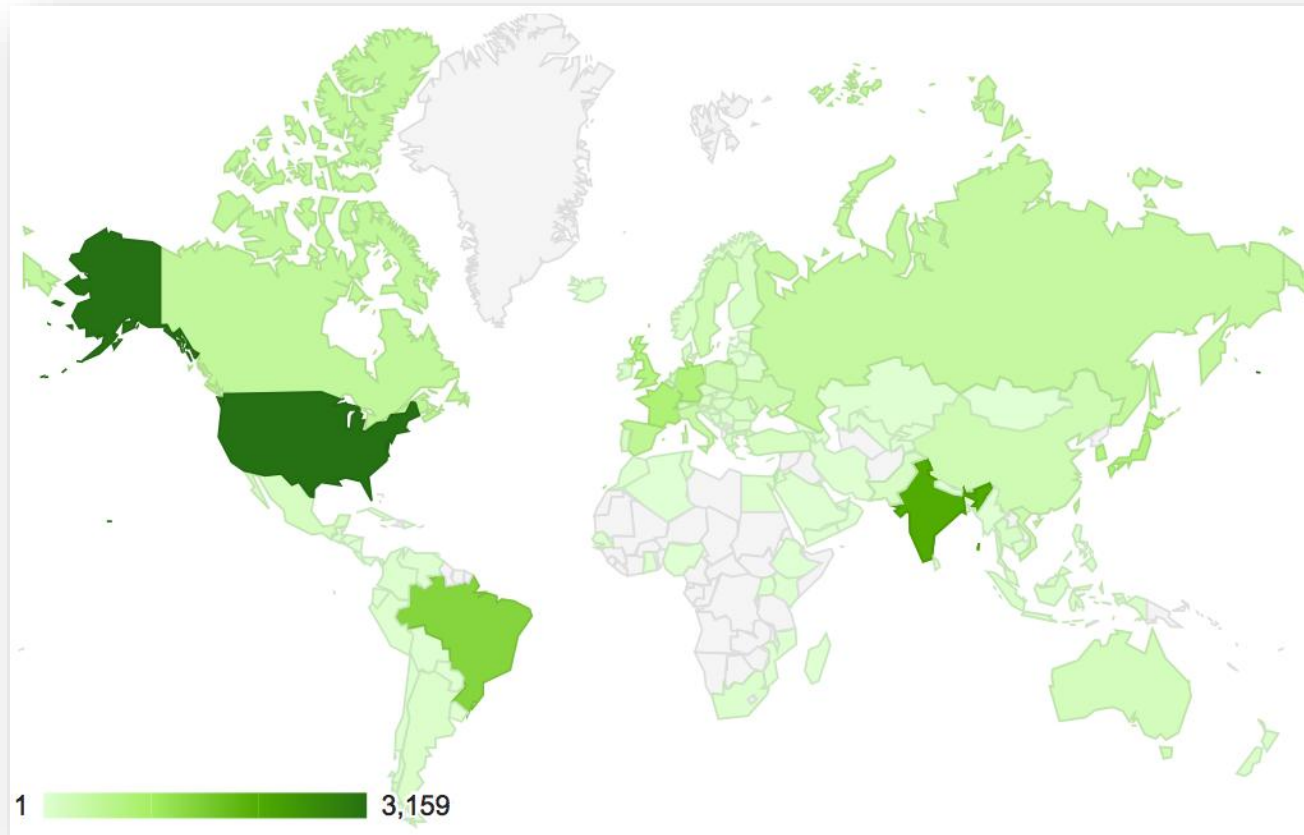
# Public Comments

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- *“Damn, all API docs need this!”* – Reddit
- *“Mais parfois un petit bout de code exemple serait bien pratique! APIMiner fournit ce service bien appréciable.”* – frandroid
- *“Use StackOverflow as your documentation? Try combining StackOverflow examples with the API docs with APIMiner!”* – Twitter

# Demographics

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Visits from 130 countries

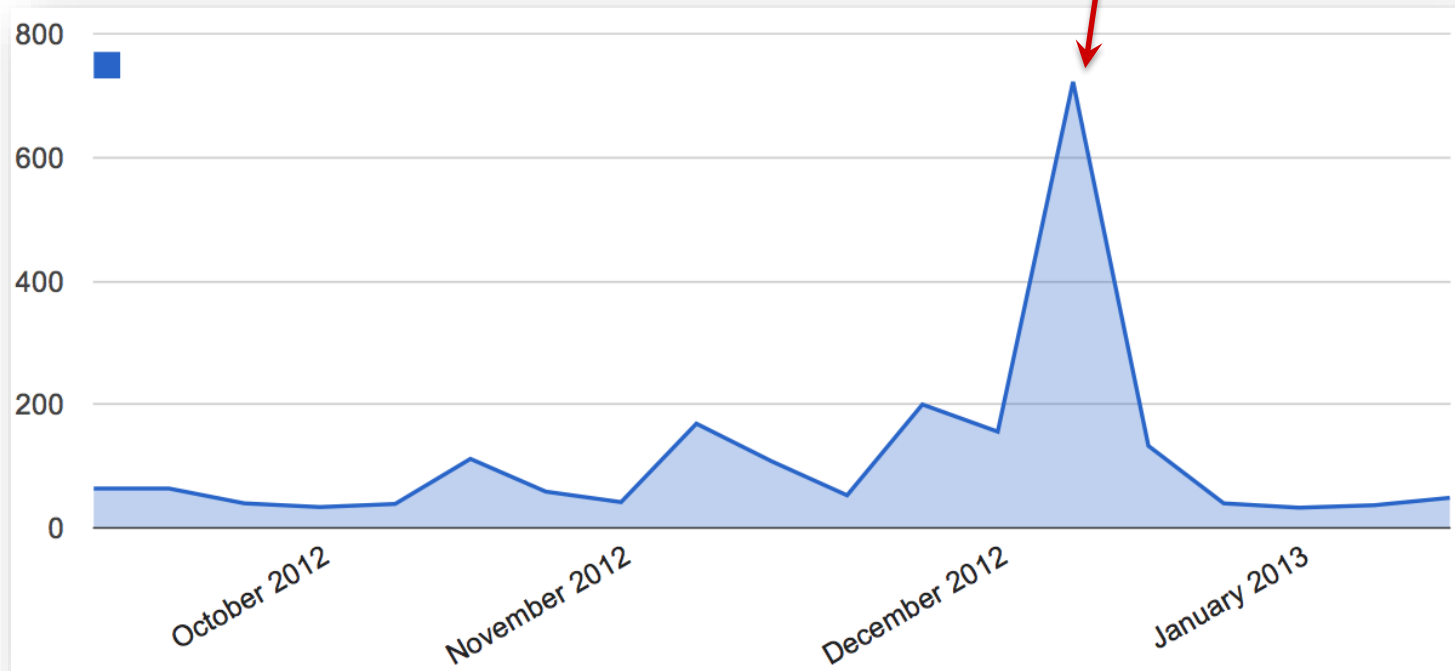


# Number of Examples

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2,157 examples

722 examples



<http://apiminer.org/treemap-requests.html>

# Do Developers Really Search for Examples?

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Keyword	# Queries
speechrecognizer wait timeout	53
apiminer	30
datepicker.keep_screen_on	16
eglquerysurface egl_width android resize	15
listpopupwindow <span style="border: 1px solid red; padding: 2px;">example</span> android	15
android.net.rtp <span style="border: 1px solid red; padding: 2px;">example</span>	14
gridlayoutanimationcontroller <span style="border: 1px solid red; padding: 2px;">example</span>	13
android notificationcompat <span style="border: 1px solid red; padding: 2px;">example</span>	12
notificationcompat.builder <span style="border: 1px solid red; padding: 2px;">example</span>	12
fragmentactivity <span style="border: 1px solid red; padding: 2px;">example</span>	11
<b>Total</b>	<b>191</b>

# Controlled Study

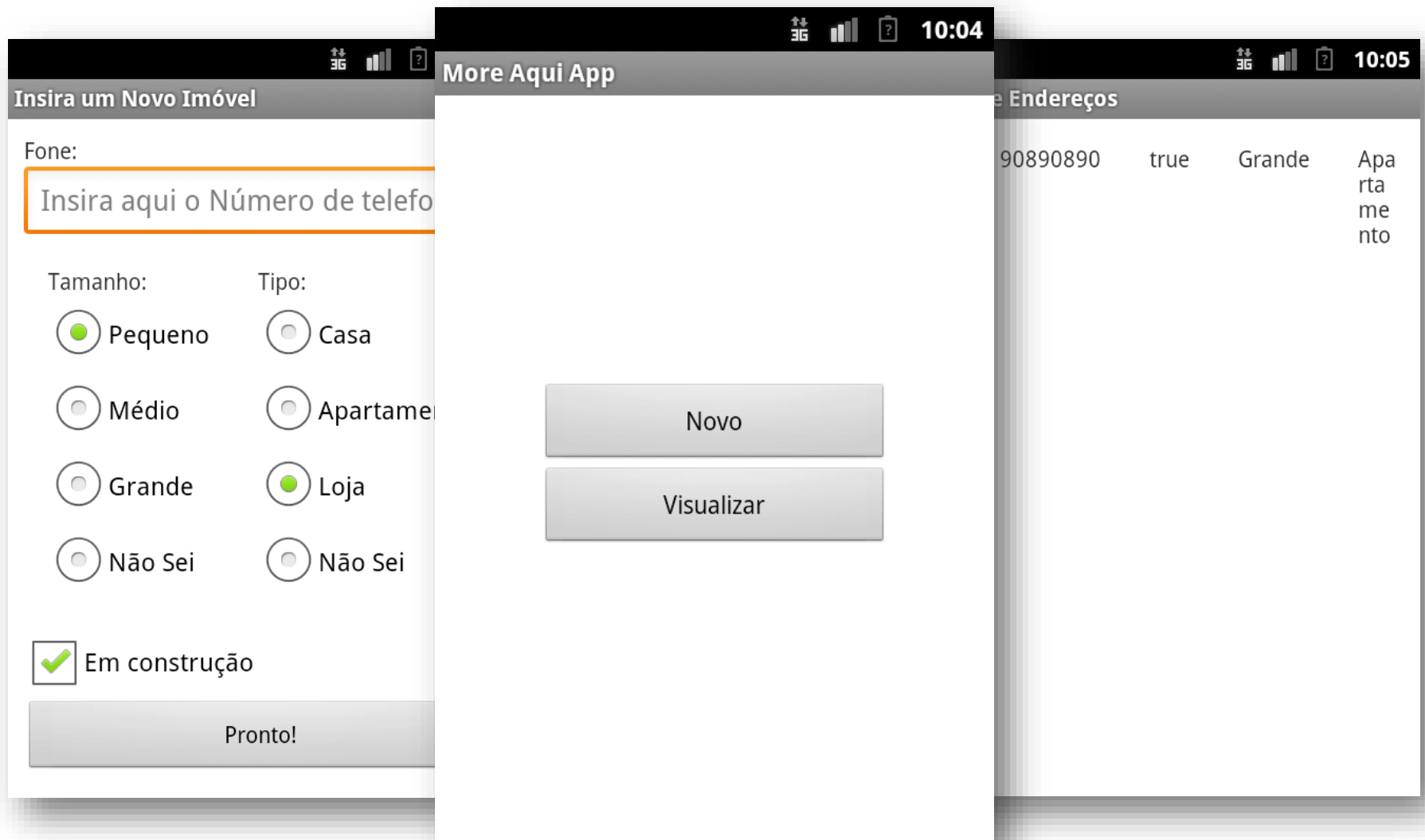
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*Do the **examples** provided by APIMiner help developers to **implement** a given **maintenance task**?*

- ✓ 17 subjects
- ✓ Two maintenance tasks in a small Android app

# More Aqui

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# Maintenance Tasks

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- ✓ Adding an OnClick event to the buttons of the main screen (tutorial task)
- ✓ Screen transition
- ✓ Persisting a record in the database

# Setup

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- Subjects:
  - Good programming skills in Java
  - No proficiency in Android
  
- Tasks:
  - Time limit: 20 minutes
  - Crossover methodology
  - Tasks are synchronized

# Methodology

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① We showed how the application works

② Subjects:

① Read the task forms

② Access the Android JavaDoc

③ Implement the tasks

# Results

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- Only 6 subjects implemented at least one task
  - Difficulties related with mobile development paradigm

<b>Task</b>	<b>Android APIMiner</b>	<b>Traditional JavaDoc</b>
Screen Transition	4	1
Database Insertion	1	3
<b>Total</b>	<b>5</b>	<b>4</b>

Table 4.10: Number of subjects who implemented each task

Complex task



# Conclusion

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# Contributions

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- ① A platform that documents APIs with examples
- ② Slicing algorithm that extracts examples automatically
- ③ Particular instance for the Android API
  - <http://apiminer.org>
- ④ Field study
  - APIMiner scales to real APIs and developers
  - Developers search for examples
- ⑤ Controlled Study
  - Examples for API protocols are important

# Related Work

Category	System	Input	Interface	Output	
CSEs	CSEs	Text	Web	File	
CSEs	CSEs	Statement	Plugin	Method	
		Statement	Plugin	—	
		Statement	Plugin	Method	
		Method	Web	Slicing	
IDE Tools	IDE Tools	Type	Web/Plugin	Text	
		Type	Desktop	Method	
		Method	Web	Slicing	
JavaDoc Tools	JavaDoc Tools	Repository	Clus		
		Web			
		Private			
JavaDoc Tools	JavaDoc Tools	API Explorer			
		MAPO			
		ExoaDocs	Web	✓	✓
		APIExample	Web	✓	✓
JavaDoc Tools	JavaDoc Tools	PropER-Doc	Web	✓	✓
		APIMiner	Private		✓

## CSEs

✓ Simplest approach

## IDE Tools

✓ Context specific

✗ Not documentation-focused

✗ Restricted to IDEs

✓ Widely available

✗ May lack original JavaDoc

## eXoaDocs

✗ Web repository

✗ Only data slicing

✗ Static JavaDoc

✗ No field study

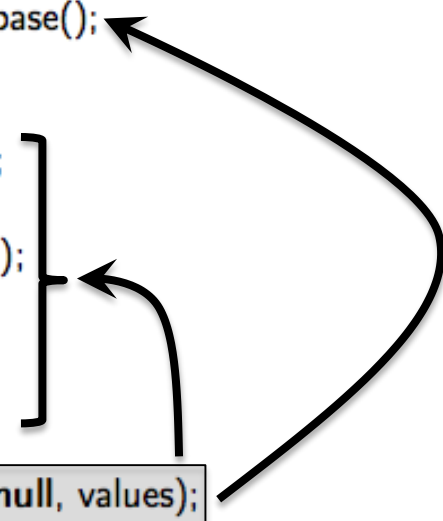
Table 5.1: Comparison between APIMiner and other API recommendation systems

# Future Work

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## Association rules

```
1 SQLiteDatabase db = estatesDb.getWritableDatabase();
2 ContentValues values = new ContentValues();
3
4 values.put(DBConstants.PHONE, estate.PHONE);
5 values.put(DBConstants.SIZE, estate.SIZE);
6 values.put(DBConstants.STATUS, estate.STATUS);
7 values.put(DBConstants.TYPE, estate.TYPE);
8 values.put(DBConstants.LAT, estate.LAT);
9 values.put(DBConstants.LONG, estate.LONG);
10
11 db.insertOrThrow(DBConstants.TABLE_NAME, null, values);
```

A diagram illustrating the call graph for the `insertOrThrow` method. A large arrow points from the `insertOrThrow` call on line 11 to the `getWritableDatabase` call on line 1. A bracket on the right side of lines 4 through 9 indicates that these five `put` calls are grouped together and call the `put` method of the `ContentValues` object. A smaller arrow points from this bracket to the `put` call on line 4.

Listing 4.2: Source code for the Database Insertion task

`insertOrThrow => {getWritableDatabase, put}`

# Future Work

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## Other summarization techniques

```
InputStreamReader i; //initialized previously
BufferedReader reader = new BufferedReader(i);
String s;
while ((s = reader.readLine()) != null)
    //do something with s
}
reader.close();
```

Buse and Weimer, ICSE, 2012

# Publications

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## Accepted

- ✓ MONTANDON, J. E., VALENTE, M. T. O.: “**APIMiner: Uma Plataforma para Recomendação de Exemplos de Uso de APIs**”. CBSoft, Tools Section, 2012.

## Submitted

- ✓ MONTANDON, J. E., BORGES, S. H., VALENTE, M. T. O.: “**Documenting APIs with Examples: Lessons Learned with the APIMiner Recommendation Tool**”. Submitted to journal publication.

