

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

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



# The App Economy





# Tremendous success ...

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

2013: **850,000** apps available  
(GooglePlay) with around **48**  
**billion** downloads



# **Revenue models**

**Tremendous  
SUCCESS ...**



image: eyefix.com

**Customer loyalty**

**Low cost of  
handsets**





# However...



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



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

**THERE ARE SOME  
ISSUES RELATED  
TO APIS**





**Breaking changes**

**Instability**

**Bugs**

**Backward compatibility**



# Among 1513 bug reports:

## Useful, but usable? Factors Affecting the Usability of APIs

Minhaz F. Zibran

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Chanchal K. Roy

Department of Computer Science, University of Saskatchewan, Saskatoon, SK, Canada S7N 5C9  
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**Abstract**—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.  
There are many different API usability attributes observed  
researchers and practitioners, though no one  
until Zibran [21], the  
comprehensive list of 22



# Among 1513 bug reports:

# 562 API usability issues

## Useful, but usable? Factors Affecting the Usability of APIs

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# Among 1513 bug reports:

# 175 API

# correctness

## Useful, but usable? Factors Affecting the Usability of APIs

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**Is the Android  
API change/  
fault prone ?**



**17 releases in about 5 years ...**

**17 releases in about 5 years ...**

**3269**

**classes**





**New classes**



**17 releases in about 5 years ...**

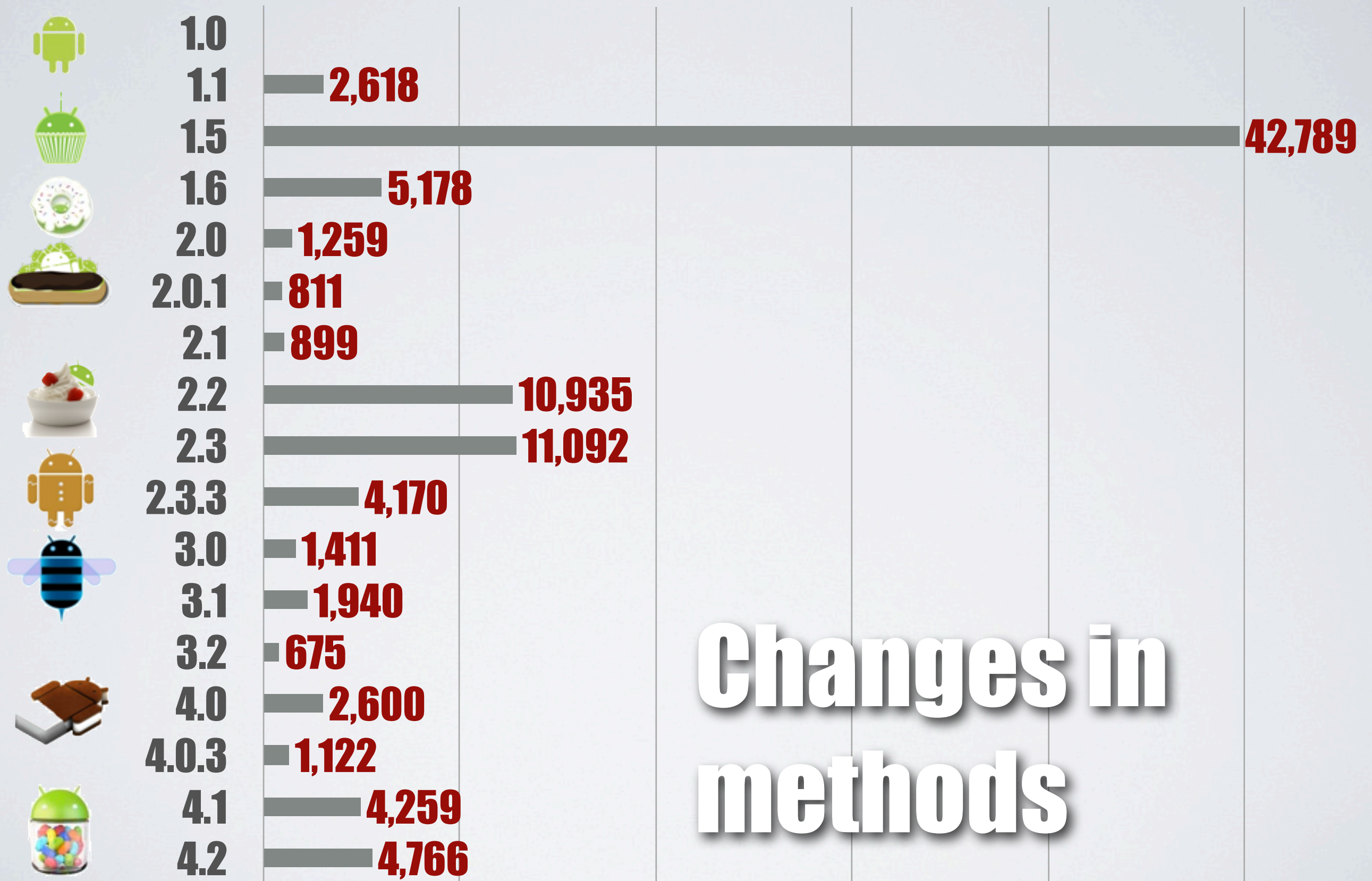
**17 releases in about 5 years ...**

**96524**

**changes in  
methods**

**96524**





Changes in  
methods

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





# 7097

**Free Apps  
analyzed**



# 30

Domain  
categories from  
Google play





**App's success:** **Average users  
rating**

**App's success:** **Average users rating**

**API fault-proneness:** **Number of bugs fixed in the APIs**



**App's success:** **Average users rating**

**API fault-proneness:** **Number of bugs fixed in the APIs**

**API change-proneness:** **Number of API changes at method level**

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 weeks ago

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

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 ago

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 ago

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

098fe71 Merge remote-tracking branch 'origin/jb-mr2-zeroday-release' into HEAD by The Android Automerger - 8 weeks ago

android-4.3\_r2

090c669 Reconcile with "

do not merge by The Android Open Source Project - 9 weeks ago

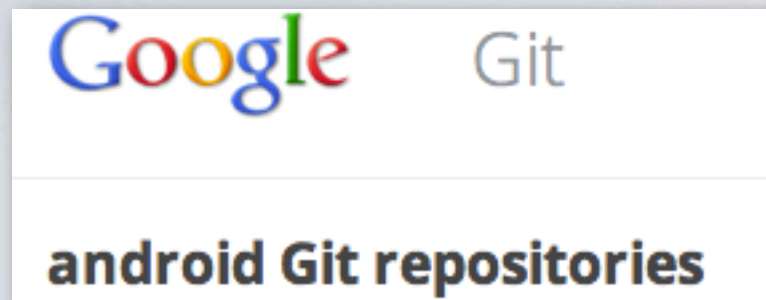
## Populating a Release History Database from Version Control and Bug Tracking Systems\*

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. Unfortunately, current version and bug report systems provide no support for the combination of both data in software evolution

# Bug-fixes in APIs





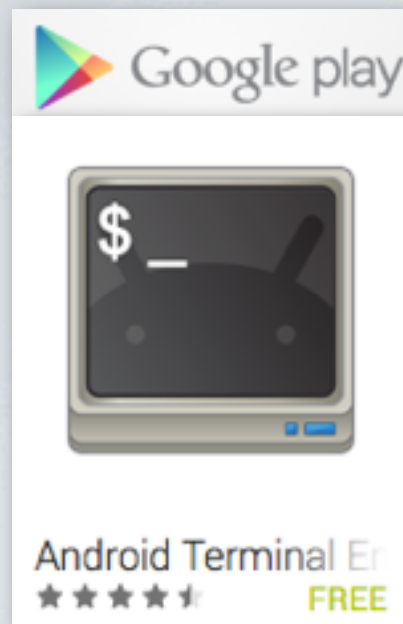
# MARKOS code analyzer



**Changes  
at method level**

- **Generic changes**
- **Method signature**
- **Exceptions**



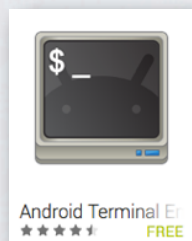


**android.app.ActionBar**

⋮

**android.gesture.Gesture**

# Bug-fixes, and changes in the used APIs



**time...**

**Considered version**

**Next version or last rating**



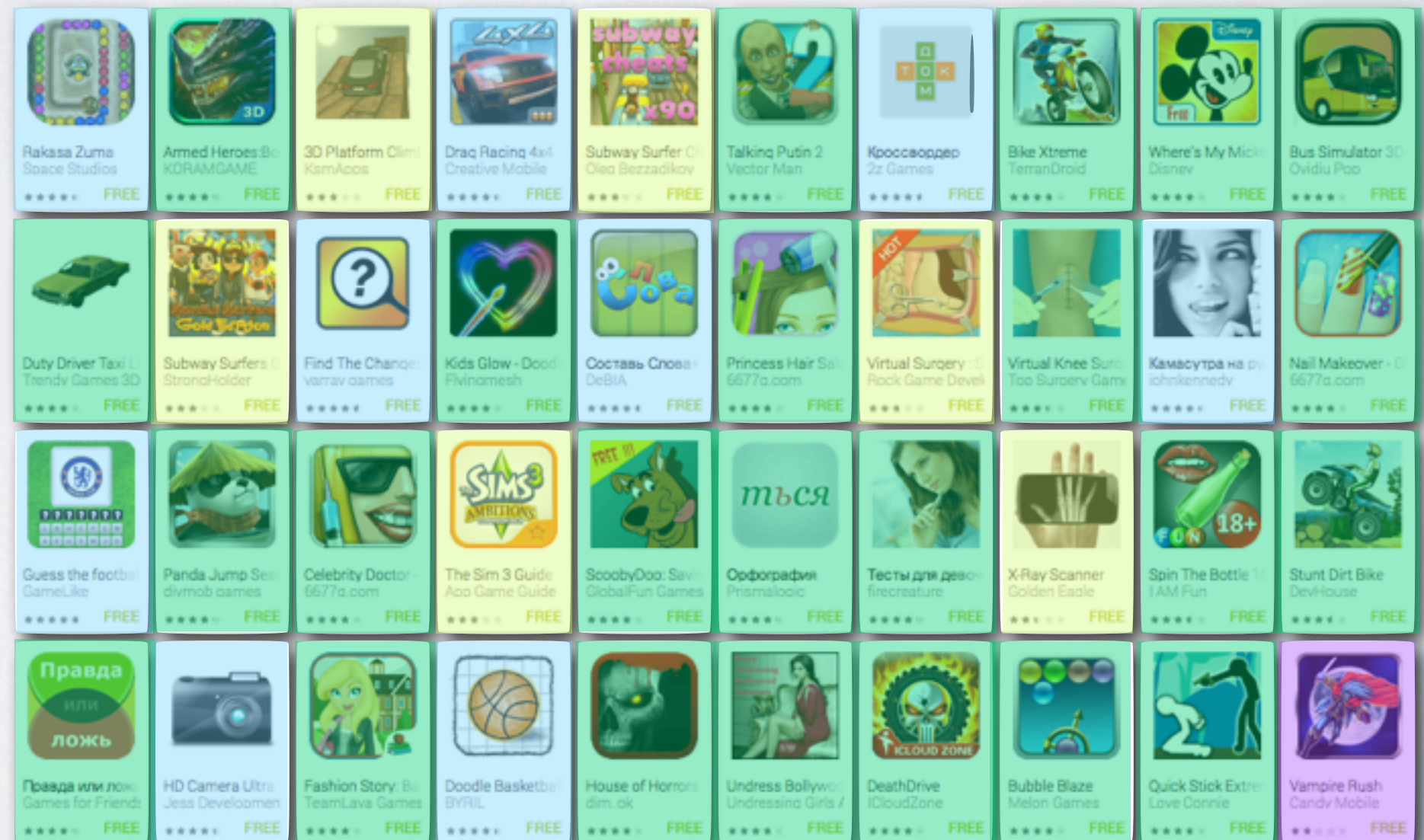
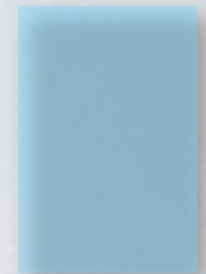
# Average App rating

$2 \leq r_a$

$2 < r_a \leq 3$

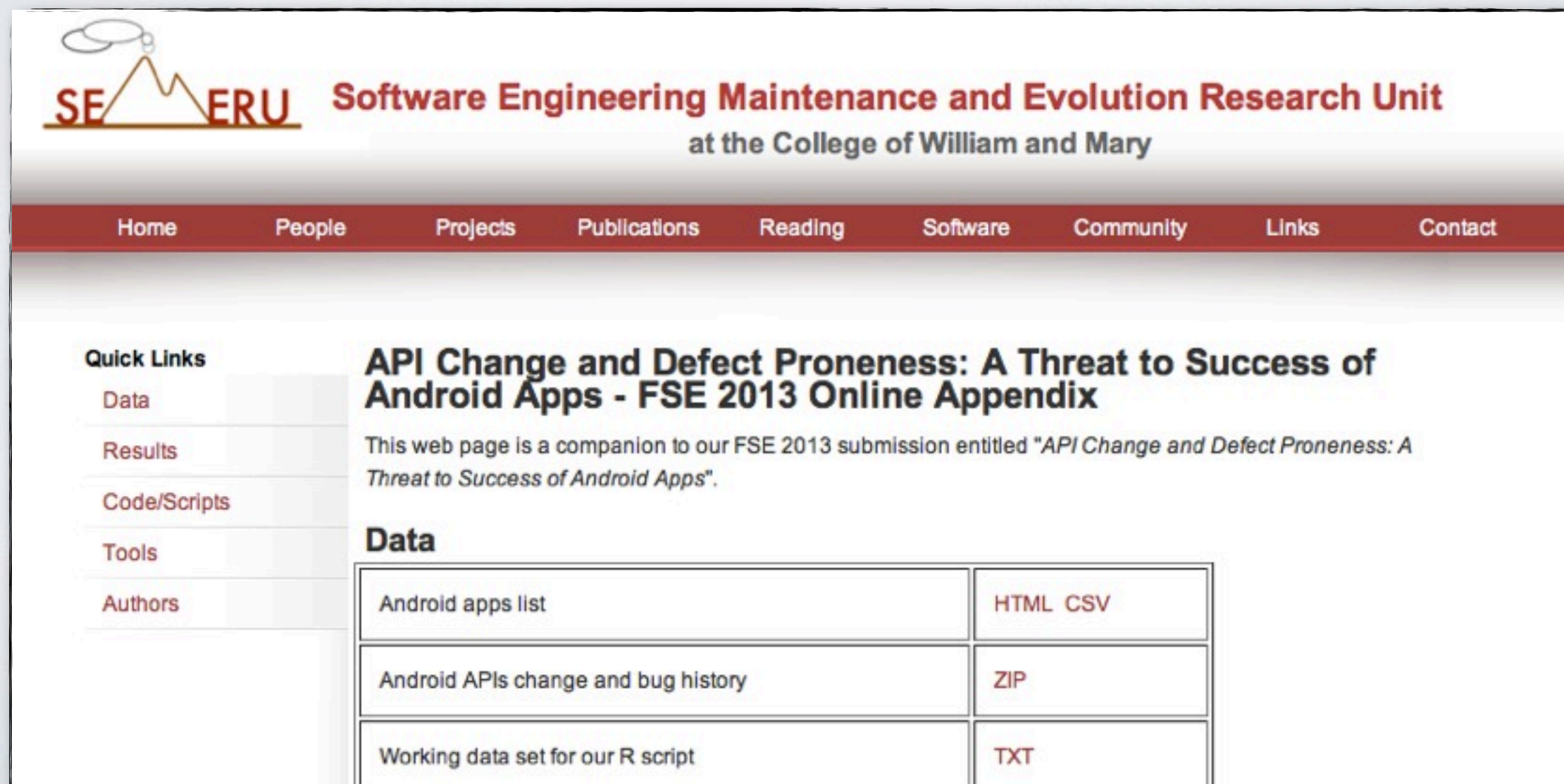
$3 < r_a \leq 4$

$r_a > 4$



# All the data are available at...

**[http://www.cs.wm.edu/semeru/  
data/fse-android-api/](http://www.cs.wm.edu/semeru/data/fse-android-api/)**



The screenshot shows the SEMERU website. The header includes the SEMERU logo (a stylized mountain with a thought bubble) and the text "Software Engineering Maintenance and Evolution Research Unit at the College of William and Mary". A navigation bar contains links: Home, People, Projects, Publications, Reading, Software, Community, Links, and Contact. On the left, a "Quick Links" sidebar lists: Data, Results, Code/Scripts, Tools, and Authors. The main content area features the title "API Change and Defect Proneness: A Threat to Success of Android Apps - FSE 2013 Online Appendix", a description of the page as a companion to an FSE 2013 submission, and a "Data" section with a table of available datasets.

**SEMERU** Software Engineering Maintenance and Evolution Research Unit  
at the College of William and Mary

Home People Projects Publications Reading Software Community Links Contact

**Quick Links**

- Data
- Results
- Code/Scripts
- Tools
- Authors

**API Change and Defect Proneness: A Threat to Success of Android Apps - FSE 2013 Online Appendix**

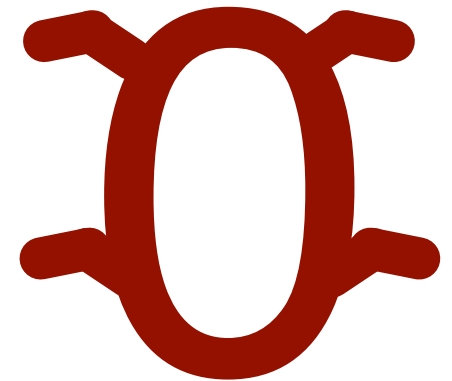
This web page is a companion to our FSE 2013 submission entitled "*API Change and Defect Proneness: A Threat to Success of Android Apps*".

**Data**

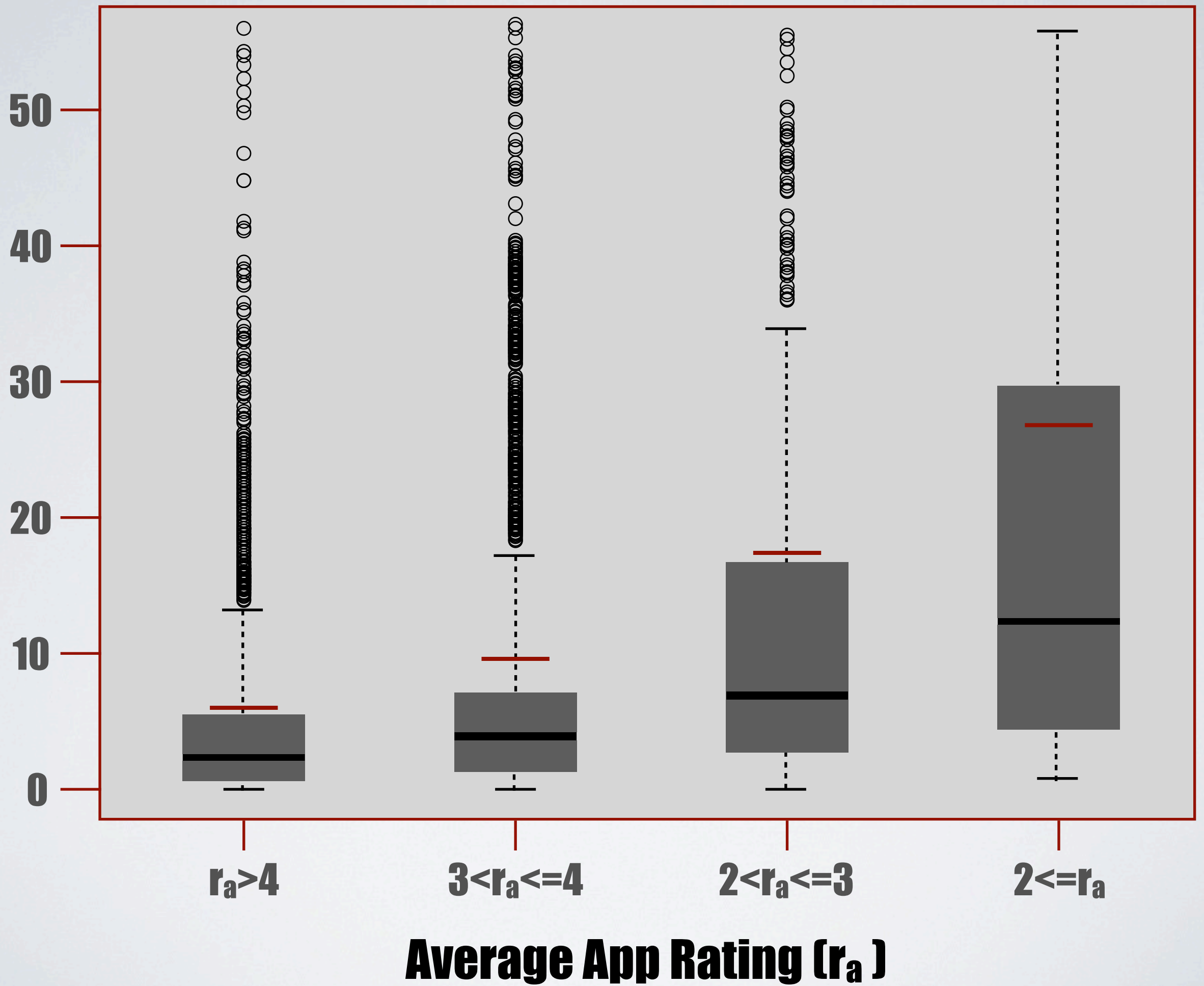
Android apps list	HTML CSV
Android APIs change and bug history	ZIP
Working data set for our R script	TXT



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



# Bug-fixes in used APIs





# Avg bug-fixes in used APIs

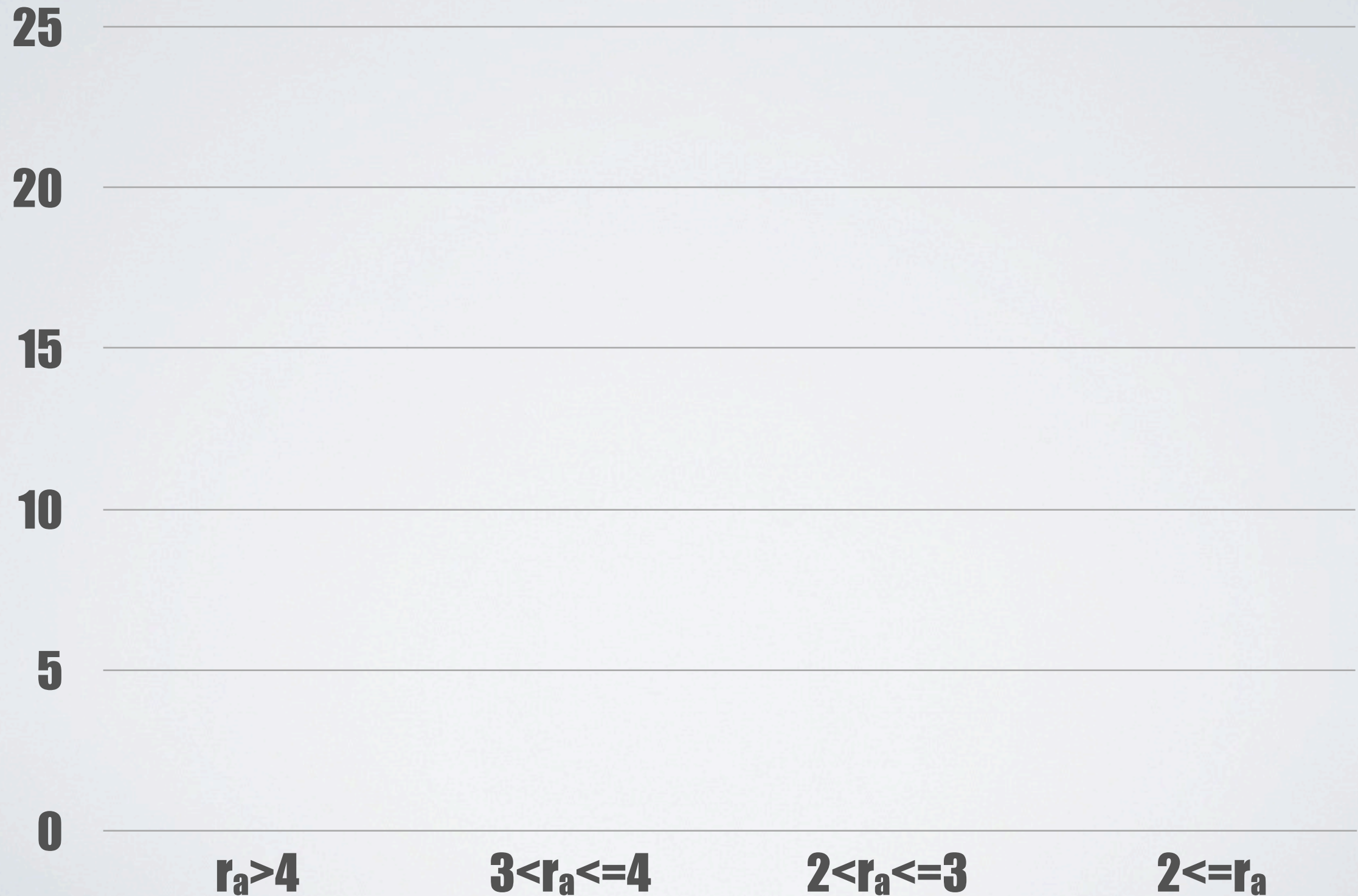
$r_a > 4$

$3 < r_a \leq 4$

$2 < r_a \leq 3$

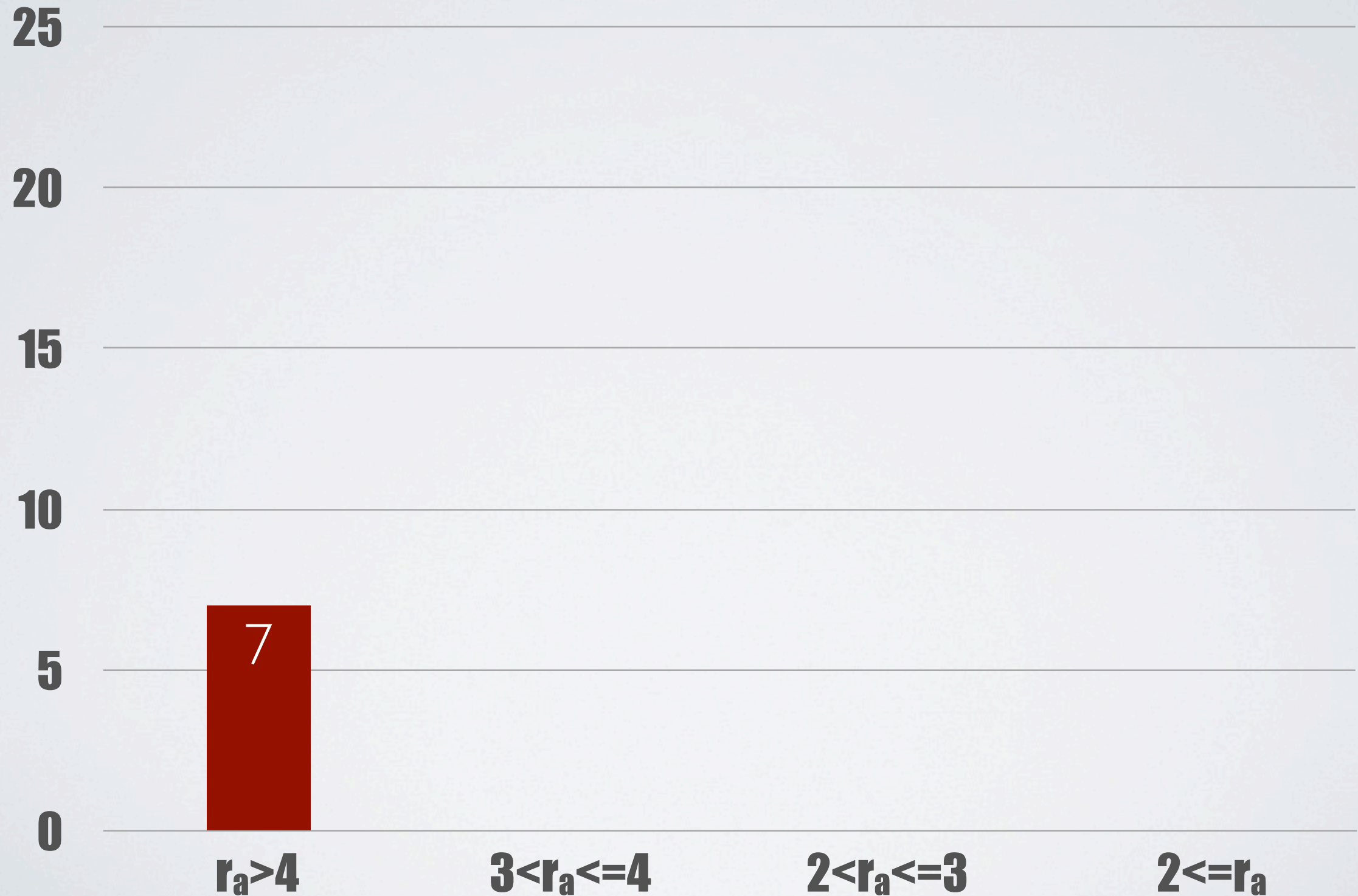
$2 \leq r_a$

# Avg bug-fixes in used APIs

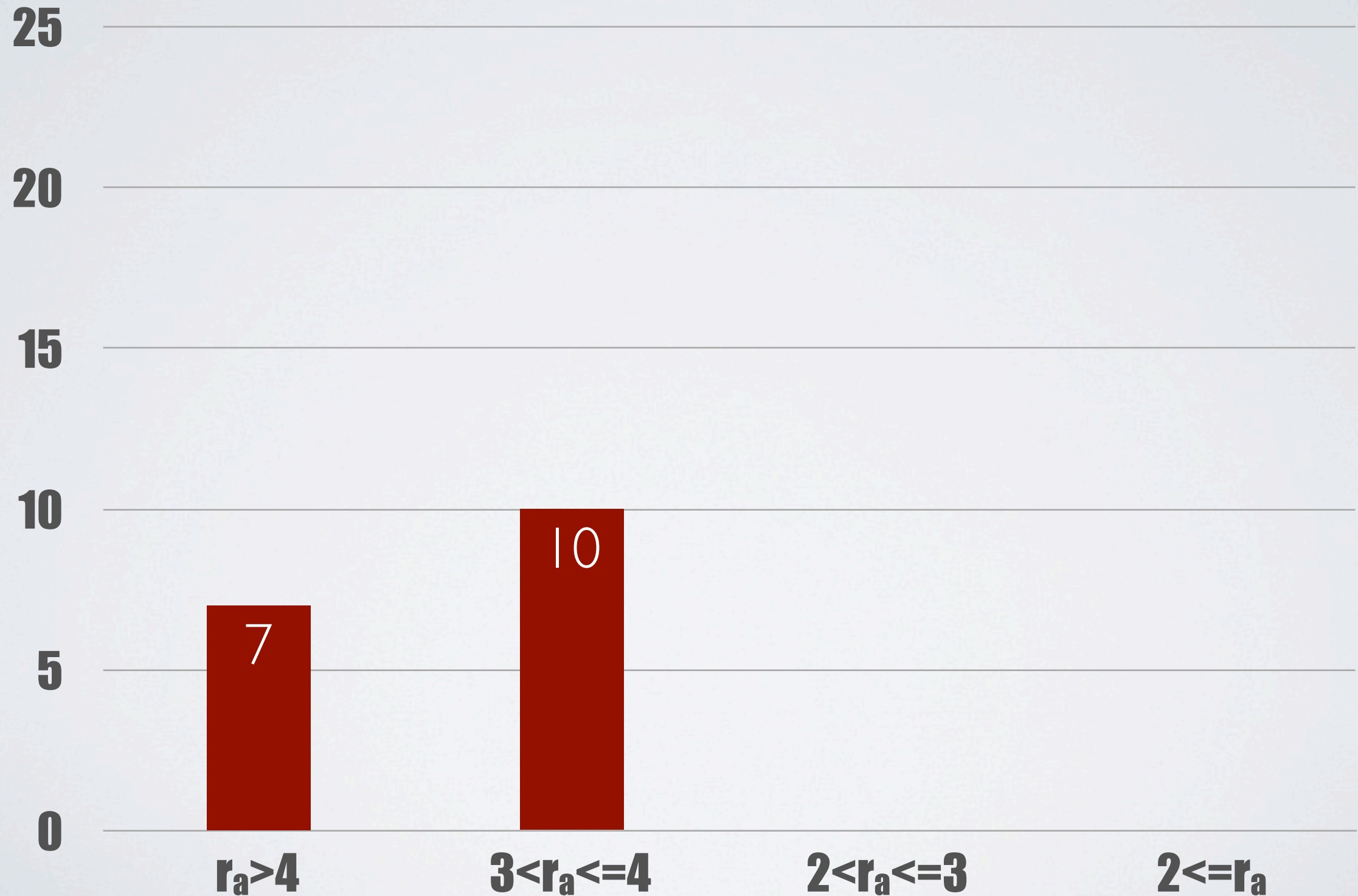




# Avg bug-fixes in used APIs

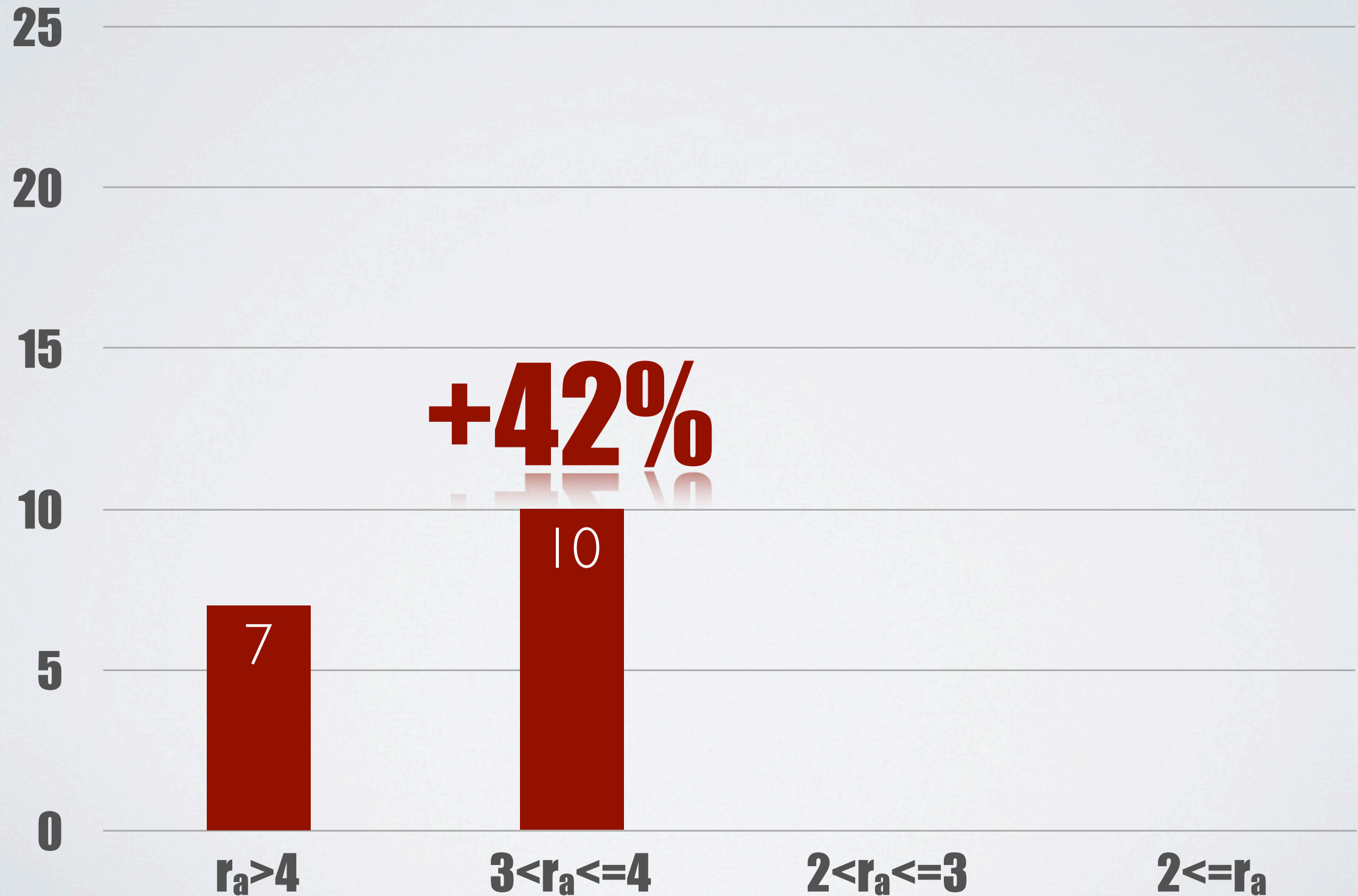


# Avg bug-fixes in used APIs

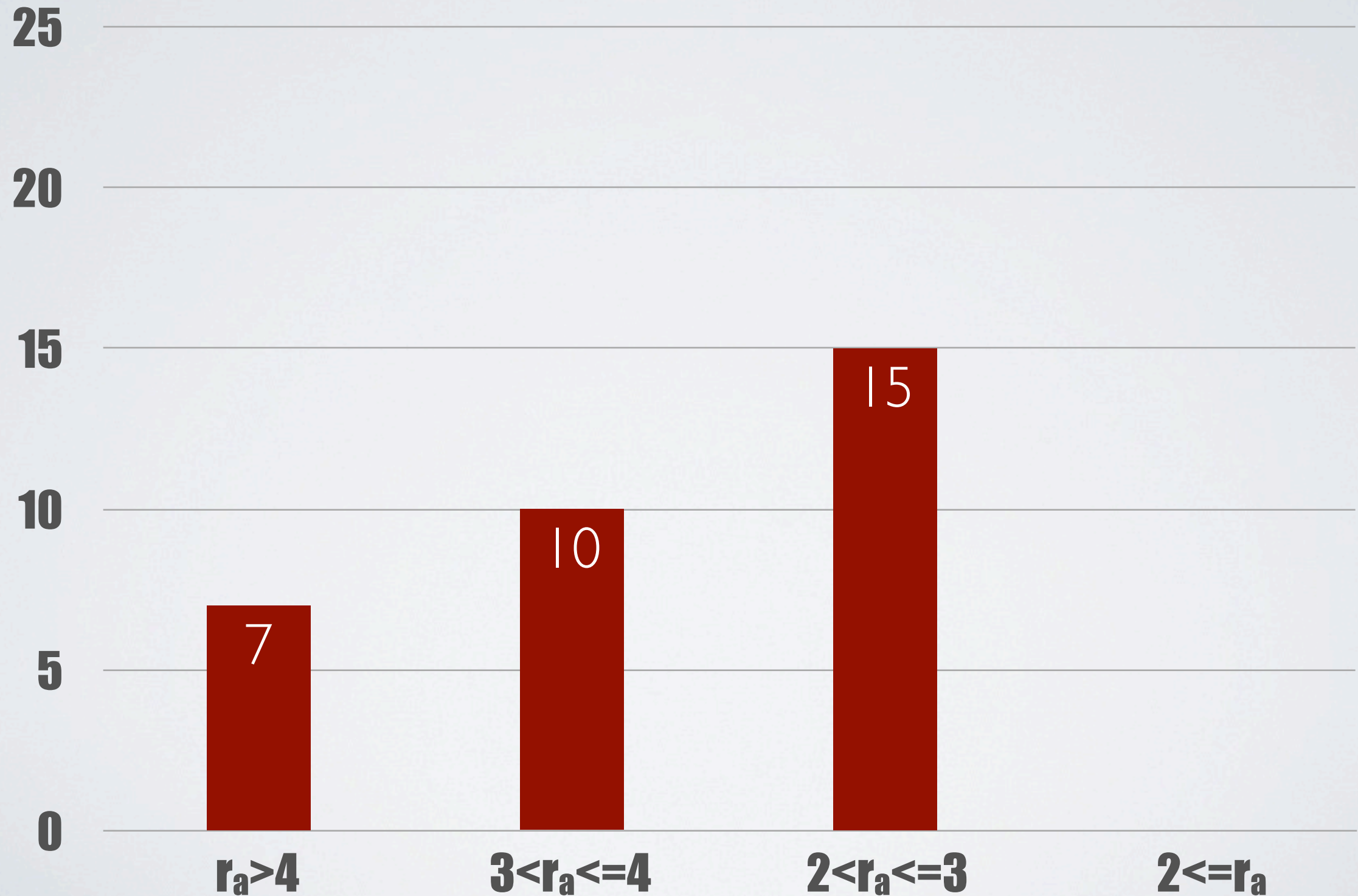




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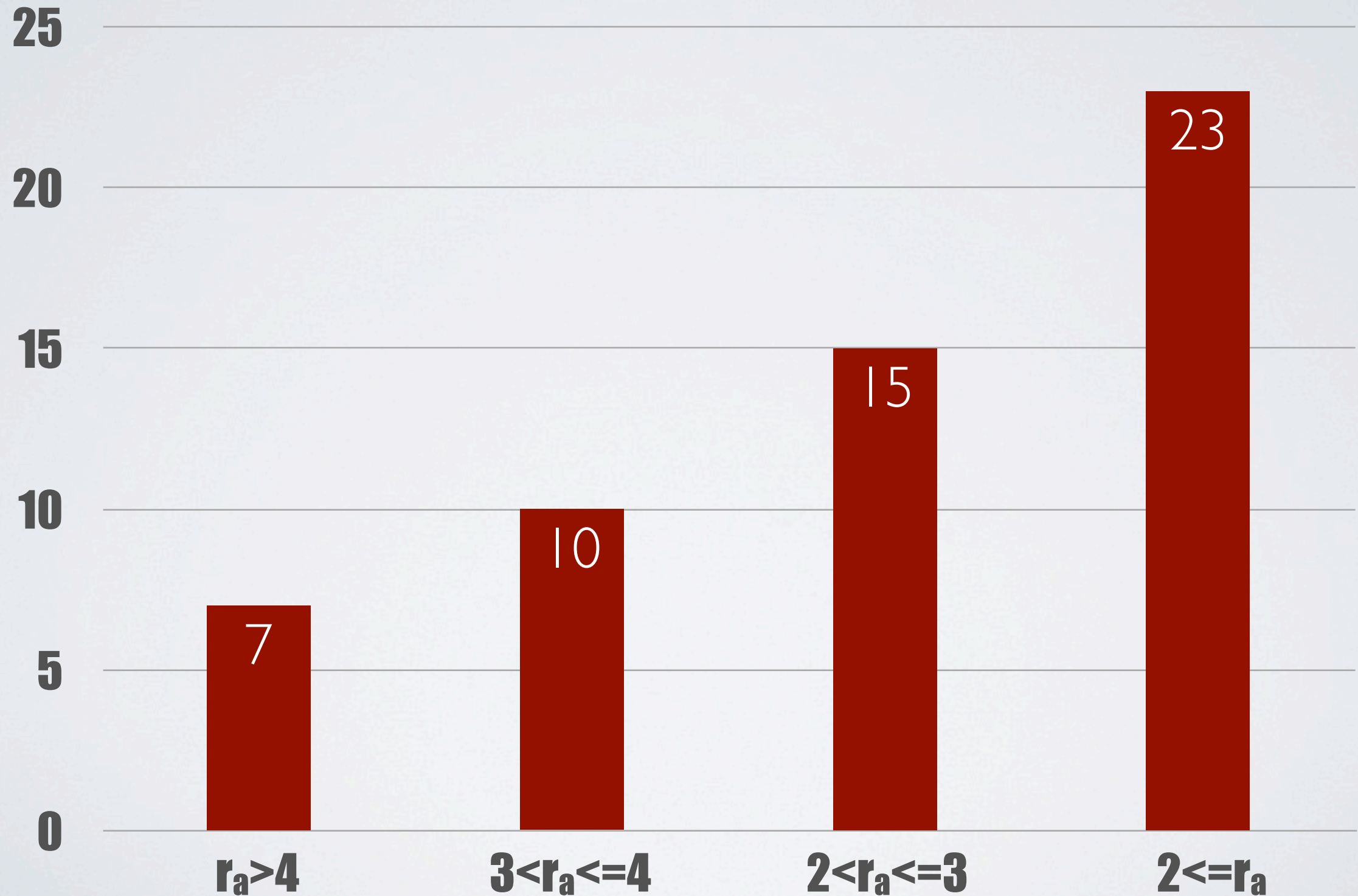




# Avg bug-fixes in used APIs

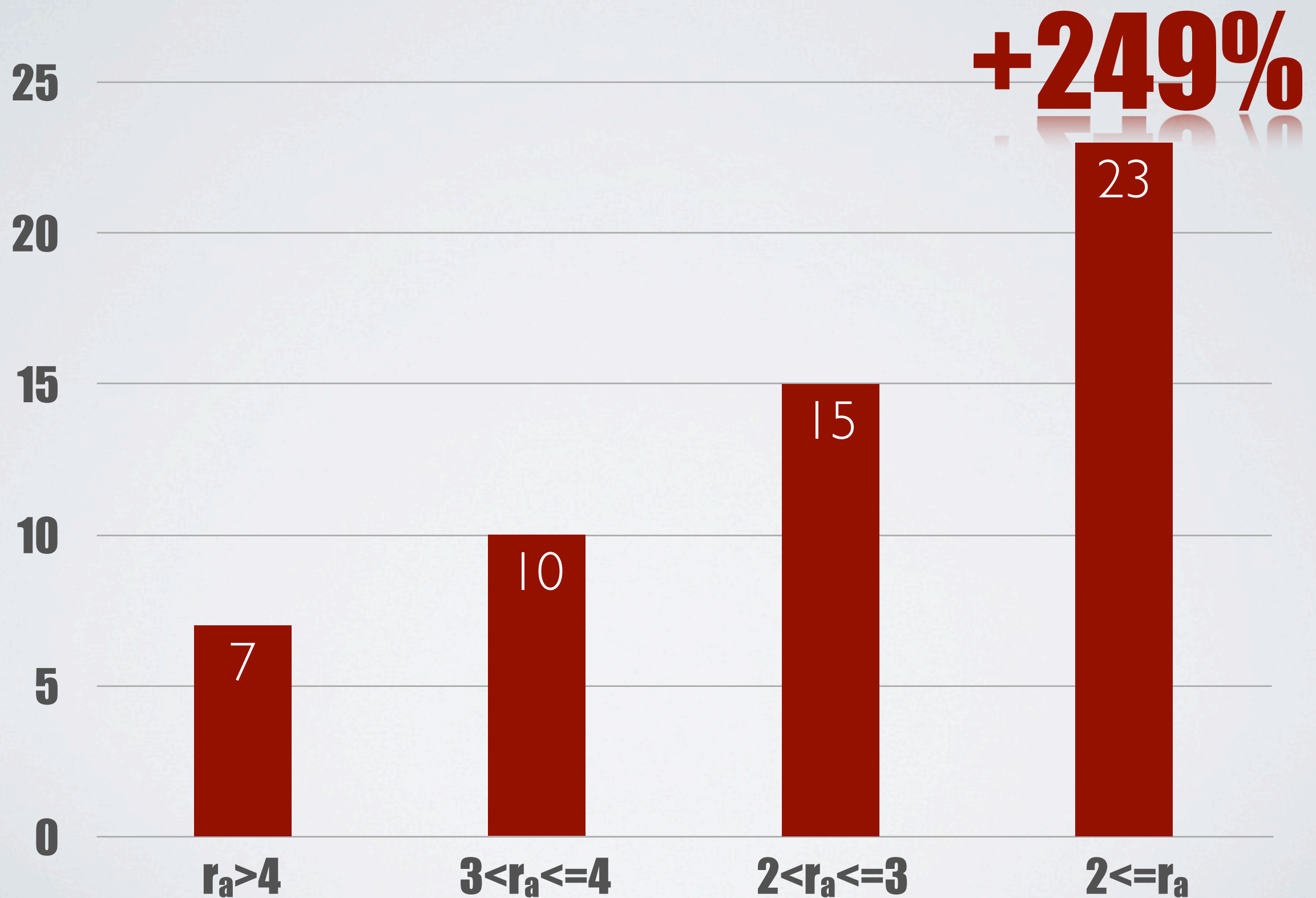


# Avg bug-fixes in used APIs





# Avg bug-fixes in used APIs



# **50 most successful vs 50 least successful apps**



**50 most successful vs  
50 least successful apps**

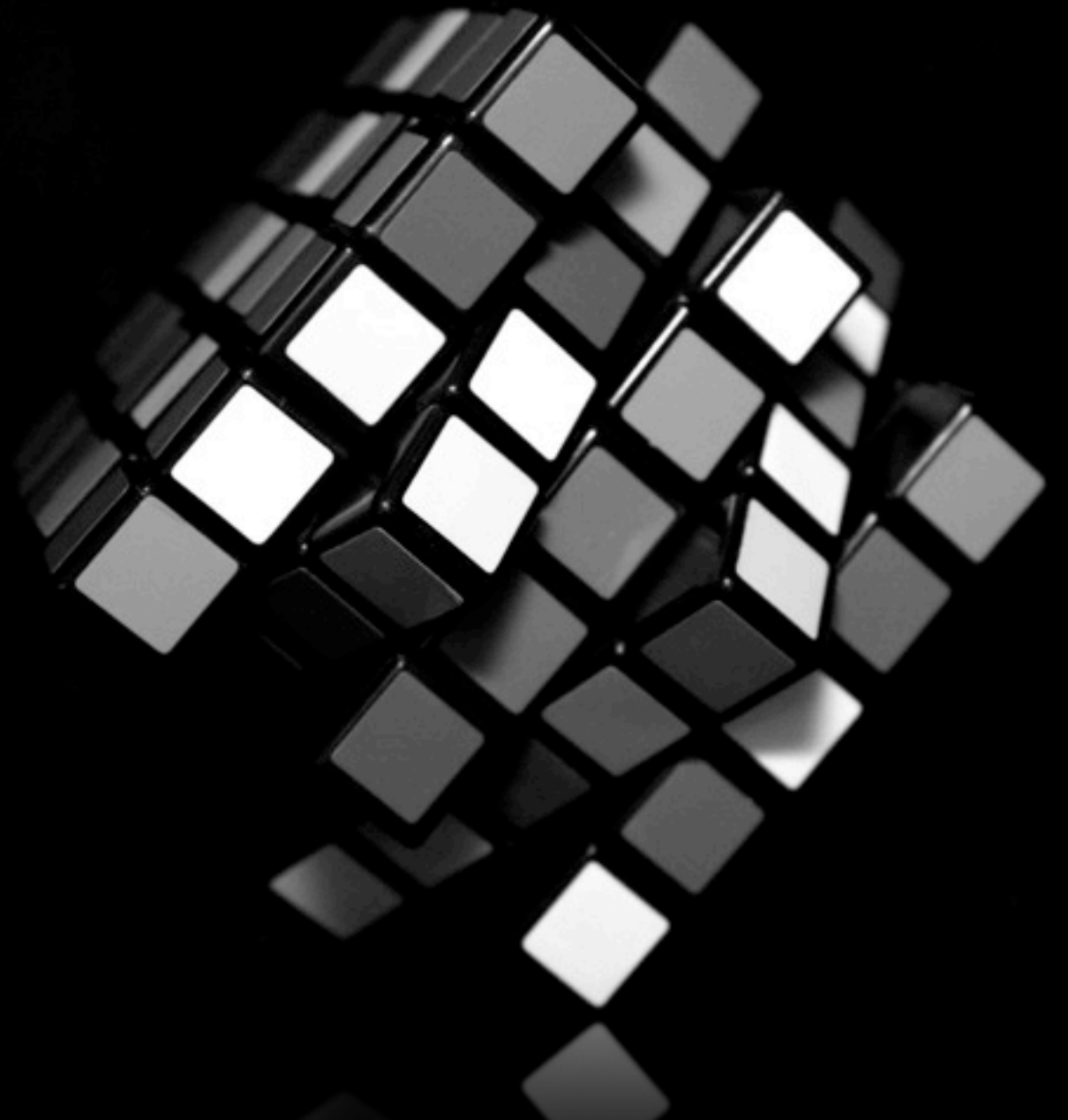
**+500%**



**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?**



**Overall method changes in used APIs**

250  
200  
150  
100  
50  
0

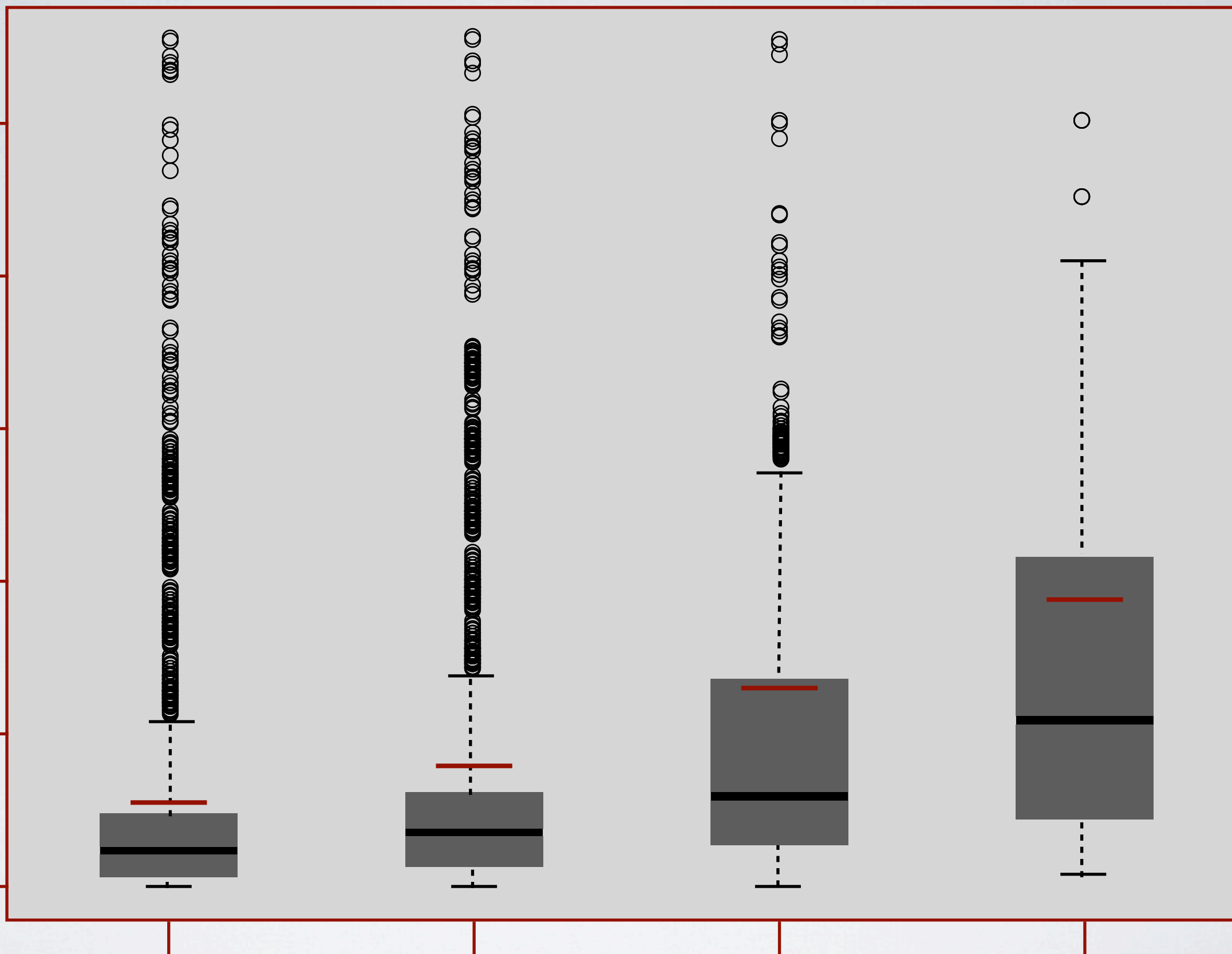
$r_a > 4$

$3 < r_a \leq 4$

$2 < r_a \leq 3$

$2 \leq r_a$

**Average App Rating ( $r_a$ )**





# Avg changes in used APIs

**$r_a > 4$**

**$3 < r_a \leq 4$**

**$2 < r_a \leq 3$**

**$2 \leq r_a$**

# Avg changes in used APIs

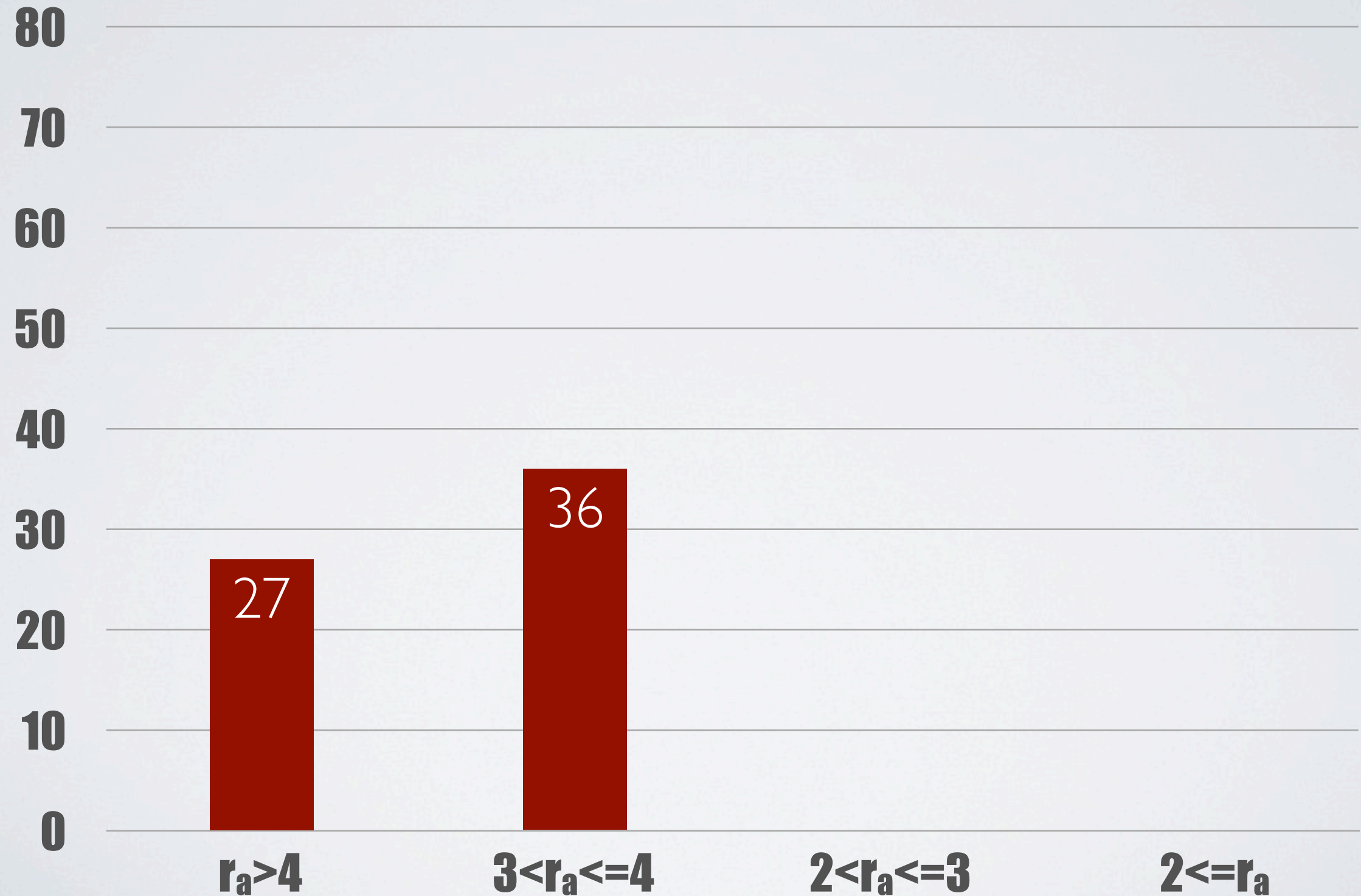




# Avg changes in used APIs

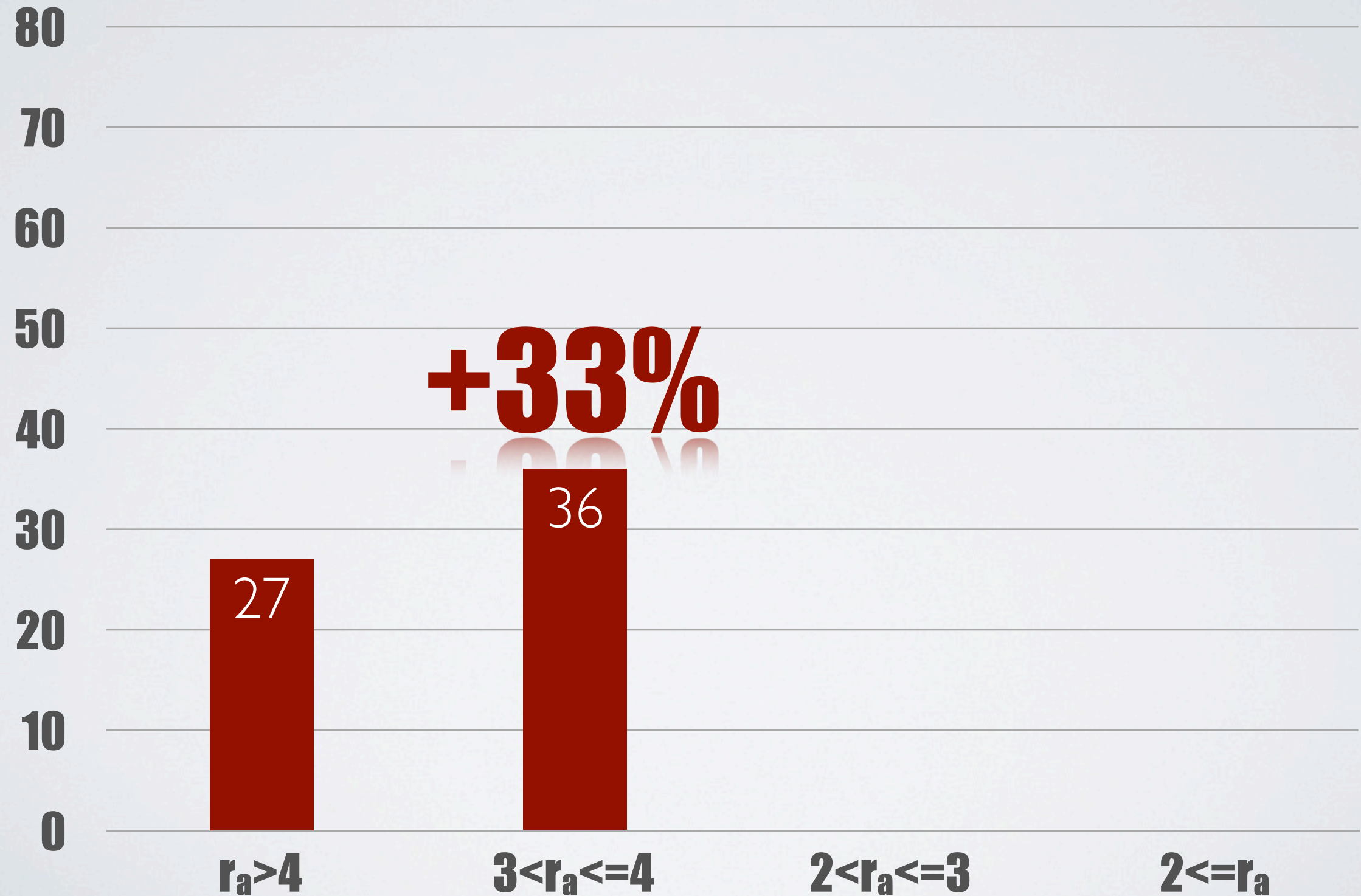


# Avg changes in used APIs

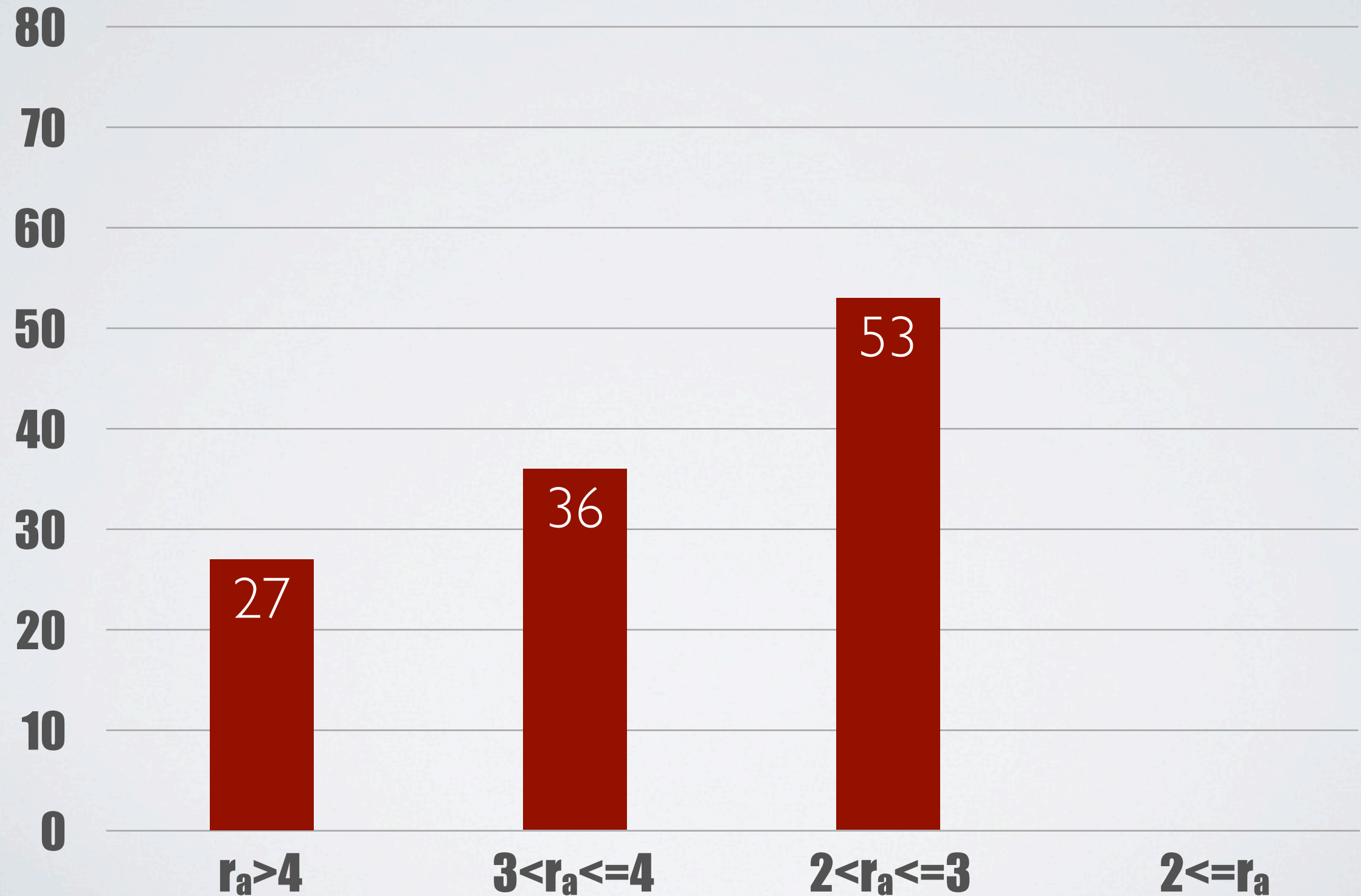




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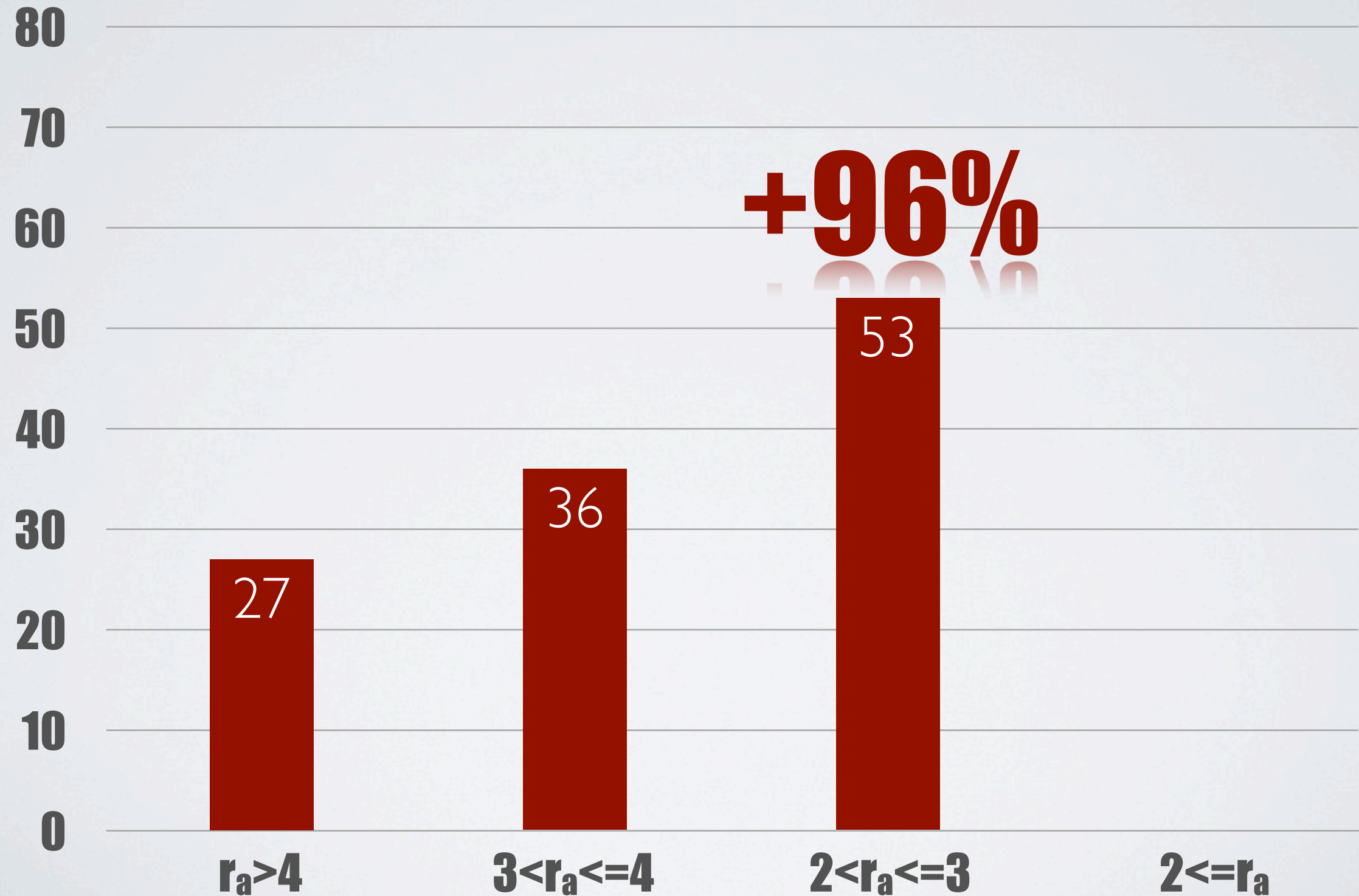


# Avg changes in used APIs

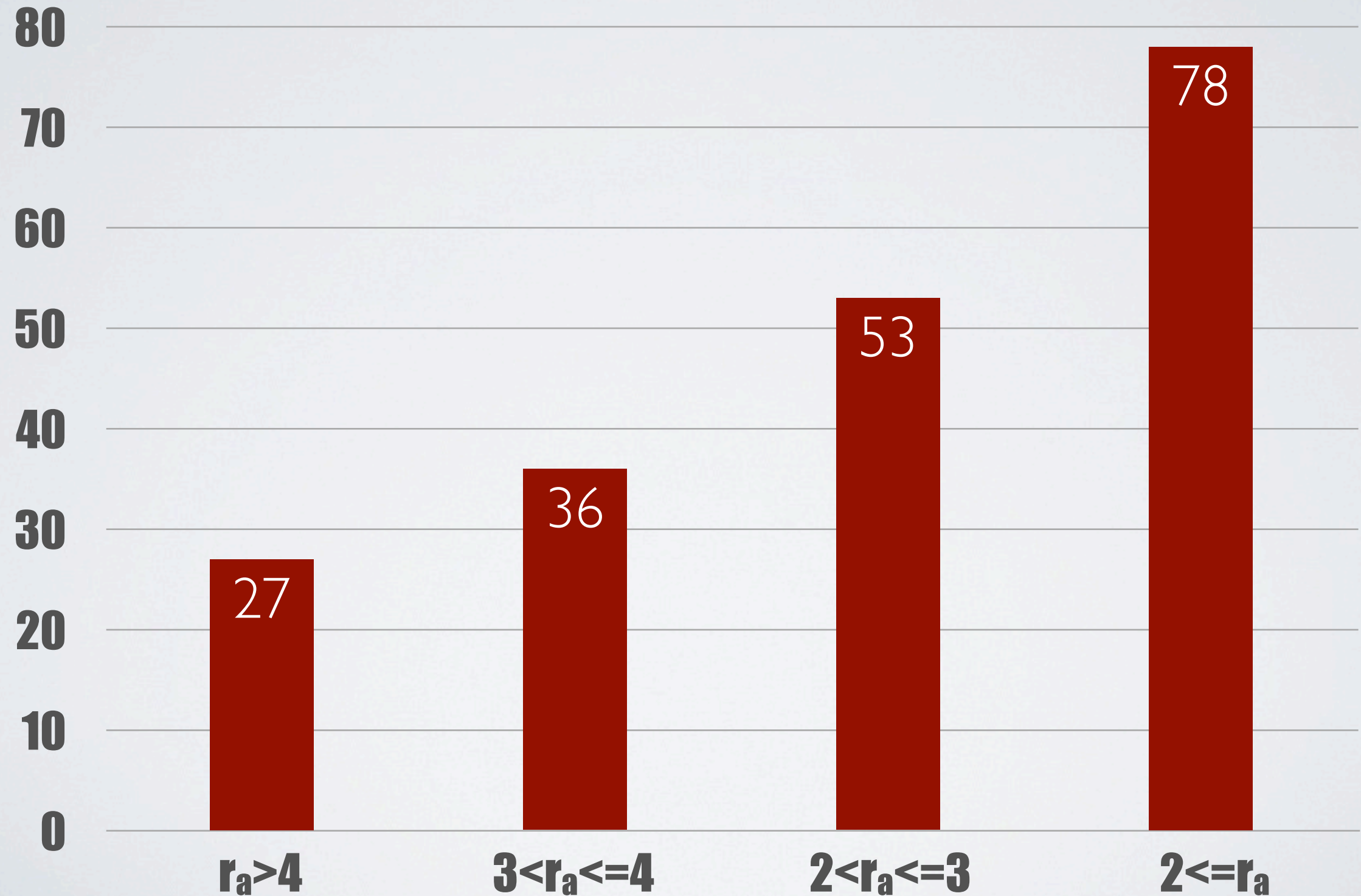




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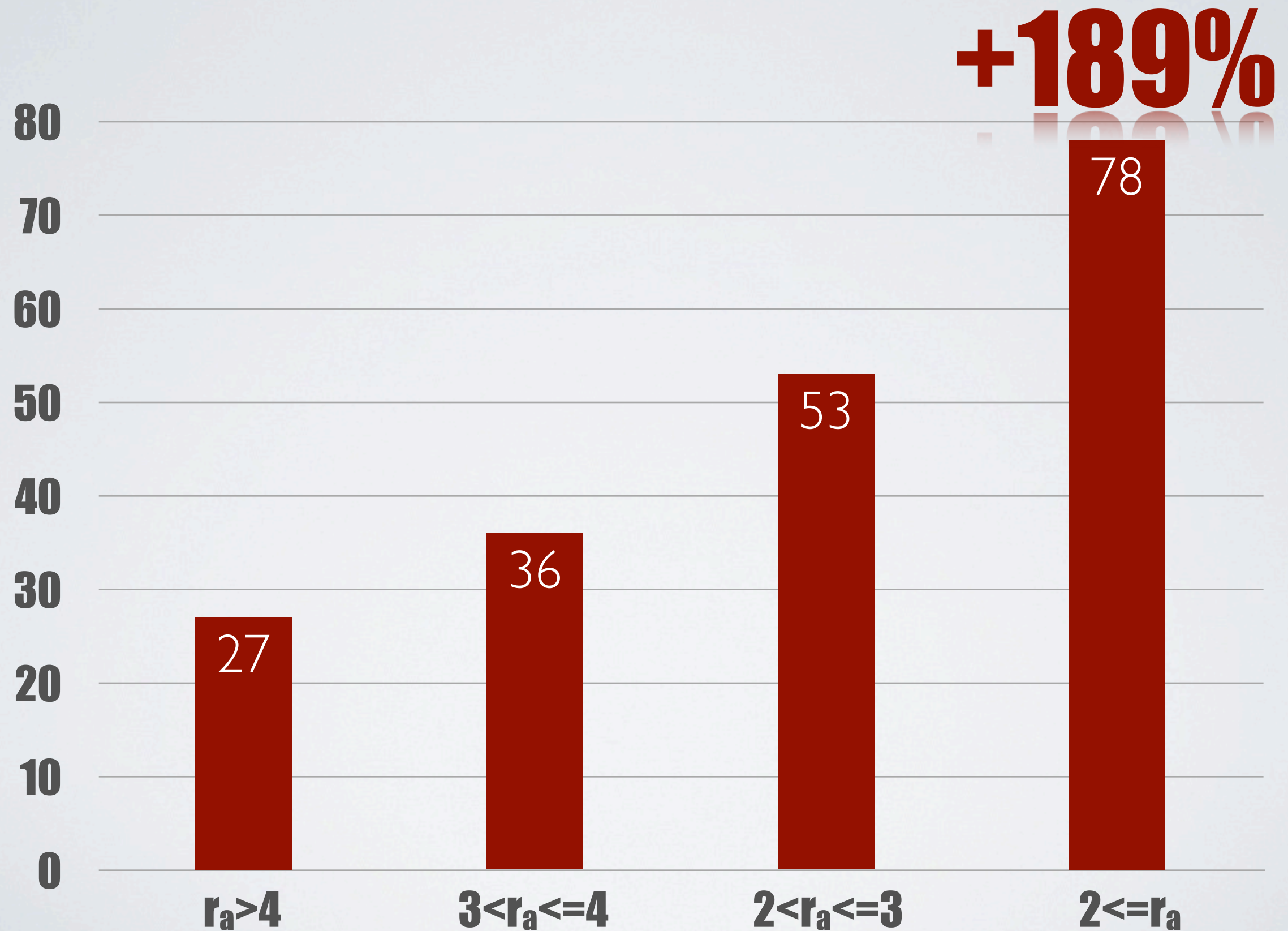


# Avg changes in used APIs





# Avg changes in used APIs



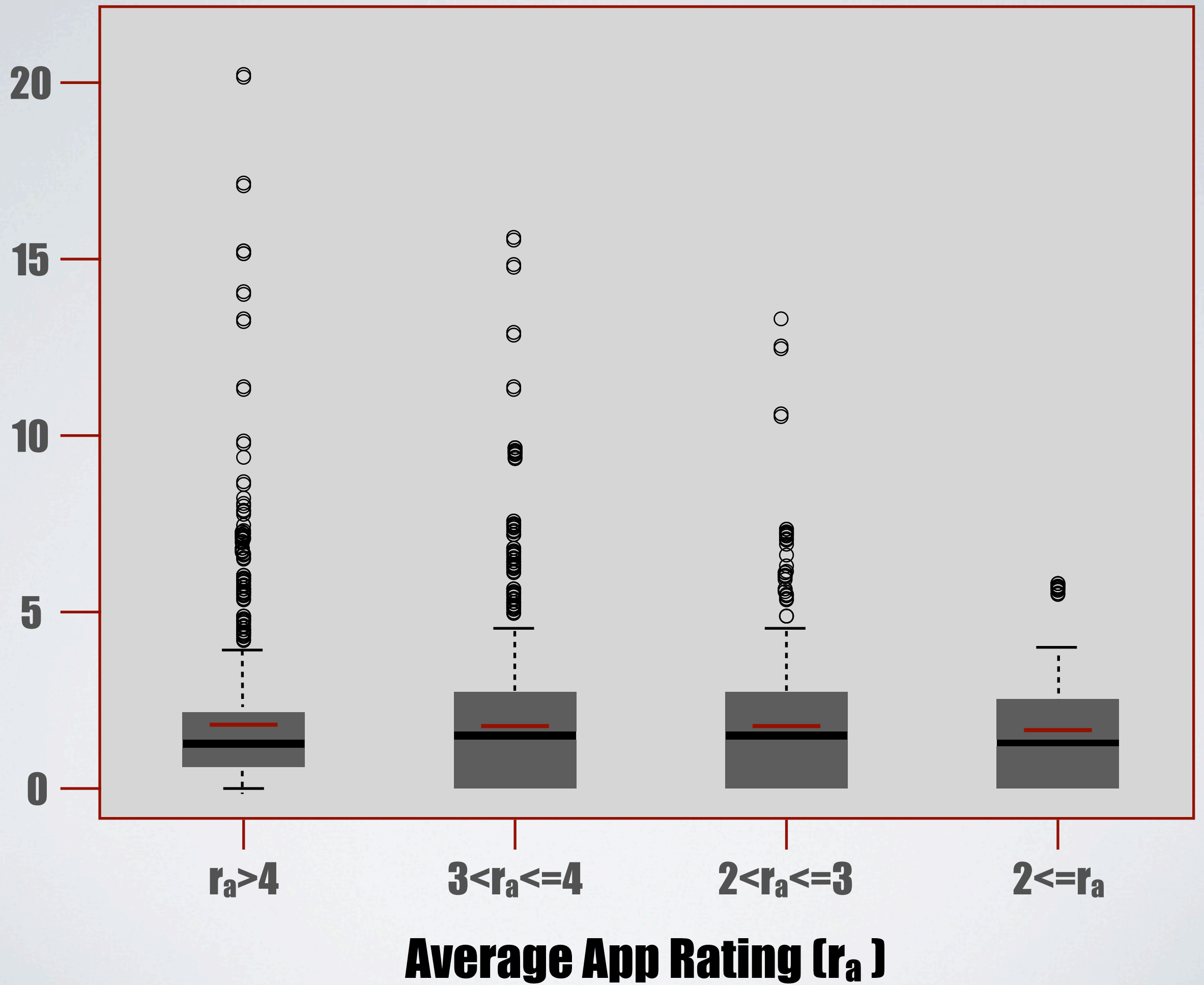
# **50 most successful vs 50 least successful apps**



**50 most successful vs  
50 least successful apps**

**+333%**

**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.**





**Black  
magic?**





# CNN App for Android Tablet

CNN - July 29, 2013

News & Magazines

Install



Add to Wishlist

★★★★★ (1,056)

Top Developer



+591 Recommend this on Google



## CNN App for Android Tablet

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Add to Wishlist

★ ★ ★ ★ ★ (1,056)

Top Developer



+591 Recommend this on Google

---

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





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+591

Recommend this on Google

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

**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**



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

android.speech.tts





# android.speech.tts

15 Classes



# android.speech.tts

15 Classes

460 Method changes



# android.speech.tts

15 Classes

460 Method changes

289 to public methods





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69 bug fixes

A change each 13 days



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More than 200 users  
complained about  
problems related to  
this feature

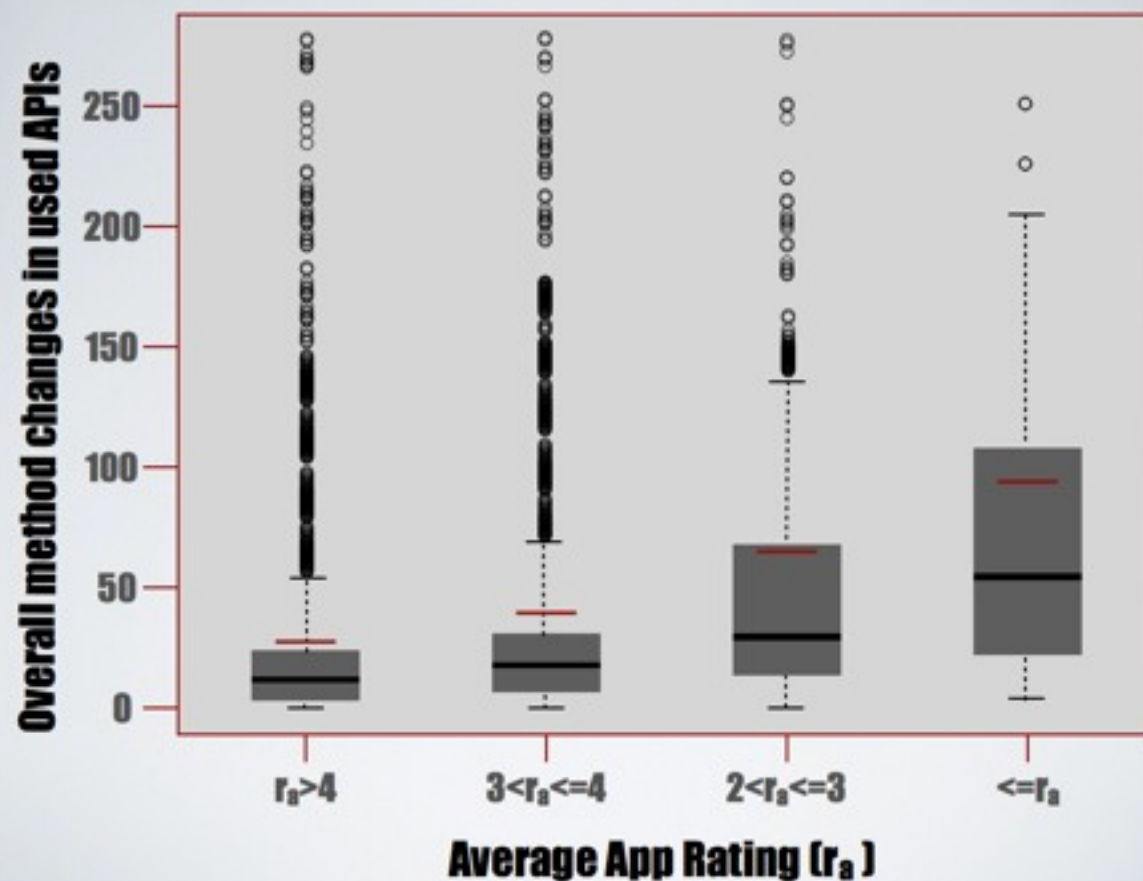
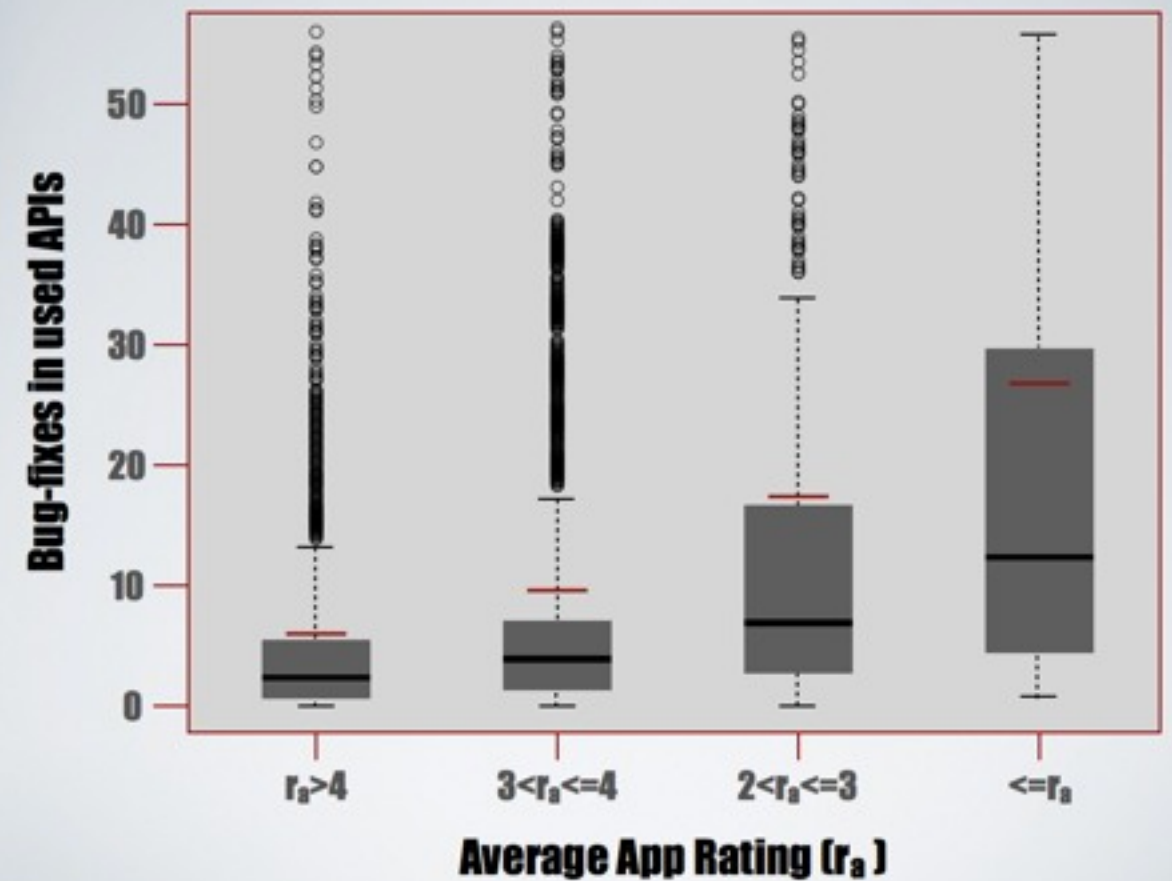


# Conclusion



# 7097

Free Apps  
analyzed



## android.speech.tts

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

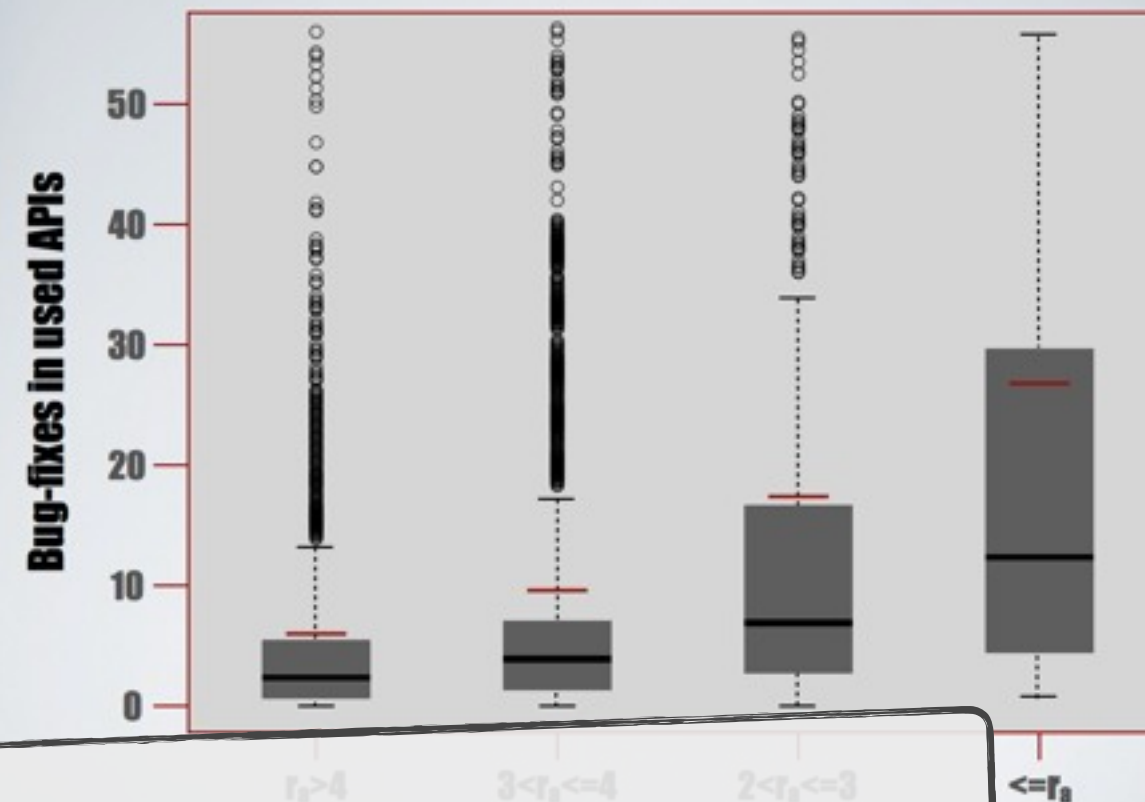


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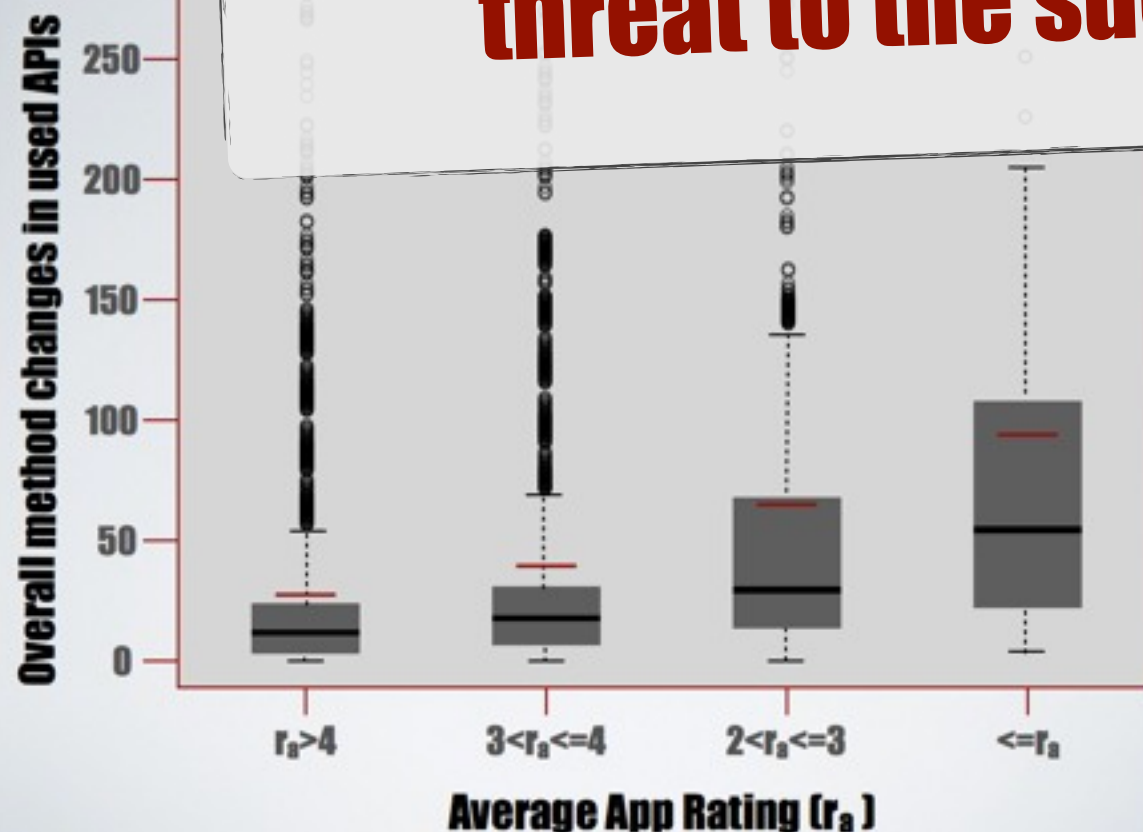


# 7097

Free Apps  
analyzed



**API change and fault proneness represent a threat to the success of Android Apps**





# Long-term Goal





# Long-term Goal

**Create a recommendation system able to alert the developer when some of her choices could negatively impact the success of her App**



# **Thank you!**

## **Questions and / or comments**

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**The College of William and Mary**

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