On the Impact of API Change- and Fault-proneness on the User Ratings of Android Apps

Denys Poshyvanyk

Software Engineering Maintenance and Evolution Research Unit - SEMERU

WILLIAM & MARY

WILLIAM & MARY

WILLIAM & MARY

- Chartered on February 8, 1693, by King William III and Queen Mary II of England

- The second oldest college in America

- One of the 8 “Public Ivy”

WILLIAM & MARY

Research at the SEMERU lab

Factors impacting apps' success

Software reuse

Detecting similar Android apps

Energy consumption

Crowdsource-based requirements

GUI - based testing

Automatic generation of crash reports

Mining Android Software Repositories

Supporting evolution and maintenance of Android apps

WILLIAM & MARY

API Change and Fault Proneness: A Threat to the Success of Android Apps

Mario Linares-Vásquez[1], Gabriele Bavota[2], Carlos Bernal-Cárdenas[3]
Massimiliano Di Penta[2], Rocco Oliveto[4], Denys Poshyvanyk[1]
[1]The College of William and Mary, Williamsburg, VA, USA
[2]University of Sannio, Benevento, Italy
[3]Universidad Nacional de Colombia, Bogotá, Colombia
[4]University of Molise, Pesche (IS), Italy
mlinarev@cs.wm.edu, gbavota@unisannio.it, cebernalc@unal.edu.co,
dipenta@unisannio.it, rocco.oliveto@unimol.it, denys@cs.wm.edu

FSE 2013

An Exploratory Analysis of Mobile Development Issues using Stack Overflow

Mario Linares-Vásquez, Bogdan Dit, Denys Poshyvanyk
Computer Science Department
The College of William and Mary
Williamsburg, VA, USA
{mlinarev, bdit, denys}@cs.wm.edu

MSR 2013

WILLIAM & MARY

How Do API Changes Trigger Stack Overflow Discussions? A Study on the Android SDK

Mario Linares-Vásquez[1], Gabriele Bavota[2], Massimiliano Di Penta[2], Rocco Oliveto[2], Denys Poshyvanyk[1]
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ICPC 2014

Revisiting Android Reuse Studies in the Context of Code Obfuscation and Library Usages

Mario Linares-Vásquez[1], Andrew Holtzhauer[1], Carlos Bernal-Cárdenas[2], Denys Poshyvanyk[1]
[1]The College of William and Mary, Williamsburg, VA, USA
[2]Universidad Nacional de Colombia, Bogotá, Colombia
mlinarev@cs.wm.edu, asholtzhauer@cs.wm.edu, cebernalc@unal.edu.co, denys@cs.wm.edu

MSR 2014

WILLIAM & MARY

Mining Energy-Greedy API Usage Patterns in Android Apps: An Empirical Study

Mario Linares-Vásquez[1], Gabriele Bavota[2], Carlos Bernal-Cárdenas[3]
Rocco Oliveto[4], Massimiliano Di Penta[2], Denys Poshyvanyk[1]
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MSR 2014

On the Impact of API Change- and Fault-Proneness on the User Ratings of Android Apps

Gabriele Bavota, Mario Linares-Vásquez, Carlos Bernal-Cárdenas,
Massimiliano Di Penta, Rocco Oliveto, Denys Poshyvanyk

TSE 2015
minor revision

The App Economy

Android Markets

1.3 Million+ apps (Google Play)

Several unofficial and fake markets

Thousands of open source apps (GitHub, Google Code, etc)

Tremendous success …

2012: average monthly revenue of over $4,800 (iOs), $3,700 (BlackBerry), $3,300 (Android)

2013: global app economy was worth $68 billion and projected to $143 billion (2016)

2014: around 50 billion downloads (Google Play)

Revenue models

Tremendous success …

Customer loyalty

Low cost of handsets

Apps are built using APIs... and....

Breaking changes

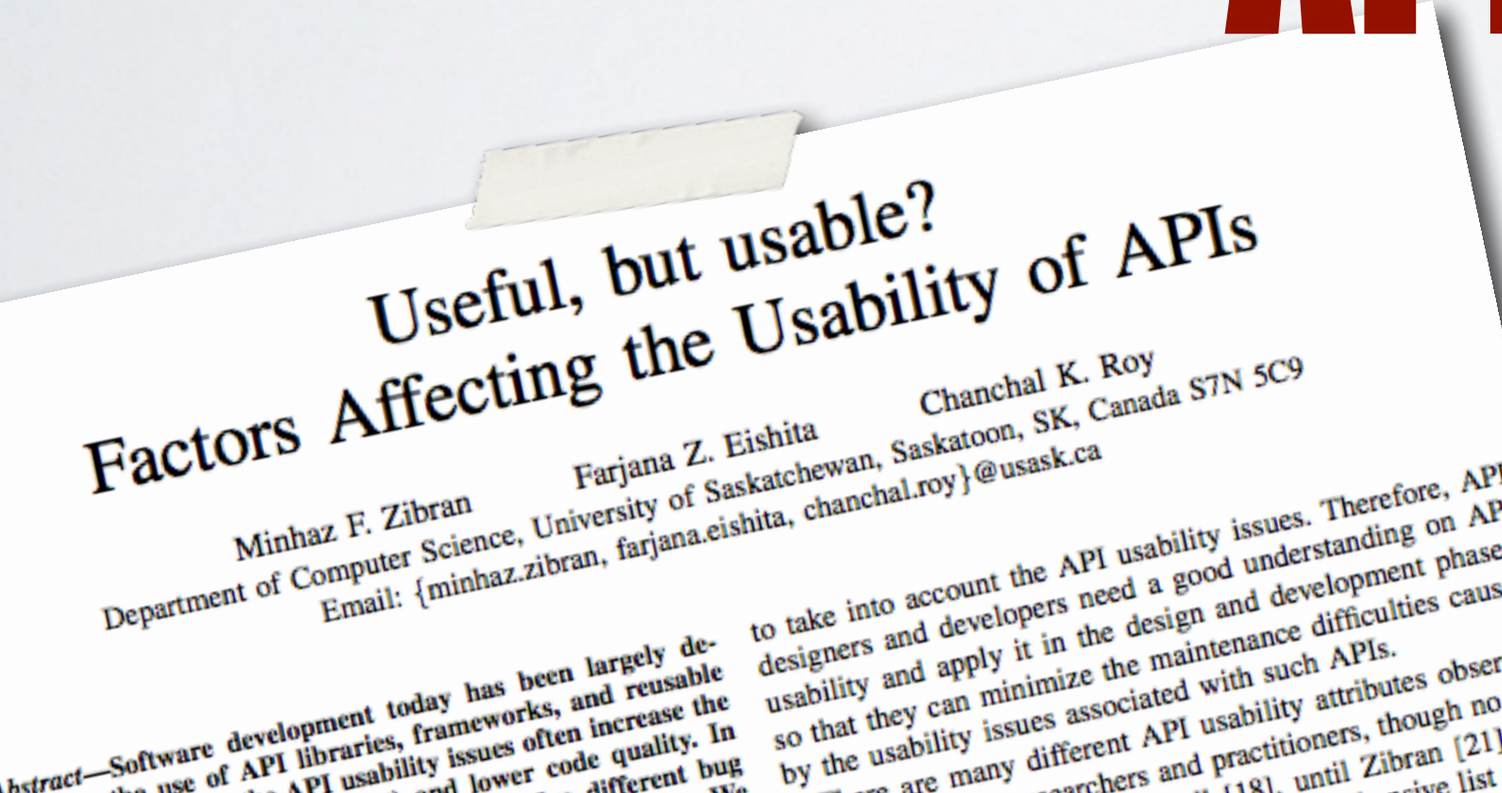
Instability

Bugs

Backward compatibility

Among 1513 bug reports:

562 API usability issues



Useful, but usable?
Factors Affecting the Usability of APIs

Minhaz F. Zibran Farjana Z. Eishita Chanchal K. Roy
Department of Computer Science, University of Saskatchewan, Saskatoon, SK, Canada S7N 5C9
Email: {minhaz.zibran, farjana.eishita, chanchal.roy}@usask.ca

bstract—Software development today has been largely de-
the use of API libraries, frameworks, and reusable
the API usability issues often increase the
and lower code quality. In
different bug

to take into account the API usability issues. Therefore, API designers and developers need a good understanding on API usability and apply it in the design and development phases, so that they can minimize the maintenance difficulties caused by the usability issues associated with such APIs.
are many different API usability attributes observed
earchers and practitioners, though no one
[18], until Zibran [21], the
ive list of 22

Among 1513 bug reports:

175 API correctness

Useful, but usable? Factors Affecting the Usability of APIs

Minhaz F. Zibran Farjana Z. Eishita Chanchal K. Roy
Department of Computer Science, University of Saskatchewan, Saskatoon, SK, Canada S7N 5C9
Email: {minhaz.zibran, farjana.eishita, chanchal.roy}@usask.ca

Abstract—**Software development today has been largely de-**
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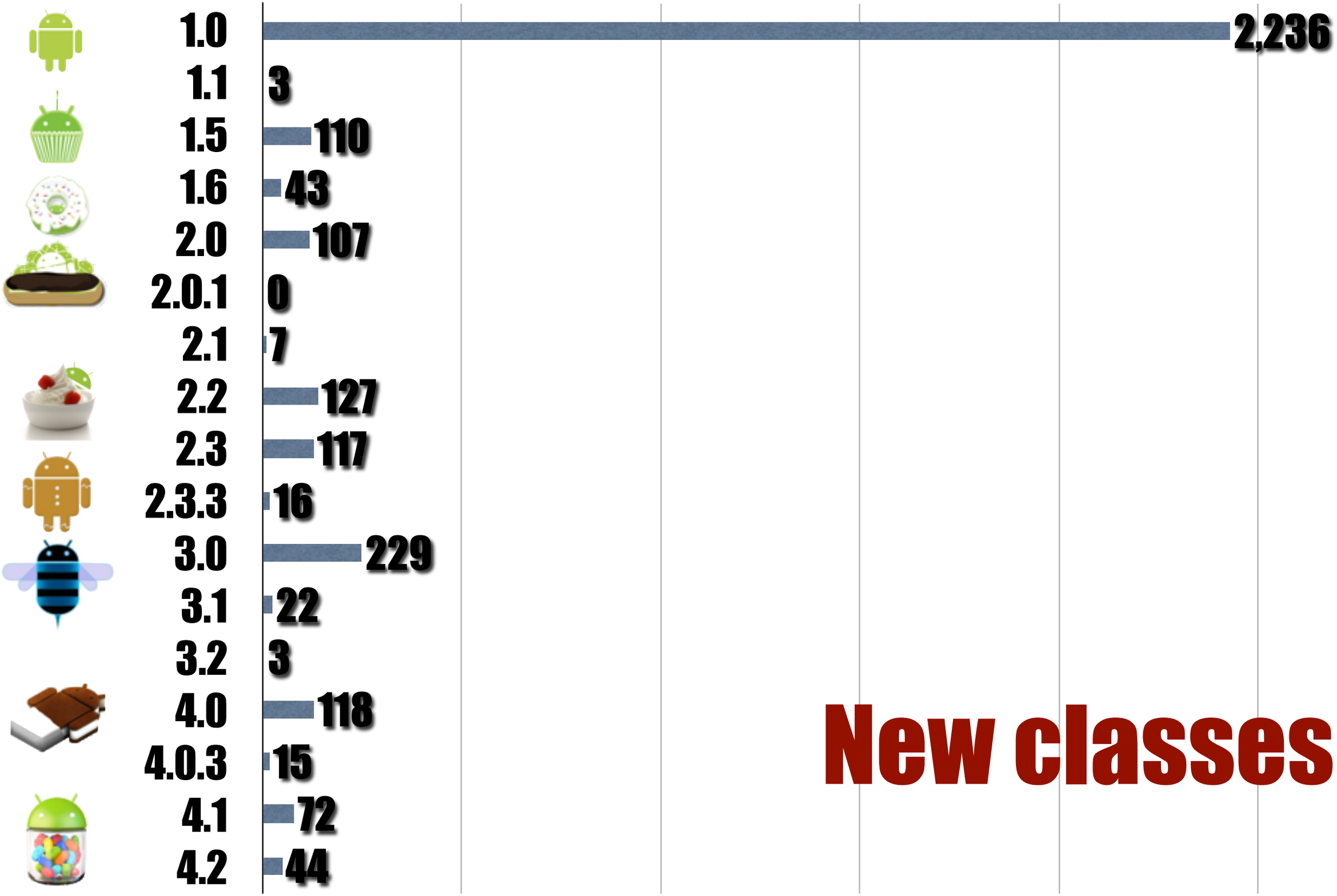
searchers and practitioners, though no one
(18], until Zibran [21], the
sive list of 22

17 releases in 4 years (2008-2012)

3,269

classes

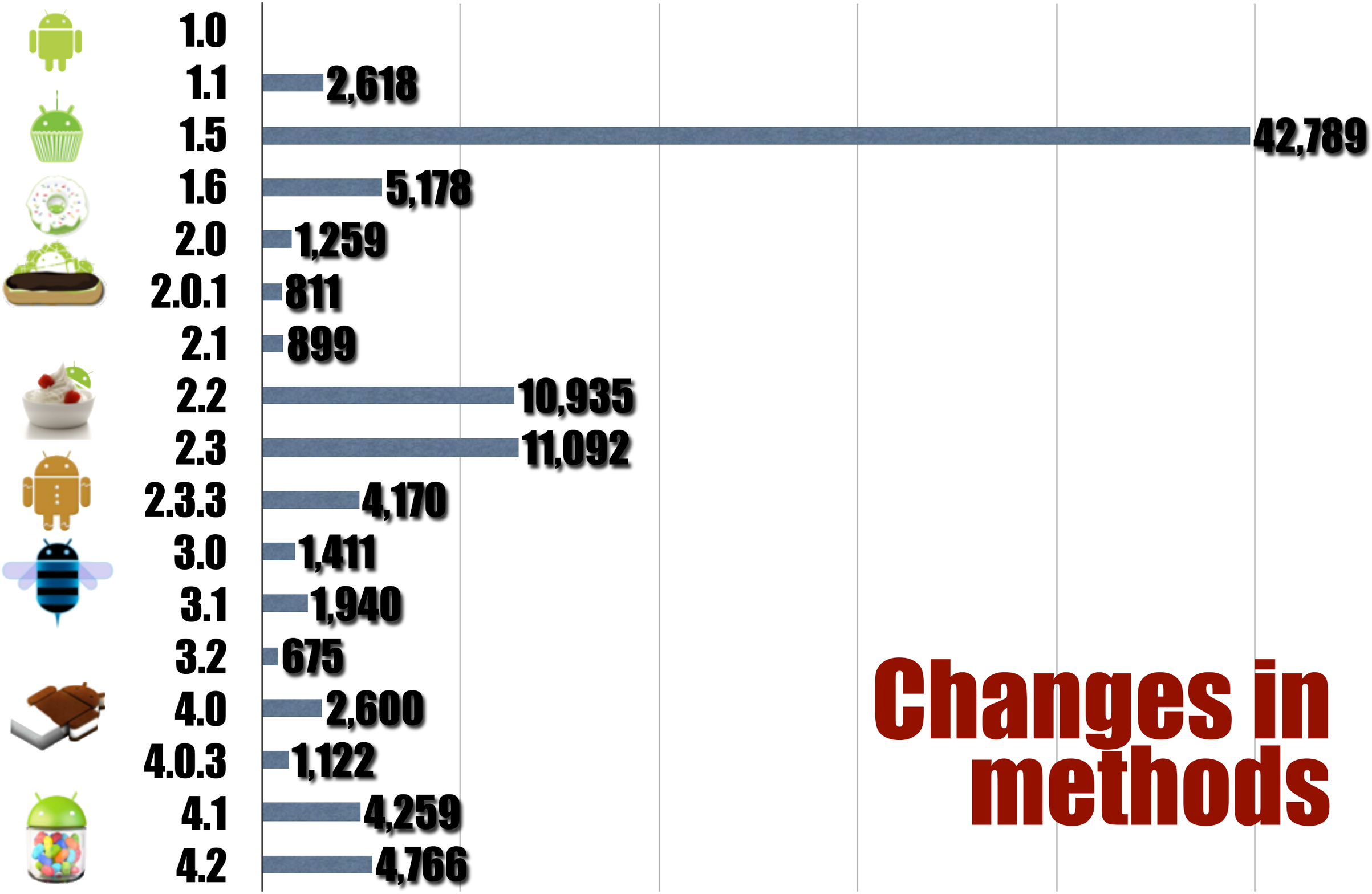

1.0
2,236
1.1
3
1.5
110
1.6
43
2.0
107
2.0.1
0
2.1
7
2.2
127
2.3
117
2.3.3
16
3.0
229
3.1
22
3.2
3
4.0
118
4.0.3
15
4.1
72
4.2
44

New classes

17 releases in 4 years (2008-2012)

96,524

changes in methods



Changes in methods

May API instability and fault-proneness impact the success of Android applications ?

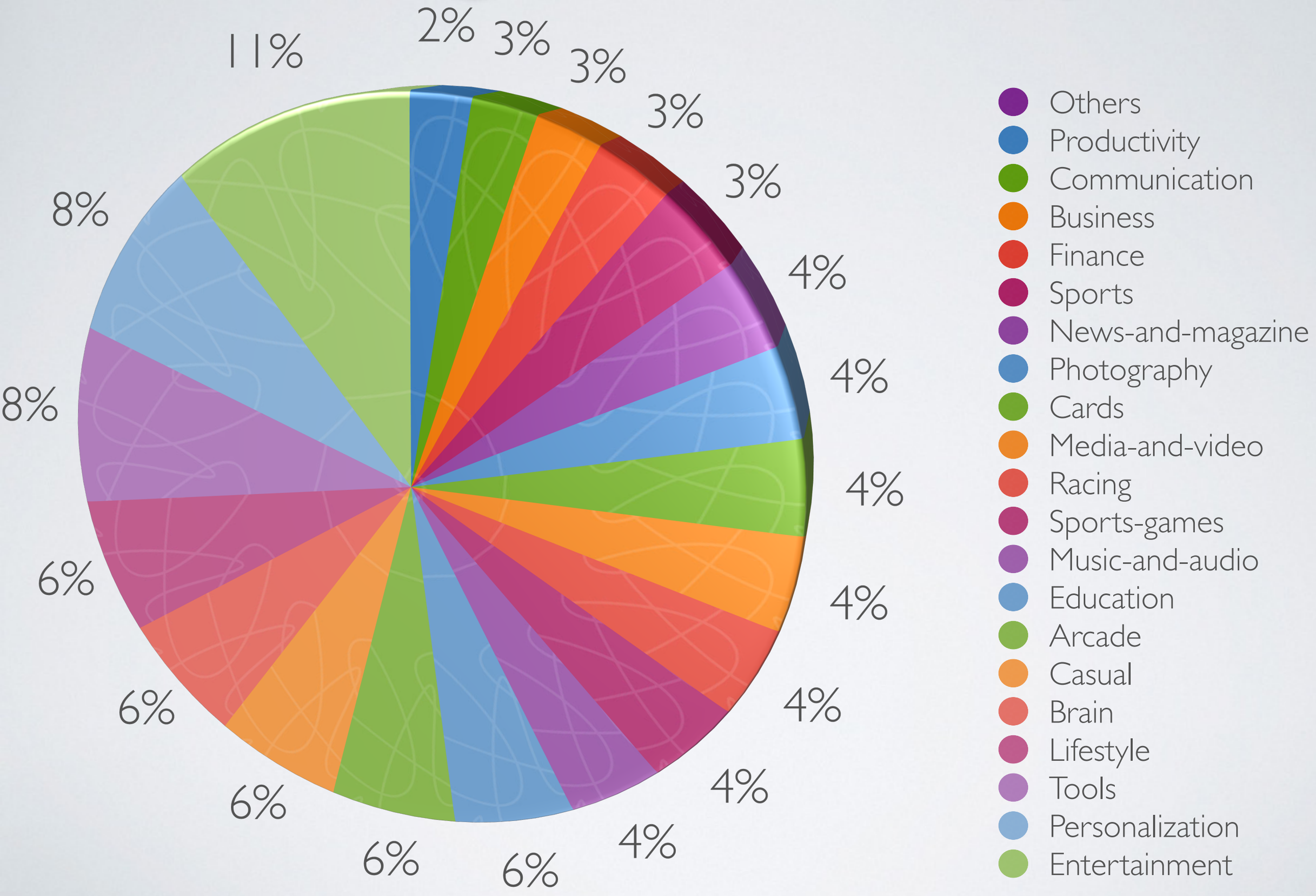
5,848

Free Apps analyzed

30

Domain categories from Google play

Categories and Apps



68

Third party librares

85k+ developers' commits

39k+ bug-fixing activities

1M+ method's changes

85k+ developers' commits

35k+ Android API

49k+ Third party libraries

85k+ developers' commits

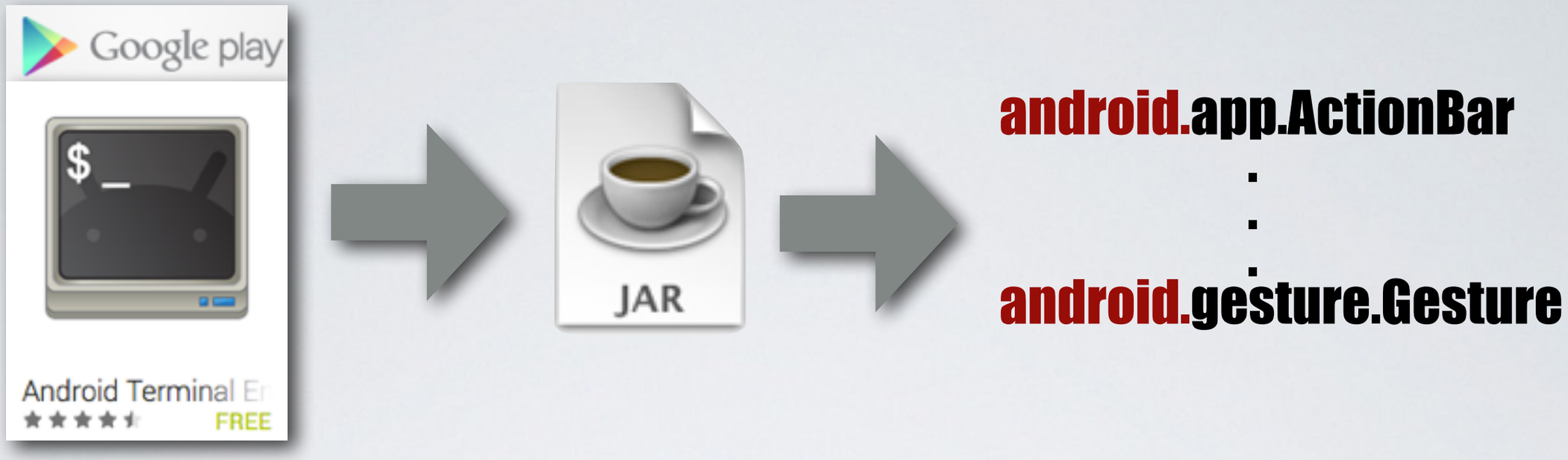
1,068 Android API developers

1,232 Third party libraries devs

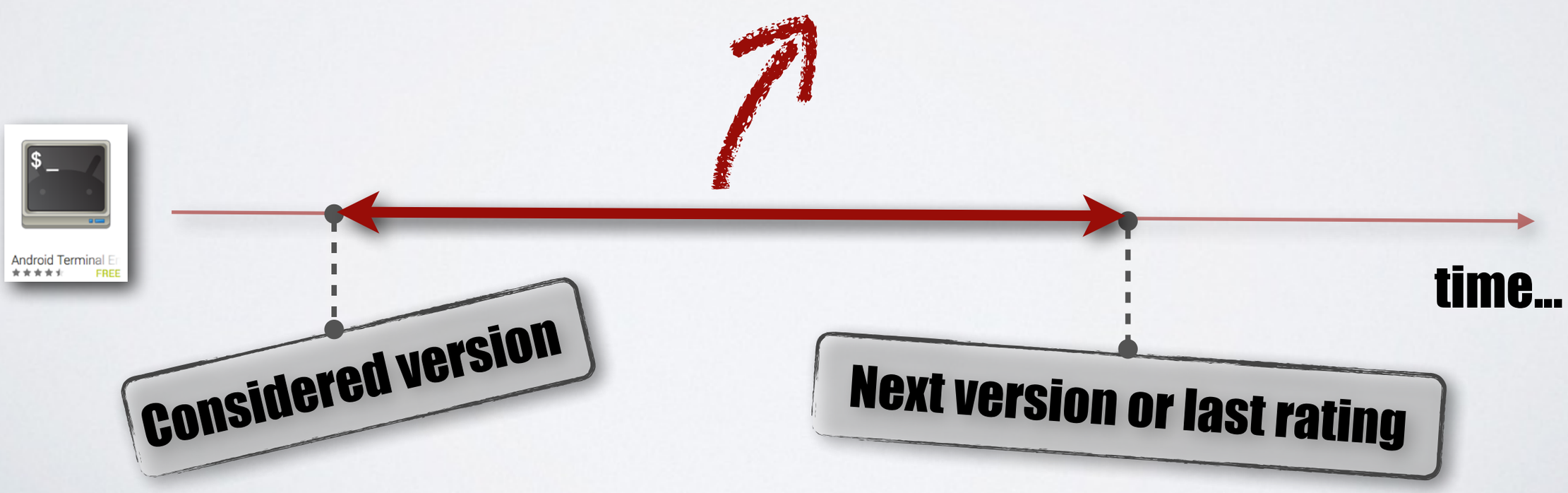
App's success: Average users rating

API fault-proneness: Number of bugs fixed in the Android API

API change-proneness: Number of changes at method level in the Android API



Bug-fixes, and changes in the used APIs



Google Git

android / platform/packages/apps/Gallery2

git clone https://android.googlesource.com/platform/packages/apps/Gallery2

Branches

- **master**
- ics-factoryrom-2-release
- ics-mr0
- ics-mr0-release
- ics-mr1
- ics-mr1-release
- ics-plus-aosp
- jb-dev
- jb-mr0-release
- jb-mr1-dev

More...

f6167c8 Reconcile with jb-mr2-zeroday-release - do not merge by The Android Open Source Project - *6 week*

84b75bf merge in jb-mr2-zeroday-release history after reset to jb-mr2-dev by The Android Automerger - *6 wee*

release android-4.3_r2.1

8569545 am ee14cce0: am e8e2610f: Fix preview thumb and touch target out of sync by Doris Liu - *6 weeks a*

ee14cce am e8e2610f: Fix preview thumb and touch target out of sync by Doris Liu - *6 weeks ago*

e8e2610 Fix preview thumb and touch target out of sync by Doris Liu - *6 weeks ago* jb-mr2-dev

57d45b6 Reconcile with jb-mr2-zeroday-release - do not merge by The Android Open Source Project - *8 weeks*

e873a55 merge in jb-mr2-zeroday-release history after reset to jb-mr2-dev by The Android Automerger - *8 week*

098fe71 Merge remote-tracking branch 'origin/jb-mr2-zeroday-release' into HEAD by The Android Automerger -

android-4.3_r2

090c669 Reconcile with

not merge by The Android Open Source Project - *9 weeks a*

Populating a Release History Database from Version Control and Bug Tracking Systems*

Michael Fischer, Martin Pinzger, and Harald Gall
Distributed Systems Group, Vienna University of Technology
{fischer,pinzger,gall}@infosys.tuwien.ac.at

anticipating future evolution of software projects. Unfor-
nately, current version and bug report systems provide no
t support for the combination of both data
ities in software evolution
version

Bug-fixes in APIs

Google Git

android Git repositories

MARKOS code analyzer

Changes at method level

- Generic changes
- Method signature
- Exceptions

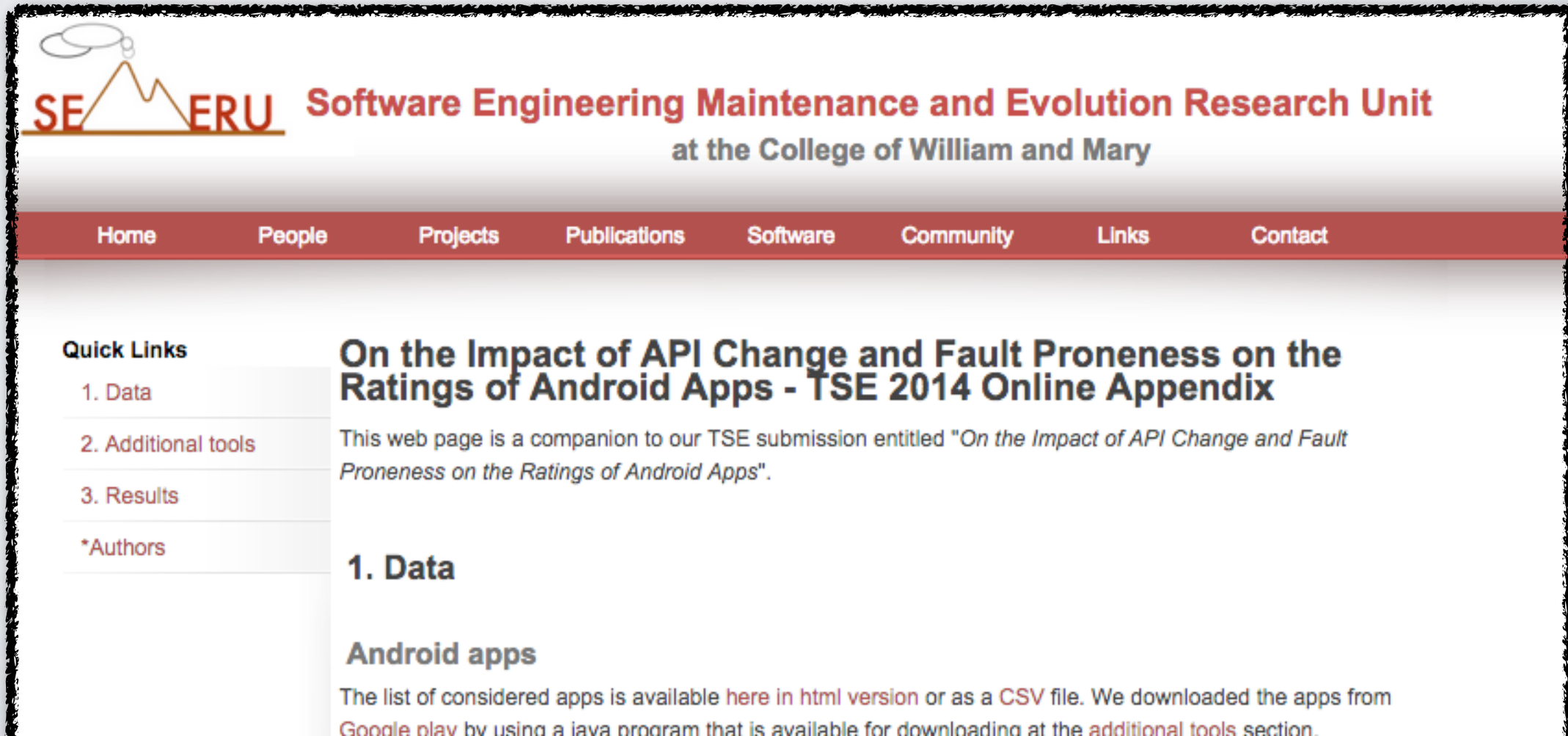
markos

The MARKet for Open Source

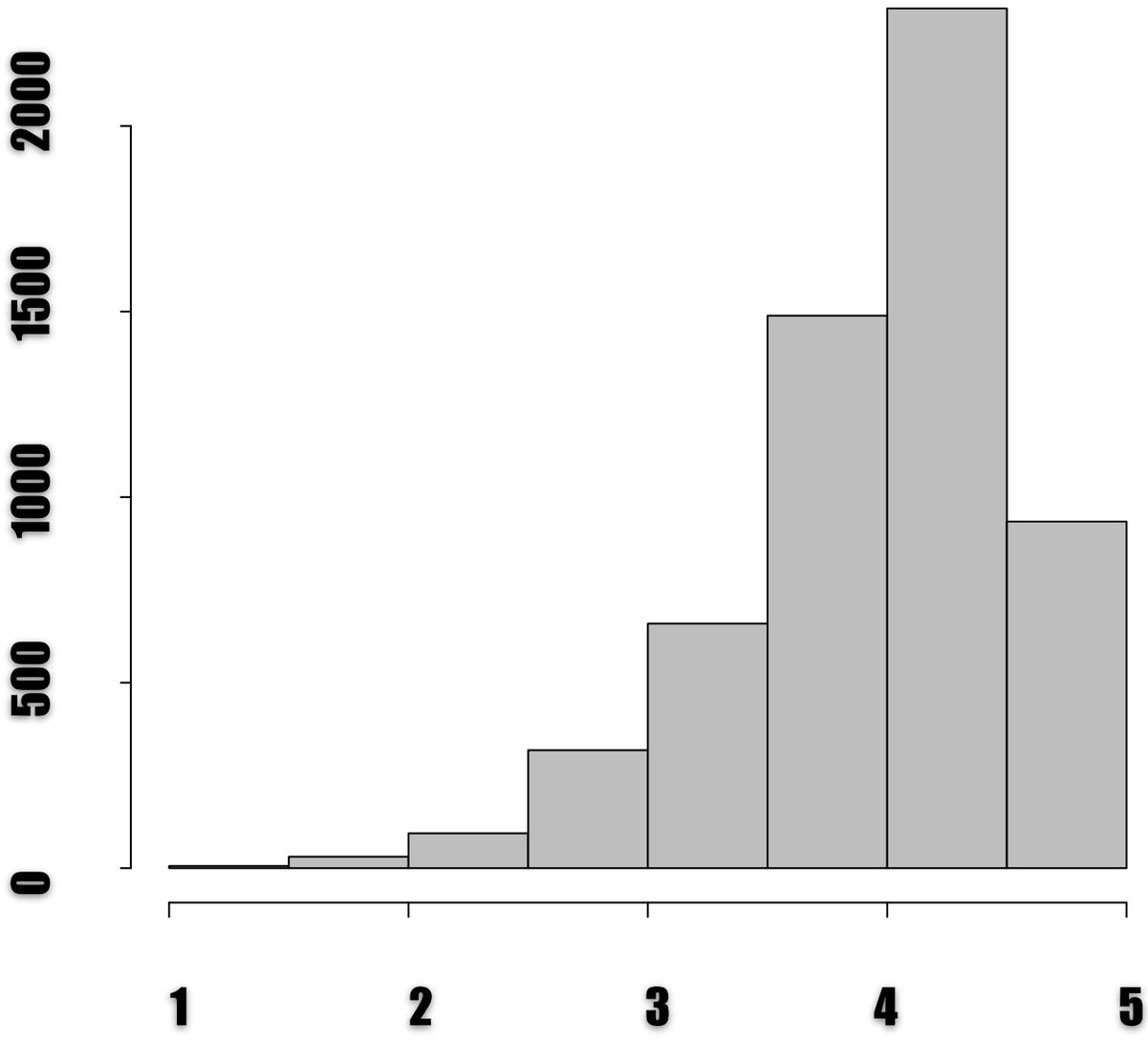
An Intelligent Virtual Open Source Marketplace

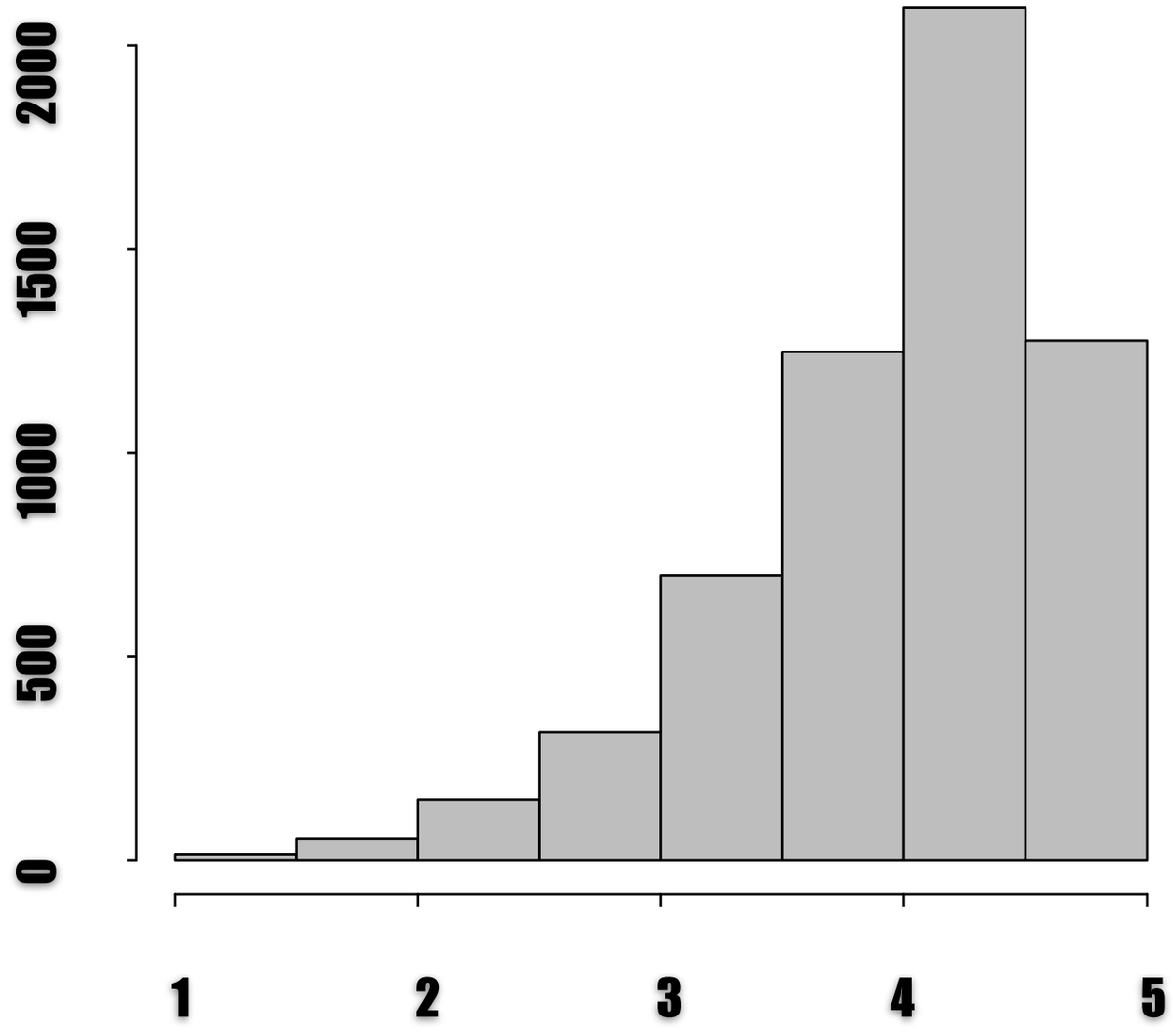
All the data are available at...

http://www.cs.wm.edu/semeru/data/tse-android/



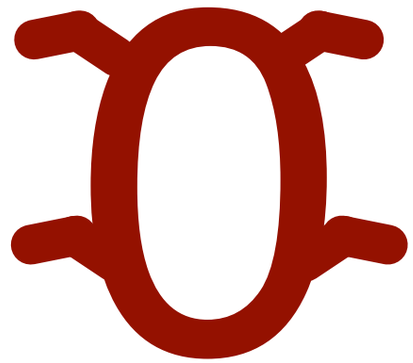
Free vs. Paid (5,848 apps)

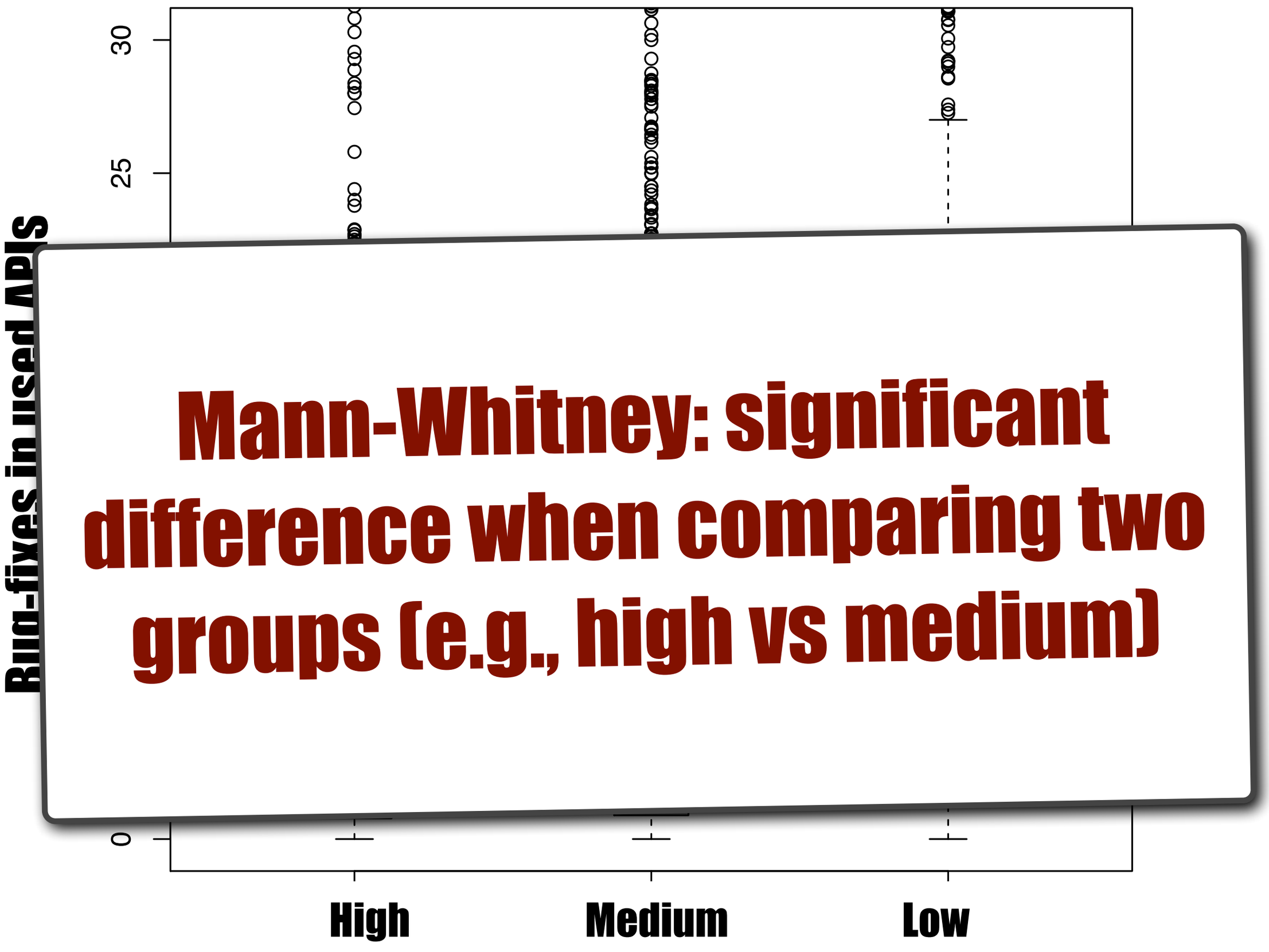




Average App Rating

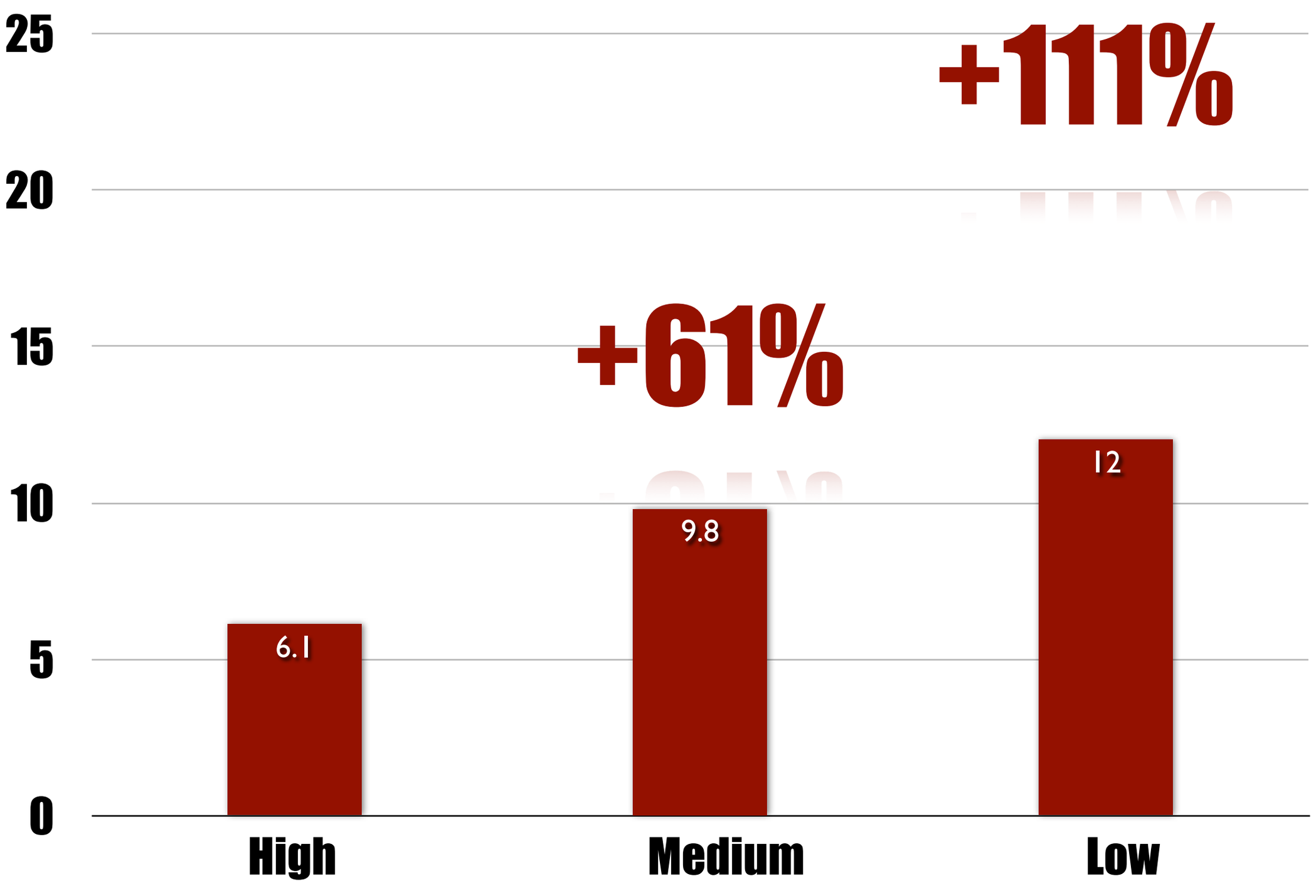
Does the fault-proneness of APIs affect the success of Android Apps?





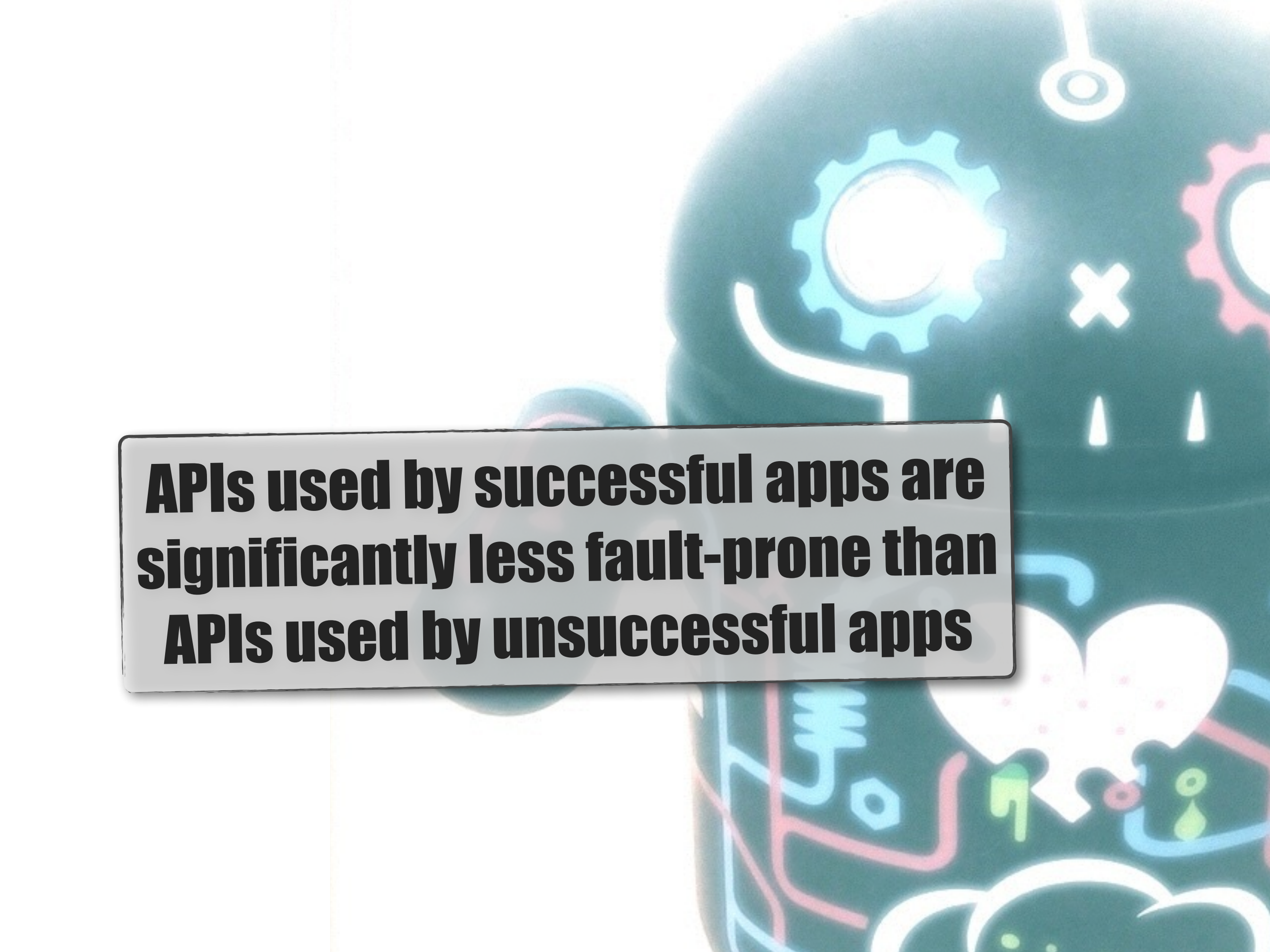
Mann-Whitney: significant difference when comparing two groups (e.g., high vs medium)

Avg bug-fixes in used APIs



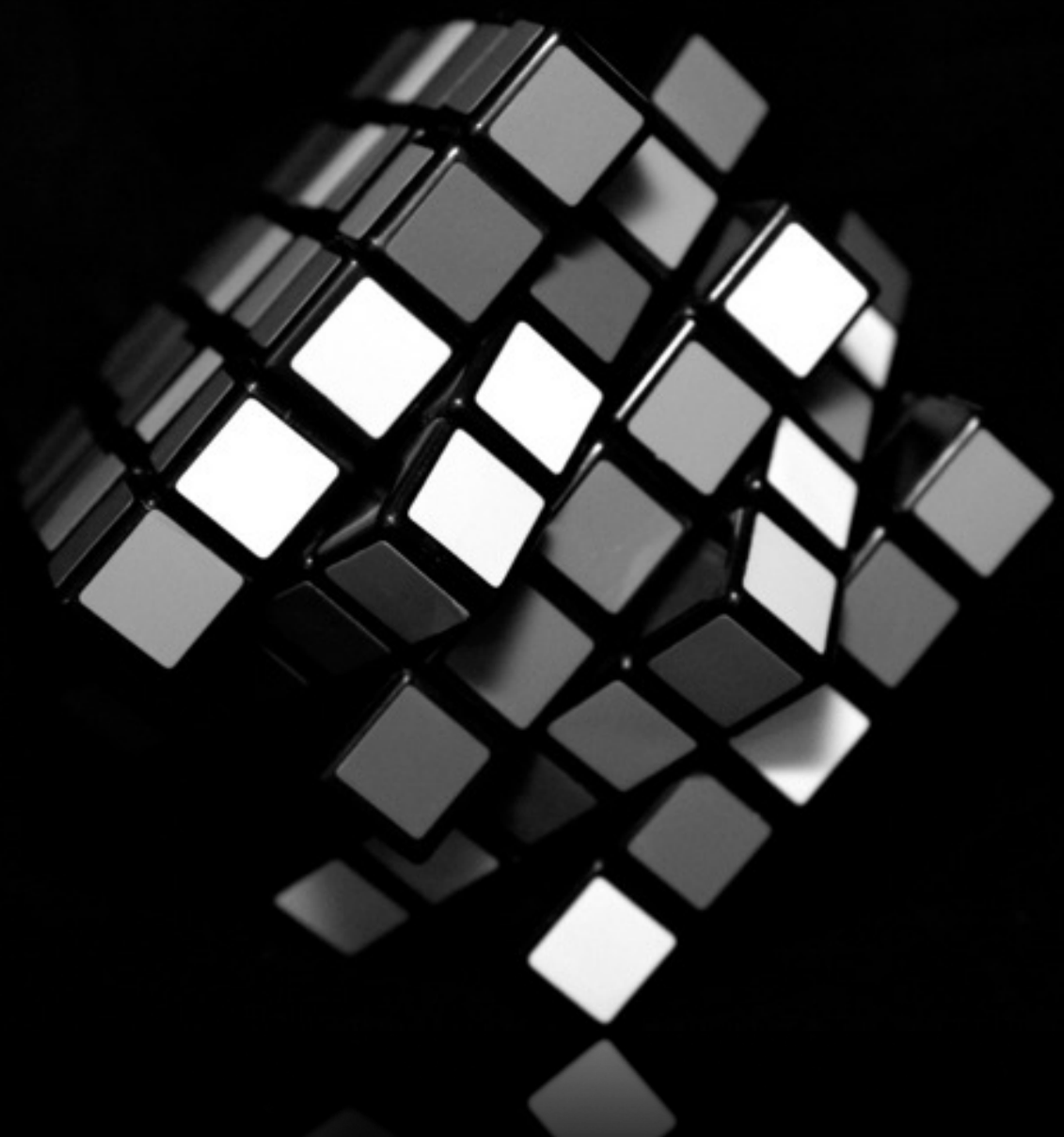
50 most successful vs 50 least successful apps

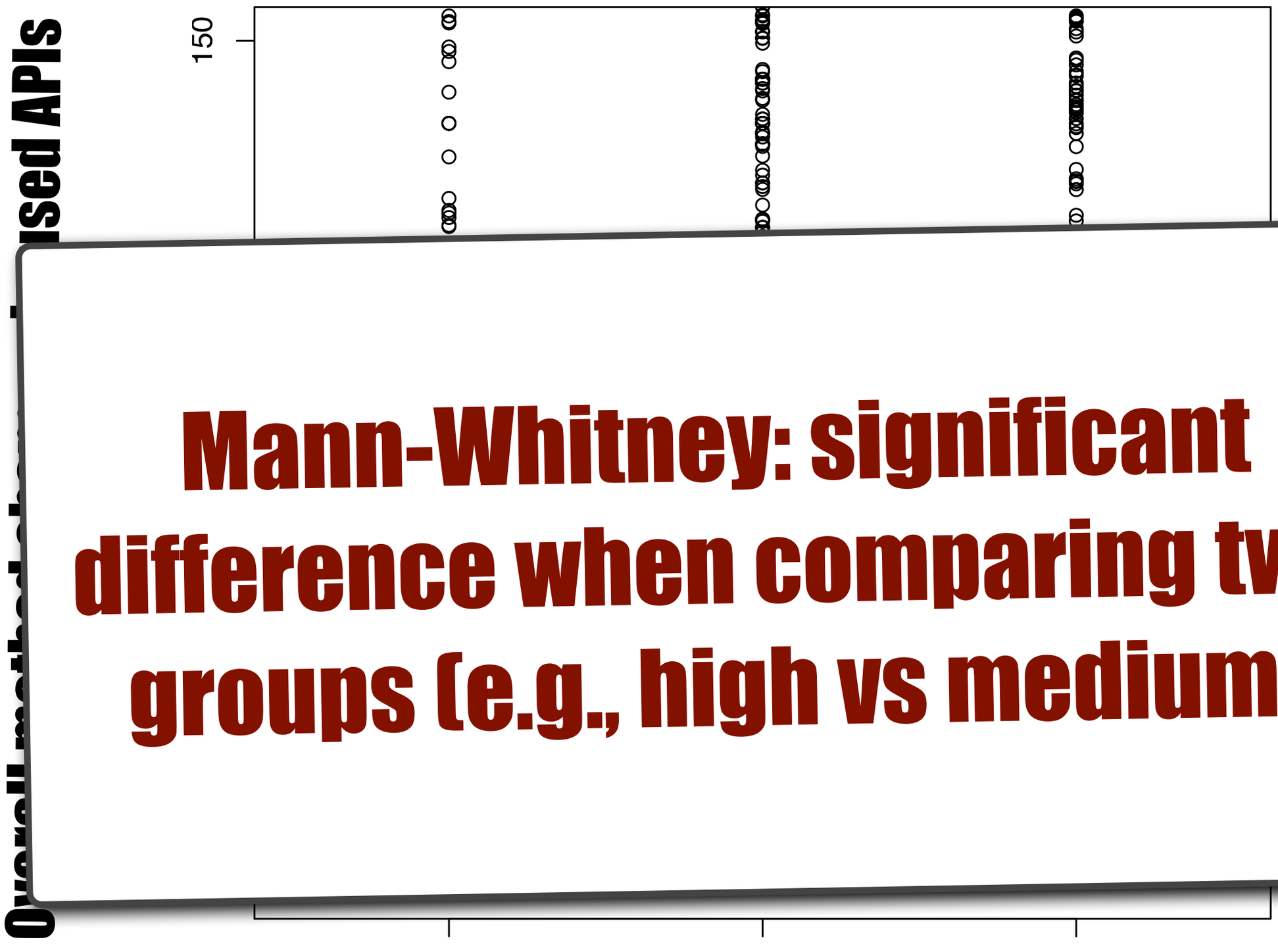
+457%



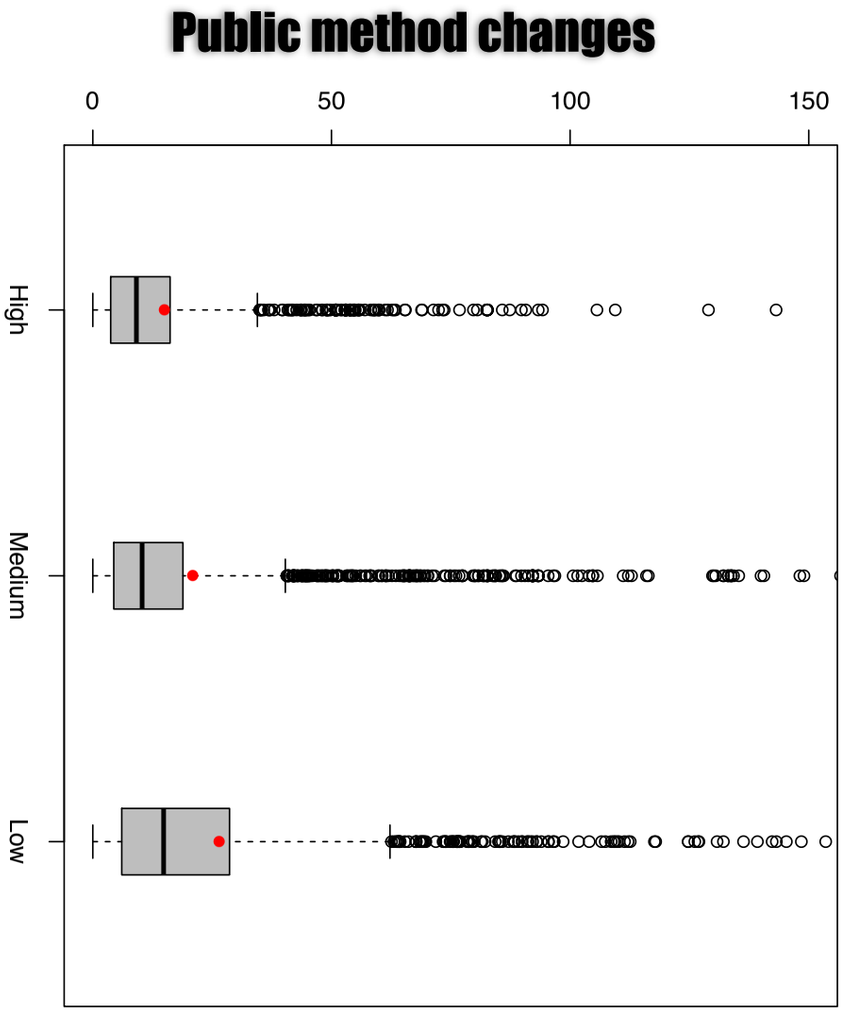
APIs used by successful apps are significantly less fault-prone than APIs used by unsuccessful apps

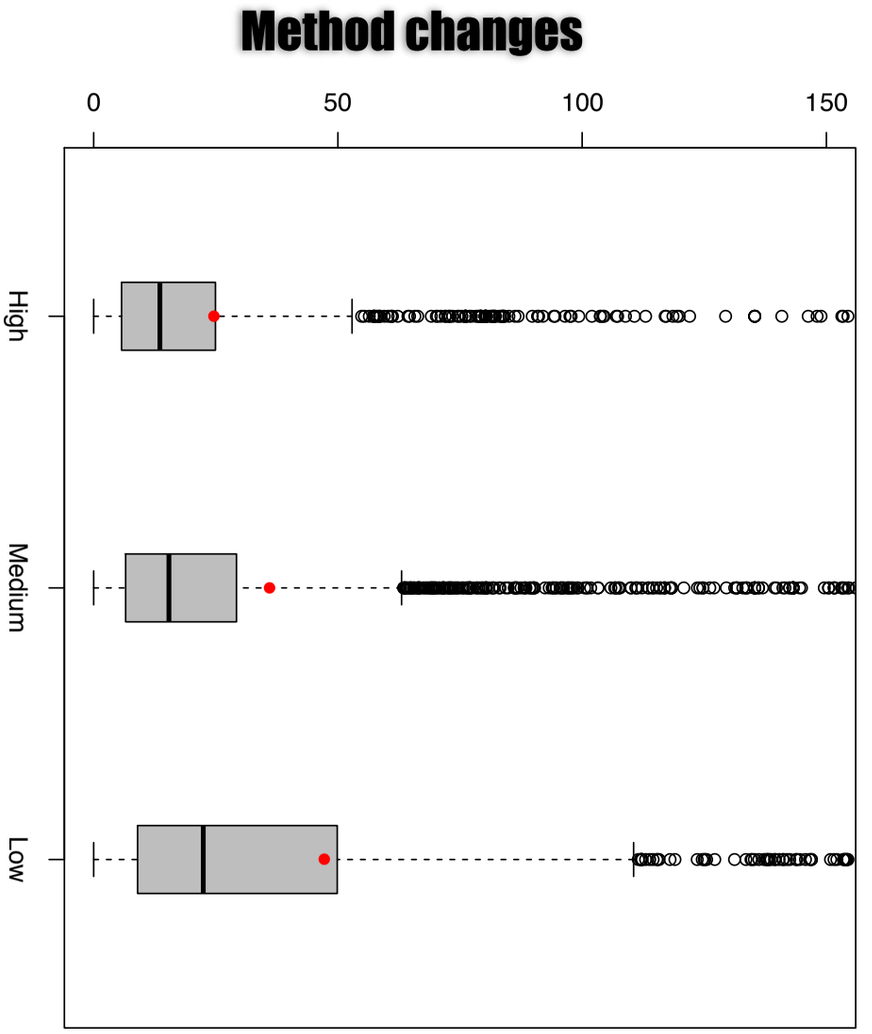
Does the change-proneness of APIs affect the success of Android Apps?

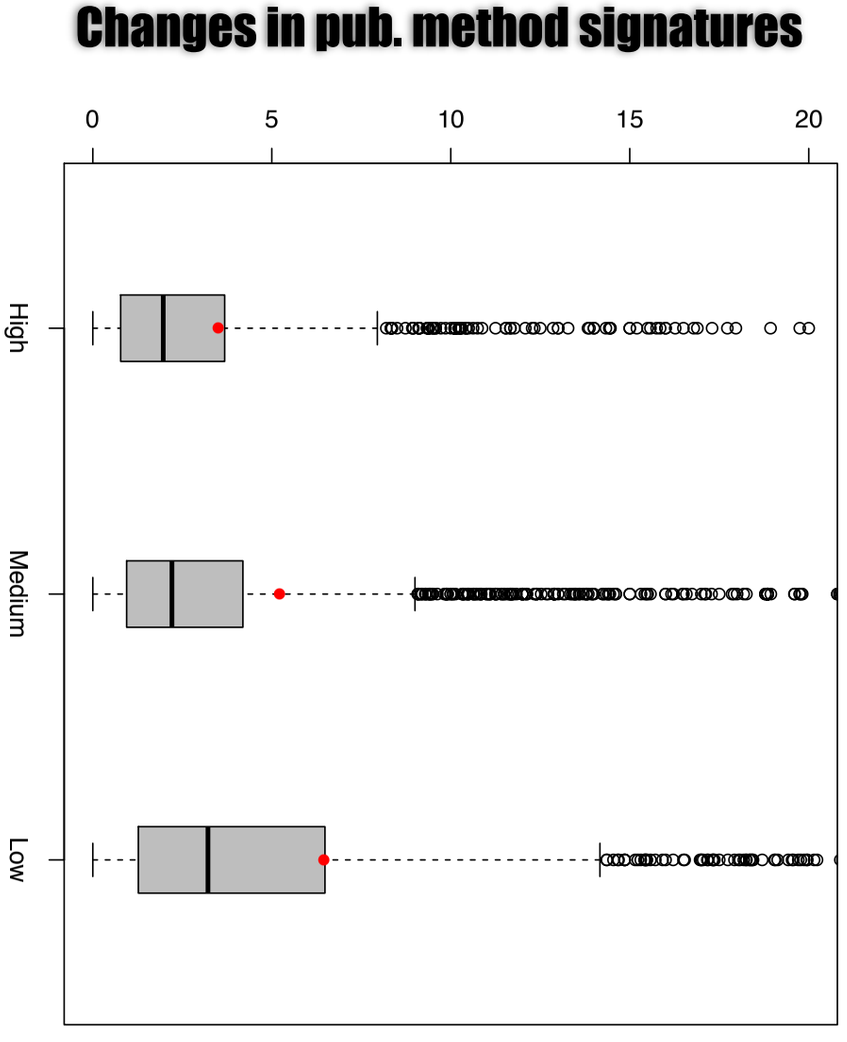


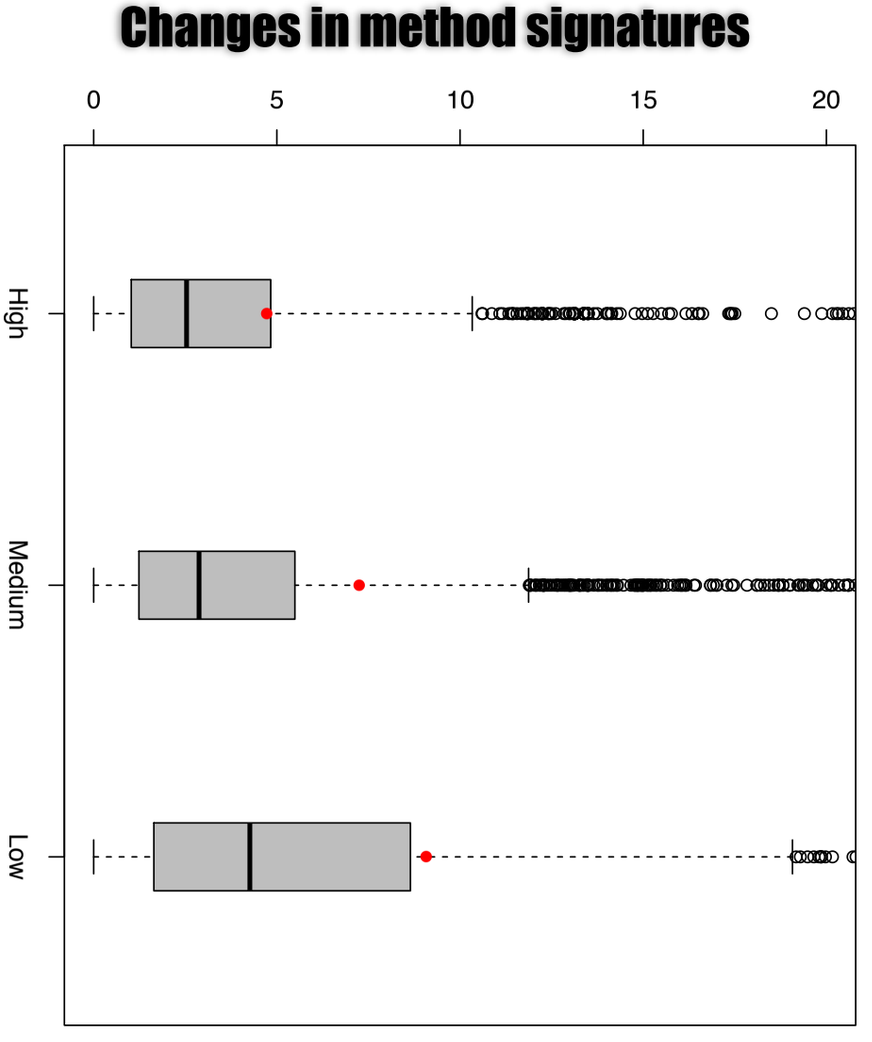


Mann-Whitney: significant difference when comparing two groups (e.g., high vs medium)

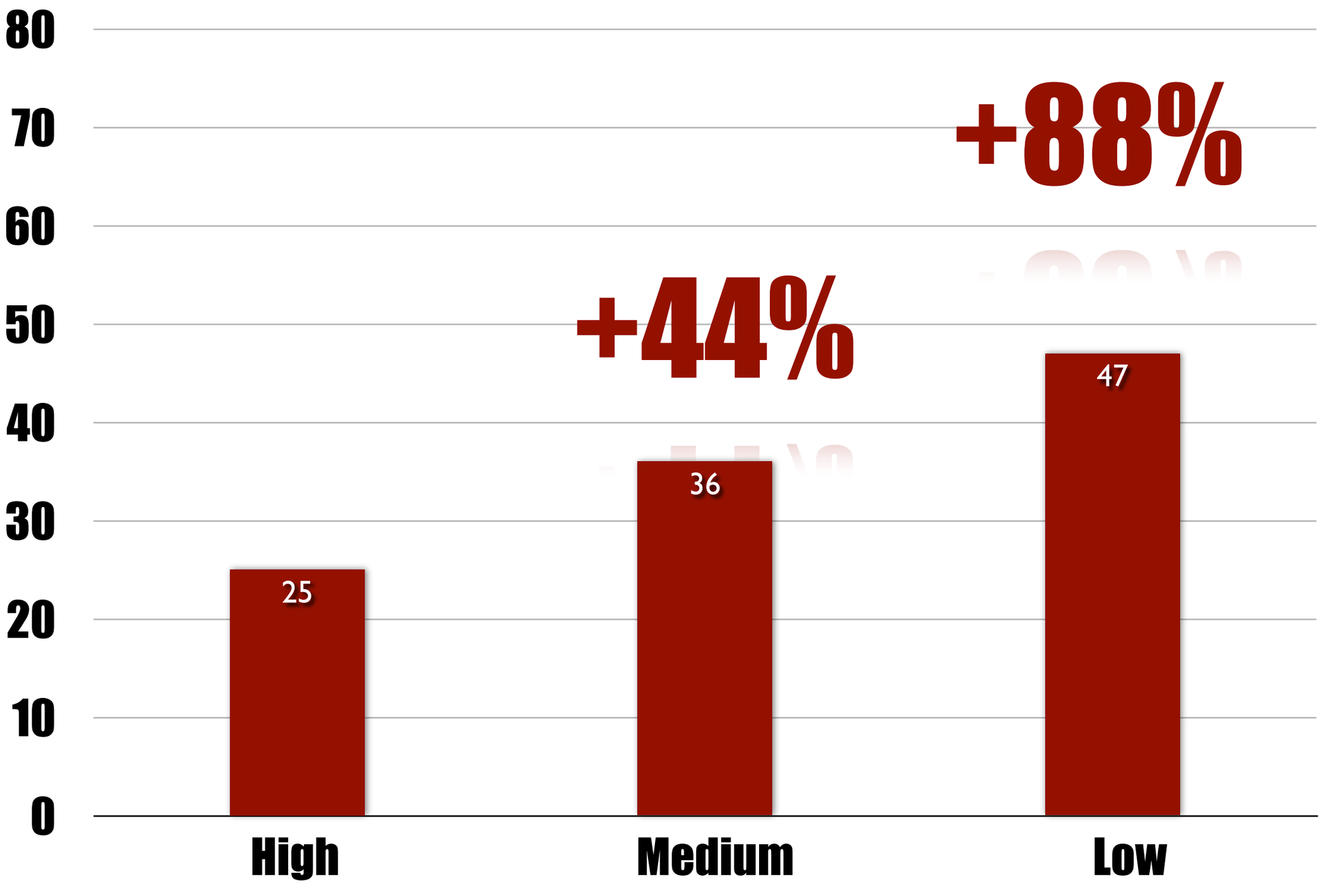

Public method changes
0
50
100
150
High
Medium
Low


Method changes
0
50
100
150
High
Medium
Low


Changes in pub. method signatures
0
5
10
15
20
High
Medium
Low


Changes in method signatures
0
5
10
15
20
High
Medium
Low

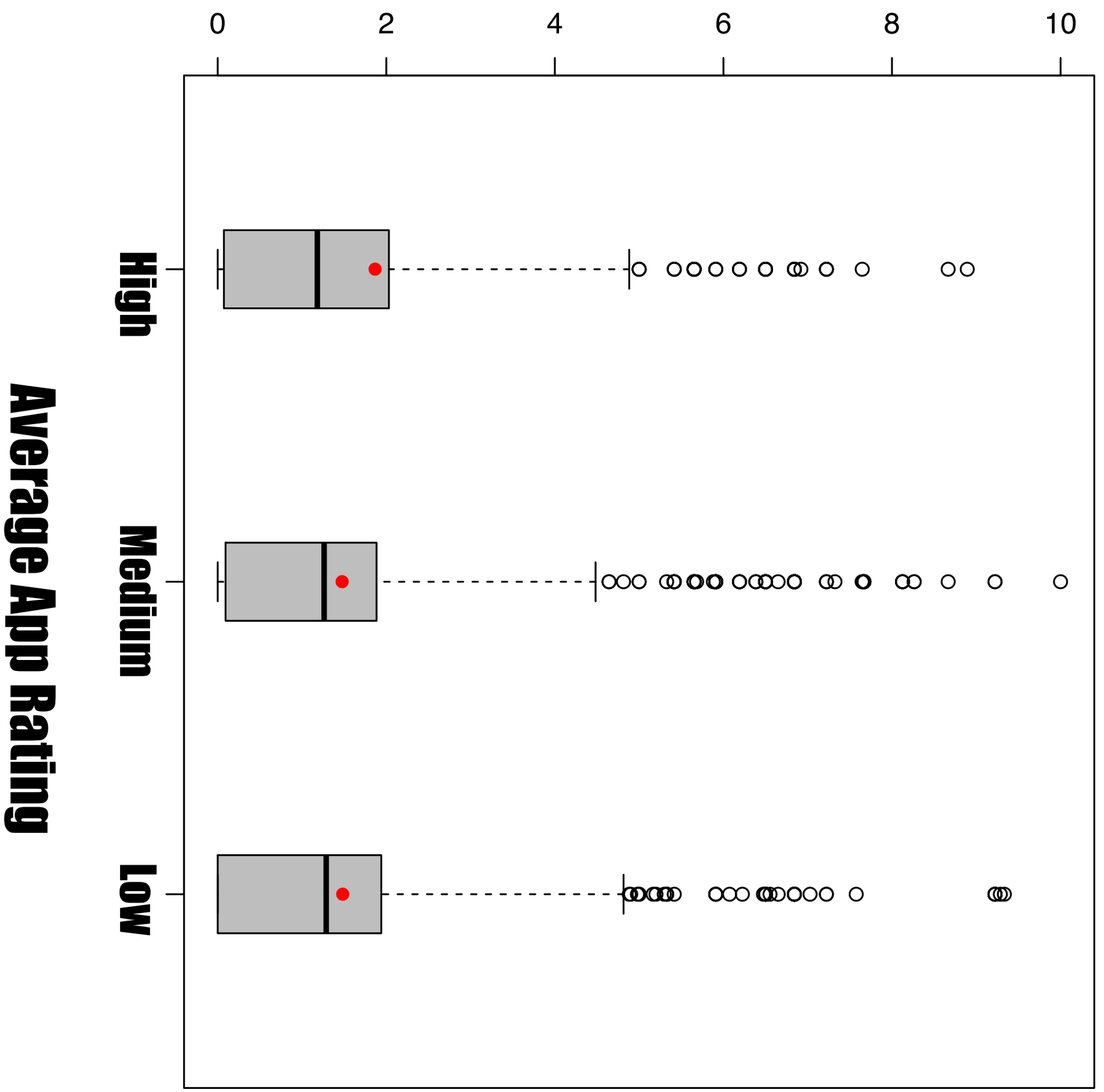
Avg changes in used APIs



50 most successful vs 50 least successful apps

+315%

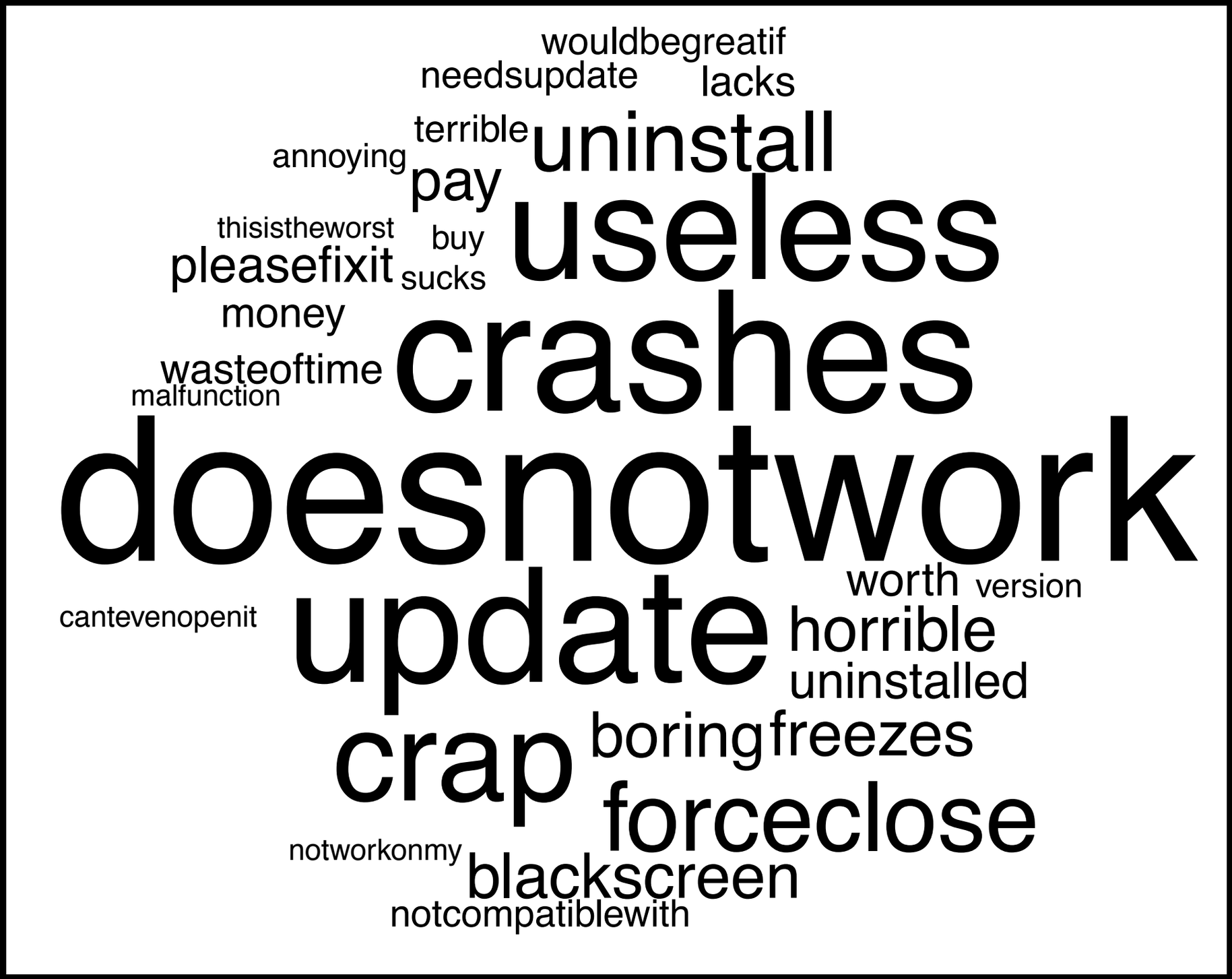
Changes in exceptions thrown by methods



APIs used by successful apps are less prone to changes than APIs used by unsuccessful apps.

No difference when the changes are on the exceptions thrown by API methods.

Qualitative analysis



Most common n-grams in low rated apps user comments

CNN App for Android Tablet

CNN - July 29, 2013

News & Magazines

Install | Add to Wishlist

★★☆☆☆ (1,056)

+1 +591 Recommend this on Google

Top Developer

482 out of 812 votes were 1 star, mostly due to presence of a bug

Rating: ★
A Google User - July 3, 2012
Widget?
The widget looks awesome when it doesn't foul up. I just don't understand the invisible widget thing. please fix

Rating: ★★
A Google User - July 6, 2012
Needs some MAJOR bug fixes
I was excited to see that the app has finally been updated. But some of its widgets became invisible.

FIX BUG #6773607: Layered views animating from offscreen sometimes remain invisible

android.speech.tts

15 Classes
460 Method changes
289 to public methods
69 bug fixes
A change each 13 days

More than 200 users complained about problems related to this feature

Facebook Android SDK (3.5)

“Every time I login to Facebook the app is forced to close”

“Started once, seemed to login with Facebook, but after that, it went back to the main screen and nothing happened”

Bug solved in version 3.5.1

Survey with Android Developers

- **Purpose:** understanding to what extent they experience problems when using APIs and how much they consider these problems to be related to negative user ratings/comments

- **Focus:** the developers' perception of the impact change- and fault-prone APIs can have on the apps' user ratings

- Developers' emails mined from Google Play

- 1,221 developers contacted via email

- Online survey (qualtrics)

45

professional Android developers

21 Questions

- Background
- Problems

when using APIs

- Impact of API on user ratings

Select, among the following, the most frequent perceived causes of app bugs/crashes

11. Java programming errors in the app

12. Use of third party libraries affected by bugs (e.g., a bug in a library used by the app causes crashes)

13. Changes in new releases of third party libraries used by the app cause crashes

14. Bugs present in the official Android APIs (e.g., a bug in the Android APIs causes the app to crash)

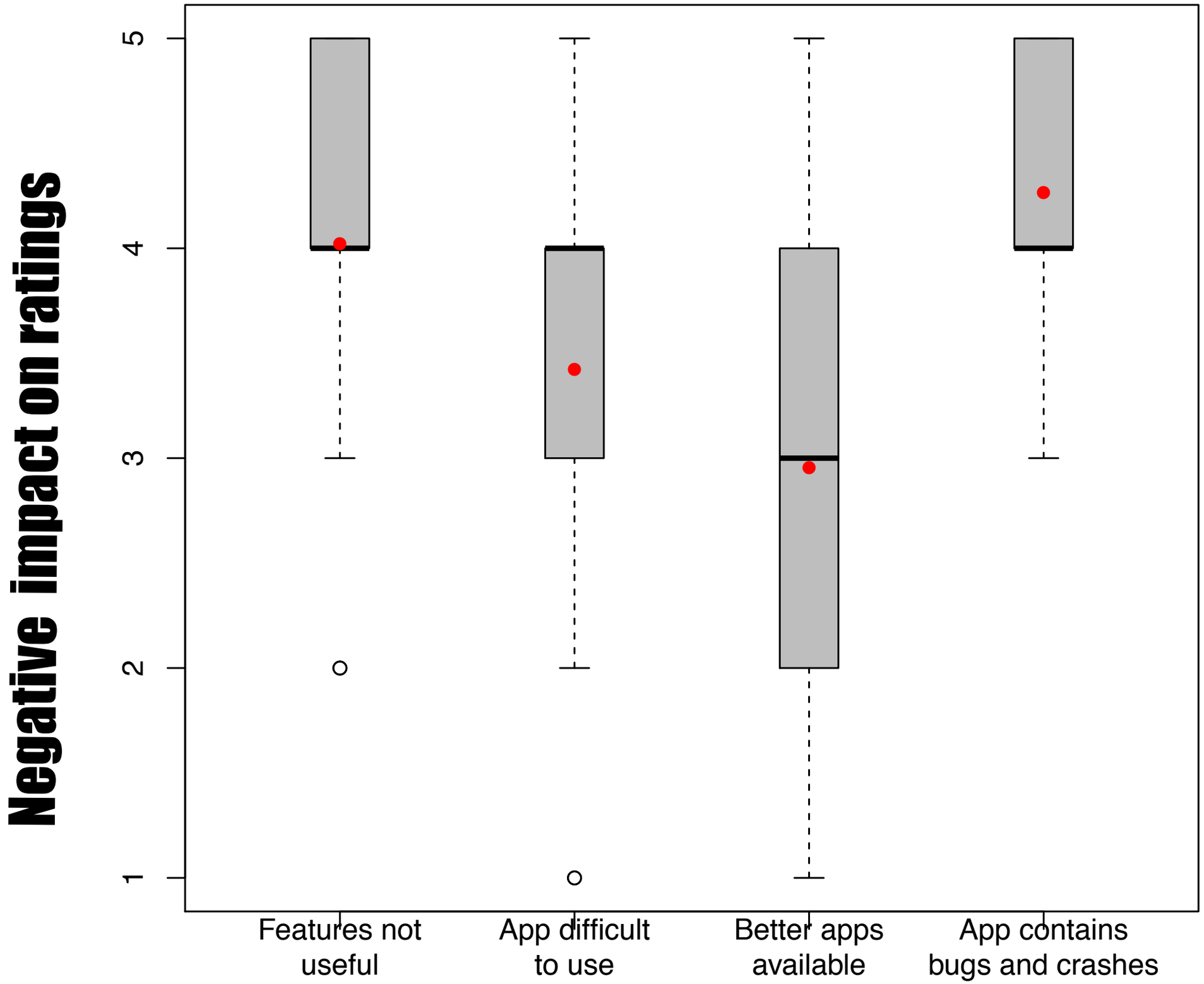
15. Changes in new releases of the official Android APIs cause the app to crash

Experiences with used APIs

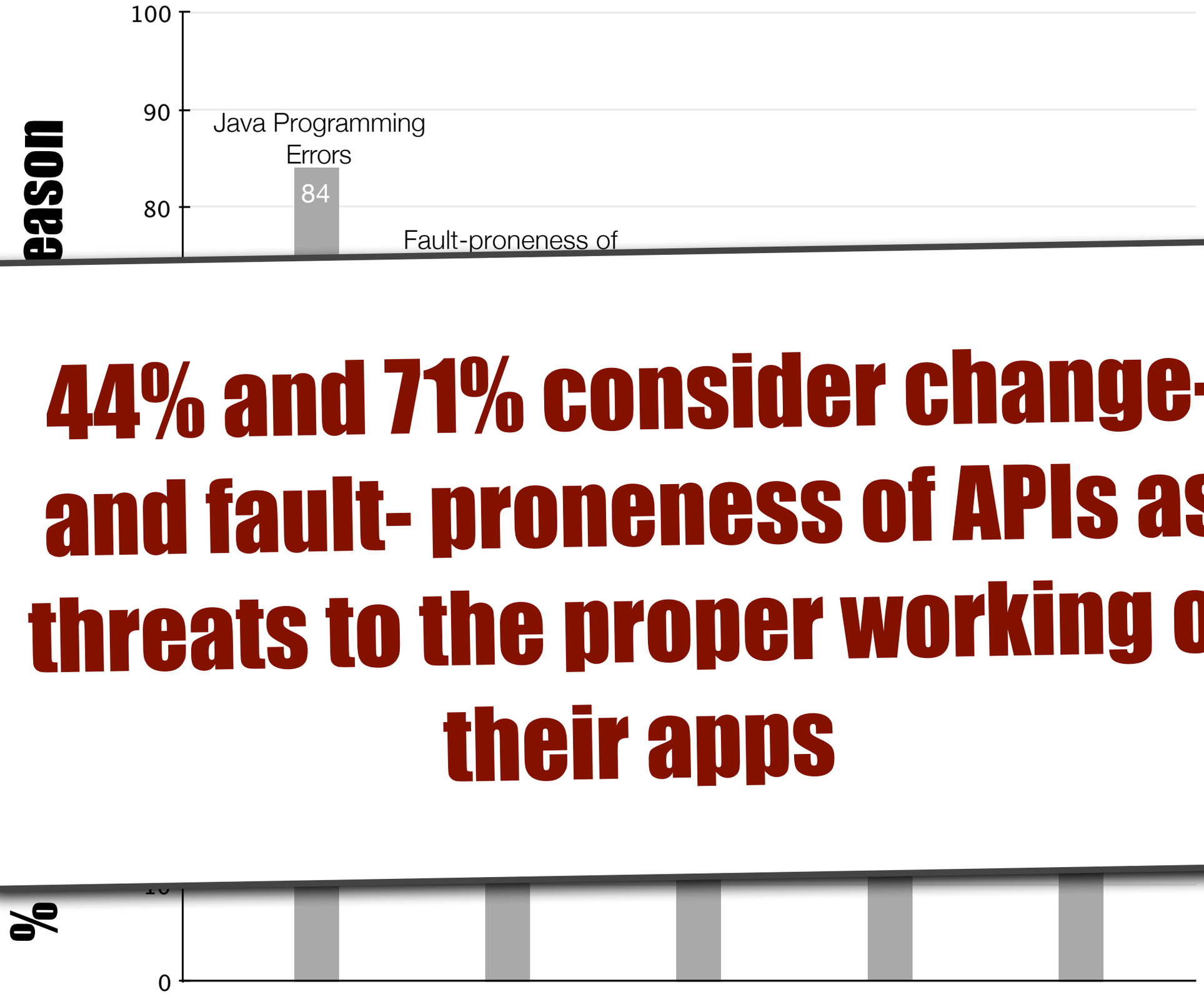
16. Did you ever experience problems with mobile development APIs?

17. If YES to 16, were they official Android APIs or third party APIs? Indicate release version and describe the problem if possible

8. Did you ever have new bugs in your app due to the new releases of the Android platform?use



Factors affecting negatively apps' rating



44% and 71% consider change- and fault- proneness of APIs as threats to the proper working of their apps

Android Honeycomb (3.0)

"the removal of the menu button resulted in bad user experiences with my apps and, consequently, in bad user ratings/comments"

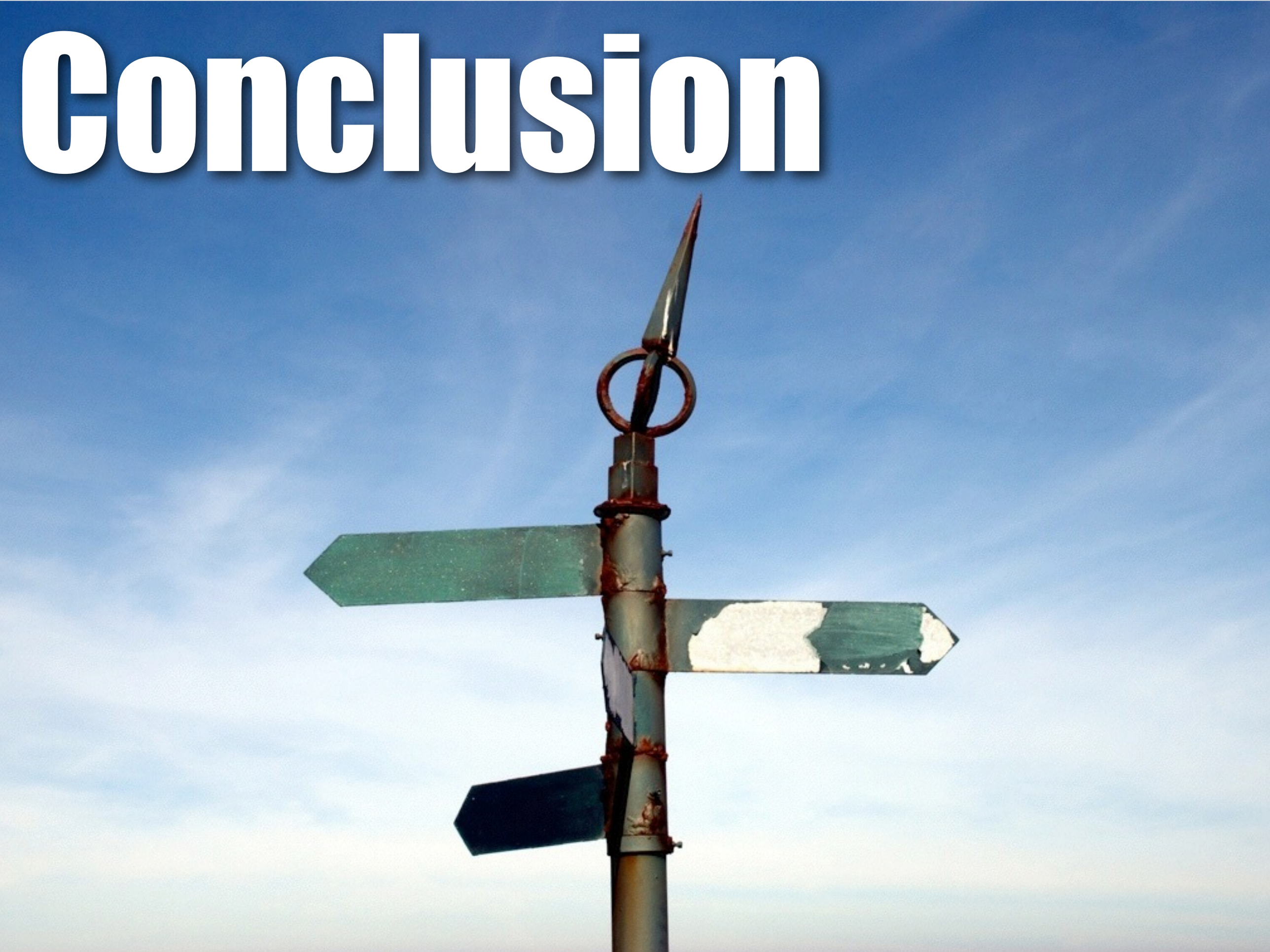
MoPub library

"for few days I received bad user comments due to crashes in my app. However, the moPub team rapidly fixed the problem"

Android Honeycomb (3.2)

"my app worked fine until Android 3.2 (API level 13). Then, the app started to crash on screen rotation. This was due to a change in the Android APIs requiring, besides the management of the orientation value (as needed until API level 12), also the management of the screenSize value when a screen rotation event arises. Unfortunately, given to commitments on other projects it took some days to fix the problem and this resulted in several low ratings for my apps"

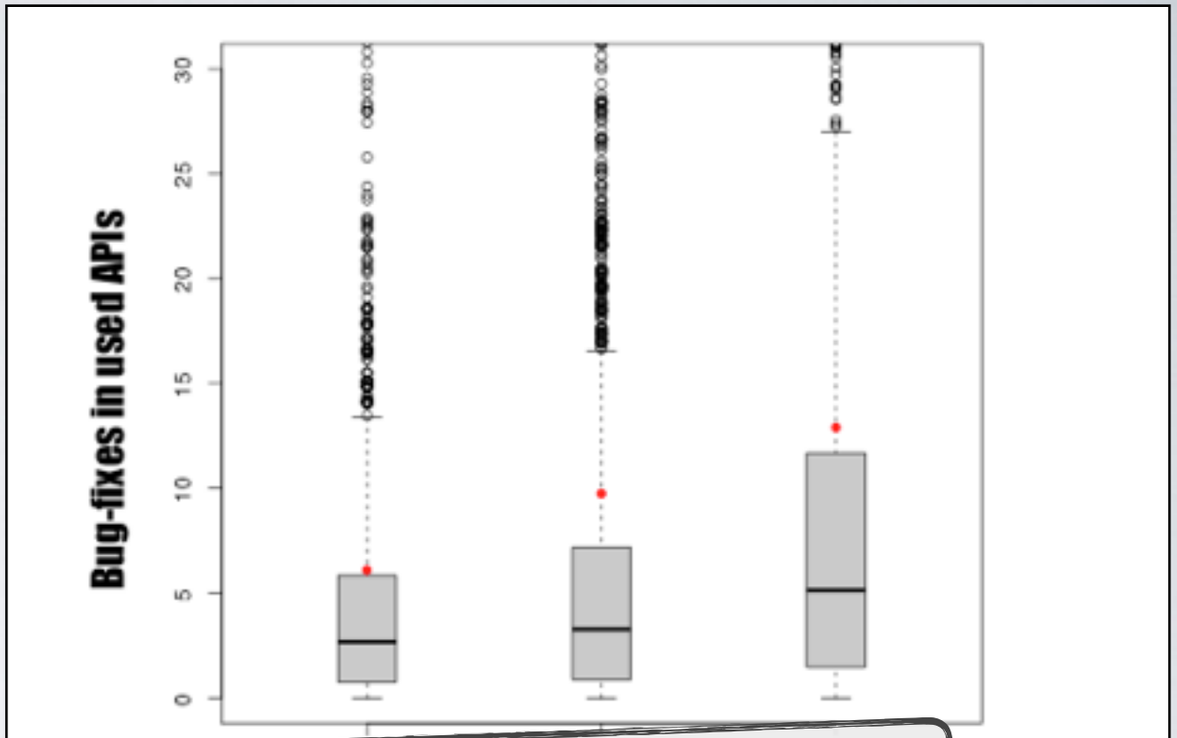
Conclusion



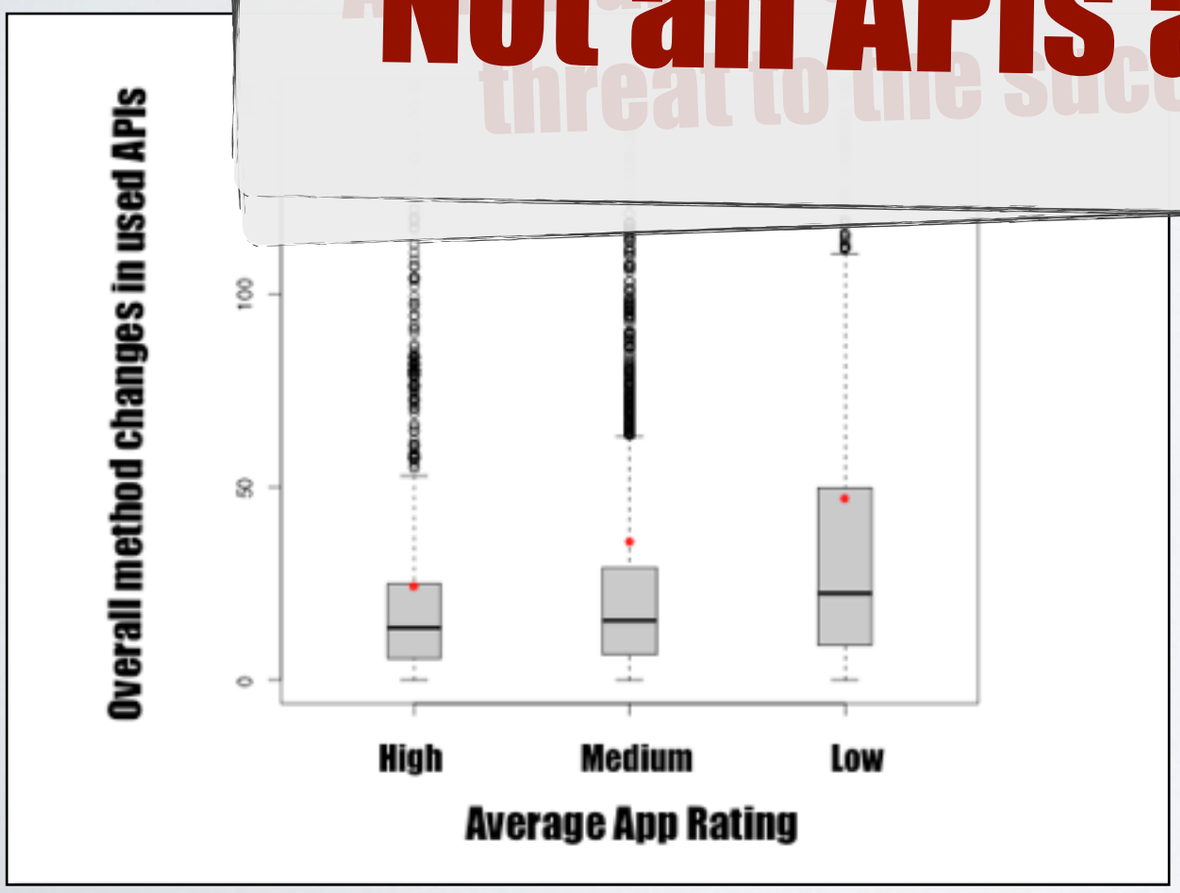
5848

Free Apps

analy



Not all APIs are the same...



Long-term Goals

Create recommendation systems aimed at warning developers about breaking/buggy changes in the APIs

Create recommendation systems aimed at suggesting the developers which APIs to use given specific needs

Thanks

Denys Poshyvanyk
denys@cs.wm.edu

http://www.cs.wm.edu/~denys/